Directlink Joint Venture

Directlink
Revised Revenue Proposal

Attachment 5.2

Directlink
Capex business cases

Effective
July 2015 to June 2020

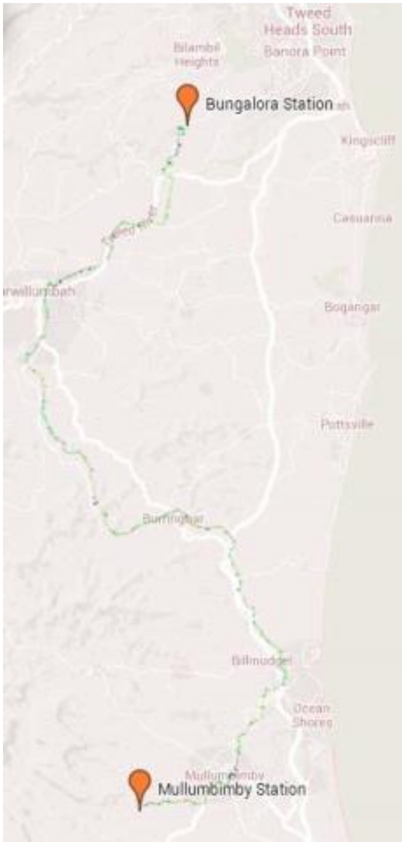
January 2015

Business Case

Service Provider:	APA Group	**Date:**	8 January 2015
Asset:	Directlink		
Project:	Cable Replacement Program		
Project Type:	*Capex/Opex :*	*$7.994 million ($2013-14)*	
Prepared:	*Stuart Dodds*	*Operations Manager Power Transmission*	
Endorsed:	Paul Thorley	*State Manager Asset Management*	
Approved:	Kerryanne Mallitt	*General Manager Asset Management*	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal for the financial years 2016 to 2020.



BACKGROUND

Directlink is a 59 kilometre bipolar HVDC cable and converter stations located between Bungalora and Mullumbimby, New South Wales. There are 3 systems connected by pairs of bipolar transmission cables. Each pair of cables operates at +/-80 kV and transmits 60 MW. In New South Wales it is connected with a 132 kV transmission grid and from Queensland with 110 kV transmission grid. The system was commissioned in December 1999 and became a regulated asset on 10 March 2006.

The operational performance of this asset has driven the need for an expanded cable replacement program to address recurring faults along the HVDC cable.

IDENTIFICATION OF NEED

An expanded cable replacement program is required to ensure the DC cable reliability improves and the cable meets its forecast asset life.

There has been a significant amount of investigation, into the cause of the cable faults, and more is required to fully characterise the cause. The investigation work to date has increased the understanding of the cable faults, however cable replacement remains the only known remediation method.

The Directlink DC transmission cables have a high frequency of failure predominantly caused by:

- moisture in the cable, hereafter referred to as moisture; and
- design of the underground to above ground transitions, hereafter referred to as transitions.

Moisture

Currently, the single biggest contributor to cable failure is moisture, and the expanded cable replacement program is directed at replacing the moisture affected cable. It is not precisely known when or how the moisture entered the cable, however it possibly occurred during cable installation or cable joints failure. Cable joint failure was frequent during commissioning and during the early years of Directlink operation, but is rare now. Moisture causes the aluminium conductor to corrode and the products of corrosion chemically damage the inner semiconductor layer of the cable, leading to DC voltage stresses that ultimately cause localised failure of the cable insulation.

