BHP BILLITON IRON ORE
NEWMAN TOWNSHIP ELECTRICITY SUPPLY

ANNUAL AUDIT REPORT ON COMPLIANCE MONITORING SYSTEMS 2014/2015 FINANCIAL YEAR

REVISION A

8/12/2015

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APD POWER ENGINEERING

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EXECUTIVE SUMMARY

BHP Billiton Iron Ore (BHPBIO) is one of the world's major suppliers of iron ore and is based in the Pilbara region of Western Australia.

The township of Newman is located approximately 1200km to the north of Perth, within the Shire of East Pilbara. The electricity network is owned, governed and operated by BHP Billiton Iron Ore Supply Authority (BHPBIOSA). The network encompasses the township of Newman, Newman Airport, Capricorn Roadhouse, town water supply bore field, Mt Whaleback iron ore mine, and several smaller mine leases in the adjacent areas.

In accordance with Western Australia Electricity Industry Code 2005 (the Code), the electrical supply authority must publish a report setting out the information described in Schedule 1 of the Code, in respect to each year ending on 30th of June. This document, known as the Annual Audit Report, is to provide the full suite of information outlined in Schedule 1 of the Code, relating to the Network Quality and Reliability of Supply. As per the Code's Division 3 Section 26 Performance Reporting: BHPBIOSA, as the network owner and operator, is required to arrange an independent audit, and subsequent report, on the operation of the systems that the *distributor* has in place for monitoring its compliance to the Code's Part 2.

The audit interviews where undertaken on the 10 November 15 at BHPBIOSA's Newman offices; all relevant stakeholders made themselves available for the audit process. It should be noted that there had been a reasonable number of personnel change since the previous audit interviews were conducted. The general demeanour of the office was one of professionalism and commitment to their roles; and it was noted by numerous interviewees that considerable positive change had occurred since the previous reporting period.

The results for 2014/2015 audit (together with the previous year's results) are shown below in the table titled 'Audit Scorecard'. General improvement has been noted in many areas including:

- Utilisation of HV Power Quality (PQ) monitor devices and other secondary asset (Oscillography and statistical metering from protection relays).
- Targeted asset replacement with a focus on improved reliability.
- Creation of a Network Controller role to enable enhanced collaboration between electrical supervisors and Engineering Supervisors.
- Better utilisation of the contracted retail/billing contractor.

There are 2 areas where BHPBIOSA can improve:

- The accurate documentation of planned and unplanned outages; and
- PQ monitoring of the LV network in order to ensure compliant supply at the customer's *point of connection*.

With regards to the holistic electrical network, the PQ metering data indicates that Newman's electrical network is a robust and inherently good network. The basic electrical parameters of voltage, frequency and voltage total harmonic distortion were consistently stable and well within compliance-levels. There were events where peak harmonic and flicker levels were momentarily excessive. It is recommended that BHPBIOSA investigate such events, the outcome of which could indicate deteriorating primary equipment (e.g., capacitor switches) or non-compliant loads acting as sources of excessive harmonics.

Audit Scorecard		
Audit Description	Audit Overall Rating	
	2013/2014	2014/2015
The Electricity Industry Code 2005 Part 2 Division 1 – Quality Standards – Section 6 - **Voltage Fluctuations**		
The Electricity Industry Code 2005 Part 2 Division 1 – Quality Standards – Section 7 - **Harmonic Distortion**		
The Electricity Industry Code 2005 Part 2 Division 1 – Quality Standards – **Voltage Level**		
The Electricity Industry Code 2005 Part 2 Division 1 – Quality Standards – **Frequency**		
The Electricity Industry Code 2005 Part 2 Division 2 – Standards for the interruption of supply to individual customers – Section 9 – **General standard of reliability**		
The Electricity Industry Code 2005 Part 2 Division 2 – Standards for the interruption of supply to individual customers – Section 10 – **Duty to reduce effect of interruption**		
The Electricity Industry Code 2005 Part 2 Division 2 – Standards for the interruption of supply to individual customers – Section 11 – **Planned Interruptions**		
The Electricity Industry Code 2005 Part 2 Division 2 – Standards for the interruption of supply to individual customers – Section 12 – **Significant Interruptions to Small Customers**		
The Electricity Industry Code 2005 Part 2 Division 3 – Standards for the duration of interruption of supply in particular areas – Section 13 – **Standard for Other Areas (Newman Township electricity system 290mins)**		

Legend		
Overall Compliance Rating	Description	
	High	Best practice quality systems and processes
	Medium – High	Above average quality systems and processes
	Medium	Adequate quality systems and processes
	Low – Medium	Quality systems and processes require further development
	Low	Quality systems and processes require major further development

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1. INTRODUCTION

BHP Billiton Iron Ore (BHPBIO) is one of the world's major suppliers of iron ore and is based in the Pilbara region of Western Australia.

