ABN 85 082 464 622

MANAGEMENT PLAN 2011
HIGH VOLTAGE REGULATORS

DOCUMENT NUMBER: NW#-30161495-V2

DATE: 8 MAY 2011

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TABLE OF CONTENTS

REV NO.	DATE	REVISION DESCRIPTION	APPROVALS	
0	16 Feb 2011	Original Issue. (NW#-30161495-V1A). Based on Asset Management Plan 2007 - Regulators (NW10219870).	Prepared by	SG
			Reviewed by	GS
			Approved by	AD
1	8 May 2011	Updated with comments from EY. (NW#-30161495-V2).	Prepared by	ST
			Reviewed	FP
			Approved by	AD

1. PURPOSE

The purpose of this document is to describe for High Voltage Regulators and related assets:

- Aurora's ap proach t o as set management, as r eflected t hrough i ts legislative and r egulatory obl igations a nd N etwork M anagement Strategy;
- The key projects and pr ograms underpinning its activities for the period 2012/13 to –2016/17; and
- Forecast C APEX an d O PEX, i ncluding t he bas is upon w hich t hese forecasts are derived.

2. STRATEGY

The objective of the Network Management Strategy is:

To minimise cost of supply to the customer whilst:

a. Maintaining network performance;

b. Managing business operating risks; and

c. *Complying w ith r egulatory, c ontractual and l egal responsibilities.*

3. SCOPE

This d ocument c overs hi gh v oltage (HV) regulators and t heir associated enclosures and earthing systems.

4. DESCRIPTION OF THE ASSETS

The assets covered by the High Voltage Regulator Thread and Management Plan are:

1. **High Voltage Regulators:** to maintain acceptable voltage levels along high voltage feeders
2. **Earthing System:** to ensure personnel and public safety and to ensure correct operation of protection equipment; and
3. **Enclosures:** to provide a s afe and s ecure l ocation for hi gh v oltage regulator equipment.

The following as sets ar e not c overed un der t he H igh V oltage R egulator thread:

- Connecting overhead lines or cables; and
- Capacitor banks.

4.1 High Voltage Regulators

High voltage regulators are installed at various locations along HV feeders to maintain voltage levels within the distribution network to industry acceptable standards.

HV r egulators ar e g enerally l ocated on r ural 11 k V and 2 2 kV feeders according t o t he l oad and l ength o f t hese feeders, w ith s everal i nstalled i n rural zone substations.

HV regulators can be split into two groups:

1. **Single phase units:** usually pole mounted in an open-delta configuration (two tanks), but may also be ground mounted; and
2. **Three phase units:** typically older units that are ground mounted within a fenced enclosure.

Table 1 lists the different types of HV regulators installed in Aurora's system that were identified in a 2009 audit (reference 1).

Table 1: HV regulators installed in Aurora's distribution system

Regulator type	Manufacturer	Mounting	Voltage (kV)	Size	Installation Period	Number of Sites
Single Phase Regulators	Cooper	Pole	11	100	2000 to present	1
				150	2000 to present	1
				200	2000 to present	4
			22	100	2000 to present	4
				150	2000 to present	1
				200	2000 to present	18
		Ground	22	300	2000 to present	1

Regulator type	Manufacturer	Mounting	Voltage (kV)	Size	Installation Period	Number of Sites
Three Phase Regulators	Crompton Parkinson	Ground	11	52	1979	2
	Wilson/ Ferranti	Ground	11	52	1978	1
				105	1966 to 1998	2
				157	1980 to 1982	3
				262	1976 to 1978	4
			22	52	1983 to 1986	2
				80	1982 to 1988	5
				131	1976 to 1984	7
	ABB	Ground	22	131	1993 to 1999	8
				197	1995 to 1999	2
				262	1998	1
	English Electric	Ground	11	52	1978	1
	Tyree	Ground	22	79	1997	1
				131	1982 to 1984	2
	Wilson/ Fuller	Ground	22	52	1983 to 1999	2

Figure 1 and Figure 2 show typical installations for three phase regulators and pole-mounted single phase open-delta regulators.

Figure 1: Typical Three Phase Regulator

Figure 2: Typical Pole-Mounted Single Phase Open-Delta Regulator

4.2 Earthing Systems

The integrity of the earthing system is essential for maintaining personnel and public safety and for the correct operation of protection equipment. The fault level, protection clearing time and site soil resistivity dictate the extent of earthing required.