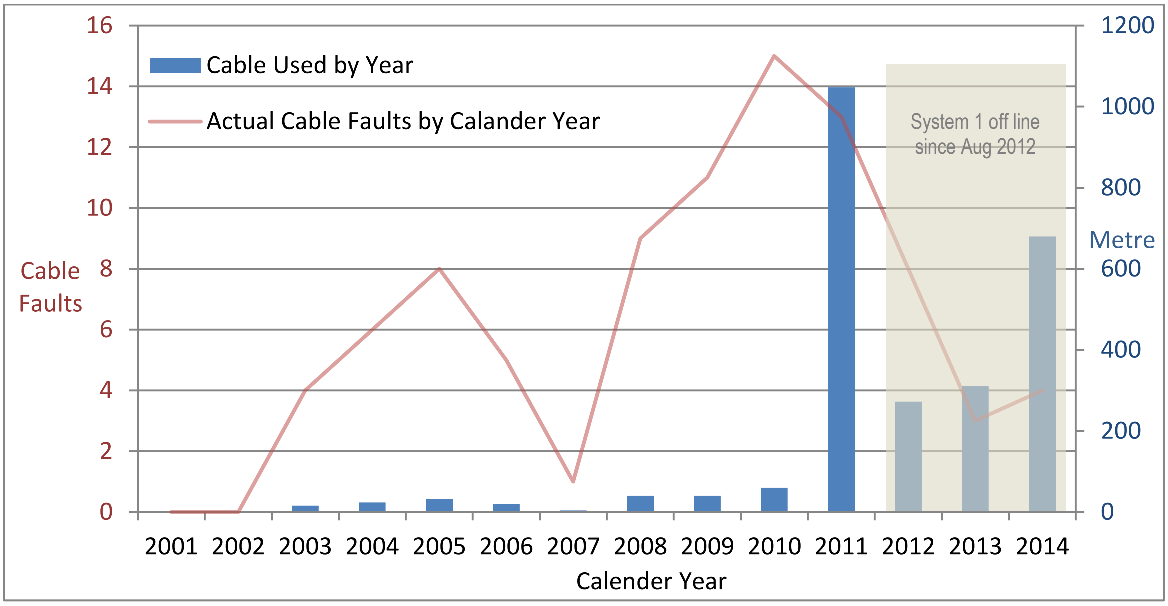
Transitions

A large proportion of Directlink cable is installed above ground in galvanised steel troughing (GST), however the cable transitions to underground around population centres and for road crossings. The transitions have an elevated frequency of cable faults, particularly where there is also moisture present in the cable. More investigation is required to fully characterise the higher cable fault frequency at transitions and it is currently considered that ambient temperature differentials, from below ground to above, may contribute. The DC resistivity of polymeric insulating material is temperature dependent and temperature differentials at the transitions may contribute to the higher cable fault frequency. The expanded cable replacement program will, where possible, reduce the number transitions by undergrounding the cable.

Historic Performance

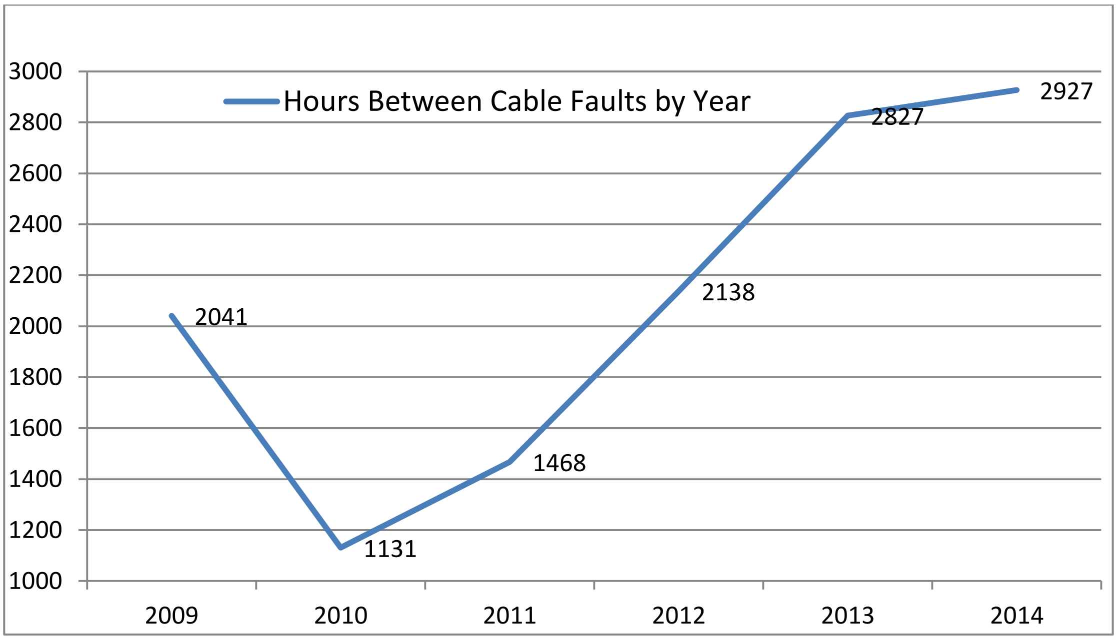
Replacing moisture affected cable has been shown to rectify high cable fault frequency in localised sections of individual cables. The cable sections where internal cable moisture is known or probable to exist, must be replaced to ensure the cable meets its forecast asset life.

The graph below demonstrates historic usage (replacement) of cable in maintaining Directlink's assets. Since 2011 larger sections of cable have been replaced due to the high number of faults in specific locations. Replacing larger cable sections has delivered positive results and has formed the basis of the expanded cable replacement program for the next regulatory period.



The graph below provides further demonstration of the reliability improvement to be gained from targeted cable replacement. The graph shows that, by 2010, the time between cable faults for that year had dropped to a low of 1131 hours. This has been improved to about 2927 hours, over the last four years. The data indicates that when all three Directlink systems are operational again (Mid 2015) a maximum of 3 cable faults per system per year should be expected at 100% availability. That is 9 cable faults per year.

