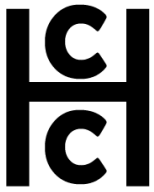

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Report to the Australian Energy Regulator

Murraylink Proposal May 2012: Report on Engineering Issues

Final October 19, 2012

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CHC Report to the AER
Murraylink Proposal May 2012: Selected Engineering Issues

EXECUTIVE SUMMARY

The Australian Energy Regulator (AER) has engaged CHC Associates Pty Ltd (CHC) to provide engineering services in relation to the Murraylink transmission interconnector revenue determination 2014-23.

This report follows consideration of the Proposal documents supplied to CHC and particulars provided progressively in response to a request for further information and after a telephone conference involving the AER, Murraylink and CHC. It should be noted that the information supplied to date by Murraylink following that conference does not satisfy all requests by CHC.

The Terms of Reference, set out in detail below, encompass the areas now summarised. The Report considers:

1. The capex projects set out in the Murraylink proposal as to the appropriateness of the engineering solutions to present and future problems.
2. Previously undertaken expenditure, as to whether it is capex or opex in nature.
3. The asset lives of Murraylink equipment
4. Contingent projects proposed

In carrying out the evaluations CHC had particular regard for:

- Capex business cases
- Asset management principles
- Cost information template
- Cost allocation method
- Explanations provided by Murraylink for certain expenditures

The system operational environment is a significant consideration in the asset maintenance regime.

The binding constraint equation report for Murraylink, AEMO 2011, shows that, with changing patterns of demand and generation and constraints within the supporting networks, it is now less important to maintain the full capability of Murraylink and there is therefore scope for undertaking maintenance and refurbishment activities at times where a reduction in availability can be accepted.

This may not be always the situation in the future, but is not likely to change significantly during the next regulatory period.

This means that plant repair in periods of low utilisation is a viable option for the maintenance of asset performance.

In each aspect of the Murraylink Proposal it is appropriate to consider the underlying principles concerning the term of reference and then to look at the specifics of the Murraylink proposal.

The proposals set out in the Murraylink Asset Management Plan, with further details set out in the Ancillary Data spread sheet of 20/09/2012, provide for some enhancement of Murraylink's functionality, while others aim to maintain the asset at an appropriate level of reliability.

The principles adopted by Murraylink for asset maintenance are not seen as reflecting modern industry practice in that there is an emphasis on replacement of plant due to age or number of operational

hours. The principle should be that action is based on condition assessment and the performance history of the asset.

Specifically with respect to the Asset Management Plan the following observations are made:

Term of Reference 1: Capex Proposal

- Seven of the capex proposals meet the requirements of the Rules- Clause 6A.6.7. In some cases there are concerns regarding the level of expenditure and a more rigorous estimation would seem appropriate.
- A number of the projects, classified "Stay in Business", are considered to be opex.
- The proposal for replacement of the control system seems to warrant closer consideration, with time and experience of maintainability providing greater justification.
- The estimation of some costs does not appear sufficiently rigorous.
- Two projects that included the word "contingent" in their definition have been considered by CHC under this term of reference with the following conclusions:
    - The project for control system enhancement to cater for black starts does not meet the requirement for a prescribed service and should not be allowed.
    - The benefits of a contingent project for the reduction of converter losses are largely undefined and would seem to be marginal; the project should not be allowed.

Term of Reference 2: Capex or Opex

- A capex allowance was not provided for in the original regulatory control period, and the justification for the expenditure that was actually incurred in this period is not clear. Much of this expenditure is considered to be opex in nature**.**
- The opex allowance in the original regulatory control period was based on a notional interconnection option that satisfied the regulatory test. Opex expenditure above this allowance is thus not recoverable. Murraylink has submitted this expenditure as capex, and proposes that this be included in the roll forward model.
- CHC considers that expenditure on spare parts and plant repairs should be treated as opex, resulting in no change to the asset value or life time.
- CHC has not been able to resolve how this matter can be resolved within the current regulatory framework.

Term of Reference 3: Asset lives and classes

- The proposed asset lives seem to be too short and a more rigorous approach is suggested. This should not be in the context of the proposed asset replacement approach which is based essentially on operational hours. It is preferred that the emphasis should be on asset management, which requires inspection, maintenance and repair in accordance with normal industry practice.
- A program of asset replacement (rather than asset repair) should not be an option that is undertaken without extensive consideration of the condition for what seems to be high quality plant.

Term of Reference 4 Contingent Project

- The contingent projects for the duplication of Murraylink should not be allowed, as the responsibilities for the necessary related enhancements in the connected systems appear to fall

on other entities and in respect of duplication of Murraylink, greater capacity could be provided by an AC 220 or 275 kV transmission line at lower cost, so the project could not satisfy an RIT-T.

On the 5th October AER requested by email that CHC provide advice on a number of questions in respect of asset lives. These were considered and a reply forwarded on 11th October . This is attached as Appendix B

On the 18th October CHC was provided with an Asset Management Strategy for Directlink and Murraylink. This document is a high level strategic document and aligns with a number of the recommendations of CHC in this report. However, CHC believes the link between the high level strategy of this document and the specific asset replacement proposals put forward by Murraylink has not been established.

1. TERMS OF REFERENCE

The Australian Energy Regulator (AER) has engaged CHC Associates Pty Ltd (CHC) to provide engineering services in relation to the Murraylink transmission interconnector revenue determination 2014-23.

The terms of reference that are addressed in this Report are:

1. Provide a view, with evidence, about whether Murraylink's May 2012 regulatory proposal (*regulatory proposal*) for the 2014-23 regulatory control period contains a capex forecast that meets the National Electricity Rules criteria set out in clause 6A.6.7
    - Specifically, is the scope of projects for which capital expenditure (capex) has been forecast in the regulatory proposal over-engineered? That is, do any of the projects appear to exhibit a significant degree of excess scope? Assessment should take into account the National Electricity Rules' capex objectives, factors and criteria set out in clause 6A.6.7
    - Are there other alternative projects to those set out in the regulatory proposal that might better meet the requirement of clause 6A.6.7? Are non-network alternative available (and relevant) for an interconnector such as Murraylink?
    - Forecast costs in the regulatory proposal should be tested against other industry sources or available evidence.
2. Assist AER staff understand the regulatory proposal's preferred approach to convert some expenditure which Murraylink has previously undertaken as operating expenditure to capital expenditure, for the 2014-23 regulatory control period. This does not require the consultant to assess accounting definitions of opex or capex, rather make an assessment from a business practice and regulatory perspective.
3. Provide a view and recommendation to AER staff on the appropriate asset lives and asset classes set out in the regulatory proposal. This should be approached from an engineering perceptive and refer to asset lives and asset classes adopted by the AER in other transmission network service providers' final decisions.

In undertaking the above scope of works, have regard to the following Murraylink documents, and any other material AER staff may provide:

    - Capex asset business cases
    - Asset management plan
    - Cost information template
    - Cost allocation method

4. In respect of the proposed contingent project:
    - Is Murraylink's proposal technically feasible? At a high level only, does the forecast capex look consistent with clause 6A.8.1(b)(2)(i)(ii)?
    - Assist AER staff review the proposed triggers (noting some of the triggers are identical to those in Powerlink's 2012-17 final decision) for compliance with clause 6A.8.1(c).

- Provide high level comments on the probability of the contingent project being triggered in the 2014-23 regulatory control period.

2. CHC'S APPROACH

CHC has undertaken the following steps:

- Review characteristics of Murraylink's operating environment
- Review the Proposal and supporting information
- Undertake independent research of selected documented proposals
- Identify issues
- Seek clarification from Murraylink and the AER
- Review industry best practice
- Comment on Proposed expenditure

3. MURRAYLINK'S OPERATING ENVIRONMENT

3.1 Current Revenue Stream

Murraylink's current MAR is derived from the determination by the ACCC at the time of the conversion of Murraylink from a Market Network Service Provider (MNSP) to a Transmission Network Service Provider (TNSP) in 2003.

Murraylink was constructed and configured to provide income as an MNSP. In essence the ACCC determined that Murraylink, as constructed, was not the preferred project when the Regulatory Investment Test was applied to the prescribed service it would provide after conversion - in fact it was ranked fourth of five alternatives. Accordingly the RAB was set to be that of the preferred project (an overhead AC transmission line), and the opex allowance was set to be equal to the efficient cost of maintaining the preferred assets. At the same time a performance incentive was calibrated around maintaining a very high energy transfer capability.

The determination made no allowance for capex in the initial period, reflecting the fact that the RAB had been written down from the book value.

The initial determination placed considerable weight on the ability of Murraylink to achieve its maximum capacity of 220 MW[1] and on achieving high availability.

3.2 Performance in the Current Regulatory Control Period

Murraylink's Operating Costs are substantially fixed, being determined by overheads, insurances, control room etc. It has entered into a contract with a third party to carry out routine and some non-routine maintenance, so creating a predictable environment. The total of the operating expenditure in the current regulatory period is nearly equal to the allowance.

[1] Measured at the sending end - only 200 MW is received because of losses

However this maintenance regime apparently did not cover some unanticipated costs involving repair and/or refurbishment of ancillary equipment that Murraylink has considered to be necessary.

Murraylink has proposed that these works be treated as replacement capex.

A relatively small amount of this expenditure has already been incurred, and more substantial amounts are forecast in the 2012 and 2013 years.

Murraylink proposes to assign lifetimes of 7, 10 or 15 years to different replacement assets.

3.3 Murraylink's Operating Duty

Murraylink's performance target for regulatory purposes is currently set at a high level (roughly consistent with that of an AC transmission network supplying loads and Directlink). This setting was evidently cognisant of the assumptions in the application of the regulatory test, where Murraylink was given credit for providing a transmission service that would postpone the augmentation of the AC system that supplies the Riverland area from the South Australian side, as well as allowing increased optimisation of generation plant location and cost.

The value of Murraylink at the time of conversion was derived principally from the benefits associated with SA importing lower cost energy from the eastern states at high load, and providing an additional path to supply the Berri/ Monash loads. These benefits would not have been realised if Murraylink was unreliable.

In its current Proposal, Murraylink stresses that it has assumed that the same performance target will be imposed in the next regulatory control period and that, to achieve this target, the capex referred to in section 3.3 is essential to "staying in business".

In the years from Murraylink's commissioning until now the generation profile in the network has changed such that now there is a trend developing towards additional export from SA when there is high output from SA wind generators, rather than import capacity being required to offset higher cost SA generation. However Murraylink is frequently unable to transfer power at its nominal capacity - not because it is unreliable, but because the networks that support it have insufficient capacity. This is due to the fact that they are now required to meet higher demands in the regional networks they were originally constructed to supply.

The decline in network capacity has been lessened to an extent by the installation of "run-back" schemes. These monitor critical AC network elements. If they become overloaded a signal is sent that causes Murraylink to reduce its loading to the extent that the network overload is removed. Capex for the last of these schemes (to permit higher loading on some NSW lines) is included in the proposal, and adds to Murraylink's functionality.

Murraylink provided a data file that was generated from operational data for the FY 2011 – 2012 that was provided by AEMO. This comprised dispatch data (MW target and direction of flow) for Murraylink as generated by the dispatch engine NEMDE (105,414 data sets at 5-minute intervals). The data also included:

- Measured MW at the Red Cliffs connection point to the Victorian network
- Calculated Murraylink path MW losses
- Magnitude of Constraint on Import from Victoria, and text describing the cause of this constraint

- Magnitude of Constraint on Export to Victoria, and text describing the cause of this constraint

An analysis of this data, and of further information provided by Murraylink in response to CHC's questions, is included in Appendix A.

This analysis demonstrates that the utilisation of Murraylink was relatively low over the 2011– 2012 FY.

The period of operation at full capacity for export from Victoria to SA via Murraylink was just 28 hours, and for operation within 20 MW of this capacity it was 50 hours.

For export from SA to Victoria via Murraylink there was no operation at full capacity, and just over one hour was spent within 20 MW of this full capability.

Only around 12% of time (105 hours) was spent outside the range of +/- 100 MW, and 70 % of time was spent within +/- 50 MW.

The service that Murraylink provides in deferring augmentation of supply to Berri from SA requires good availability, but not at full capacity.

The important conclusion of the analysis is that the long periods of low transfer occur principally because AEMO's dispatch calculation has determined that a higher transfer over Murraylink is not required. At these low transfer levels network constraints are not often a limitation.

Murraylink's contention that "*It can reasonably be concluded that the full link capacity of 220 MW is regularly being used to provide market benefits"* is not supported by this analysis. Rather it has been shown that the use of the full capacity in either direction is quite rare, and that transfer is most frequently within less than half of the available capacity.

With changed patterns of demand and generation since Murraylink's conversion to a regulated interconnector it is now less important to maintain the full capability of Murraylink.

With developments that have a reasonable probability of occurring in the next regulatory control period CHC considers that actual utilisation of the full capacity will continue to be infrequent, and confined to times when the supporting networks are unconstrained.

Furthermore AEMO will be in a position to predict, during the market predispatch process, times when the full capacity is unlikely to be required, giving Murraylink the opportunity to schedule maintenance activities to jointly optimise critical availability and costs. There is therefore scope for undertaking maintenance activities (that result in a reduction in availability) over longer periods of time.

3.4 Plant Redundancy

Murraylink is a single transmission link. If it fails in service then the power it was transmitting is automatically diverted to other transmission paths. AEMO always operates the network so that any such single failure can be managed without any immediate impact on supply.

Murraylink uses a single cable pair. It has one set of transistor valves at each end terminal and one set of transformers at each end. In other words it does not incorporate redundancy in its primary equipment.