The earthing system for ground mounted regulator installations is typically a copper earth grid, possibly with associated earth pins. All metallic components of the installation including the wire fence enclosure and lightning protection are connected to the earthing system. The earthing system for a pole-mounted regulator installation is typically a series of earth rods driven into the ground and connected by copper conductor.

The difference between the two earthing systems is due to the location of the operator when operating a regulator site. In ground-mounted sites, the operator is on the ground and may be exposed to step and touch potentials, whilst pole mounted regulators are operated from a ladder, significantly reducing the exposure to step and touch potentials.

4.3 Enclosures

Ground mounted regulator sites are surrounded by a chain wire fence enclosure topped with barbed wire. The purpose of the enclosure is to provide a secure location for the equipment and to provide for public safety. A possum guard and warning signs are also installed on the fence. Typically there are two gates installed in the enclosure fence.

At some ground-mounted sites, oil containment is provided to contain the oil in the event of loss of oil from the regulator unit. There is no oil containment at pole-mounted sites.

Typically the pole-mounted sites are mounted at a height to prevent public access and possum guards are installed on the poles to prevent wildlife access, with no requirement for an enclosure.

5. AGE PROFILE

The age profile data for HV regulators was compiled using data from a 2009 audit (reference 1). The manufacture year of the assets was used to calculate the age of the asset, where known. Otherwise, the installation year was used as a proxy.