The trend shown by the graph below indicates that the rate of improvement, made by the large amount of cable replaced in 2011, is declining and more replacement is required to improve the cable reliability to the industry standard.



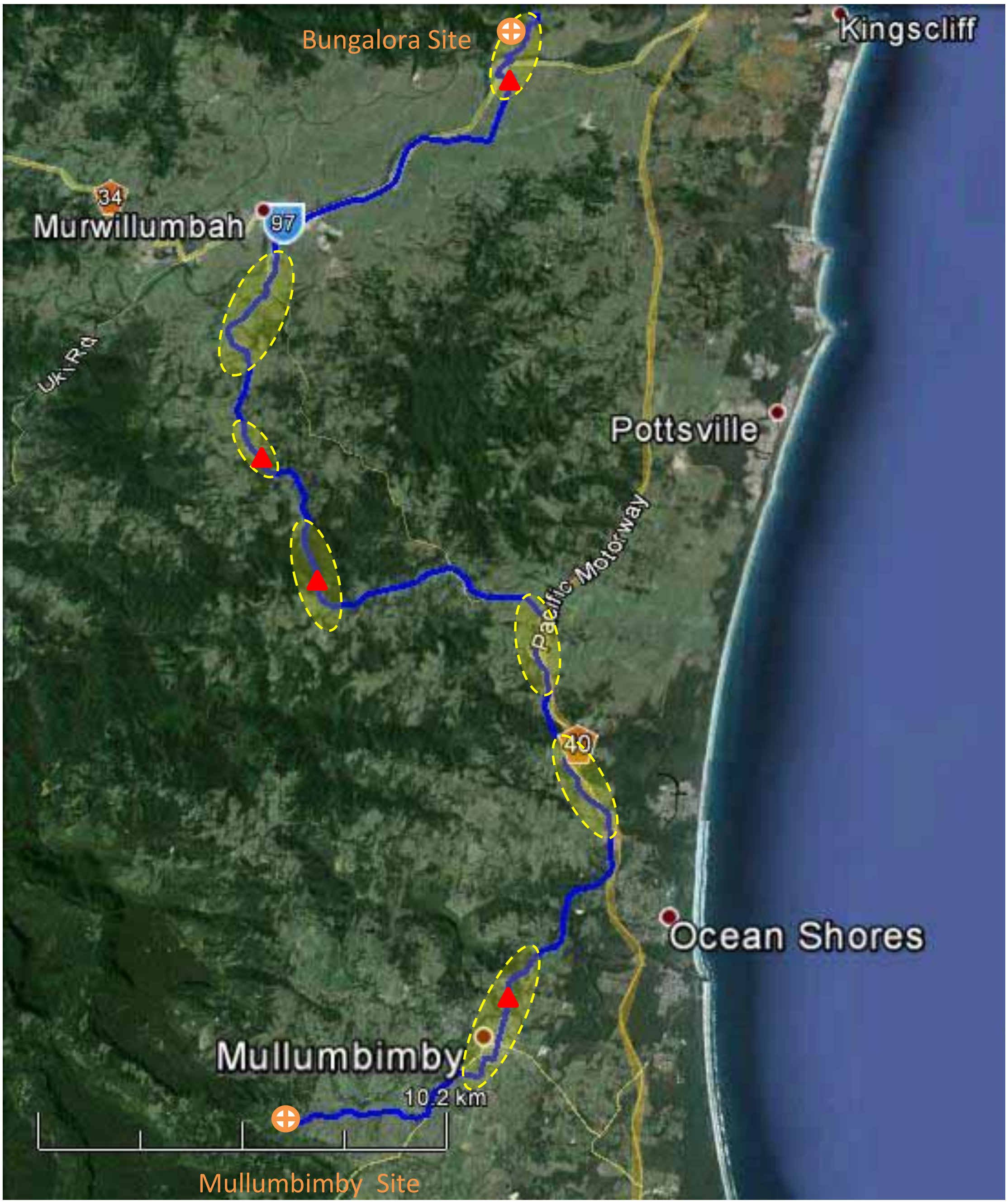
Planned Replacement Program

The expanded cable replacement program replaces the moisture affected cable proactively and reactively. The plan is to continue replacing cable in response to cable faults, as well as undertake planned remediation of localised cable section with known moisture. The program plans to complete 12 replacements per annum. The number of cable faults each year will determine the number of proactive cable replacements under taken for that year.

The basis of the capital expenditure is replacement of an average 250m of moisture affected cable (125m of cable on each side of fault). Two cable joints are required for each section of cable replaced.