However each transistor valve assembly is made up of many components, and incorporates some redundancy in its IGBT[2] modules, so that failure of more than one module must occur before it must be

[2] IGBT's (Insulated-gate bipolar transistor) power electronic valve arrays convert between alternating current and direct current at the Murraylink terminals.

shut down. Also there is a spare AC transformer phase unit on each site, so that if one of the three in-service phases fails it can be replaced very quickly (e.g. within days).

Murraylink has advised that the following ancillary items are the most critical:

- Air conditioning/chilling systems in summer (for which corrective action to increase redundancy is proposed)
- Transformer Cooling fans in summer
- Split system air conditioners in some areas of the plant in summer e.g. communications room.
- Fire detection and extinguisher systems at all times
- Capacitor units in filters at all times

Murraylink also advised that, in the case of the cooling water systems for the valves and phase reactors, the critical parts generally have redundancy. A failure of one item of plant will result in an alarm condition and the control system will initiate a change to the standby plant. The protection systems will operate if the changeover to the standby does not occur smoothly, though this is rare.

The loading of Murraylink is the critical factor because the losses that create heat are approximately proportional to the square of the power transfer. The failure of a pump with the above amount of redundancy will leave Murraylink vulnerable to forced outage if the replacement also fails, at times when Murraylink is heavily loaded and/or the ambient temperature is very high. However the probability of this combination occurring is low and it will often be possible for Murraylink to remain in service at reduced loading.

Having regard for the reduced operating duty CHC considers that there should be scope for dealing with ancillary plant failures as urgent and major maintenance as they occur, instead of anticipating potential failures and replacing all plant as currently proposed.

4. TERM OF REFERENCE 1: CAPEX PROPOSAL

4.1 Good Industry Practice in Strategic Asset Management

The general discussion that follows seeks to place in context the specific comments that follow with regard to the Murraylink capex project proposals.

Asset management has developed quite significantly over recent years, as scientific analysis has sought to improve asset performance and reliability, while at the same time reducing costs. This has occurred in industries as diverse as those of electric power and aviation.

In the power industry, the CIGRÉ [3] organisation has devoted significant emphasis to asset management and condition monitoring techniques on a wide range of equipment.

In its most formal structure, this has developed into Reliability Centred Maintenance (RCM), covered by a technical standard. However there are many lesser forms of such a process, which still have essential features of the discipline. Significant features are:

- that the vast majority of failures are not necessarily related to age or number of operations;

[3] CIGRÉ is the Conseil International des Grands Réseaux électriques (In English: The International Council on Large Electric Systems) It is a prestigious world organization in the field of high voltage electricity. The scope of its activities includes the technical and economic aspects of the electrical grid.

- a program of condition monitoring is in place; and
- procedures to handle failures are rigorous, and include consideration of the adequacy of the original purchase specification .

The adoption of such principles has been widespread in the power industry, given the high value of the assets, the pressure for performance in the electricity market and the challenging environment that exists for power station assets in particular.

The adoption of a programmed replacement strategy for asset components as a prime activity (as proposed by Murraylink) is not in accord with such practice. Rather, modern strategy is directed to condition monitoring.

The general application to assets is suggested as follows:

1. The life of the component assets should be commensurate with the life of the parent asset, normally not less than 25 years for components of the power system.
2. The specification of equipment should be specific and rigorous so that, for example, motor bearings can, with normal maintenance, be expected to perform over the full life of the asset.
3. A program of asset maintenance is developed, reflecting manufacturer input, industry technology and condition monitoring programs.
4. The occurrence of equipment faults requires that the reasons for the failures be determined and performance statistics be analysed. Defective components may need to be replaced by more suitable designs.

In reference to the Murraylink equipment the following is noted:

- The equipment was supplied by a leading manufacturer for the power industry;
- The life of the link was predicted to be 40 years; and
- The environmental and operational duties are not excessively onerous when compared, for instance, to that of a thermal power station.

Strategic management of assets involves the following elements:

- An initial determination of a necessary regime to establish the continuing condition of the particular asset. For a new group or basket of assets this may involve all or some of the following steps:
    - The recommendations of manufacturers for particular asset classes or the particular plant items involved
    - Consideration of industry best practice
    - The availability of test and assessment techniques
    - Assessment of the consequences of failures.
- This will result in the formulation of a Strategic Asset Management Plan and an initial Asset Management Plan for a nominated period.
- A process for recording the outcomes of maintenance actions, defects and test results
- Critical review of the outcomes from applying the initial Asset Management Plan
- Outcomes will cause the strategic asset management to be modified and cause the periodic program to be reformulated.

CHC's Assessment of Murraylink's Strategic Management Framework

CHC requested evidence that Murraylink has implemented practices along the lines described above.

Murraylink provided, for perusal, copies of the Major Plant Supplier's consolidated "Maintenance Instruction" and a set of "Work Instructions" for the many items of plant that together form the total asset.

The Maintenance Manual included a tabulation of "time between maintenance" and suggestions of the skills, resources and time required.

The Work Instructions gave details of the required work, and provided for reporting on the maintenance outcomes.

CHC was not shown any evidence that the process had progressed beyond this point, despite the fact that levels of asset refurbishment and replacement have been undertaken, and are planned, that fall well beyond what is described in the Maintenance Instructions. As noted in the Executive Summary, CHC was forwarded on 18th October a copy of the APA Asset Management Strategy for Murraylink and Directlink. This document appears to provide a good high level overview of maintenance strategy, but at this time is not fully reflected in the current proposals; the following comments are believed pertinent.

The Asset Management Plan appears to not address major maintenance issues, but concentrates on capital expenditures.

It is considered that that an effective Asset Management Plan should integrate normal scheduled maintenance with decisions about the need for major unscheduled refurbishment or replacement.

For instance:

A finding that plant has deteriorated to the extent that unscheduled refurbishment or replacement need to be considered should lead to a formal, documented review, in the first instance, about the adequacy and efficacy of the regular maintenance activities and schedule.

A finding that all motors, pumps or fans of a particular type need to be refurbished to the same extent should lead to investigations into the presence of a "type fault". If this is found to exist the solution could be to replace faulty items with items that do not have this fault, so that the same problem would not occur at all or at least only at a longer interval.

The following is a quote from the introduction to the supplier's Maintenance Instruction

> *"Required Scheduled Maintenance (RSM)*
>
> *There are very few apparatus that require scheduled maintenance activities. Some of these activities can be performed with the equipment energized (or in operation).*
>
> *Most of the apparatus in the HVDC Light station require no scheduled maintenance (nearly free of maintenance). It means that the time between maintenance is a recommendation and this interval in most of the cases could be longer."*

With this expectation for trouble-free operation it is surprising that a finding that ancillary plant apparently has a shorter life expectancy than the plant as a whole should not be arrived at without extensive questioning and documented enquiry.

4.2 Failure Statistics

The expectation for rates of failure in engineering systems and other products is often illustrated by the generic graph shown in Figure 4.1 below[4].

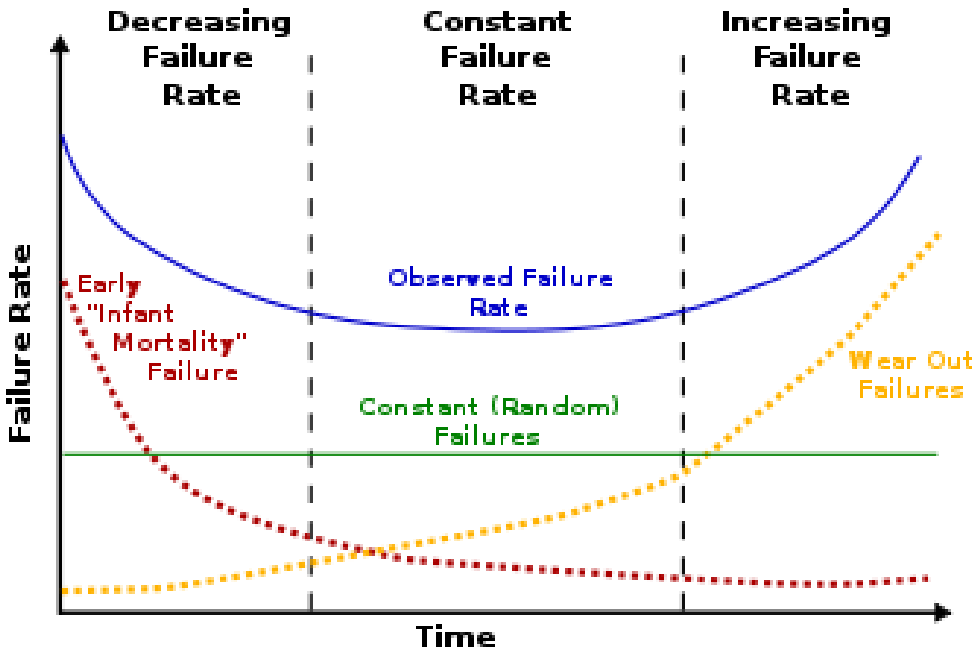

Figure 4.1: Generic representation of the relative importance of three types of equipment failure over the lifetime of an engineering plant.

The total observed failure rate, shown in blue and sometimes referred to as the "bathtub" curve, is the combined result of three causes of failure that are distinctly different. These are

1. The red curve illustrates early infant mortality failures, such as those due, for instance, to insufficient testing of the components of the plant, their assembly, or poor selection of components for the equipment. By definition these should reduce to zero after a short time. With mature technologies being used in normal environments this mode of failure could be negligible.
2. The green curve is a constant failure rate characterised by random failures of components. In mid-life all failures could be due to this cause.
3. The orange curve represents age-related wear out of components, which may be hard to detect, but among a significant population of components would become evident over time. There is discussion in the literature that this form of failure can be significantly delayed by appropriate maintenance (i.e. by repair of failed components). Failing this it might require extensive refurbishment or replacement.

[4] This is copied from Wikipedia where the source was not referenced. Similar graphs are available in many references and it is not possible to identify an originator.

Applying this theory to Murraylink's experience, it is probable that the early failures of the Liquid Chiller units and the Split System Air Conditioners were due to their unsuitability for the operating environment. Simply replacing this plant using similar unsuitable items without addressing this fundamental issue would not solve the problem. The installation of different replacement items is therefore supported as a once-off capital cost.

Murraylink has presented no convincing evidence that the remaining ancillary failures are due to some generic type fault and are not normal random failures, and that carrying out maintenance repairs as and when required will not be sufficient to maintain reliable operation. There is no evidence presented that this plant is in the wear-out phase, requiring the total replacement strategy that has been proposed.

CHC therefore considers that the activities already carried out to address failures should be treated as normal maintenance repairs, and is therefore essentially opex, rather than capex.

4.3 Overview of Murraylink's Capex Proposal Documentation

Documentation regarding capex is covered in the following areas of the Proposal:

- Section 4.2 Historic Capital Expenditure.

  Table 4.1 in this section summarises the capital expenditure over the current regulatory period. The total expenditure was about $2.226M compared with a capex allowance of zero. Only general comments were made in justification of this expenditure

- Section 2.4 A Maturing Asset Base.

  This contends that major plant elements and ancillary equipment have differing lives and in the latter case are approaching the nominated 7-20 year asset life.

- Chapter 7 Forecast capital expenditure.

  This sets out the principles involved in the capex submission together with a discussion of six of the major expenditure proposals. Some of the issues raised include:

  - The capital expenditure is not growth related
  - The projects identified can be categorised as one of the following
    - Refurbishment
    - Compliance
    - Augmentation of Capability, involving contingent projects

- Section 7.3 sets out capital expenditure objectives.

  The Stay in Business concept is implied in this outline, in reference to maintaining full capacity of the link and maintaining reliability, safety and security of the transmission system. This is a matter for further consideration, as to where the delineation occurs between opex and capex.

- Appendix 7.1 - Murraylink Asset Management Plan.

  This outlines firstly the various regulatory and other performance requirements as well as principles adopted. As set out below the planned capital works projects (19) are listed with brief commentaries. It is noted that the term "Stay in Business" is introduced.

  Also set out are four projects considered opportunities to grow the asset base.

- Appendix 7.2 – Capex asset business cases

  Business cases are provided for a number of the projects.

- Appendix 7.3 Proposed contingent project

  This project results from a study involving works in South Australia and Victoria to strengthen networks which are associated with Murraylink, providing an opportunity for Murraylink capacity to be doubled.

- Cost Information

  The information for the years 2016 t0 2023 is set out in a spread sheet; this provides for a continuation of the program set out in the AMP.

  These items are all referred to as “stay in business”.

- Ancillary data
  This spread sheet data sets out all the details of the various plant items, and including some information on plant failures.

There are some discrepancies between the documents supplied. For example the costs quoted in some Business cases apparently included a margin on the cost in Table 6 of the Asset Management Plan. There are also discrepancies between Table 6 and Resubmission v04 –Murraylink Cost Information v04. The discussion below has been in accordance with the latter. However the principles are unchanged.

4.4 Historic Capex

In Table 4.1 of the Proposal the amounts of historic capital expenditure are set out, encompassing the years 2004 -2013. Murraylink did not have a capex allowance in this period but incurred some expenditure that it has classified as capex from fiscal years 2008 onwards. Estimated expenditure for 2012 and 2013 are $0.64M and $1.118M respectively.

Some of the expenditure in these two years is referred to in the Asset Management Plan, as shown in Table 4.1, which is an extract from a Table covering the fiscal years 2012 to 2017. The item numbers in the first column are those used in the original Table.

The Asset Management Plan does not cover expenditure before FY 2012, and does not include all historic capex in FY 2012 and 2013 as detailed later in this section.