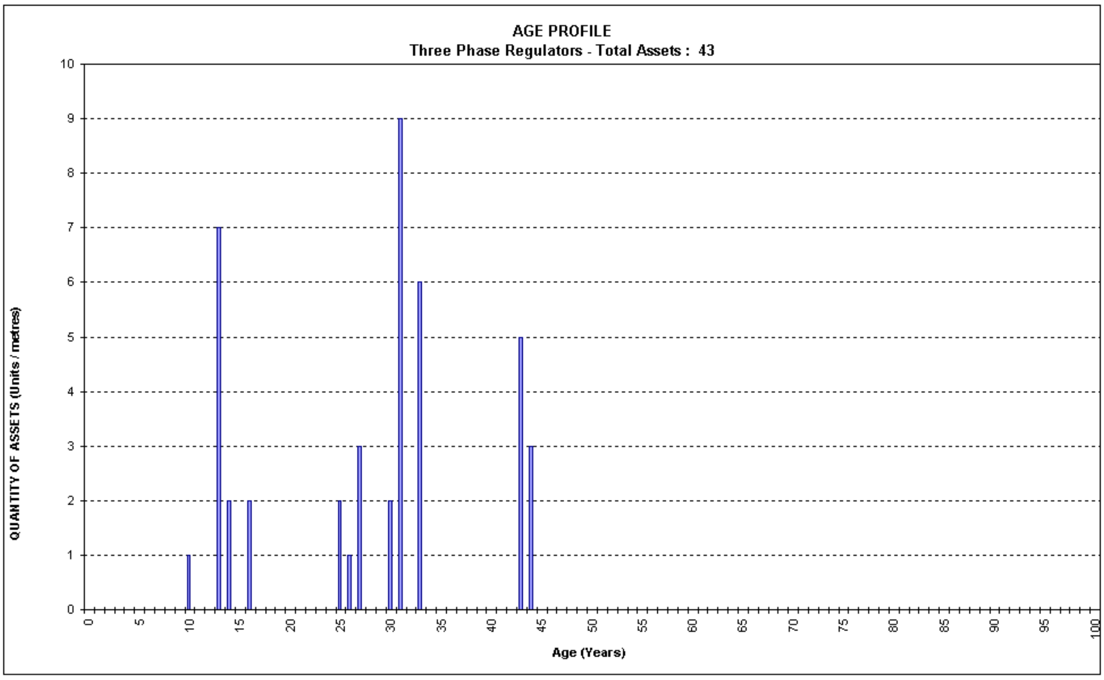

Figure 3 Age profile of Three Phase Regulator Sites as at September 2009

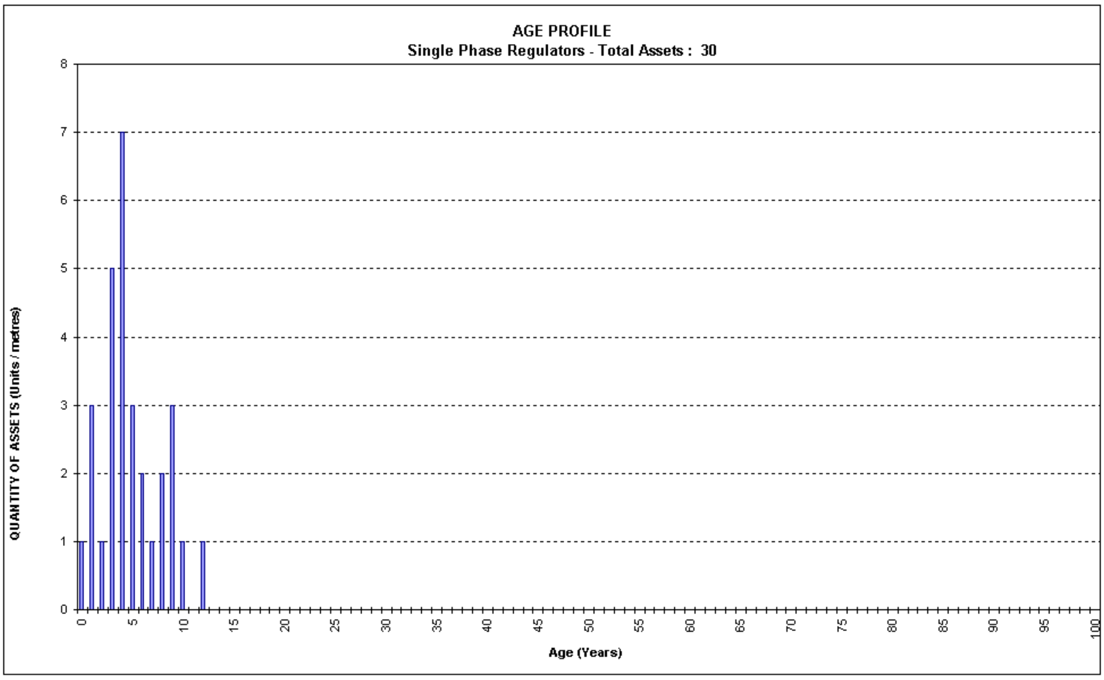

Figure 4 Age profile of Single Phase Regulator Sites as at September 2009

There has been an increase in the number of regulator sites installed since 2000 to address voltage compliance issues and defer larger network investment such as network augmentation.

Regulator failures have minimal impact on SAIDI and SAIFI due to their small volumes in the system. However, there is a known operational issue with the single phase open delta pole mounted units that require the regulator to be set to the Neutral Tap position when paralleling two feeders. This can limit the time that a switching can occur for planned outages and can cause significant voltage issues during unplanned outages and load restoration.

6. FACTORS INFLUENCING ASSET MANAGEMENT STRATEGIES

The principle factors influencing asset management strategies are classified as per objectives set out in Section 2.

6.1 Minimising Cost of Supply to the Customer

- Ensuring cost effective trade-offs are made between pro-active and reactive maintenance practices;
- Maintenance activities cost effectively ensure a reasonable service life is achieved from the asset; and
- Capturing adequate information on the assets to facilitate informed decision making.

6.2 Maintaining Network Performance

- As failure of this asset class generally impact a large number of customers and loads, it is crucial to maintain in-service failures to a very low level; and
- Ensuring the general operational condition of the assets is maintained to an acceptable level to ensure reliable function of the regulators and do not supply non-compliant voltages to the customers.

6.3 Managing Business Operating Risks

- Ensuring the assets perform reliably and do not supply non-compliant voltage to consumers;
- Ensuring adequate security is maintained to restrict unauthorised access to Aurora's assets; and
- Ensuring all risks are identified and have adequate management plans integrated into the business' practices.

6.4 Complying with Regulatory, Contractual and Legal Responsibilities

- Ensuring adequate monitoring and inspection activities cover legislative compliance obligations and safety risks.

The following is a brief description of the specific regulatory obligations directly influencing Aurora's management of HV regulators.

6.4.1 Changes to the Occupational Licensing Act 2005

Changes to the Occupational Licensing Act 2005 that became effective on 19 January 2009 require Aurora to be compliant with *AS2067 Substations and high voltage installations exceeding 1 kV a.c.* (reference 2) in the construction and operation of its distribution network.

6.4.2 Polychlorinated Biphenyls (PCBs)

Aurora manages PCBs in accordance with Aurora's Procedure EM-M09 Management of PCB's, which reflects the requirements of the Australian and New Zealand Environment and Conservation Council (ANZECC) Polychlorinated Biphenyls Management Plan (reference 3). Both plans satisfy the legislative requirements of the *TAS Environmental Protection & Pollution*

Act 1994 and the *National Environment Protection Council Act 1994* (references 4 and 5).