The expanded cable replacement program will see less than 1% of Directlink's cable being replaced per year. While the proportion of the Directlink cable affected by moisture is unknown, the failure history of the Directlink cable indicates that between 5% and 6% of the Directlink cable has to potential to be moisture affected.

The following map represents some general concentrations of faults over the entire operational life of Directlink. The fault concentration areas are highlighted yellow. The approximate location of past, large cable section replacements are marked with a red triangle. It is proposed that the fault concentration areas will receive specific focus, to mitigate any future faults, with the expanded cable replacement program.


Bungalora Site
Kingscliff
Murwillumbah
97
34
Uki Rd
Pottsville
Pacific Motorway
40
Ocean Shores
Mullumbimby
10.2 km
Mullumbimby Site

EVALUATION OF ALTERNATIVES

The cable used is specifically nominated by the original equipment manufacturer ABB. Experimenting with alternative third party products would increase technical risk as well as jeopardise the original design performance and ongoing OEM support of the cable system. With equipment of this scale and complexity it is good industry practice to follow the manufacturer's recommended products to maintain the overall integrity of its system.

Cable remediation, by silicone injection into cables, was investigated with the aim of reducing the forecast consumption of cable and cable joints. Recent laboratory testing of the injection, with service aged Directlink cable, demonstrated that injection increase the likelihood of a cable fault. Consequently, cable replacement is the only known remediation method.

ESTIMATED COST

The following table represents the proposed expenditure for the labour and materials costs associated with the planned 12 cable replacements per annum.

To enable the planned cable replacement program, it is necessary to maintain an effective inventory of cable and cable joints due to the long lead times from order for these items.

Additional engineering and planning resources are required to undertake the expanded cable replacement program. The efficient and effective execution of the program requires:

- analysis of historic cable fault data and cable samples taken from cable replacements, both in the past and future, to target the replacement program for greatest effect;
- planning and scheduling of resources to minimise the overall outage time of Directlink, leveraging the outage time for cable replacement to undertake planned and corrective maintenance;
- detailed focus on the quality of the replacement works to ensure the investment in cable replacement yields the maximum reliability improvement.

	Total in Revenue Period	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**
PROCUREMENT						
Cable Purchase	$2,772,000	$554,400	$554,400	$554,400	$554,400	$554,400
Cable Joint Purchase	$1,893,936	$378,787	$378,787	$378,787	$378,787	$378,787
CABLE REPLACEMENTS						
APA Staff Costs	$590,430	$118,086	$118,086	$118,086	$118,086	$118,086
APA Sundry Materials	$30,000	$6,000	$6,000	$6,000	$6,000	$6,000

Contractor Labour	$1,138,015	$227,603	$227,603	$227,603	$227,603	$227,603
SENIOR RELIABILITY ENGINEER						
APA Staff Costs	$615,555	$123,111	$123,111	$123,111	$123,111	$123,111
WORKS PLANNER						
APA Staff Costs	$476,915	$95,383	$95,383	$95,383	$95,383	$95,383
WORK PRACTICES SPECIALIST						
APA Staff Costs	$476,915	$95,383	$95,383	$95,383	$95,383	$95,383
Total	$7,993,766	$1,598,753	$1,598,753	$1,598,753	$1,598,753	$1,598,753

PLAN FOR EFFECTIVE EXECUTION

The requirement for AER acceptance of capital and operating expenditure specified in 6A.6.7(c) and 6A.6.6(c) of the National Electricity Rules is that the expenditure must be such as would be incurred by a prudent service provider acting efficiently, and represent a realistic expectation of the costs to achieve the requirement.

The cable and cable joint purchase costs to secure the relevant inventory are those quoted by the original equipment manufacturer ABB who is the sole provider of this product consistent with their original design specification for this system.

Labour activties (cable joining and laying, etc) will be undertaken via APA group's standard procurment practices to ensure the approate quality and cost efectivness for these services.

JUSTIFICATION

This expanded cable replacement program is required to meet the following capital and operating expenditure objectives set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The expenditure for the program is justified under clauses (1), (3) and (4), being required to maintain the efficient operability (minimise turnaround times on outages) and the security of supply in the provision of prescribed transmission services.

RECOMMENDATION

It is recommended to undertake an expanded cable replacement program, to remediate the high frequency of cable faults. The program plans to continue replacing cable in response to cable faults, as well as to undertake proactive remediation of localised cable section with known moisture.

To enable the planned cable replacement program, it is necessary to maintain an effective inventory of cable and cable joints for the efficient execution of the plan.

Additional engineering and planning resources are required to efficiently and effectively undertake the expanded cable replacement program.

The estimated costs have been included in the operating and capital expenditure forecasts for the Directlink Regulatory submissions.