NOTE – some values in table 4.1 have been redacted.

Item	Description	2012 $K	2013 $K
2.	**Reprogram runback control logic**	61	0
4.	**Capacitor can spares replacement**		
6.	**SF6 Pressure gauge**	3	0
7.	**Optic Fibre test equipment**	4	0
8.	**Switchyard Barrier Fences**	9	0
9.	**Critical spares**	35	44
10.	**Replace fire alarm Vesda chassis**	0	32
11.	**Fire system pressure vessel testing**	0	132
12.	**Chilled water piping lagging**	0	20
13.	**Refurbish rotating ancillary equipment**		
Totals			

Table 4.1 Historic Capex items described in the Asset Management plan - and amended in Murraylink Cost information v04- resubmission

4.4,1 Minor Historic Capex

Expenditure on the following items in Table 4.1 is relatively small, and appears to be in accordance with the Capex Objectives:

- **Item 2: Reprogram Runback Control System Logic**

This project changed the Murraylink runback scheme to allow for operator override. This is seen as appropriate and, as an enhancement, it adds operational flexibility to Murraylink and value to the market. It is therefore capex in nature.

- **Item 8: Switchyard Barrier Fences**

Barrier fences within switchyards assist safe working. This is appropriate capex.

Expenditure on the following items in Table 4.1 appears to not fall within the definition of capex in the APA Group Accounting Policy[5], and arguably should have been classed as opex. This is not a comment on the necessity or efficiency of the expenditure.

- **Item 4: Capacitor Can Spares Replacement**

It is proposed that spare capacitor cans be purchased, to provide for failures among the 300 units that are part of the harmonic filters. The rate of failure was noted in the Ancillary Data sheet supplied but an explanation to justify particular levels of spares acquisition was not provided.

It is normal practice to purchase spare units on the original plant supply and construction contract. Purchase of further units is dependent upon service experience and obtained from time to time as opex.

[5] Refer to Chapter 5 of this Report for an outline of this Policy

If service proves that service failures are inordinately high and the bank needs rebuilding then this is capex. See Item 9 below.

- **Item 6: Pressure Gauge**

The pressure gauge is a small expense, but there is no supporting information. Purchase of test equipment is justified. It could be included as capex.

- **Item 7: Optic Fibre Test Equipment**

This is similar in nature to item 6 above. It is believed justified.

- **Item 9: Critical Spares.**

The need for such spares is not in dispute but there is no indication of the nature of the spares or the basis for the proposed level of expenditure. The initial supply of major equipment would normally include provision for component spares to be supplied within the contract. This is then included in the original asset base amount.

Subsequent needs are met from time to time after assessment and are opex in nature. If it is necessary to carry out extensive remedial work, beyond routine then a capex project is appropriate**.**

- **Item 10: Replace Fire Alarm Vesda chassis**

There is no justification presented, other than that there have been periodic failures. This is understood to be an essential component of the fire detection scheme, and reliability is paramount. However it does seem a little unusual for such failures to occur and that a better engineering solution would seem appropriate to lessen the possibility of future defects.

The problem is operational in nature. It is noted that Murraylink must be shut down if this equipment is unavailable.

As a maintenance activity it would be opex and a justifiable expense.

- **Item 11: Fire System pressure vessel testing**

This expenditure is likely to be justifiable, but no details are provided. There are statutory requirements for such testing. The cost seems very high.

- **Item 12: Chilled water piping lagging.**

This is a small expense and justified as a maintenance activity. It should not need complete replacement, It is opex in nature.

- **Item 13: Refurbish Rotating Ancillary Equipment**

This is discussed in the following section 4.4.2, because of the size of the expenditure.

4.4.2 Major Historic Capex

The major items of historic capex over the current regulatory period are:

- Gateway Project (Category: Replacement): $0.398M in 2008 (prior to AMP)
- Refurbish rotating ancillary equipment (category: Replacement) $0.56M in 2012 and 2013
- Regulatory Review (Category : Other) $0.654 in 2012 and 2013

Gateway Project

No explanation was offered in the proposal documentation for the Gateway Project so CHC sought additional information. It was advised that this comprised work to allow remote operation of Murraylink

by ElectraNet. This is considered justifiable, and the expenditure is appropriate. No explanation was offered for classifying this as "replacement". It appears to be a new installation.

Refurbish Rotary Ancillary Equipment

CHC sought an explanation for the need for this expenditure from Murraylink. It was noted that the Maintenance Instructions for these items indicated that only normal regular inspections and minor maintenance would be required and there was no reason to believe that replacement would be required.

On the basis of industry experience of comparable plant CHC would need more evidence from Murraylink that the scope of works undertaken is not excessive. We consider it unlikely that the same treatment would need to be applied to all this plant. We further consider that with adequate maintenance replacement so early in the life of the plant would be unlikely, and that a longer life should be applied to any replacements. We also have doubts about the accounting for this work. The APA Accounting Policy requires replaced plant to be de-recognised in the accounts. We cannot see where this has been done in the spread sheets.

This type of expenditure is further discussed under the heading of Proposed Capex.

Regulatory Review

CHC understands that expenses incurred for Regulatory Reviews are normally treated as opex. Inclusion of the costs as capex appears to be contrary to the APA Group Accounting Policy for Property, Plant and Equipment.

4.5 Proposed Capex for Asset Base Enhancement and Refurbishment

Information about Murraylink's proposed Capex is scattered. Basic information about most projects in the period FY 2014 to 2016 is presented in the Asset Management Plan, and more detailed Business Cases for some of these are collated in a separate document.

Some of the projects in the AMP continue or are repeated in subsequent years but justification for this continuation is not separately presented.

CHC's assessment of the Proposed Capex follows and is based on the documentation available.

4.5.1 Murraylink's Proposal for the period FY 2014-2016

Table 4.2 is an extract from a table in Murraylink's Asset Management Plan under the heading of "Planned Capital Works"; this extract includes only those projects with expenditure in the period FY 2013 to 2016, thus covering the first 3 years of the next regulatory period (Planned capex).

The Asset Management Plan gives no information about the substantial amounts of expenditure proposed from 2016/17 to the end of the next regulatory period.

Business Cases were presented in a separate document for six of the projects in table 4.2. Business cases have also been provided for two projects that are proposed for beyond the time period covered by the Table.

It has been noted that there are some discrepancies in the costs quoted in this table, and those in the spread sheets, and also between the costs in the table and in the Business cases, where these have been provided. These will be noted as they are discussed.

In addition there are two projects presented as "opportunities for growth capital" (sic).

NOTE – some values in table 4.2 have been redacted.

Item	Description	2014 $k	2015 $k	2016 $k
1.	**Install fixed earth switches**	0	297	601
3.	**IGBT replacement**	84	84	84
5.	**Perimeter safety fence enhancement**	845	0	0
9.	**Critical Spares**			
13.	**Refurbish rotating ancillary equipment**			
15.	**Install additional control room cooling**	0	496	0
16	**Berri water tank and plumbing**	7	0	0
17.	**Control system end of life replacement**	0	767*	0
18	**Probable relocation of cables**	0	16	15
19	**Building ventilation changes**	0	209	0
Totals				

- See discussion below on value and timing

Table 4.2 Proposed Capex Projects included in the Asset Management Plan and amended in Murraylink Cost information v04- resubmission

The proposals may be divided into the following categories:

Businesses cases for "stay in business" projects

Replacement of individual plant components

Growth capital opportunities

Each of these areas is discussed in turn. Item numbers are in accordance with table 4.2.

4.5.2 Business Cases for "Stay in Business" Projects

These projects are characterised by proposed enhancements to the existing asset base. It is considered that this expenditure is in accordance the Capital Expenditure Objectives in clause 6A.6.7 (a) of the Rules, as they assist in the maintenance of reliability of prescribed transmission services.

Comments are as follows for each project:

- **Item 1: Transformer earth switches at Berri and Red Cliffs**

This is essential work to meet industry standards from an OH&S perspective, and there are no issues other than a cost discrepancy ($900,000 in Business case, $898,000 in the Table and Spread Sheets).

The capex project will add to substation asset value.

- **Item 5: Security Fence Replacement**

This is essential work, as it is now standard practice to surround electricity transmission assets with a substantial fence that provides security for the assets and safety for the public. CHC has verified that the

cost per meter for the type of fence proposed and the length are reasonable. There is a cost discrepancy in the documentation ($812,000 in Business Case, $845,000 in the Table and Spread Sheets).

- **Item 15: Air Conditioning Redundancy**

It is understood that an 80 kW chiller was installed to supplement an original 40 kW chiller that was found to be inadequate in summer. The 80kW chiller is adequate for all conditions but in the eventuality of its failure, the 40kW unit is not able to meet summer ambient conditions. The proposal is to install an additional 40kW unit, thus providing a firm 80kW. There is a cost discrepancy for this item ($500,000 in Business Case, $496,000 in Table and Spread Sheet).

Given that all the critical ancillary plant has a similar level of redundancy this expenditure is considered to be prudent and reasonable.

- **Item 16: Berri water tank, pump and reticulation ($7,000),**

This is minor expenditure to overcome the lack of a high pressure reticulated supply to remove dust.

It is an appropriate project given the location of the terminal.

- **Item 18: Contingent Cable relocation $78,000 x 2 by annual payments)**

Murraylink has advised that this is not a "Contingent Project" as defined in the Rules, but a project that is contingent upon a need arising to relocate cables that are laid on the verge of roads. The expenditure pattern indicates that it is anticipated that there could be two such requests to move the cable during the regulatory control period. Cable relocation was costed in the capex program as an annual amount based on 2/20 of the likely expenditure of 2*$78K, or $15.6k per annum for each year of the regulatory period.

Murraylink advised that it had carried out one cable relocation in the first 10 years under circumstances where the cost was reimbursable. It claims that a similar request from the road authorities would not be reimbursed. In the Asset Maintenance Plan it is stated that the cables have non-exclusive rights to occupy road reserves under statutes in Victoria and South Australia. This is further expanded in the Business Case, stating that "Murraylink is required by the terms of its tenancy agreements with road authorities to relocate the cable if so requested."

Having regard for the nature of the country traversed by the cable CHC considers it improbable that there would be a frequent demand for road realignment, and that an allowance for two events in the next 10 years would be adequate. It is therefore considered that the proposed allowance should be agreed.

- **Item 19: Positive pressure ventilation ($209,000)**

This appears to be capex to correct a design fault, and there are no issues.

This will add to substation asset value.

4.5.3 Item not in AMP but with a Business Case

A business case is presented for one project that is not included in the AMP, namely:

- **Control system enhancements – NSW Runback ($256,000 2013-14 + $68,000 annually)**

This is understood to be a capital contribution payable to TransGrid for work it has undertaken to implement a run-back scheme that will enhance Murraylink's capacity. TransGrid's 2012 APR refers to Murraylink's intention to pay for these works.

The work would result in the capacity of Murraylink being enhanced for transfers from Victoria to South Australia coincident with high transfer from NSW to Victoria. AEMO has advised in its interconnector report that the availability of this scheme has a value of $481K per annum, and so it is well justified.

The above costs should be allocated to capex and opex respectively.

4.5.4 Projects for Plant Refurbishment over FY 2014 to 2023

- **Item 3: IGBT Replacement**

This is a proposal to purchase additional Insulated Gate Bipolar Transistors (IGBT) to provide for future failures. Present stocks, given existing faulty units, will last for about two years. It is prudent to have a provision for progressive purchases.

Restocking is a routine opex activity and should not be a function of capex and its attendant approval procedures.

- **Item 9: Critical Spares. ($95,000 over 3 years and continuing in subsequent years with escalation).**

The comments made for historic capex apply to this proposed capex. The need for such spares is not in dispute but there is no indication of the basis for the proposed level of expenditure.

It is considered that the expenditure should be opex as, according to the APA Group Accounting Policy for Property, Plant and Equipment spares are not recognised as capex until they are installed, and at that time the replaced items are de-recognised as capital.

- **Item 13 Ancillary Equipment Refurbishment**

A large part of the capex proposal relates to Murraylink's ancillary equipment, such as the electric motors, the pumps and the fans that are required for cooling systems. Murraylink stated that:

> "The motors and contactors associated with valve cooling systems, reactor cooling systems and cooling towers have a service life much shorter than the primary equipment. This equipment has been in service for a decade and the refurbishment of several items is planned to ensure the continued reliable operation of the link."

The items in Table 4.3 (below) are extracted from the Spreadsheet "Cost Information Template" Sheet [SIB Capex]. The expenditure profile spans both the historic and proposed capex.

This Table also shows the asset life that Murraylink proposes to apply to these replaced plant items.

With the exception of items with ID SIB001 to SIB013 all other plant items that have been assigned a life of 10 years or less have already had one replacement that has been entered as Historic Capex.

The items covered in Table 4.3 are substantially those covered in CHC's Supplementary Report, forwarded on 11th October 2012, with the following considerations now restated:

It is noted that the Murraylink proposal centres on giving a prescribed life to certain assets, probably because of a preference for replacement of these assets at defined intervals which then can be argued as capex.

There are assets which can be expected to be replaced on a time basis, where it can be established that there is a wearing out process, with time or numbers of operations. However, in the power industry

generally the approach has been to monitor, test and review before deciding on an estimated cyclical replacement program. If problems become evident then decisions need to be made with respect to increased surveillance, replacement of elements causing lack of performance or total replacement. If total replacement is necessary in an early time frame then a better designed replacement may be appropriate, rather than replace like with like.