The township of Newman is located approximately 1200km to the north of Perth, within the Shire of East Pilbara. It is the main town for the Mt Whaleback iron ore mine, Mining Area C and several smaller satellite mines.

The electricity network is owned, governed and operated by BHP Billiton Iron Ore Supply Authority (BHPBIOSA). The network encompasses the township of Newman, Newman Airport, Capricorn Roadhouse, town water supply bore field, Mt Whaleback iron ore mine, and several smaller mine leases in the adjacent areas.

At present, the township of Newman has approximately 2546 premises comprised of a mixture of residential and commercial customers.

In accordance with Western Australia Electricity Industry Code 2005 (the Code), the electrical supply authority must publish a report setting out the information described in Schedule 1 of the Code, in respect to each year ending on 30th of June. This document, known as the annual audit report, is to provide the full suite of information outlined in Schedule 1 of the Code, relating to the Network Quality and Reliability of Supply.

The Code is effectively written in four Parts plus a reporting-requirements schedule; namely:

1. Part 1: Preliminary information associated with term of reference.
2. Part 2: Quality and reliability standards, which is further partitioned into 4 *divisions*.
3. Part 3: Payment to customers for lack of regulatory adherence.
4. Part 4: Incidental duties as a Supply Authority.
5. Schedule 1: Information to be published in this report.

As per the Code's Division 3 Section 26 Performance Reporting: BHPBIOSA as distributor is required to arrange an independent audit, and subsequent report, on the operation of the systems that the distributor has in place for monitoring its compliance to the Code's Part 2.

APD were engaged by BHPBIOSA to undertake the required audit and report on the current compliance monitoring processes and systems that BHPBIOSA have in place to ensure compliance with the Code.

2. SCOPE OF AUDIT

The scope of audit was limited to the review of the policies, guidelines, processes, systems and procedures that BHPBIOSA currently have in place to ensure that the network is complying with the following performance requirements specified in the Code:

- Part 2, Division 1 – Quality Standards, Section 6(2) – Voltage Fluctuations
- Part 2, Division 1 – Quality Standards, Section 7 – Harmonics
- Part 2, Division 1 – Quality Standards, Section 8 – Duty to disconnect if damage may result, Note (a) Voltage Levels Compliance
- Part 2, Division 1 – Quality Standards, Section 8 – Duty to disconnect if damage may result, Note (b) Frequency Levels Compliance
- Part 2, Division 1 – Quality Standards, Section 8 – Duty to disconnect if damage may result
- Part 2, Division 2 – Standards for the interruption of supply to individual customers, Section 9 – General standard of reliability
- Part 2, Division 2 – Standards for the interruption of supply to individual customers, Section 10 – Duty to reduce effect of interruption
- Part 2, Division 2 – Standards for the interruption of supply to individual customers, Section 11 – Planned interruptions
- Part 2, Division 2 – Standards for the interruption of supply to individual customers, Section 12 – Significant interruptions to small use customers
- Part 2, Division 2 – Standards for the interruption of supply to individual customers, Section 13 - Standards prescribed for particular areas

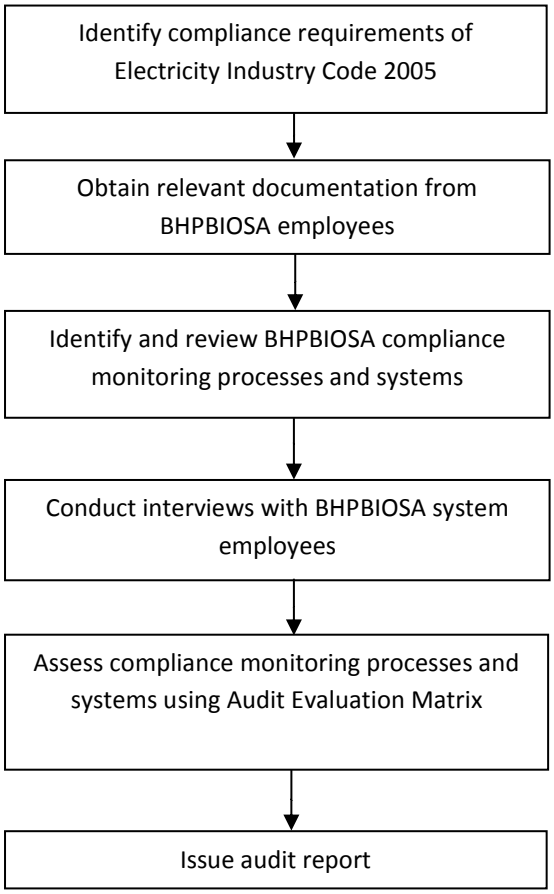
The audit scope covered the electricity network supplying the gazetted township of Newman, Newman Airport and the town water supply bore field. The electricity network supplying the mining infrastructures at Mt Whaleback Iron mine and all other mine leases in the surrounding of the township of Newman were not evaluated in the audit.