Business Case

Service Provider:	APA Group	**Date:**	26 May 2014
Asset:	Directlink		
Project:	Zero Sequence Reactor Repair		
Project Type:	*Capex / Opex :*	*$1.46 million ($2013/14)*	
Prepared:	*Stuart Dodds*	*Operations Manager Power Transmission*	
Endorsed:	Paul Thorley	*State Manager Asset Management*	
Approved:	Kerryanne Mallitt	*General Manager Asset Management*	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal covering the financial years 2016 to 2020.

BACKGROUND

Directlink is a 59 kilometre bipolar HVDC cable and converter stations located between Bungalora and Mullumbimby, New South Wales. There are 3 systems connected by pairs of bipolar transmission cables. Each pair of cables operates at +/-80 kV and transmits 60 MW. In New South Wales it is connected with a 132 kV transmission grid and from Queensland with 110 kV transmission grid. The system was commissioned in December 1999 and became a regulated asset on 10 March 2006. APA acquired this asset in December 2006 (finalised in February 2007).

IDENTIFICATION OF NEED

During a site visit 2013 by ABB Power Transformer's Group (Ludvika, Sweden) it was identified that there was corrosion to the core of APA's spare Zero Sequence Reactor which is a critical spare maintained for repairs to the Directlink systems.

Extract from ABB report:

ABB AB
Power Transformers

Rapport
Report

R SETFO 2013-195

Författare - Author: Sebastian Jutäng
Från – From: PPTR/DKS
Datum - Date: 2013-09-26
Rev. ind
Sida -: 1 (10)

Godkännare – Approved by: Martin PerOls PPTR/DK
Ordernr – Ref.No: Direct Link
Uppdragsgivare – Requested by: Hashim Malik PPTR/AM
Pkl/Akl
Titel - Title: Site Inspection Direct Link
Antal textsidor – No. of text pages: 10

7. ZSSR inspection

At inspection of the spare ZSSR that was stored in the warehouse close to the airport in Brisbane (The Eagle farm) the following was noticed:

- Corrosion found in the corner window at the over-lap joints at bottom yoke.
  How serious is this? Probably it will increase the losses but could it even cause a core melt? This must be investigated by core specialists at ABB Power Transformers in Ludvika.
- The windings need to be megged to verify the insulation between windings and between each winding and earth. Megging instruction has been sent to Stuart Dodds APA and he will return the result.
  The result of the Megging will be checked by the senior electrical test specialist Bengt Jönsson at ABB Power Transformers in Ludvika.

ABB subsequently advised that the damage to the core would not be practical to repair via dismantling, cleaning / repair and then reassembly back into the reactor. ABB advised that a new replacement core was the most cost effective treatment to restoring the reactor back into a serviceable unit.

The core requires a long lead time (47 weeks) to procure, build and supply, and for this reason it is imperative to maintain at least one spare unit in stock.

EVALUATION OF ALTERNATIVES

The Zero Sequence Reactor is a specialised item developed by the OEM ABB. The construction is unusual, being made by winding polymeric high voltage DC cable onto a frame which is mounted onto a laminated core.

Experimenting with alternative third parties, for remediation the damaged core, will increase the technical risk that the reactor will not meet the original design performance and will jeopardise ongoing OEM support of the Directlink system. The spare reactor will potentially be stored for a long time before being required for operation. Any performance deficiency, at the time of use, could be difficult to attribute to the repair party. Given the critical nature of the spare reactor it is considered prudent and good industry practice to engage the OEM for the refurbishment.

There are synergies with the manufacture of the zero sequence reactor for the current Mullumbimby system 1 converter station rebuild. ABB currently has sufficient cable in stock, from the zero sequence reactor manufacture, to fully rewind the spare reactor should the existing cable fail during the post core replacement testing.

ESTIMATED COST

The proposed works are outlined below:

1. Project administration of activities here and in Sweden
2. Suppling a new Core for the spare Zero Sequence Reactor
    - Involving Design calculation's and Engineering support from ABB Ludvika
3. Movement of the spare core from APA's storage facility
4. Transportation costs for the new core from Sweden to ABB Darra
5. Exchanging the core at the Brisbane offices of ABB
    - It is anticipated that the installation will take 3 weeks, utilising a installation team of 4 personnel consisting of a supervisor and technician from Ludivka and 2 transformer technicians provided by the local transformer service.
6. Testing of the unit after completion
7. Sundry costs associated with travel, accommodation, local transport of staff, plant and materials.