In commenting on the items requested, CHC has not had an opportunity, at this time, to review the specification and suitability of the assets, but CHC derives some significant confidence from the fact that the manufacturer is a major international supplier of power system equipment. CHC would find it difficult to believe that components supplied for a project with a 40 year life would need comparatively frequent replacement as proposed.

Many years' observance and experience of asset management in power stations and similar plant has supported CHC in arriving at this conclusion..

Reference should also be made to the discussions in Sections 4.1 and 4.2 above.

It is understood that the items in this set that were not included in the Historic Capex might have been dealt with under the plant warranty.

Murraylink intends that all the items in this list will be replaced within the next regulatory period, so that all items with a life of 10 years or less, except those identified above, will have at least two replacements during the time of this proposal (historic plus proposed), and those with a life of 5 years have three.

Based on industry experience the scope of the proposed work appears to be excessive.

It is most unexpected that industrial-grade plant of this nature, supplied by a reputable manufacturer (ABB and other Swedish specialists) should be anticipated to have such short lives. Similar plant in, say, a power station would stay in service with regular inspections and infrequent overhauls for many more years.

It would be normal and expected that such plant items would be inspected and, if required, refurbished. There would be a requirement to carry a minimal number of spare units, because refurbishment can require workshop services and is time-consuming.

The Maintenance Instructions prepared by the manufacturer appear to be in accordance with this practice, and would be expected to identify items of ancillary plant that have begun to operate abnormally. It would be unexpected that all plant of a particular type would be so identified, requiring all to be refurbished at the same time.

CHC posed a series of questions to Murraylink to explore the rationale for this approach and to judge its efficiency. The information was supplied was insufficient to draw any conclusion other than that proposed expenditure was not appropriate in its current form.

ID	SYSTEM	PLANT	ITEM	LIFE (Years)	COST /ITEM	# of ITEMS	TOTAL COST
SIB001	Ventilation	Room Fans	Electric Motor	10	$3,000	40	$120,000
SIB002		Building Fans	Electric Motor	10	$6,000	10	$60,000
SIB003		Fan Coils	Fan Motor	7	$4,000	40	$160,000
SIB004			Corrosion	15	$8,000	40	$320,000
SIB005	Chilled Water	Liquid Chiller 1	Pump	7	$7,000	2	$14,000
SIB006			Compressor	15	$10,000	2	$20,000

SIB007			Fan motor	7	$4,000	2	$8,000
SIB008		Liquid Chiller 2	Pump	7	$7,000	2	$14,000
SIB009			Compressor	15	$10,000	2	$20,000
SIB010			Fan motor	7	$4,000	2	$8,000
SIB011		Piping	Corrosion	15	$50,000	2	$100,000
SIB012			Valves	15	$2,000	60	$120,000
SIB013			Lagging	10	$10,000	2	$20,000
SIB015		Expansion Vessel	Corrosion	8	$5,000	2	$10,000
SIB016	Fire Protection	Fire System Test	Pressure Vessel	10	$65,000	2	130000
SIB017		VESDA Scanner	Chassis	10	$8,000	4	$32,000
SIB018	Capacitors	Capacitors	Failed Units	5	$8,000	4	$32,000
SIB019	Valve	Cooling System	Pump	7	$10,000	4	$40,000
SIB020			Electric Motor	9	$5,000	4	$20,000
SIB021			Blocking Valve	15	$7,000	4	$28,000
SIB022			Prop Valve Motor	15	$7,000	4	$28,000
SIB023			Insp Press Vessel	7	$6,000	2	$12,000
SIB024			Motor Contactors	10	$800	4	$3,200
SIB025	Reactor	Cooling System	Pump	7	$10,000	4	$40,000
SIB026			Electric Motor	9	$5,000	4	$20,000
SIB027			Blocking Valve	15	$7,000	4	$28,000
SIB028			Prop Valve Motor	15	$7,000	2	$14,000
SIB029			Insp Press Vessel	7	$6,000	2	$12,000
SIB030			Motor Contactors	10	$500	4	$2,000
SIB031	Cooling	Cooling Tower	Electric Motor	10	$8,000	106	$848,000
SIB032			Motor Contactors	10	$400	106	$42,400
SIB033	Transformer	Cooling	Cooling Fan motors	15	$7,000	12	$84,000
SIB034			Motor Contactors	10	$400	2	$800
SIB037	IT	Work Stations	Software	10	$5,000	6	$30,000
SIB038	Valve Control	Control System	Industrial Computers	15	$382,500	2	$765,000
Cap012	AC Area	SF6 System	Pressure gauge	7	$3,000	1	$3,000
Cap013		Switchyard	Barrier fences	15	$9,000	1	$9,000

Table 4.3 Ancillary Plant proposed for refurbishment with shorter lives

The following specific comments are made:

- Electric motors should have a life to last for the project, 40 years
- Corrosion, of coils etc should not cause a problem with properly treated water
- Pumps should last the life of the project
- Compressor life should extend to the life of the project with appropriate maintenance
- Corrosion of piping should not be an issue, with appropriate water oversight.
- Valves should not require replacement
- Lagging may require attention at some stage. This is normally a low level maintenance activity.
- Pressure vessels are controlled by statute, which will set out the regime for inspection. It would be unusual if a pressure vessel needed to be replaced.

- The Vesda fire protection scanner should not need to be replaced, The action already taken is presumed to be a one-off circumstance
- Motor contactors should last the duration of the project
- The life of the work station software is dependent upon support and the need to make changes efficiently. The suggested 10 years is reasonable

In all cases there will be a need for routine maintenance involving the use of spare components but not requiring total change of the item. The accounting treatment of these spare items may often be opex but this is a matter for accounting practice.

- **Item 16. Control system end of life replacement $767,000 (AMP shows $2,208,000)**

The rationale for this project is stated by Murraylink to be:

"The Murraylink control system consists of a variety of computerised components and software. As the components and software age, it becomes more expensive to support and maintain the system. The proposed solution is to replace the control system components".

It appears reasonable that there would be a need to undertake this strategy at some time during the life of the plant. On past experience the high-tech computer-based equipment is likely to be superseded and unmaintainable at some stage depending upon the technology and the strength of support from the original manufacturer. It would be expected that the original supplier would give a reasonable period of notice of a decision to no longer support the control system, either with replacement cards or components or to provide support for software issues.

A proposal to replace the control system in the absence of definitive causation factors is unjustified. However it might logically be carried out in consideration that the expected life of the plant as a whole is 40 years, and so control system replacement could take place at intervals of 10 to 15 years. It would however be expected that evidence of the withdrawal of support and a detailed business case would be required to demonstrate the prudence of the timing, including consideration of the above factors. At this stage no such case has been presented.

The Asset Management Plan proposes $2.387m in 2016 and Murraylink Cost Information Forecast Capex Network suggest a value for this work of $2.208m, the latter in 2015/2016 This amount seems unreasonable. The Ancillary Data document suggests an amount of $767,000 - $383,500 per end. This latter amount (while still requiring specific justification from Murraylink as part of a business case) seems to be closer to a reasonable amount for the replacement of a full control system for such an installation.

4.5.5 Capex Items for which there is no written justification

The following items are included in the Cost Information Template, Worksheet [SIB Capex]:

SIB001 to SIB015 (ventilation and Chilled Water systems)

SIB033 to SIB037 (Power Transformer and Work Station Computers)

CHC noted that no Business Case has been presented for any of the SIB items 001 to 037. A brief explanation only is given in the Asset Management Plan (AMP) for items SIB019 to 032 within this set. Murraylink was advised that this provides insufficient information upon which to base an assessment of

substantial expenditure, and was asked whether Murraylink intends to provide a full business case? In response Murraylink advised that individual business cases were not provided because APA did not consider the individual items warranted a full business case because of their low value.

CHC recognises that this might be the case for individual items, but as a group the expenditure is significant, and creates a precedent that is not in accordance with current industry practice.

4.5.6 Growth Capital Opportunities

The AMP includes the following projects that are considered "opportunities to grow the asset base" (subject to Regulatory Approval):

Item	Description	2012	2013	2014	2015	2016
1	**Black start capability**	0	0	2293	0	0
2	**Contingent reduction of converter losses**	0	0	0	2134	0
3	**Contingent duplication of DC link**					265000
4	**Contingent duplication of transmission lines**					551000
	Totals	0	0	2293	2134	816000

Table 7 – Murraylink growth capital opportunities ($000's)

Note that this table does not cover the entire regulatory period. Items one and two are capex proposals, while three and four are "Contingent Projects" as defined by the Rules. The Contingent projects are considered in Section 7. The two capex projects are assessed below.

A Business case is presented for:

- **Item 1: Control system enhancement – Black Start Proposed Expenditure $2,293,000 in 2014**

At present Murraylink can function only if there is a live transmission connection at both of its terminals (i.e. at both Red Cliffs and Berri). The proposed augmentation of its capability would enable it to energise the network at a terminal, and supply power into an otherwise dead network, provided Murraylink is connected to a normal live network at the other end.

If, for example, the AC network around Berri became disconnected from the remainder of the SA network at present Murraylink would not be able to operate. However if the Berri equipment is modified it would be able to supply loads around Berri in the period until normal AC supply is restored. Similarly if the Red Cliffs terminal was modified loads around Red Cliffs could be supplied (in both cases up to the capability of the network on the sending side).

In effect Murraylink would provide a similar service to that provided by a normal AC line over the same route.

CHC's consideration

Three possible applications of this augmentation have been identified, namely:

- To provide a means of supplying Riverland loads if both AC lines supplying the Berri area are out of service
- To provide a means of supplying North West Victorian loads if both AC lines supplying the Red Cliffs area are out of service
- To participate in AEMO's System Restart strategy if supply to both South Australia and Victoria is interrupted.

It is first necessary to consider whether this augmentation would provide a prescribed service in any of these situations.

The first two applications are complementary and the same considerations apply to both.

Supply to both Berri and Red Cliffs is provided by two AC lines plus a contribution from Murraylink operating within its current capability i.e. there are three transmission paths.

The reliability standard at both these locations is the ability to meet the whole demand (or a defined portion of it) while one of these paths is unavailable. According to this standard at least one of the AC paths will always be assumed to be available, and there is no requirement for Murraylink to operate into a dead system. The proposed enhancement would therefore result in a capability to supply the regional loads that is in excess of the requirement for a prescribed service.

In respect of the third application AEMO must secure the capability to restart the power system after it has been totally blacked out, due for instance to some rare but catastrophic event. Its strategy for doing this is documented, and involves the procurement under contract of System Restart Ancillary Services (SRAS).

Essentially AEMO enters into contracts with small generators that are capable of being started while totally isolated from a live system. These small generators then energise parts of the network that will give access to larger generators that require an external power source, and so enable these generators to start in turn. This sequence is repeated until eventually enough generators are started to begin to supply some loads, as well as start the remaining generators.

AEMO's strategy is to do this within defined geographic areas, and the final stage is to interconnect these areas. Under the current strategy two of the initial areas are the states of Victoria and South Australia. Because Murraylink is situated between these, the path it provides would not be used as part of the current SRAS strategy.

Nor does the proposal fall within the types of SRAS currently contracted by AEMO, and it is not likely that AEMO would want to purchase it. Such services are not prescribed.

In implementing a system restart strategy AEMO uses the prescribed networks to connect pair of generators, and there is no additional payment made for this service. All the AC network elements have the inherent capability to energise a dead network, and the fact that Murraylink cannot do this without being modified makes it unique. However there would be no justification for incurring expenditure if it is not required.

If a generator located nearby wished to tender to supply SRAS services to AEMO, but needed Murraylink to provide a path it is possible that Murraylink could enter into a commercial arrangement to implement this change. This would not be a prescribed service.

It is concluded that this proposal does not pass the test of providing a prescribed service, and therefore this expenditure should be removed from Murraylink's allowed capex.

There is a very large discrepancy in the cost quoted, but this is not relevant if the capex is not allowed.

- **Item 2: Contingent reduction of converter losses (proposed expenditure $2,134,000 in 2016)**

A description, but no Business Case is presented for this project. To quote:

> *"Future carbon pricing may focus attention on transmission system losses and Murraylink may be required to take action to reduce transmission losses.*
>
> *A significant cause of transmission losses is the switching of the valve IGBTs. The switching losses may be reduced by utilising an improved switching pattern for the IGBTs. The proposed solution is to change the switching pattern for the IGBTs and retune the AC and DC filter banks for the resultant harmonics. This proposal is contingent on a requirement to reduce transmission losses."*

Murraylink was invited to provide details of the magnitude of the loss reduction that would be achieved through this expenditure, and to provide a Business Case, including a cost – benefit analysis to justify the expenditure. At the time of writing no response has been received from Murraylink. However in a teleconference it was indicated that quoted cost was uncertain and the project might not be economic.

CHC's consideration

This expenditure should be accepted only if it can be demonstrated to have a positive economic benefit.

Murraylink dispatch data for the 2011 – 2012 fiscal year records that Murraylink's total losses were approximately 30,000 MW-hours. This is a low figure that represents average utilization at about 20% of Murraylink's full capacity. The value of the total lost energy is of the order of $1.2m at an average regional reference node price of $40/ MW-hour. A 10% reduction in the total loss would be worth $0.12M per annum, or $2.04m if capitalized at 10% over 30 years remaining life.

The proposed expenditure would reduce the portion of the loss that is due to the operation of the Ac/Dc and Dc/Ac converters by an amount that has yet to be defined. However it will have no effect on other losses such as arise in the transformers and connecting cables. The capital cost is quoted as $2.134M.

Based on these rough figures the economic case appears marginal and it will be important to obtain accurate figures.