Polychlorinated biphenyls (PCBs) were used in transformers and capacitors amongst other things from the 1930s to the 1970s. However, they were shown to be toxic and carcinogenic and have been banned in Australia in the 1970s.

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7. SPECIFIC ISSUES AND MANAGEMENT PLAN

7.1 Treatment Trade-offs

7.1.1 Preventative versus Reactive Maintenance

There is a fundamental requirement for Aurora to periodically inspect the assets to ensure their physical state and condition does not represent a hazard to the public. Other than visiting the assets, there is no other economic solution to satisfy this requirement.

Preventative maintenance of the tap changer units is required as failure of the units can result in serious or catastrophic damage, especially in the older three phase units. Jamming of the mechanism can result in non-compliant voltages to customers so a basic level of preventative maintenance is required, despite the reliability of the modern single phase units.

7.1.2 Refurbishment

Where HV regulators are removed from the network in good operating condition by activities such as capacity and power quality drivers, these assets are assessed for redeployment back into the network where such refurbishment is deemed to be required and an economic proposition.

7.1.3 Planned versus Reactive Replacement

Regulators are an essential element in the network infrastructure that generally do not have redundant or alternate elements in the system design. To minimise consumer disruption for extended periods and maintain system voltages within required bounds, reactive replacement is avoided.

7.1.4 Non Network Solutions

Regulators are generally installed as a cost effective alternative to upgrading other system assets.

7.2 Preventative Maintenance and Asset Repair

7.2.1 Three Phase Regulator Inspection

A monthly load and operational check is conducted on three phase regulators to capture load information and check the units are tapping correctly. Historically, three phase regulators have exhibited the following failure modes:

1. Contactors sticking – the relays that pass the motor current during a tap change sometimes get stuck causing the tap changer to run away to

either top or bottom tap, resulting in unacceptable voltages for downstream customers

2. Blown resistors in the timing boards (Wilson/Ferranti)
3. Burnt out timing boards (Wilson/Ferranti)
4. Faulty Automatic Voltage Relay (AVR) for older type ground mounted units
5. Water getting into the control cubicle causing shorting problems (especially on the ABB units); and
6. Springs and other parts have come adrift especially on the braking systems.

All of these failure modes result in incorrect tapping of the units and ultimately voltage problems on the system.

7.2.2 Operational Checks and Asset Inspections

Quarterly operational checks and asset inspections are conducted on every ground mounted regulator site. The operational checks and asset inspections consist of:

1. Load and tap information check: to collect load data;
2. Operational check: to ensure the unit is tapping properly; and
3. Asset inspection: to inspect the asset condition.

This inspection is conducted in conjunction with Civil Maintenance (section 7.2.3).

7.2.3 Civil Maintenance

Civil maintenance of ground mounted regulator sites is conducted quarterly to address environmental, safety and security issues and undertake site maintenance tasks such as weed spraying and painting as required. The frequency is based on Aurora's previous experience to make sure that sites are safe and clean. This maintenance is conducted in conjunction with the Operational Checks and Asset Inspections (section 7.2.2)

7.2.4 Routine Mechanical Maintenance

Routine mechanical maintenance is required to inspect the mechanical components of the tap changer. Over time the tap changer contacts corrode due to normal operation and the insulating oil develops a build up of carbon and foreign particles, reducing its dielectric strength, cooling properties and arc-quenching ability.

At routine full mechanical maintenance the tap changer contacts and other mechanical parts are inspected and replaced if required and the insulating oil is replaced.

The routine mechanical maintenance for three phase regulators is conducted every four years as per the manufacturer's recommendations and the performance of the equipment. The maintenance is performed on site and requires de-energising of the unit. No transportation to a workshop is required.

The routine full mechanical maintenance for single-phase units is conducted every ten years or 100,000 tapping operations (whichever occurs first), as per the manufacturer's recommendations. The maintenance requires the unit to be removed from the system and transported to workshop for full mechanical maintenance. Thus, to perform the maintenance without impacting on customer power quality, replacement units are required to be installed and commissioned at the time the old units are removed from site for maintenance.

7.2.5 Single Phase Regulators – Tap Position Indicators

To address the issue of older style tap position indicators on the single-phase regulators suffering from corrosion and water ingress, it is proposed to replace the tap position indicators during routine mechanical maintenance (section 7.2.4).

Whilst the tap position indicators can be replaced on site, it is more efficient to address this issue as part of the routine mechanical maintenance, as on-site replacement requires the units to be de-energised.