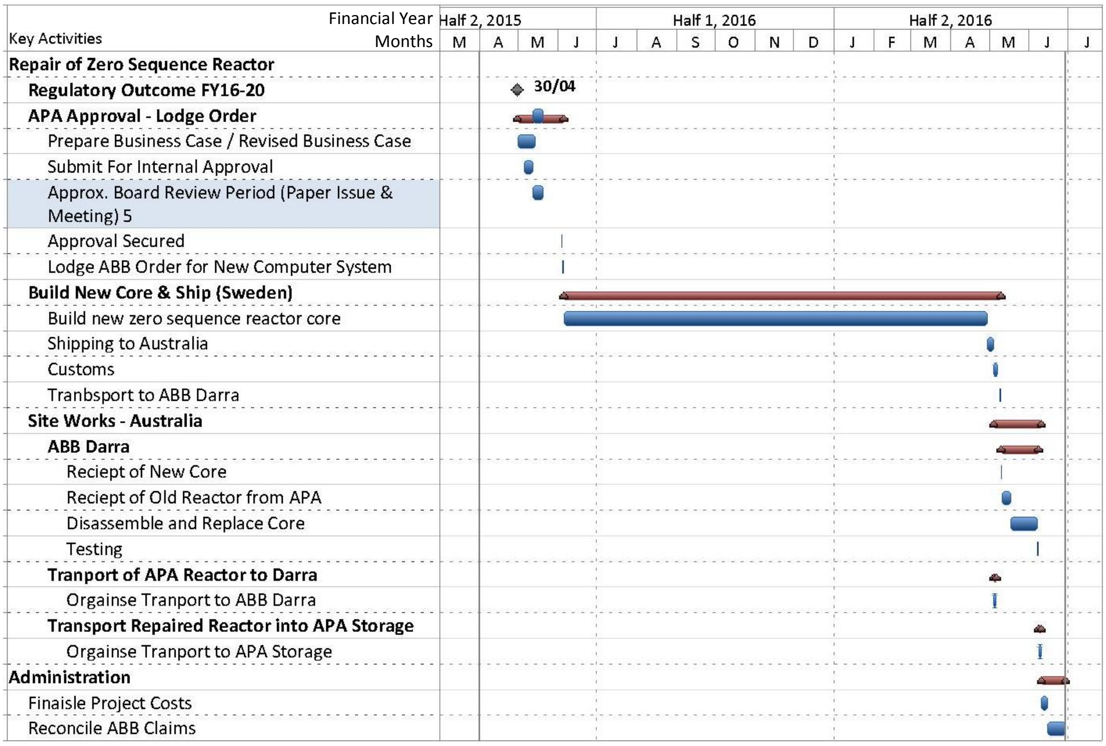
The repaired Zero Sequence Reactor will meet the original design specification for the Directlink system.

Total Cost **$1,461,547**

PLAN FOR EFFECTIVE EXECUTION

The requirement for AER acceptance of capital and operating expenditure specified in 6A.6.7(c) and 6A.6.6(c) of the National Electricity Rules is that the expenditure must be such as would be incurred by a prudent service provider acting efficiently, and represent a realistic expectation of the costs to achieve the requirement.

The following schedule represents the key activities for ABB to undertake the repair of the spare Zero Sequence Reactor (FY 2016-2020 regulatory period).



JUSTIFICATION

The repair of the spare Zero Sequence Reactor for "Directlink" is required to meet the following capital and operating expenditure objectives set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The project is justified under clauses (3) being required to maintain the efficient operability of the plant. The project will ensure that stock is maintained of a critical, long lead time, spare Zero Sequence Reactor to minimise the risk of long term outages should such a unit need to be replaced.

The Directlink Zero Sequence Reactor is a critical spare and should a problem occur in the period leading up to the repair of the spare Zero sequence reactor significant outages will be experienced whilst an alternative unit is sourced.

RECOMMENDATION

It is recommended that the repair of the spare Zero Sequence Reactor be undertaken as a matter of urgency to maintain critical spares for the Directlink assets and ensure:

- adequate stock of critical components are maintained for the longer term maintenance and availability of the system;
- timely response to any future faults with the Zero Sequence Reactors allowing effective repair and minimised outages; and
- Good industry practice by maintaining stock of critical components for the long term sustainability / availability of the plant.

The estimated costs have been included in the operating and capital expenditure forecasts for the Directlink Regulatory submissions.

Business Case

Service Provider:	APA Group	**Date:**	26 May 2014
Asset:	Directlink		
Project:	Roof Repair of Converter Buildings		
Project Type:	*Capex/Opex :*	*$ 269,287*	
Prepared:	*Stuart Dodds*	*Operations Manager Power Transmission*	
Endorsed:	Paul Thorley	*State Manager Asset Management*	
Approved:	Kerryanne Mallitt	*General Manager Asset Management*	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal for the financial years 2016 to 2020.

BACKGROUND

Directlink is a 59 kilometre bipolar HVDC cable and converter stations located between Bungalora and Mullumbimby, New South Wales. There are 3 systems connected by pairs of bipolar transmission cables. Each pair of cables operates at +/-80 kV and transmits 60 MW. In New South Wales it is connected to the 132 kV transmission grid and from Queensland to the 110 kV transmission grid. The system was commissioned in December 1999 and became a regulated asset on 10 March 2006.