The justification would improve if and when the constraints in the AC networks are alleviated, permitting higher power transfers with losses increasing as the square of the transfer.

However pending proper analysis it is concluded that this expenditure should not be approved.

5. TERM OF REFERENCE 2: CAPEX OR OPEX?

Murraylink proposes to treat many items of expenditure that could arguably be opex as capex and to depreciate this over relatively short periods.

At the present time the entire cost of the Murraylink assets is held in three Capex classes:

- Terminal equipment, (depreciated over 40 years)
- Cables (depreciated over 50 years), and
- Easements (not depreciated).

Murraylink made available for perusal the "APA Accounting Policy – Property, Plant and Equipment" in support of its proposal to introduce new asset classes with shorter lives and depreciation periods.

The two issues of interest are:

- Is the proposed allocation of the proposed expenditures to Capex consistent with the APA Accounting Policy and accepted industry practice?
- Are the proposed asset lives appropriate?

The first of these questions is addressed below, and the second is addressed in Section 6.

The Accounting Policy generally supports the proposal in respect of replacement of Plant Items and Major Inspections, with some significant qualifications, namely:

- Items of property, plant, and equipment must be recognised as assets only when:
    - It is probable that the future economic benefits associated with the asset will flow to the entity[6]; and
    - The cost of the item can be measured reliably
- Day to day servicing, including labour, consumables and some spare parts must be expensed. This implies that spare parts that are purchased but not immediately used should not be capitalised until they are placed into service;
- Where the cost of a replacement component is significant in relation to the total cost and the life of the replaced component differs from the life of the item, then the replaced component is depreciated separately;
- The replaced item must be derecognised in the accounts at its residual value, which must be expensed;
- Regular major inspections may be capitalised, irrespective of whether they result in replacement expenditure;
- The remaining carrying cost of a previous inspection must be derecognised, regardless of whether it was previously separately identified and depreciated;
- Where an inspection has been performed to determine the extent of maintenance works required (i.e. to repair a defect) such costs must be expensed as the economic life of the asset is not expected to be extended beyond its current expected life;
- The Policy refers to APA's pigging activities in relation to gas pipelines. Depending on the nature of the activity such costs may be capitalised as they provide future economic benefits. CHC considers that "pigging" could be analogous to inspection of cooling pipelines for corrosion;
- The carrying amount of an item of property, plant and equipment shall be derecognised on its disposal; or when no future economic benefits are expected from its use. The gain or loss from de-recognition of an item shall be included in the profit or loss.

Based on these principles CHC considers that Murraylink should treat the following types of activity as opex:

- Purchase of spare parts, not intended for immediate installation;
- Routine inspection, monitoring and repair of ancillary plant that has failed;
- Running repairs such as replacement of lagging; and
- Purchase of test and monitoring equipment.

CHC has applied these principles when commenting on the capex expenditure items in Section 4.

These expenditures will simply replace plant items like-for-like and the end result should be that the Murraylink asset will have no additional value on a replacement cost basis.

[6] This would be satisfied if the AER recognised the expenditure in its Determination.

It is understood that when a capital item is repaired the cost of the spare part (which might be as extensive as an entire pump or motor) replaces the original item in the asset register, and the residual cost of the item that is removed is written off. Assuming that the cost of the replacement reflects the original cost there is no net change in the asset value.

Under this regime it is not necessary to assign a life to plant that simply requires repair unless and until it is determined that plant having a greater functionality should replace existing plant.

It will be important to verify that Murraylink properly derecognises replaced plant and makes the appropriate adjustment to the profit and loss account in accordance with its policy.

It will also be important to set asset lives that represent realistic expectations for actual service in the presence of an efficient maintenance regime.

This will be discussed in Section 6.

Murraylink advanced the argument that:

> *Within electricity transmission and distribution systems, the following types of major maintenance on substations and lines would commonly be capitalised:*
>
> - *Circuit breaker replacement within substations;*
> - *Substation security fence upgrade/replacement;*
> - *Protection replacement within substations;*
> - *Conductor replacement on lines;*
> - *Pole replacement or pole staking on lines (although not uniformly).*
>
> *These types of expenditures are seen as analogous to the Murraylink refurbishment expenditures that APA proposes to capitalise.*

CHC does not agree with this conclusion in respect of Murraylink's ancillary plant. The proposal to replace all ancillary plant cannot be likened to anything that other TNSPs are proposing that is classified as "replacement capex". Where applied by TNSPs an entirely new asset using new technology is created at a time close to or beyond the technical and economic life of the entire asset.

CHC therefore recommends that this part of the capex expenditure should not be approved in its present form.

Costs will be incurred in maintaining the condition of the equipment, and CHC recommends that this be provided through the Opex allowance. CHC's brief does not extend to the Opex proposal. However it is understood that at the original revenue determination this was set at the notional efficient cost of maintaining the AC transmission asset that would have satisfied the regulatory test at that time.

Such an allowance would not have been sufficient to adequately maintain the type of equipment that comprises the Murraylink asset. Hence it is not surprising that Murraylink has incurred additional costs that it has chosen to submit as historic capex.

We assume that the original allowance has, however, been sufficient to carry out the routine inspections and maintenance actions that is defined by the maintenance work instructions that was shown to CHC. This would have included, for instance, the monthly inspection and placing into service of all rotating plant, and the application of grease or oil as required to the moving parts. Moreover we assume that the allowance did not extend to the repair of equipment that was found to have failed or was acting abnormally.

CHC recommends an increased Opex allowance that would provide for the following:

- Call out of specialist staff to address failures that become apparent through operational monitoring;
- Purchase of a reasonable number of spare ancillary plant modules that will be available on-site and can be installed rapidly;
- Repair of equipment as required using spare parts drawn from stock;
- Payment to specialist staff to carry out the above work, plus workshop repair of the failed items and delivery back to spare stock

Murraylink has provided very few estimates of failure rates. Assuming a typical value of 5% per annum a reasonable annual allowance would be 5% of the cost of full replacement of all ancillary items per annum, or 50% over ten years. It equates to about $172,000 per annum.

The repaired (or replaced) items are indistinguishable from the items they replace, and so will continue to be depreciated over the life of the parent plant.

Payment for repairs that are incurred in the current regulatory period and are currently treated as historic capex represents an issue because CHC understands that there is no mechanism to recover expenditures on opex that are above the allowance. On the other hand historic capex can be rolled into the asset base if found to be justified and efficient.

CHC recommends that AER staff address this issue.

CHC agrees that upgrading a security fence could be capex, as could replacement of a protection or control system with another offering better functionality.

Other capex items proposed by Murraylink will add value to the asset, or are required for OH&S or compliance with changed practice, and the above comments do not refer to these.

6. TERM OF REFERENCE: ASSET LIVES AND CLASSES

Originally the Murraylink Capital Assets were classified either as

- Substations (40 years life), or
- Transmission lines (Cables) (50 years life).

Table 9.1 of the Proposal proposes different lives for:

- A Transportable Office (30 years),
- Converters Electronics and Control Systems (25 years),
- Other Plant and Equipment (3 to 20 years).

The Roll Forward Model does not include the classifications named in table 9.1, but it has provision for

- Ancillaries 15,
- Ancillaries 10,
- Ancillaries 7,
- Test Equipment,
- Other Operating Assets, and
- Office Machines.

In the spread sheets these classifications have all been assigned an initial (2002/03) value of zero, but new “Capex” commissioned in the last 10 years has been entered for Ancillaries 15 and Ancillaries 10 (representing components that are now claimed to have physical lives of 15 or 10 years respectively).

The assets that have been removed from service when replaced were originally in the Substations class and were an assigned a life of 40 years. It is not evident that they have been de-recognised when removed from service.

Murraylink proposes to align the life of the cable (now 50 years) with that of the substation (40 years) on the basis that there is no use for the cables when the substations are retired. This argument is reasonable.

A number of the capex expenditures appear to be in the nature of infrequent major repairs, and by APA's accounting principles should be opex. If treated as such the repaired item replaces the failed item and there is no change to the capital value of the asset.

The proposal from Murraylink promotes the category of capex by introduction of the classification "Stay in Business". This is stated to be in line with transmission and distribution industry practice. Murraylink has suggested that replacement of high voltage conductors, high voltage circuit breakers, transformers and protection systems would be treated in this way, as capex. Most of the items in this classification are discrete and small parts of an individual plant item. It would be fair to say that all maintenance is directed to a "stay in business" objective.

In this Report CHC has advanced the argument that the approach proposed of replacing plant in anticipation of possible failure is not optimal, nor in line with power industry practice.

Equipment should be monitored and serviced according to manufacturer's instructions and evaluated. Failures of a small proportion of plant items over time are normal and expected.

Repairs are carried out as detected, and the repaired item can be expected to behave "as new". These repairs should be treated as opex, and there is no change to the asset base, and lives of the equipment are unchanged.

Typical lives of equipment of the type used in Murraylink are:

- Electric Motors: normally 40 years. If the life is extended by repair, it is suggested that, before any subsequent replacement is planned, a rigorous consideration should be made of the results of maintenance, operational performance and industry practice to develop a more convincing case.
- Pressure Vessel check: As required by statute or 5 years. Pressure vessel safety is a statutory requirement and the inspection should be carried out in accordance with the standards. This is usually considered an opex activity but APA's policy allows it to be capitalised. This is not a major issue.
- Control System: The life should be at least 10-15 years. The decision to change the control system would reflect factors such as difficulty with replacing components, growing defects, lack of manufacturer support and the possible availability of a new system providing economic benefits. A reputable manufacturer will give advance notice of an intention to withdraw support from its equipment. The work should be carried out only when the causation factors are identifiable, as evidenced in an appropriate Business Case.
- Capacitor Units: These should be replaced on an as needed basis by the use of spares purchased as opex. It is not unusual to replace individual cans from time to time. Records should be kept of replacement actions and these used to develop a profile of any abnormal trends

7. TERM OF REFERENCE 4 – CONTINGENT PROJECT

The AMP included projects that are considered "opportunities to grow the asset base" (subject to Regulatory Approval). Two of these are presented as Contingent Projects (as defined in the Rules). The capex details supplied are summarised in Table 7.

Item	Description	2014	2015	2016
3	Contingent duplication of DC link			265000
4	Contingent duplication of transmission lines			551000
	Totals			816000

Table7 – Murraylink growth capital opportunities ($000's) - the Contingent Projects

Although other projects (Items 1 and 2 in the original table) were described as "contingent" this is the only project put forward by Murraylink that could be a valid Contingent Project as defined by the Rules. It far exceeds the minimum expenditure required for it to be considered.

A description, which is probably intended as a Business Case, has been provided.

This expenditure is proposed as a series of Contingent Projects, subject to each relevant project being determined to satisfy an RIT-T.

The need for additional interconnection capacity between South Australia and the other States has been examined by a Committee that is jointly sponsored by ElectraNet and AEMO. The conclusions of the study were published in February 2011.

The Report concludes that the need for additional capacity is not immediate, but will develop over a medium or longer time frame depending on scenarios that represent different views of the development of demand growth and new generating technologies to meet it.

Essentially Murraylink contends that these studies have overlooked the potential to build an augmented interconnection capacity between South Australia and the other States by uprating Murraylink and other works to augment the AC networks on both ends.

Furthermore Murraylink argues that it will be disadvantaged if this project turns out to be the preferred one, and it has not been included it as a contingent project in its revenue proposal. They note that their proposed 10 year reset period is longer than that of the relevant TNSP's.

Murraylink made references to the Report on the Interconnection Study and to the 2011 APR's of ElectraNet, AEMO (as Victorian Declared Shared Network Planner) and TransGrid.

CHC's consideration

Subsequent to Murraylink's Proposal the 2012 Annual Planning Reviews of ElectraNet (SA)[7] and AEMO (Victoria)[8] have been published. These confirm that the AC network capacity on both sides of Murraylink is under review by these responsible entities, and it is possible that both networks will be augmented in the medium term. Revisions downwards in the forecasts for demand growth indicate that augmentation would be later than determined in the 2011 APR's. For example the major augmentation to Berri/Monash is now in the period 2023- 2028, with an earlier date possible if support from Victoria via

[7] South Australian Annual Planning Report 2012, ElectraNet June 2012

[8] 2012 Victorian Annual Planning Report/Electricity and Gas Transmission Network Planning for Victoria, AEMO 2012

Murraylink is lower than assumed. AEMO is monitoring the loading on two 220 kV connections, namely Bendigo to Kerang and Kerang to Red Cliffs via Wemen, but considers that no action will be taken within 10 years.

It is important that the respective responsibilities of ElectraNet and AEMO be appreciated when considering the potential addition of these assets to Murraylink's RAB by their inclusion as Contingent Projects.

Planning Responsibility in South Australia

ElectraNet has been granted a Licence by the Essential Services Commission of South Australia (ESCoSA), which obliges it to comply with the Electricity Transmission Code TC/07, a document also issued by ESCoSA[9]. The Code defines reliability standards applicable to different categories of exit points, including those at Berri and Monash to meet contracted forecast loads, and requires ElectraNet to plan to meet those standards.

Murraylink has also been granted a License by ESCoSA, which obliges it to comply with the Electricity Transmission Code, but specifically not to the provisions relating to reliability standards at exit points. Moreover Murraylink's License is confined to its assets constructed within areas of SA defined on a map. The Licence refers to the maximum current transfer capacity of Murraylink. The SA Licence has no effect beyond the SA/ Victorian border, and therefore affects less than one third of the cable length.