7.2.6 Single Phase Regulators – Tap Changer Motor Drive Capacitor

Single phase regulators were introduced into the distribution system in 2000. Aurora has one recorded incident in 2006 were two tanks failed in service due to faulty tap changer motor drive capacitors.

In early models of the single phase regulators, installed with a CL-5 controller, the motor drive capacitor is located within the regulator tank. Thus, a faulty motor drive capacitor requires the unit to be removed from site and de-tanked to replace the capacitor.

Knowing that this failure mode exists in earlier models, it is desirable for future models to have the motor drive capacitor located outside the tank to remove the need to de-tank the regulator for capacitor failures.

The manufacturer has advised that it is possible to relocate the tap changer motor drive capacitor from inside the tank to the control cubicle. Thus, it is planned to relocate the tap changer motor drive capacitor to the control cubicle on all units with an internal capacitor as part of the routine mechanical maintenance (section 7.2.4).

7.2.7 Single Phase Regulator Oil Checks

Single phase HV regulators have an oil test conducted every five years to check the integrity of the insulating oil between routine mechanical maintenance because the tapping occurs in the main tank.

Three phase units have separate main tank and tap changer compartments and as part of the maintenance of three phase units the oil is changed in the tap changer compartment, so there is no requirement to test the oil between maintenance cycles.

7.2.8 Remote Control

Where shown to be an economic proposition, remote monitoring equipment will be installed at single-phase unit regulator sites. This equipment will be used to monitor the voltages, currents and operation of the equipment and will be used to remotely control the regulators. From a maintenance point of view, the information gathered from each site using the remote monitoring will assist in maintenance decisions, for example, if a regulator is heavily loaded or is tap changing frequently, this site may require preventative maintenance more frequently than others.

The Network Development Team manages this program. Remote control of older three phase regulator sites will be investigated once all single phase units have been completed.

7.2.9 Maintenance Improvements

The CL-6 controller, installed on some single phase regulators (those with quick-drive tap changers) has two features, which may improve single phase regulator maintenance, namely:

1. Duty Cycle Monitoring; and
2. Preventative Maintenance Tapping.

It is proposed that both options of this feature be trialled at Aurora's Training School regulator sites for further analysis before rolling it out to the entire CL-6 population.

These readings can be included in the information download once the single phase units are remote controlled.

Duty Cycle Monitoring

Duty cycle monitoring calculates the worst case value of used life as a percentage for each arcing surface contact on the tap changer based on measured current, voltage, power factor and tap position. The manufacturer recommends that routine mechanical maintenance be scheduled once the Duty Cycle Monitor reaches 75%.

This feature may be used to allow for more efficient scheduling of routine mechanical maintenance, as the maintenance is scheduled based on the estimated condition inferred from the measured duty of the tap changer rather than at set time intervals.

Preventative Maintenance Tapping

The Preventative Maintenance Tapping feature automatically operates the tap changer periodically to prevent a build-up of carbon, known as coking, on the tap changer contacts.

Two Preventative Maintenance Tapping options are available:

1. Tap up once, down twice, then up once again to remove carbon from the tap position contacts; and
2. Tap past the neutral tap position by one to remove carbon from the reverse switch contacts.

7.3 Asset Replacement

7.3.1 Three Phase Regulator Replacement Program

Due to known failure modes with three phase regulators and the high preventative maintenance costs associated with these assets (monthly load and operational checks, four yearly routine mechanical maintenance, etc.), Aurora has made the decision to replace these units as they fail, require significant maintenance or refurbishment work.

Aurora proposes to replace one site each year based on the condition of the asset. Section 7.4 covers the replacement strategy in more detail.

7.3.2 Single Phase Regulators – Rusted Tanks

The current population of single phase regulators were supplied with mild steel tanks and after less than 10 years in service several of these units are showing severe signs of rusting.

To address the issue of rusted tanks on the single phase regulator units, Aurora investigated remediation options including:

- Replacing the existing tanks with stainless steel tanks as part of routine mechanical maintenance
- Repairing the existing tanks as part of routine mechanical maintenance
- Repairing and galvanising the existing tanks as part of routine mechanical maintenance.

The cost for a new steel tank was found to be approximately $22,000 per tank.

The cost of repairing of the tank and providing protective coating of epoxy paints suitable for all kind of hostile environmental conditions (C4) was found to be approximately $3000 per tank.

The option of repairing and galvanising the existing tanks was discounted, as there was no local supplier able to galvanise a tank of this size.