The efficient maintenance of this asset has driven the need for a program of work to address corrosion forming on the steel roof sheets and fastening screws of the converter buildings.

IDENTIFICATION OF NEED

A roof restoration program of work is required to ensure the converter building roof meets its forecast asset life.

The performance of the roof is critical for protecting key components inside the converter building. The 3 phase reactors and the zero sequence reactor are not designed for outdoor service and must be completely protected from rainfall. Demonstrating this is the 2007 failure of a phase reactor in the system 3 Bungalora converter building. In this instance, a phase reactor shorted circuited, burning a large track from the top of the reactor to the bottom. The most likely cause of this failure is attributed to improperly sealed flashing around the phase reactor exhaust chimney which allowed rain water to enter the reactor.

Corrosion is present on the steel roof sheets as hundreds of small rust patches. A small number of the rust patches have corroded completely through the roof sheets. These have been addressed urgently to prevent rain water collecting in the roof insulation and steel substructure, causing further damage to both. The remaining rust patches must be abraided and coated to halt the progression of the corrosion.

Corrosion is present on the heads of the fastening screw protruding above the steel roof sheets. The zinc coating of the screw heads has been consumed, allowing the steel beneath to corrode.

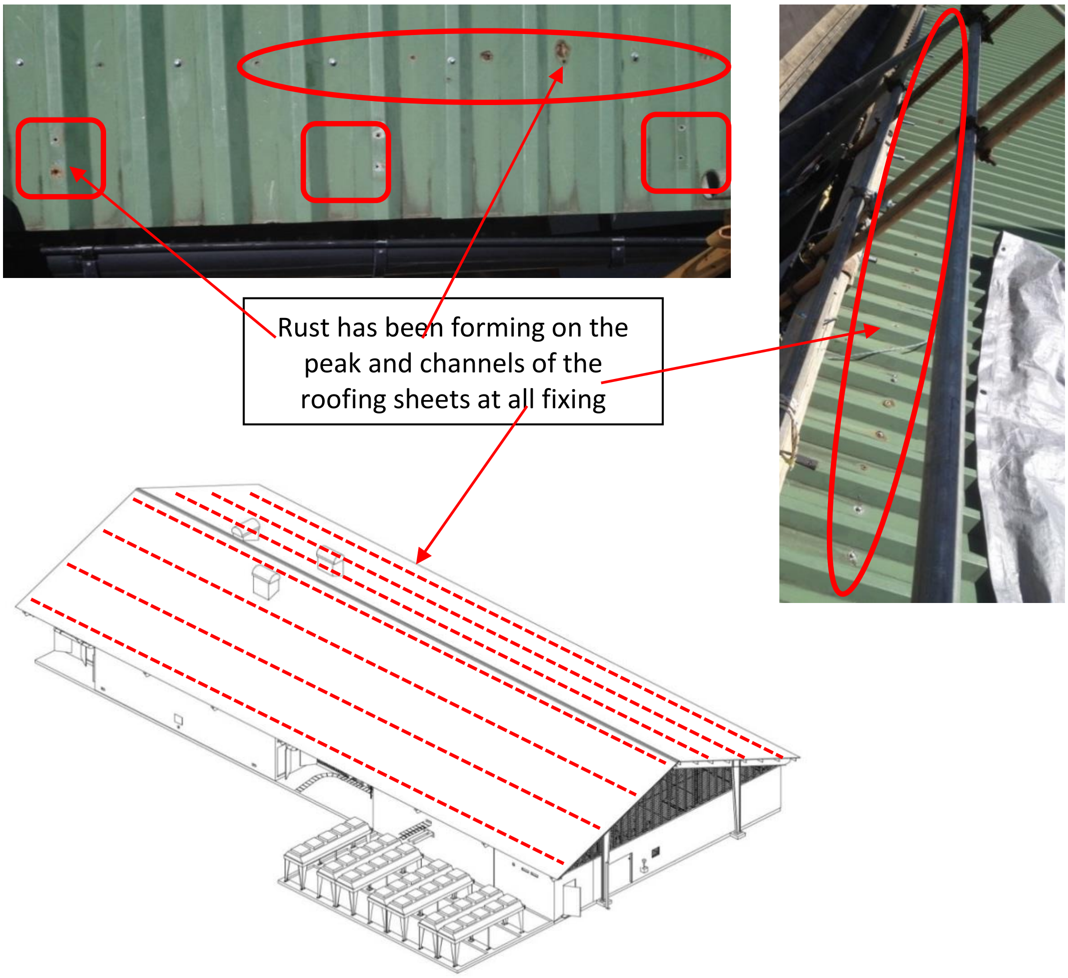
The project plans to repair the converter building roof corrosion as follows:

1. scrape back deteriorated paint from roof sheets;
2. remove rust and paint with corrosion inhibitor;
3. strengthen with fiberglass matting and gel coat;
4. coat with polyurethane membrane.