ElectraNet has addressed these regional supply and reliability obligations in its 2012 APR, and has proposed a Contingent Project to address the eventual need to augment supply to Berri and Monash from within its SA network. The APR suggests that this could be required in the early 2020's. This date depends on the power available from Victoria for transfer via Murraylink.

It might be relevant to the eventual determination of the date for this augmentation that it might be influenced by the fact that it would relieve or totally remove constraints within the South Australian network that limit the power than can be exported from South Australia to Victoria. This might be determined to provide a market benefit that would supplement the justification, which would otherwise be related solely to reliability of supply to the Berri load. CHC is not in a position to comment on whether this effect would be significant.

Given ElectraNet's regulatory obligations, and the absence of similar obligations for Murraylink, CHC concludes that Murraylink's proposal, as it relates to this part of the SA AC network, should not be allowed, while ElectraNet's proposal should be considered on its merits. The fact that the term proposed for ElectraNet's next regulatory period is shorter than that for Murraylink should not influence the decision.

Planning Responsibility in Victoria

The National Electricity Victoria Act 2005 (as amended) gives effect to the National Electricity Law in that State, and in particular states that Subdivision 3 of Division 2 of Part 5 of that Law is applicable in Victoria. This Subdivision defines AEMO's Declared Network Functions.

Declarations have been gazetted for the Victorian Declared Shared Network, and Victorian Declared Network Operators under this Law.

The Victorian Declared Shared Network includes all the assets that supply the Red Cliffs terminal from Victoria. It is this network that Murraylink has proposed to augment under this Contingent Project.

[9] A recently-issued amendment of this Code comes into force from 1 July 2013.

The following are extracts from the Law:

Section **50C—AEMO's declared network functions**

Clause (1) defines AEMO's declared network functions to include:

(a) to plan, authorise, contract for, and direct, augmentation of the declared shared network;

Section 50F—Augmentation

Clause (1)

A declared transmission system operator must not augment the declared shared network, or any part of the declared shared network, unless—

(a) AEMO authorises or directs the operator to carry out the augmentation; or

(b) the operator wins a competitive tender conducted by AEMO to carry out the augmentation; or

(c) the augmentation is authorised by the Rules.

AEMO has exclusive rights to plan augmentations of the Victorian Declared Shared Network. If it determines that an augmentation is required then it procures the service by contacting with an entity that would become a Declared Network Operator. Importantly the revenue stream would be determined under a different process to Murraylink's current revenue proposal. CHC concludes that it would not be appropriate to approve Murraylink's proposal that the AER include the augmentation of the Victorian network as a Contingent Project.

Augmentation of Murraylink Capacity

Augmentation of the regional AC networks should alleviate the constraints that currently prevent the full utilisation of Murraylink in one or both directions and, depending on their form and capacity, might give scope for additional transfer over the Murraylink path.

Murraylink has assumed that there would be sufficient additional capacity in the networks to not only relieve the constraints, but to double the Murraylink capacity, and therefore proposes that the duplication of the entire Murraylink assets be allowed as a Contingent Project.

At this stage it is not known what augmentations of the AC networks would be determined to be economic. It is possible that incremental augmentations would be identified that would delay the need for larger-scale additions that would provide the magnitude of capacity increase envisaged by Murraylink.

If Murraylink's assumption was realised there is a significant barrier to the proposal because the Murraylink "HVDC Light" technology is significantly more expensive for a given transfer capacity than conventional AC line technology. This was found to be the determining factor in valuing Murraylink at the time of its conversion to a regulated network in 2003.

The ACCC's Decision[10] concluded that the alternative that satisfied the Regulatory Test then applied was a "Red Cliffs to Monash 220 kV AC mostly overhead transmission line, with substation augmentations at Red Cliffs and Monash, including augmentations to the Victorian transmission network".

This decision was made on the basis of the AC networks that existed at that time. However with the network changes that would be implemented to give rise to the possibility of augmenting Murraylink the same comparison is likely to apply.

[10] Murraylink Transmission Company/ Application for Conversion and Maximum Allowed Revenue/ 1 October 2003

The Report by ElectraNet and AEMO on the Joint Feasibility Study[11] includes a table of generic costs of AC transmission lines and terminal equipment. This suggests that the budget cost for a double circuit 275 kV line with a 275/220 kV transformer would be around $198M. This would have greater capacity than the Murraylink alternative.

The conclusion is that duplication of Murraylink at a cost of $265M would be more expensive than an AC alternative and offer negligible additional benefits and accordingly would not pass a RIT-T.

A final consideration is that the AC network augmentations to Berri and Red Cliffs to support this capacity are unlikely to be in place during the next revenue period.

CHC therefore concludes that a project to augment Murraylink by constructing a parallel HVDC Light link of similar capacity is not probable within the next reset period. The efficient cost should be no more than $198M, and in addition to passing a RIT-T the project should be supported by AEMO under its Victorian planning powers, and be granted an amended Transmission Licence in South Australia.

8. CONCLUSIONS

The response to the Terms of Reference is developed in the context of the operational requirements for Murraylink, viewed firstly from an historical perspective but then also taking into account the likely effect of future system developments.

This leads to the perspective that Murraylink is not likely to be called upon to provide the full technical capacity of the system for extended periods and there is therefore scope for taking advantage of effective redundancy in the event of failures of some plant.

Considering the Terms of Reference (TOR):

Terms of Reference 1: Does the regulatory proposal meet the requirement of the Rules – Clause 6A.6.7

- There are a number of proposals which are within the scope of Clause 6A.6.7 These relate to AMP items as follows:
  - Item 1 Install earth switches
  - Item 2 Reprogram runback control logic
  - Item 5 Perimeter fence security
  - Item 8 Switchyard barrier fences
  - Item 15 Install additional air conditioning chillers
  - Item 16 Berri water tank and plumbing
  - Item19 Building ventilation changes

  The process of cost estimation for these items does not appear to have been rigorous and the amounts suggested somewhat broad in definition. A more rigorous approach would be likely to lead to reductions in some estimates.
- There are a significant number of items which have been classed as “Stay in Business” which relate to maintenance and therefore are arguably opex. This includes items 4, 6, 7, 9, 10, 11, 12, 13 and 14. The maintenance intervals and costs need further examination**.**
- Item 18 relates to the end of life replacement of the control system. There is a discrepancy in the costs quoted in different parts of the proposal. Also the assigned life and costs should be re-examined. It is suggested that this should be undertaken after consideration of performance.

[11] ElectraNet-AEMO Joint Feasibility Study / South Australian Interconnector Feasibility Study February 2011

Replacement of the control system, when justified after technical performance assessment, is an activity that may cause operational performance problems in the short term.

- Two proposals for capital growth have been treated as normal capex proposals. These are
  - *Item 1: Control system enhancement – Black Start.*

  Three possible applications of this augmentation have been identified, namely:
  - To provide a means of supplying Riverland loads if both AC lines supplying the Berri area are out of service
  - To provide a means of supplying North West Victorian loads if both AC lines supplying the Red Cliffs area are out of service
  - To participate in AEMO's "System Restart" strategy if supply to both South Australia and Victoria is interrupted.

  The duplicate AC paths available to supply the load area at the terminal of Murraylink result in an acceptable reliability standard for these loads, without the need for an AC supply from Murraylink

  With regard to the last application, the AEMO strategy is to firstly progressively recover the systems in defined geographical areas. As Murraylink does not provide this facility, AEMO would not want to purchase a facility, which is not a prescribed service.

  The proposal does not pass the test of providing a prescribed service and should not be allowed as part of the capex

  - ***Item 2: Contingent reduction of converter losses.***

  There was no business case to support this proposal and Murraylink was asked to provide details, including a business case.
  CHC analysed the proposal based on available data, to ascertain whether there was a possible economic benefit.
  The analysis by CHC suggests that the case would be marginal and is not recommended, pending the supply of further data.

Term of Reference 2: Classification of historic expenditure as capital rather than operating expenditure.

The expenditure of concern has been described as "Stay in Business" and involves activities similar to asset maintenance, except that it is proposed to replace plant items that have not failed, based on time in service rather than condition assessment.

A capex allowance was not provided for in the original regulatory control period for historic reasons. No evidence has been brought forward to justify this scale of expenditure.

The expenditure should be classified as opex, but will require an increased opex allowance. However we recognise that this could be a matter for adoption of different accounting practices.

Terms of Reference 3: Asset Lives.

It is suggested that the approach being taken is not optimal. In many cases good equipment will be replaced and possibly lead to lesser standards of reliability.

Equipment should be maintained according to manufacturer's instructions and evaluated.

Indications that serviceability is deteriorating on a type fault basis should lead to proposals for change. This would be done in a progressive manner as units required attention.

- Electric Motors: should be 40 years, with appropriate maintenance and asset management processes. . If the life is extended in this way, it is suggested that, before any t replacement is planned, a rigorous consideration should be made of the results of maintenance, operational performance and industry practice to develop a more convincing case.
- Pressure Vessel check: As required by statute or 5 years. Pressure vessel safety is a prime statutory requirement and the inspection should primarily be carried out in accordance with the standards. This is an opex activity. It is unlikely that inspection will lead to asset replacement.
- Control System: The life should be at least 10-15 years. The decision to change the control system would reflect factors such as difficulty with replacing components, growing defects, lack of manufacturer support and the possible availability of a new system providing economic benefits.
- Capacitor Units: These should be replaced on an as needed basis. It is not unusual to replace individual cans from time to time. Records should be kept of replacement actions and these used to develop a profile of any abnormal trends

Terms of Reference 4: Contingent Project Feasibility *duplication of DC link and transmission lines*

This Contingent Project consists of a number of inter-related projects which include possible projects in South Australia and Victoria, together with duplication of Murraylink to enhance capacities which would provide market benefits. The conclusions of a Committee formed by ElectraNet and AEMO were published in February 2011. The report concluded that the need for such additional capacity is not immediate but will develop over a medium or longer term. Murraylink considers that the potential for its project was overlooked.

Important considerations are that ElectraNet has a licence obligation to plan this supply in SA, whereas Murraylink does not. Further AEMO has an exclusive right and obligation to plan enhancements to the Victorian Declared Shared Network. Murraylink could not be given a revenue determination for its proposed line in Victoria. It is also important to note that the HVDC light technology is considerably more expensive than a conventional 220 or 275 kV AC transmission link over the same path. CHC contends that it would not pass the RIT-T test.

9. REFERENCES

1. Murraylink Revenue Proposal Effective July 2013 to June 2023, Murraylink Transmission Company P/L (MTC) May 2012
2. Electricity Transmission Network Service Provider Roll Forward Model, AER .xls file, (as completed by MTC)
3. Asset Management Plan (Murraylink), 2012-2016, Energy Infrastructure Investments (EII)
4. Capital Expenditure Business Cases, Effective July 2013 to June 2023, MTC
5. Contingent Project Proposal, May 2012, MTC
6. Cost Allocation Methodology, Effective July 2013 to June 2023, MTC
7. Murraylink 2013 Cost Information Template .xls file (as completed by MTC)
8. NSW Annual Planning Report, June 2011, TransGrid
9. South Australian Annual Planning Report, June 2011, ElectraNet

10. Victorian Annual Planning Report, Chapter 5, June 2011, AEMO
11. SA Interconnector Feasibility Study, ElectraNet – AEMO Joint Feasibility Study, February 2011
12. The NEM Constraint Report 2011, 16 February 2012, AEMO
13. Decision on Murraylink Transmission Co for Conversion and MAR, 10 October 2003, ACCC
14. Directlink Joint Venturers' Application for Conversion and Revenue Cap, Decision 3 March 2006, AER

10. APPENDIX A: ANALYSIS OF MURRAYLINK OPERATING DUTY 2011- 2012

Murraylink provided a data file that was generated from operational data for the FY 2011 – 2012 provided by AEMO. This comprised dispatch data (MW and direction target) for Murraylink as generated by the dispatch engine NEMDE (105,414 data sets at 5-minute intervals). The data also included:

- Measured MW
- Calculated Murraylink path MW losses
- Magnitude of Constraint on Import from Victoria, and text describing the cause of this constraint
- Magnitude of Constraint on Export to Victoria, and text describing the cause of this constraint

Murraylink also provided an analysis based on this data and made the following comments:

> *An illustration of daily link flows derived from the 5-minute dispatch data for 2011/12 is reproduced below (Figure A1). This chart demonstrates significant daily flow variation under AEMO dispatch, with frequent use of the full ML capacity towards SA and more limited use of the capacity to Victoria, mainly constrained by the SA regional transmission system. It can reasonably be concluded that the full link capacity of 220 MW is regularly being used to provide market benefits.*

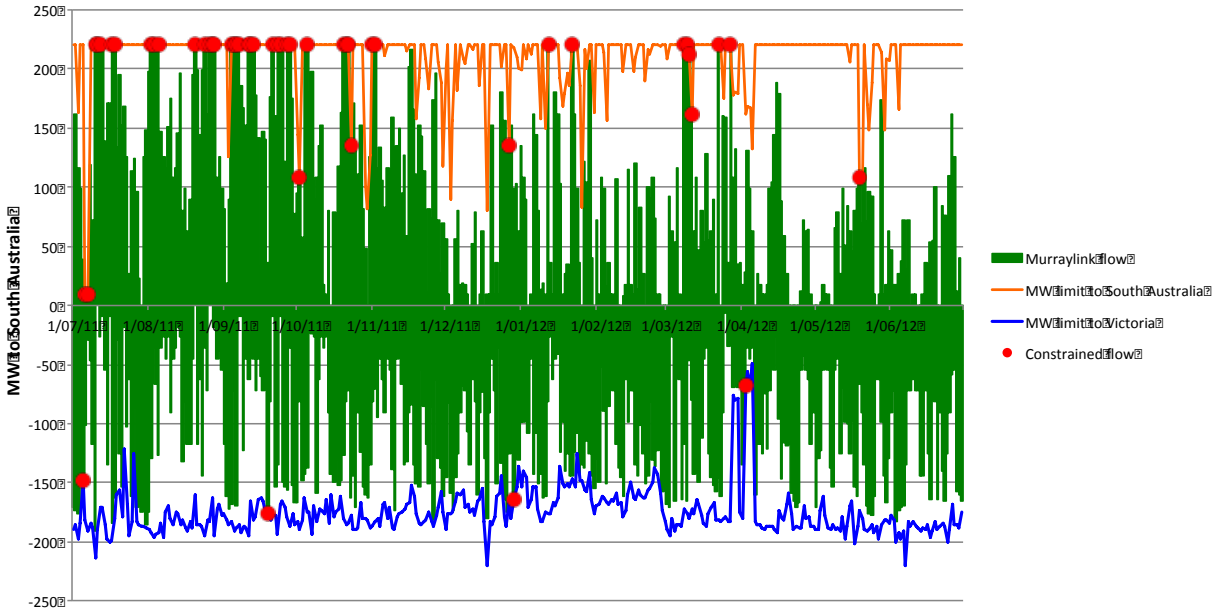

Figure A1: Graph generated by Murraylink from AEMO data, showing samples of Murraylink flow over one year, with network constraints for each direction of flow, and marks showing where the flow was constrained.