Refer to Appendix A for the geographical map of the township of Newman.

3. AUDIT METHODOLOGY

3.1.Audit Flowchart

The methodology applied to perform the audit is as per the following flowchart:



3.2.Audit Evaluation Matrix

The audit assessment was carried out as per the following procedures:

1. Review if BHPBIOSA have adequate systems, documented processes and guidelines, plans, and procedures in place to ensure compliance with each of the performance provisions defined in the Code. Assess the current monitoring processes and systems using the ten criteria shown in Table 1 below. Assign a performance ranking of Low, Medium, or High to each criterion.
2. Based on the ten performance rankings assigned, determine the overall compliance rating. The overall compliance rating indicates the effectiveness of the monitoring processes and systems in achieving compliance with each of the provisions.
3. Compare all overall compliance ratings with the preceding year's results. Improvements are measured in percentage. A 33% improvement means the overall rating has improved either from Low to Medium, or from Medium to High. An improvement from Low to High is equivalent to 66% of improvement.

Table 1 | Audit of compliance management systems and processes evaluation matrix

Item		Description	Description of Ranking		
			Low	Medium	High
1	Process	Documented Process	Process in place documentation requires further development	Process is documented	Strong documentation and may comply with ISO9001
2		Process fully integrated with corporate management systems	Requires development	Linkage with management reporting	Full integration with corporate IT system
3		Demonstration of operator understanding of the documented process	Training required	Employee understanding	Strong employee understanding and evidence of training systems
4		Evidence that the process is followed and records are kept as per process	Records available but not easily accessible or auditable	Adequate records available over full compliance periods	Auditable records available over full compliance periods with mandatory defined fields
5	Continuous Improvement	KPIs are in place	KPIs in place	KPIs are in place with some understanding by operators	Evidence that KPIs are in place and comprehensively understood by all operators
6		Reporting system supports continuous improvement	Requires development	Reporting systems exist at some levels	Reporting systems in place clearly showing gaps and trends of performance
7		Evidence action taken	Requires development	Evidence of reactive response	Evidence that gaps and trends are proactively actioned
8	Measurement Tools	Suitability of PQ measurement devices	PQ device has partial PQ functions and not fully compliant to AS61000.4.30	PQ device has full PQ functions but not fully compliant to AS61000.4.30	PQ device has full PQ functions and fully compliant to AS61000.4.30
9		Data collection methodology of the PQ measurement devices	Data manually extracted and analysed	Data extracted automatically over communications link. Data collection only.	Data extracted automatically over communications link with data analysis at the device.
10		Method of PQ measurement devices deployment	Portable devices not permanently fixed to the network.	Devices permanently installed on the network at strategic locations	Permanently fixed to the network and integrated into the network management control on a real time basis.
11		Overall Ranking	Refer to Table 2 for descriptions		

Table 2 | Overall compliance rating table

Overall Compliance Rating	Description	
	High	Best practice quality processes and systems
	Medium – High	Above average quality processes and systems
	Medium	Adequate quality processes and systems
	Low – Medium	Quality systems and processes require further development.
	Low	Quality systems and processes require major further development

4. AUDIT RESULTS

The audit assessed the performance and suitability of the compliance monitoring systems and processes that BHPBIOSA have in place to ensure compliance with each of the provisions under The Code's Part 2 Divisions 1, 2 and 3.

4.1. Part 2, Division 1 – Quality Standards - Section 6(2), 7 & 8 (a)(b)

Sections 6(2), 7 and 8(a)(b) relate to flicker, harmonics, voltage magnitude and frequency respectfully.