Based on this information, all existing tanks will be repaired and treated with a protective coating as part of their routine full mechanical maintenance.

The manufacturer of the single phase regulators has an All 304 Stainless Steel tank option available. All new single phase regulators will be supplied with All 304 Stainless Steel tanks.

7.3.3 Environmental Issues

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Environmentally sensitive sites will be relocated or converted into a ground mounted site with single phase regulators and appropriate oil bunding.

Aurora proposes to address one site each year.

7.4 Oil Containment

AS2067 requires that every high voltage installation containing equipment with more than 500 litres of a liquid dielectric such as transformer oil, shall have provision for containing the total volume of any possible leakage and meet the overall objectives of *AS1940: The storage and handling of flammable and combustible liquids, Appendix H* (reference 6).

All three-phase regulators have greater than 500 litres of oil and Table 2 lists the volume of oil contained in the various sizes of single-phase regulators.

Table 2: Single Phase Regulator Oil Volumes

Voltage (kV)	Size (A)	Oil Volume (l)
11	100	275
	150	370
	200	360 to 407
	300	674
22	50	371
	100	498 to 550
	150	659
	200	765
	300	1213

Currently, approximately 30% of ground mounted regulator sites have adequate oil containment as per AS2067 at the time of installation.

7.5 Open-Delta Operational Issue

To date, all single phase regulator sites have been installed in open-delta configuration. One of the advantages of this configuration is that it only requires two single phase units per site to regulate three phases. This results in significant cost savings.

A limitation of the open-delta configuration is that the regulator must be switched to the neutral tap position when paralleling two feeders. This can limit the time that a parallel can be in place for planned outages and can cause significant voltage issues during unplanned outages and load restoration.

There are also a number of sites where the load is such that the regulators cannot be brought back to neutral tap because this would lead to unacceptable voltage drops which eventually could lead to black outs.

The switching can also be labour intensive if there are a number of open-delta regulator sites on the feeders to be paralleled, as operators are required to visit each site to switch the units to neutral tap.

Distribution Operations have highlighted a number of regulator sites that cause frequent operational issues because of their open-delta configuration (reference 7).

To address the operational limitations of the open-delta configuration of the single phase regulators, a prioritised program is in place to convert open-delta sites to closed-delta configuration.

The Network Development team manages this program.

For all new sites, Distribution Operations will be consulted to consider the operational impacts prior to deciding on the configuration to be installed.

7.6 Standardisation of Types

Following the HV regulator audit in 2009, a whole of life cost comparison was conducted between three phase regulator units, open-delta single-phase units and closed-delta single- phase units (reference 8).

The results of this analysis found that the whole of life cost for single-phase units is significantly less than three phase units.

Additionally, spares holdings calculations were performed following the 2009 audit (reference 9) and there are reduced spare holding requirements if Aurora phases out three phase regulators.

Thus, Aurora plans to replace all three-phase regulators with single-phase units as these units are smaller and relocate more easily and require less maintenance and inspection. Additionally, single phase units are bi-directional and have the future ability to be remote controlled providing greater flexibility during routine and emergency operational system management.

7.7 Standardisation of Sizes

Table 3 summarises the sizes of single-phase regulator sites within the distribution network. There is a wide range of single-phase regulator sizes currently in service, however 200 A units account for approximately 70% of the population.

Table 3: Single phase regulator sizes within the 11 kV and 22 kV networks

Voltage kV	Capacity		Population
	Amps	MVA	
11	100	2	1
11	150	3	1
11	200	4	4
22	100	4	4
22	150	6	1
22	200	8	18
22	300	11	1

Aurora's strategy is to standardise on 200 A units to minimise both maintenance spares and emergency spares, as the cost differential between 100 A, 150 A and 200 A tanks is negligible. The larger 300 A units will be used when required.

The existing 100 A and 150 A units will remain as part of the regulator population. As these units are removed from service at routine mechanical maintenance they will be replaced with a unit of the same size if one is available in the maintenance spares holding and analysis determines this is still appropriate for this site, otherwise they will be replaced with a 200 A unit. They will be maintained and continue to be redeployed throughout the system until they are no longer serviceable. No new 100A or 150A units will be purchased.

7.8 Standardisation of Mounting Arrangements

As a result of the changes to oil containment requirements in AS 2067, pole mounting of 11 kV units greater than 200 A and all 22 kV units is no longer feasible, as there are no adequate oil containment arrangements to comply with the standard.