CHC noted that the flow samples used to generate figure A1 are the snapshots at midnight on each day of the year, and considered that this sample might not be typical of daily power transfers, since at this time of day network demand is relatively low, and therefore the constraints would also be less severe than at other times of the day.

CHC conducted additional analysis to include all the data throughout the year.

Figure A2 shows all the time sequential data for Murraylink MW flow over the year. This is measured at the Red Cliffs terminal, so that the negative figures are the power received from Berri, after accounting for losses in Murraylink. The maximum power at the sending end (either terminal) is 220[12] MW.

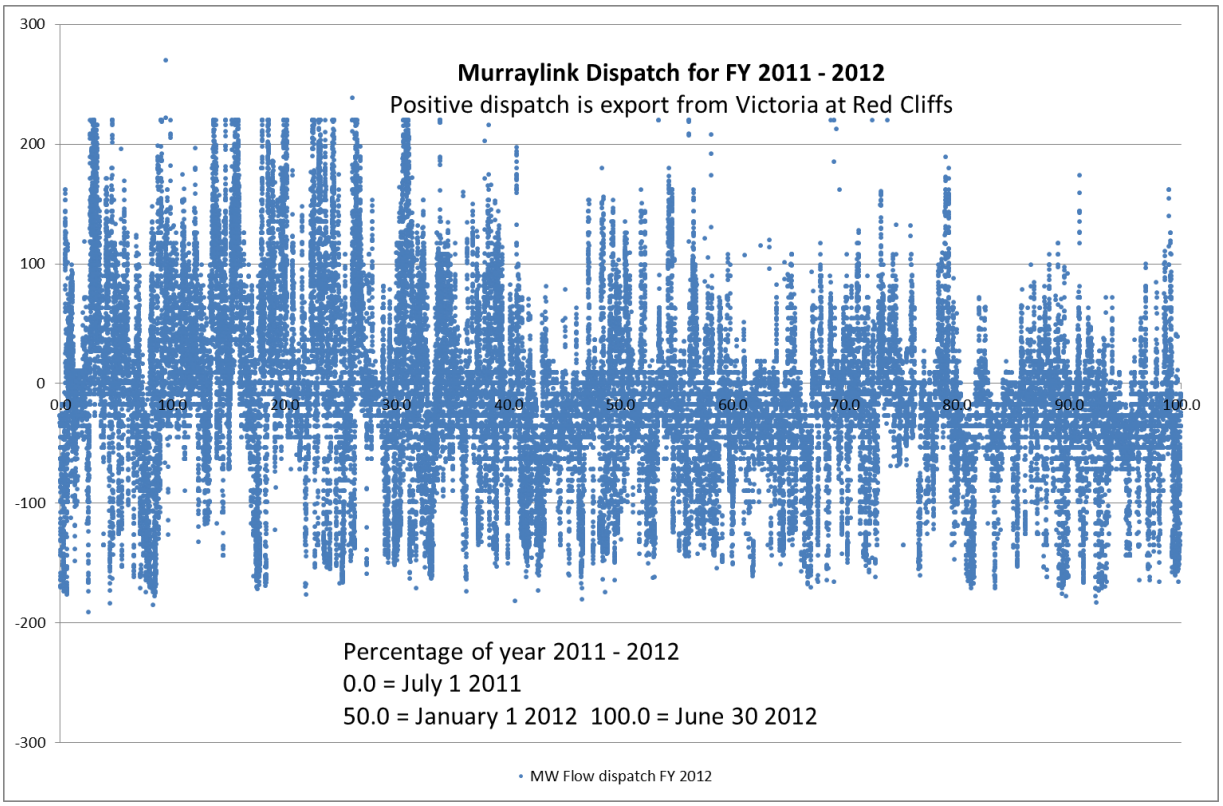

Figure A2: Murraylink 5-minute Dispatch instructions over one year (2011 – 2012) from AEMO data

It was noted that the flow on Murraylink is variable, but with only brief excursions to the maximum capacity of the link in the two directions, and substantial periods with much lower transfer.

The time spent at various flow levels is further explored in Figure A3, which shows the overall time duration of the dispatch levels (in per cent of the full year), together with the corresponding constraints[13] that applied in each direction of power flow.

[12] A few isolated data points outside this range are unexplained, but might be bad data.
[13] This graph is constructed by sorting all the 5 minute data according to the MW flow.

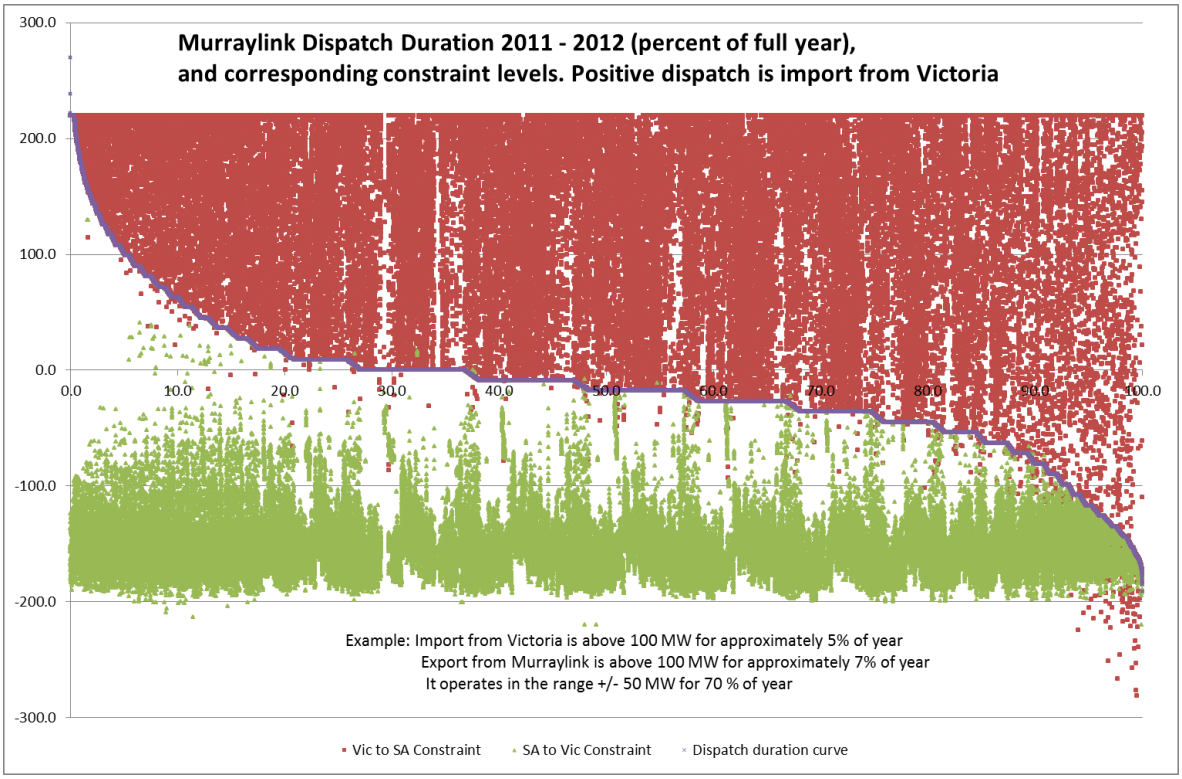

Figure A3: Time duration of MW flow, and simultaneous levels of constraint, from AEMO data

Figure A3 illustrates the relatively short amounts of time that Murraylink is utilised at anywhere near its full capacity in either direction.

The period of operation at the maximum throughput for export from Victoria was just 28 hours, and for operation within 20 MW of this it was 50 hours.

For export from SA there was no operation at maximum throughput, and just over an hour was spent within 20 MW of this full capability.

Only around 12% of time (105 hours) was spent outside the range of +/- 100 MW, and 70 % of time was spent within +/- 50 MW.

Looking at the brown data points it is observed that the Victorian export to SA via Murraylink is not always determined by a network constraint[14]. It is common for the constraint to be well above the level of flow. This indicates that the transfer is determined by the economic dispatch calculated by AEMO.

SA Export is less frequently affected by constraints. That is, there appears to be scope for additional SA export, but in this sample year this is being determined by AEMO's dispatch as not being needed.

To further explore the nature of the constraints Figure 4A shows the time duration of the constraints in the two directions[15].

[14] This is indicated by constraint points being coincident with the power flow. A constraint point above the power flow indicates that that constraint is not limiting the flow.
[15] This graph is constructed by sorting the constraint data individually.

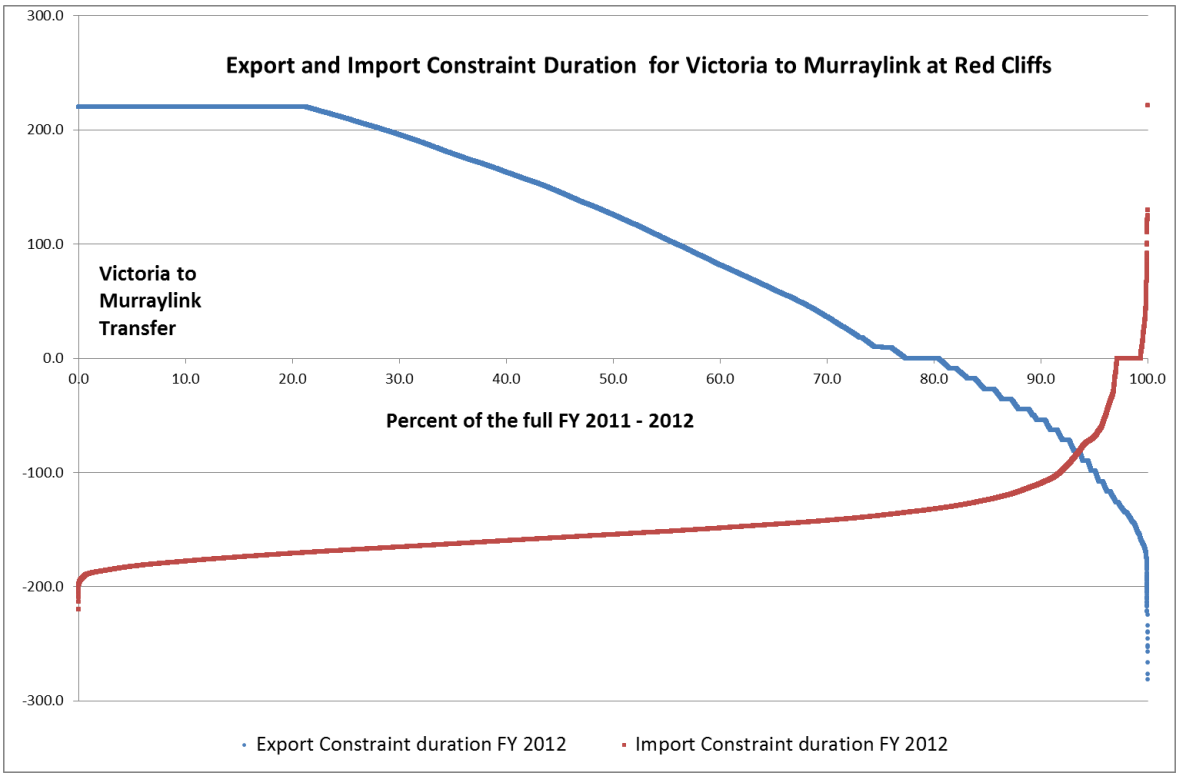

Figure 4A: Time duration of constraints on the two directions of power transfer on Murraylink FY 2011 - 2012. These are individual duration curves and do not represent coincident constraints.

These graphs further reinforce the fact that constraints are quite often not the determinant of power transfer. Times when the network is relatively unconstrained do not necessarily coincide with a need for higher transfer.

The important implication is that the long periods of low transfer occur principally because AEMO's dispatch calculation has determined that a higher transfer over Murraylink is not required. At these transfer levels network constraints are not often a limitation. It is reasonable to assume that the Heywood AC interconnection is the preferred path for the sharing of generating capacity between Victoria and SA.