The following notes relate to the Code's PQ compatibility levels:

- According to Section 6(2), the voltage fluctuation of electricity supplied must not exceed the compatibility levels of Pst=1.0 and Plt=0.8 set out in Part 3.7 clause 3 of AS/NZS 61000:2001.
- According to Section 7, the standard for the harmonic voltage distortion levels of electricity supplied is a distortion level that is less than the compatibility levels set out in a table in the same section.
- Under Section 2 of AS60038-2000 Standard Voltages, the voltage level of electricity supplied must be maintained at +10% and -6% of the nominal voltage of 230V single phase, or 400V three-phase.
- According to Section 8, the frequency must be maintained at +/- 2.5% of 50 cycles per second.

Appropriate process and system are required to identify and record any breaches of the compatibility levels, and to keep track of the remedies undertaken to eliminate the breaches.

Table 3 | Part 2 Division 1 Section 6(2), 7 & 8 (a)(b) - Evaluation Matrix

Item	Category	Description	Ranking			% of Improvement Compared to the Preceding Year Results	Comments
			Low	Med.	High		
1	Process	Processes in place and documented		1		25%	Note 1
2		Process fully integrated with corporate management systems		1		25%	Note 2
3		Demonstrated operator understanding of the process			1	25%	Note 3
4		Evidence that the process is followed and records are kept as per process	1			0%	No change
5	Continuous Improvement	KPIs are in place		1		0%	No change
6		Reporting system supports continuous improvement	1			0%	No change
7		Evidence action taken - continuous improvement		1		25%	Note 4
8	Measurement Tools	Suitability of PQ measurement devices			1	0%	No change
9		Data collection methodology of the PQ measurement devices		1		0%	Note 5
10		Method of PQ measurement devices deployment	1			0%	No change
11		Overall Ranking					

Note 1: As evident by interviewees' comments, employee's roles and responsibilities, and work processes are clearly known by each team member interviewed.

Note 2: Where appropriate, it was evident that BHPBIO's corporate management systems were utilised.

Note 3: It is evident that the existing workforce has a solid understanding of their roles within the Supply Authority.

Note 4: The introduction of a new role (Network Controller) has strengthened the interaction between field-based supervisors / maintainers and the engineering supervisor / planner. The new role appears to have 'closed the loop' between engineering and maintenance; allowing feedback to occur between the two parties and hence facilitating continuous improvement.

Note 5: The capabilities of existing, in-service PQ monitoring devices are known and utilised by the Engineering supervisor.

Audit Observations:

1. The BHPBIOSA employees that are involved in managing power quality understand the need to:
    - ensure compliance with The Code's requirements; and
    - Expeditiously rectify network disturbances that affect the quality of supply to customers.
2. BHPBIOSA staffs are well aware of their network's PQ monitoring capability. Within their sub-transmission system there are 2 high-end DIgSILENT PQ monitoring devices. Also, when appropriate, they correctly utilise SCADA statistical metering, and the oscillography recorded in relevant protection relays to their advantage.
3. It is clear that the engineering team possesses a very good understanding of the various network interferences that potentially affect the power supply quality.
4. The engineering team provides reactive response by carrying out investigations when breaches of the power quality standards are identified during the logging period, or when a customer complaint is received.
5. In the 2014/2015 period, BHPBIOSA has successfully continued to replaced several of the old transformers with new pad-mounted transformers; they've standardised their preferred distribution transformer rating and suppliers; and streamlines their processes relating to the procurement and warehousing of strategic spares.
6. The current method of recording important outage information is poor. The accurate documentation of planned and unplanned outages; including accurately and consistently detailing the outages' durations, affected locations and number of customers is of paramount importance in determining reliability indices. This is an area where BHPBIOSA aim to improve upon in the current reporting period.
7. PQ monitoring of the LV network (close to *the customers' point of connection)* is performed in an ad-hoc manner. Many electrical utilities struggle with this point as the majority of LV distribution networks have been constructed prior to the advent of smart meters and economically viable distributed communications. This is an area where BHPBIOSA can improve upon. Through systematic PQ monitoring of the LV network and the benchmarking of results again the Code compliance levels, BHPBIOSA can then gain greater visibility of adverse PQ events occurring close to (or being caused by) LV customers.

4.2. Part 2, Division 2 – Standards for the Interruption of Supply to Individual Customers, Section 9 & Section 10

Sections 9 and 10 relate to General Standard of Reliability; and Duty to Reduce Effect of Interruption respectively.