It has also been found to be difficult to design a closed-delta pole-mounted arrangement, so a decision has been made to ground mount all new regulator sites, with the exception of lightly loaded 11 kV spur lines.

All new sites will be installed with two single phase units, ground mounted, open-delta sites, with oil containment arrangement having sufficient capacity for three tanks, with the site designed to allow future expansion to closed-delta configuration.

8. REVIEW OF HISTORICAL PRACTICES

Aurora's asset management practices on these assets have been stable for a number of years and are generally considered to be providing a well balanced trade-off between maintenance and capital expenditure. In-service failures are rare and the assets are achieving and exceeding their expected service life.

Of particular concern are the three phase regulator assets that are approaching or have exceeded their normal expected service life. The deteriorating condition of the assets is making ongoing maintenance uneconomical.

Aurora has also experienced significant increase in routine maintenance costs over the last few years due to work place standard safety compliance that require two personnel to attend live sites instead of one.

Standardisation of the installations and improved controllers and communications capability will allow significant reduction in inspection and monitoring costs moving forward.

9. PROPOSED OPEX PLAN

It is proposed to continue with the current asset management practices, but with the some additional expenditure.

Inspection levels on the older units will continue at current levels as there is concern surrounding their reliable operation. Increase in proposed OPEX expenditure is attributed to the increased corrective maintenance and routine maintenance costs on these units and the volume of new units entering the system.

Table 4 shows the historical operational expenditure on HV regulators and the proposed future spend.

Table 4: OPEX for period between 2007/08 and 2016/17 financial years ($)

Work Program	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Inspection	0	82,229	132,315	42,000	140,000	104,703	95,545	88,500	81,010	74,782

Maintenance	49,255	54,627	84,832	74,241	74,240	84,550	82,087	81,064	79,504	78,905
Repair	44,804	107,310	139,237	100,000	100,000	236,700	230,032	227,267	223,050	221,428
Actual $$	94,059	244,167	356,383							
Proposed	167,065	223,450	169,351	216,241	314,240	425,953	407,665	396,830	383,564	375,114

10. PROPOSED CAPEX PLAN

The following values were obtained using Aurora's Capex Model (reference 10). Using the estimated life expectancy feature of the model for this asset category, the following envelope of renewal investment is required over the following 20 years to maintain the asset class at a stable Remaining Life Expectancy (RLE).

Figure 5 shows the outputs of Aurora's capital expenditure model for HV regulators, taking into account condition, risk and age. The model forecasts capital investment of $1.97m over the next regulatory period.

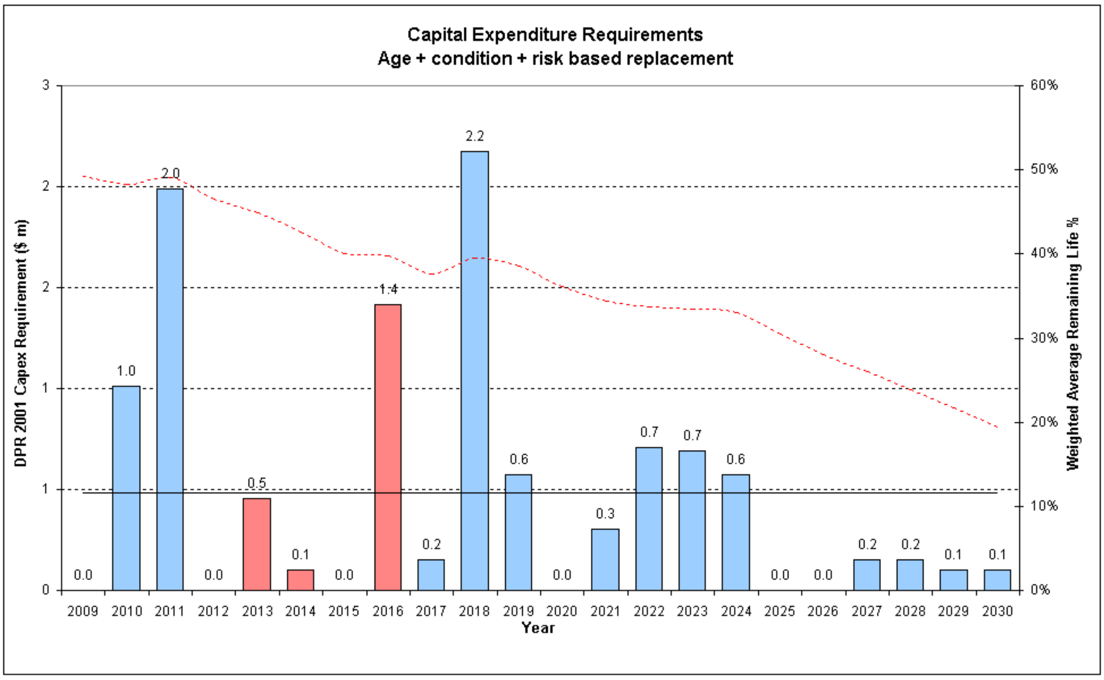

Figure 5: Forecast CAPEX Expenditure from PB Model ($M)