However, there are also significant times when transfer is constrained to be in the opposite direction, for example when a constraint within SA requires transfer to be into SA via Murraylink. This occurs because Murraylink provides a valuable service to the South Australian regional network that has deferred the need for ElectraNet to augment its supply to the Berri area. This requires Murraylink to supply relatively small amounts of power to this area to cover the unavailability of one of the two AC circuits that supplies it normally. The high value that this provides does not require Murraylink to be at full capacity.

Murraylink's contention that "*It can reasonably be concluded that the full link capacity of 220 MW is regularly being used to provide market benefits"* is not supported by this analysis. Rather it has been shown that the use of the full capacity in either direction is quite rare, and that transfer is most frequently within less than half of the available capacity.

It is not possible to deduce from this analysis the value to the market of the ability to use the full capacity on rare occasions. However it is known that the network is unconstrained only during periods when the load demand is not at peak levels.

Additional Information Provided by Murraylink

In response to questions from CHC, Murraylink made the following additional observations, in clarification of the data it provided.

> *In relation to the potential variation of Murraylink utilisation during the next regulatory control period, APA is not in a position to carry out predictive system analysis. However, there are a number of somewhat interrelated developments that are currently under investigation by the TNSPs and AEMO. Taken in turn, these would have the following implications for the utilisation of Murraylink capacity:*
>
> - *The NSW runback scheme, when commissioned, should increase utilisation towards SA for a transmission contingency within the NSW network. In effect, some constraints limiting the flow to SA would be lifted (there was one occasion in the past three months on which these were binding, but the link is normally operated within the constraint envelope);*
> - *Reinforcement of the Victorian regional transmission network is foreshadowed in the AEMO NTNDP and is currently subject to investigation as a component of the SA interconnection requirements[16]. This augmentation would also lead to increased utilisation of the link in the SA direction;*
> - *Increased wind generation in SA will increase the utilisation of the link capacity to Victoria/NSW, albeit limited by the SA transmission constraints.*
> - *Load growth in the Berri area will progressively tighten constraints on the flow of the link to Victoria, until that system is reinforced. From the AEMO chart above, it may be seen that the link is frequently constrained to less than its full capacity in supplying to Victoria*
> - *Reinforcement of the Riverland transmission system at 275 kV has been included by ElectraNet as a contingent project in its regulatory proposal to the AER[17]. This would permit a significant increase in the utilisation of the link towards Victoria;*
> - *Development of the Murraylink corridor to provide increased SA interconnection capacity (as foreshadowed in the contingent project that forms part of the Murraylink regulatory proposal) would effectively remove transmission constraints on the capacity of the link and lead to significantly increased utilisation in both directions;*
> - *Enhancement of the Murraylink control system to enable it to provide reactive support to the regional transmission networks or black start capability, as proposed, would not have a material effect on the utilisation of the link (the reactive support would marginally increase the MW capability); and*
> - *Development of a high-capacity reinforcement of the SA interconnection is presently under review by AEMO. Current indications are that this is not expected within the next 10 years. This may have the potential to reduce the utilisation of the link.*
>
> *In conclusion, it is considered that the full 220 MW capacity of Murraylink will be required to be dispatched by AEMO, on a similar basis to the existing requirement, throughout the 2013-*

[16] AEMO, 2011 National Transmission Network Development Plan for the National Electricity Market, p 2-18

[17] ElectraNet Transmission Network Revenue Proposal - Appendix R – Proposed Contingent Projects, pp 12, 13

2023 regulatory control period. Many of the potential developments described above would lead to increasing utilisation of the link.

While agreeing broadly with these conclusions, CHC considers that actual utilisation of the full capacity will continue to be infrequent, and any increase in usage would be confined to times when the supporting networks are less constrained than they are now.

Furthermore AEMO will always be in a position to predict, with reasonable accuracy, times when the full capacity is likely to be required, giving Murraylink the opportunity to schedule maintenance activities to jointly optimise critical availability and costs.

11. APPENDIX B: SUPPLEMENTARY REPORT TO THE AER

The Australian Energy Regulator (AER) has engaged CHC Associates Pty Ltd (CHC) to provide engineering services in relation to the Murraylink transmission interconnector revenue determination 2014-23.

A draft report was forwarded to AER on the 16th September with a final report to be supplied in mid-October.

In the interim AER has asked CHC to comment on two particular issues. These are:

1. The Murraylink proposal to align the asset life of the cable, now 50 years, with that of the substation, now 40 years.
2. The asset lives of some of the ancillary equipment, as listed in the email from AER.

Life of Transmission Equipment

The length of life of transmission equipment is influenced by a number of factors, including:

- Type of equipment
- Manufacturing quality processes
- Duty cycle
- Operating environment
- Efficacy of asset maintenance

While determining the expected length of life of equipment is not an exact science, there has developed a body of experience and technical understanding to give confidence to a systematic approach.

Life of Substation and Cable

The lives of substations and cables are normally different in a technical sense and in the context of commercial entities. The substation can be augmented, equipment replaced and the duty cycle of the equipment can change with time. The asset value of the substation can change to reflect these actions.

During its life a cable may come to have a different role in system operations and be connected to different terminals. However, from a technical viewpoint, a cable once properly installed and operated under normal stress conditions should not suffer any life reduction. The only hazards to the cable are from abnormal operations, such as overloads, or external factors such as diggers etc. A life of 50 years is quite technically correct if the cable is a separate identifiable asset.

It is thus quite reasonable in a general sense for these different assets to have lives of different length.

In the specific case of Murraylink, however, the cable and the substation are joined as a single entity, with a projected life of 40 years. The cable will have no useful life when the entity ceases to operate. Thus, in this situation, the substation and the cable should have the same length life, essentially dictated by the planned commercial life of Murraylink. That is 40 years.

Life of Ancillary Equipment

Previous Experience

Work Order summaries in the Murraylink Ancillary Plant spread sheets show that the following "replacements" have taken place:

- Chiller Motors: 1 at Red Cliffs, 4 at Berri out of inventory of 2 at each location
- Split System Air Conditioners: 8 at Red Cliffs, 8 at Berri, unknown inventory
- Cooling water pumps (Valves and Reactors): 3 at Red Cliffs, 3 at Berri, inventory 4 at each location
- Vesda Fire Detection: 1 at Berri, inventory 2 at each location (perhaps another was damaged in a fire)
- Cooling Tower Fan Motors: 3 at Red Cliffs, inventory of 53 at each location.
- Fan Coils: no replacements, inventory of 40 at each location

It is possible that high numbers of failures for Chiller Motors, Split system Air Conditioners, and Cooling Water pumps are symptoms of inadequate design/ specification of these items at the time of the project's inception. In these cases the initial replacement work to bring them up to standard could be considered capex.

However, if the replacement plant has an improved design, the time to the next failure should be much longer (and is currently unpredictable).

We therefore should not extrapolate the design lifetime for these items of plant from these initial failures. Nor are there sufficient records of failure to date to make any deductions as to future failure rates.

The Present Request

The email request lists 23 items for which an asset life is requested.

It is noted that the Murraylink proposal centres on giving a prescribed life to certain assets, probably because of a preference for replacement of these assets at defined intervals which then can be argued as capex.

There are assets which can be expected to be replaced on a time basis, where it can be established that there is a wearing out process, with time or numbers of operations. However, in the power industry generally the approach has been to monitor, test and review before deciding on an estimated cyclical replacement program. If problems become evident then decisions need to be made with respect to increased surveillance, replacement of elements causing lack of performance or total replacement. If total replacement is necessary in an early time frame then a better designed replacement may be appropriate, rather than replace like with like.

In commenting on the items requested, CHC has not had an opportunity, at this time, to review the specification and suitability of the assets, but CHC derives some significant confidence from the fact that the manufacturer is a major international supplier of power system equipment. CHC would find it difficult to believe that components supplied for a project with a 40 year life would need comparatively frequent replacement as proposed.

Many years' observance and experience of asset management in power stations and similar plant has supported CHC in arriving at this conclusion..

With respect to the specific asset items in Table 1 below, CHC has the following conclusions. :(item numbers have been added to assist identification):

I. Valves (Items 1 and 7): The valves should not need replacing. At the suggested 15 year interval, a sample number should be inspected and strategies developed from these inspections

II. Compressor (Item 2): Regular maintenance should avoid replacement.
III. Motors (Items 3, 10 and 18): Do not replace.
IV. Water piping (Item 4): The pipes should not need replacing if properly treated water isused.
V. Control system – industrial computers (Item 5): This is an issue which is determined by factors such as the degree of manufacturer support and the ability to interact with other system software. It is appropriate that the status of the control system be reviewed periodically and a business case for replacement be developed where appropriate. As a fallback, a review should be held in 15 years but, based on a lifecycle of such a system, one replacement over the 40 year project life would be appropriate.
VI. NSW runback capital contribution (Item 8): This is a commercial transaction and does not conform to maintenance or replacement needs.
VII. VESDA scanner chassis (Item 9): It is not known why a replacement was necessary, perhaps due to damage from an external agency. This asset should not need replacement
VIII. Inergen pressure vessel testing (Item 11): Testing governed by statutory requirements as to extent and intervals. CHC assumes an interval of 5 years.
IX. Water piping lagging (Item 12): This should not need replacement.
X. Motor start contactors (Item 13): These should not need replacement.
XI. Water tank (Item 14): These should not need replacement.
XII. Positive ventilation (Item 15): This should not need replacement
XIII. Control system- black start, reduction of converter losses, end of life replacement (Item 16): Replacement not appropriate
XIV. Expansion vessel corrosion (Item 17): Inspection should govern action but replacement is not seen as necessary
XV. Pressure vessel Inspection (Item 19): Carried in accordance with statutory requirements
XVI. Chiller and cooling system pump (Item 20): Replacement may be necessary at 20 years
XVII. Optic fibre test equipment (cap009) (Item 21): No replacement necessary.
XVIII. Split system air conditioners (SIB005) (Item 22): The life of the air conditioners will depend upon design, duty cycles and the effectiveness of routine maintenance. Replacement may be necessary after 15 years if commercial, rather than industrial, units are used..
XIX. Logic system reprogramming (cap 001) Item 23. No replacement appropriate.

The replacement plant lifetime needs to consider future performance. At this stage it should remain at 40 years until proved otherwise.

The replacement of plant items in excess of those that have actually failed is unjustified because:

- Replacement of plant that is functioning normally will serve no useful purpose, and could potentially result in lower reliability if the replacement goes through an infant-mortality phase.
- The predicted operating duty and plant redundancy of Murraylink will allow the repair of single failures without decreasing capability.

Implications for Capex and Opex

In the response to CHC's questions Murraylink said:

The historic capex in the SIB Capex work sheet was listed purely as a mechanism to forecast the future capex requirements and is not necessarily expenditure that has been incurred. The forecast capex frequencies are an attempt to predict a future reliability for the aged equipment.

It is assumed this means that Murraylink has not actually spent the entire amount listed for 2012 and 2013, and is not committed to do so. CHC cannot recommend that unspent amounts be rolled in to the Regulatory asset base (RAB).

It has not been demonstrated that the plant now in service is in an "end of life" condition.

For most plant categories the activities undertaken to date have really been monitoring and repair of failed items.

In conventional industry practice (and in the APA Accounting Policy) this activity should have been treated as opex and expensed.

However Murraylink's historic opex allowance was apparently sufficient only for routine monitoring and insufficient to pay for these repairs.

The current opex allowance was set (in 2003) equal to the "efficient" cost of maintaining the preferred AC network that satisfied the regulatory test. It therefore took no account of the significant differences between the conventional AC network and Murraylink's DC technology.

To maintain ancillary plant items of the type used by Murraylink to achieve a lifetime of 40 years will require a higher opex allowance than has been submitted in the proposal.

To transition to an opex regime for this class of work will require:

a) An adjustment to pay for necessary and justified repairs undertaken in the current regulatory control period. For practical reasons this might need to be treated as capex.

b) An increased opex allowance to cover future repair work, including the purchase of an adequate inventory of spare parts to ensure the capability to rapidly return a failed item to service.

A repair carried out under this regime will not change the remaining life of the asset (remains at 40 years), and will not change the asset value (the spare part purchased using opex replaces the failed part, which is scrapped and written off).

The higher opex will be more than offset by lower capex and lower depreciation than currently proposed.

Equipment Table

Table 1. Murraylink's new asset classes and standard asset lives

Asset class	Proposed standard asset life (Years)	Ancillary equipments	CHC suggested life (draft report page 28) (years)
Ancillary 15	15	1.Cooling system blocking valve	40
		2.Chillers compressor	40
		3.Transformer cooling fan motors	40
		4.Water piping and fan coils corrosion	40
		5.Control system - Industrial computers	20
		6 Cooling system proportional valve motor	40
		7.Water piping valves	40
Ancillary 10	10	8.NSW runback capital contribution	N/A
		9.VESDA Scanner chassis	40
		10.Electric motor	40
		11.Inergen Pressure Vessel Testing	Statute Driven, say 5 years
		12.Water piping lagging	40
		13.Motor Start Contactors	40
		14.Water tank	40
		15.Positive ventilation (Cap002)	40
		16.Control system-black start, reduction of converter losses, end of life replacement (Cap011)	40
Ancillary 7	7	17.Expansion Vessel corrosion	40
		18.Fan Motor	40
		19.Pressure Vessel Inspection	Statute Driven, say 5 years
		20.Chiller and cooling system pump	40
Test equipment	10	21.Optic fibre test equipment (Cap009)	40
Other operating assets	5	22.Split system air conditioners (SIB035)	15
		23.Logic control reprogramming (Cap001)	40

Notes:

1. 40 year lives reflect assessment that a programmed cycle of change is not necessary.