According to this provision, a transmitter or distributor must, *so far as is reasonably practicable*, ensure that the supply of electricity to a customer is maintained and the occurrence and duration of interruptions is kept to a minimum. According to this provision, it is not a breach of section 9 of the Code for BHPBIOSA to interrupt the supply of electricity to a customer for the purpose of maintaining or alter the network if the length of the interruption does not exceed 4 hours and BHPBIOSA have given notice of the proposed interruption to the customer not less than 72 hours before the start of the interruption. If it is not reasonably practicable to provide more than 72 hours of notice; notice should be given at the earliest practicable time before the start of interruption.

Table 4 | Part 2 Division 2 Section 9 & 10 - Evaluation Matrix

Item	Category	Description	Ranking			% of Improvement Compared to the Preceding Year Results	Comments
			Low	Med.	High		
1	Process	Process in place and documented	1			0%	No change
2		Process fully integrated with corporate management systems	1			0%	No change
3		Demonstrated operator understanding of the documented process			1	0%	No change
4		Evidence that the process is followed and records are kept as per process			1	0%	No change
5	Continuous Improvement	KPIs are in place			1	0%	No change
6		Reporting system supports continuous improvement			1	0%	No change
7		Evidence action taken - continuous improvement			1	0%	No change
8		Overall Ranking					

Audit Observations:

1. The BHPBIOSA employees interviewed demonstrated a clear understanding of their roles and responsibilities in maintaining supply reliability and minimising the duration and frequency of interruptions to the customers.
2. BHPBIOSA has proactively undertake asset replacements of older, inadequate, unreliable assets including:
    - Re-conductoring of Homestead Creek and TC3 feeder.
    - Replacement of distribution transformers and associated assets in the Yalara ring; within Newman centre; including 16 pad-mounted substations.

    Additionally, a 'Raiser Bracket' replacement program has been successfully completed which has significantly reduced the number of customer call-outs and complaints.

    The standardisation of assets, particularly strategic spares, has been considered by BHPBIOSA. The manufacturer and size of pole-top transformers has been reduces to two standard transformers; hence standardising design, procurement, construction and maintenance.
3. To oversee and monitor the 11kV township network using real-time data, a new role, Network Controller, has also been implemented in this financial year.
4. The processes and systems of managing both planned and unplanned outages are well understood by those involved.
5. The formal document "Supply Authority Procedure" provides safety guidance to employees that deal with live equipment.
6. The Level 1 and Level 2 filled out by the linesmen and supervisors respectively are stored in the 1DOC system accessible to all BHPBIOSA authorised personnel. The fault records keep track of all the planned and unplanned interruption. However, some important information such as work order, fault location, outage duration, cause of fault, and protection device involved were sometimes overlooked and not filled out accurately by the linesmen.
7. Fault recording system and KPI documents are in place to monitor the reliability performance of the township network and ensure compliance with the Code. The utilisation of the retailing and billing contractor (MBC Global) has been vastly improved. MBC Global is now conducting retailing, billing and organising meter reading services as stipulated in the original contract; hence freeing up BHPBIOSA human resources.
8. An electrical inspection system plan has been created this year to ensure that all new consumers' electrical installations are compliant with all relevant Act, Regulations and Codes. An Inspection System Procedure Manual has also been created, which specifies the requirements and responsibilities of the employees involved in technical inspections of the new network installations.

4.3. Part 2, Division 2 – Standards for the interruption of supply to individual customers, Section 11; Section 12; and Division 3 Section 13

Sections 11, 12, and Division 3 Section 13 relate to Planned Interruptions, Significant Interruptions and Standards prescribed for particular areas respectively.

An appropriate system is required to record all the scheduled outages that BHPBIOSA plan to undertaken in each year. An efficient process should be in place for providing notifications to each of the customers that will be affected by planned interruptions in compliance with the provision.