Aurora's proposed capital expenditure for the next regulatory period is $3.8m. This spend is greater than the model forecast due to Aurora's risk and condition based approach to asset renewal which seeks to:

- Reduce the risk of in service failure and gain maintenance efficiencies by replacing only substandard condition three phase regulators;
- Reduce the risk of Aurora's oil filled regulators located close to waterways, drinking water and sensitive areas causing environmental damage; and
- Improve the condition of the rusting single phase tanks to achieve the expected asset life.

Table 5 shows the historical capital expenditure on HV regulators and the proposed future spend.

Table 5: CAPEX for period between 2007/08 and 2016/17 financial years ($)

Work Program	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Non Demand Replacement	13,433	185,270	148,365	240,000	405,000	346,187	365,152	425,894	483,447	453,134
Specific Issues	0	0	0	0	0	346,187	344,302	343,545	342,335	341,851
Actual $$	13,433	185,270	148,365							
Proposed	287,387	177,017	140,000	240,000	405,000	692,373	709,454	769,439	825,783	794,986

11. CAPEX–OPEX TRADE OFFS

The operating expenditure programs are essential for identifying assets the require replacement for condition-based reasons. An example of this is the inspection and routine maintenance of three phase regulator sites, which may lead to a requirement for capital expenditure to replace the regulator due to uneconomical maintenance costs and impending asset failure.

There is a positive relationship between these two categories in that regular inspection programs gather continuous condition information of the assets to better target asset replacements and identify any asset trends. Maintenance and repair activities also defer the requirement for capital expenditure and increase the likelihood of the asset operating for as long as possible within the network.

Other key interactions between the capital expenditure and operating expenditure exists when older equipment with higher maintenance requirements are replaced with new equipment with lower maintenance requirements, such as three phase regulators with single phase regulators.

12. ASSET MANAGEMENT INFORMATION

Aurora maintains records of regulator assets through the periodic routine testing and inspection programs providing the following information. The equipment details and attributes are predominantly recorded within G-Tech and WASP. These being the two integrated asset management systems, however there are smaller data-sets in MS Access and Excel that currently store other information relating to the asset and its condition.

Recorded information includes:

- Identification number (unique identifier);
- Location / site / geographical details;
- Asset / equipment, terminations and jointing details (size, make, model, type, rating, installed date);
- Equipment attributes and operational numbering;
- Operational details (connectivity, protection and equipment settings / ratings, etc);

- System performance details (reliability, causes, power quality recorded data etc);
- System monitoring information / data (load – cyclic, maximum demand, load balance);
- Asset condition data and remaining residual life (general and limited);
- Oil condition, contamination levels;
- Age of asset and components, installed / refurbished date;
- Age of related equipment;
- Unit rates or agreed costs, i.e. inspection, treatment refurbishment and replacement costs;
- Maintenance details / action;
- Maintenance program progress; and
- Maintenance history (general and limited).

13. RESPONSIBILITIES

The maintenance and implementation of this management plan is the responsibility of the Asset Engineer – Substation and Underground.

Approval of this management plan is the responsibility of the Group Manager – Asset Performance and Information.

14. REFERENCES

1. High Voltage Regulator Audit Review 2009 (DM # 30062708)
2. AS 2067 Substations and high voltage installations exceeding 1 kV a.c.
3. Australian and New Zealand Environment and Conservation Council (ANZECC) Polychlorinated Biphenyls Management Plan (Revised Edition April 2003)
4. TAS Environmental Protection & Pollution Act 1994
5. National Environment Protection Council Act 1994
6. AS1940: The storage and handling of flammable and combustible liquids, Appendix H
7. Regulator Operational Issue – Feeder Parallel (DM # 30064060)
8. NPV Summary Sheet (DM # 30126955)
9. Spares Management Plans: Regulators (DM # 30087907)
10. PB CAPEX Model: HV Regulators (DM # 30160065)