The requirement for this project arises from a mixture of:

- good facility management practices to extend the asset life of the existing roof and reduce maintenance costs by select the most effective whole-of-life net cost solution.
- prudent protection of the roof substructure, sound proofing, and electrical equipment contained within the buildings.

The images below shows the current state of these buildings.



EVALUATION OF ALTERNATIVES

A number of alternatives were evaluated and the most efficient solution was to use inhibitors and fibreglass to undertake spot repairs, then paint the entire roof to prevent future corrosion developing..

The original roof profile / product was specifically nominated by the OEM ABB and has not proven durable in the Australian coastal conditions given the degree of deterioration since construction in 1999. The metal roof sheets are of European manufacture and the sheet profile cannot be sourced in Australia.

The range of alternative solutions considered (in 2014 $) is set out below with option 2 being the chosen solution:

1. Source original product to undertake spot repairs / replacement.	Not an effective long term solution as the product is not suited to Australian conditions. Cost of works and materials would be higher than local product with no warranty under Australia conditions.
2. Use locally available inhibitors and fibreglass to undertake spot repairs, then paint the entire roof.	Lowest cost option. $46k per building. One year warranty on repairs.
3. Use local product to undertake a staged replacement as and when required with the goal to fully replace roof.	Not the preferred options because it is a piece meal activity requiring tailored flashing to join between non uniform profiles at each stage. Additional mobilisation / demobilisation costs due to staging. Additional puncturing of new sheets to match staging joins will impact on warranty. Roofing works $115,000 / building. With one year warranty on joins, 25 year on materials
4. Use local product to undertake a staged, building by building replacement.	Higher cost than the preferred option. Roof completely replaced on each building. Per building roof replacement $85,000 with 25 years warranty on product and defective workmanship
5. Do nothing	Continued deterioration of roof will increase water leakage into insulation compartment in ceiling (200 mm think). Water will migrate across insulation and escape through perforated ceiling panels. Equipment will be exposed to dripping and pooling water potentially causing outages and increasing safety risk. Insulation will breakdown and issues of mould / spores may occur in ceiling.

The work is planned to annually engage roofing contractors to assess the roof of the five original converter buildings, then repair and protect the most urgent areas of deterioration for those roofs. This annual program of work will ensure the converter building roof is maintained for the life of the asset.

The new Mullumbimby system 1 converter building is not expected to require any work during the coming regulatory period.

ESTIMATED COST

Preliminary estimates have been obtained from local providers and are subject to a detailed inspection and sourcing of products at the time of construction. The work is expected to be completed in FY2017.

Activities	Duration	Cost
Roof Repairs along 945m2 x $49.5/m2 x 5 Buildings	5-8 weeks	$233,888
Site supervision	8 weeks	-
Scaffold hire, assembly and disassembly (5 buildings)	5-8 weeks	$50,000
Mobilisation of site (safety protocols, barricading, etc.)	1 week	$2,200
Demobilisation of site	1 week	$1,100
Totals	**7-10 Weeks**	**$287,188**

	FY 16	FY 17	FY 18	FY 19	FY 20
	5 Blds	5 Blds	5 Blds	5 Blds	5 Blds
Capital Program	$0	$287,188	$0	$0	$0

PLAN FOR EFFECTIVE EXECUTION

The requirement for AER acceptance of capital and operating expenditure specified in 6A.6.7(c) and 6A.6.6(c) of the National Electricity Rules is that the expenditure must be such as would be incurred by a prudent service provider acting efficiently, and represent a realistic expectation of the costs to achieve the requirement.

The selection process to secure the relevant roofing contractor will follow APA Group Policy to ensure effective sourcing. These proposed works will be repeated over 5 years, targeting the dryer months (August – September) of FY 2017.

JUSTIFICATION

This capital project for roof restoration is required to meet the following capital and operating expenditure objectives set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The expenditure for the roof restoration program is justified under clauses (3) and (4), being required to maintain the efficient operability and the security of supply in the provision of prescribed transmission services.

RECOMMENDATION

It is recommended to use locally available inhibitors and fibreglass to undertake spot repairs, then paint the entire roof. This program should be carried out to:

- ensure good facility management practices are followed in sustaining assets and reducing maintenance costs by select the most effective whole-of-life net cost solution.
- ensure prudent protection of the roof, structure, sound proofing, and electrical equipment contained within the buildings.

The estimated costs have been included in the capital expenditure forecasts for the Directlink Regulatory submissions.