Table 5 | Part 2 Division 2 Section 11, 12 & Division 3 Section 13 - Evaluation Matrix

Item	Category	Description	Ranking			% of Improvement Compared to the Preceding Year Results	Comments
			Low	Med.	High		
1	Process	Process in place and documented	1			0%	No change
2		Process fully integrated with corporate management systems		1		0%	No change
3		Demonstrated operator understanding of the documented process			1	0%	No change
4		Evidence that the process is followed and records are kept as per process		1		0%	No change
5	Continuous Improvement	KPIs are in place			1	0%	No change
6		Reporting system supports continuous improvement			1	0%	No change
7		Evidence action taken - continuous improvement			1	0%	No change
8		Overall Ranking		MH			

Audit Observations:

1. The BHPBIOSA employees interviewed demonstrated a clear understanding of the need to limit planned outages to 4 hours or less and to provide notifications to customers at least 3 days prior to the start of work, in accordance to Electricity Code 2005.
2. BHPBIOSA have a dedicated team of planners who allocate appropriate time and resources to carry out routine maintenance works, overhead line connections for new subdivisions and repair works in the township. All scheduled outages are stored in an electronic system.
3. To minimise disruption to businesses, planned interruptions for routine maintenance or new installations that will affect the industrial and commercial customers are being carried out on the weekends.
4. BHPBIOSA have portable standby generators in place to cater for extended planned interruptions.

5. CONCLUSION

The audit interviews where undertaken on the 10 November 15 at BHPBIOSA's Newman offices; all relevant stakeholders made themselves available for the audit process. It should be noted that there had been a reasonable number of personnel rotate in/out of the group since the previous audit interviews were conducted. The general demeanour of the office was one of professionalism and commitment to their roles; and it was noted by numerous interviewees that considerable positive change had occurred since the previous reporting period.

Possibly the greatest realised improvement of the 2014/2015 period was the action to improve the utilisation of the retailing/billing contractor (MBC Global). Doing so has:

- Provided consist retailing services to customers. For example, complaints/service calls are now handled by the contractor (MBC Global) who have trained telephonists; available to provide customer service 24 hours a day. Previously a security guard was used for after-hours complaints/service calls.
- Freed up BHPBIOSA human resources to concentrate on other areas of the business.

Newman BHPBIOSA are investigating industry best practices for the operation and maintenance of the Newman network. For example, preferred distribution transformer ratings and preferred-vendors have been selected in order to standardise design, construction, commissioning and maintenance. Also optimum warehousing, and optimum quantities for strategic spares have been determined.

While every utility, through failure of primary or secondary plant, are forced to execute reactionary asset replacement, BHPBIOSA have highlighted high-risk aged asset within Newman's sub-transmission network and have subsequently executed a reasonable level of strategic asset replacement. For example, from a primary asset perspective, 4 oil circuit breakers have been replaced; and from a secondary asset perspective, 5 electromechanical protection relays have been replaced. It should be noted that failure of the abovementioned assets can have a dramatic effect of reliability indices; hence Newman BHPBIOSA have been pro-active in their efforts to improve reliability.

With regards to the holistic electrical network, the PQ metering data indicates that Newman's electrical network is a robust and inherently good network. The basic electrical parameters of voltage, frequency and voltage total harmonic distortion were consistently stable and well within compliance-levels. There were events where peak harmonic and flicker levels were momentarily excessive. It is recommended that BHPBIOSA investigate such events, the outcome of which could indicate deteriorating primary equipment (e.g., capacitor switches) or non-compliant loads acting as sources of excessive harmonics.

There are 2 areas where BHPBIOSA can improve:

- The accurate documentation of planned and unplanned outages; including accurately and consistently detailing the outages' durations, affected locations and number of customers. The goal for BHPBIOSA should be that upon reading optimised documentation the reader should be in no doubt as to the location, cause and effect of the outages. This point is elaborated on in Section **Error! Reference source not found.** of this report.
- PQ monitoring of the LV network in order to ensure compliant supply at the customer's point of connection. Many electrical utilities struggle with this point as the majority of LV distribution networks have been constructed prior to the advent of smart meters and economically viable distributed communications. This point is elaborated on in Section **Error! Reference source not found.** of this report.

6. RECOMMENDATIONS

The following recommendations have been partitioned into recommendations pertaining to

1. Service reliability (e.g., accurate recording of outage interruptions and frequency);
2. Power supply quality;
3. Customers and their distribution throughout the network; and
4. Formal KPIs relating to PQ.

6.1. Outage Event Recording System

A process to effectively record information relating to field-based planned and unplanned outage events is extremely important, especially with regards to works undertaken in the LV network as the LV network does not have robust communication with a SCADA system that the sub-transmission system may have. Accurate information about fault events and planned outage events will better provide the means to accurately calculation reliability indices which are later used for network planning decisions and performance reporting.

It is recommended that:

1. Field-based crews have access to a robust system that encourages and enables them to accurately log prudent information about events that occur in relation to planned and unplanned outages. The system should be computer based; and ideally organised so that field-based personnel are required to input important information, rather than the existing scheme where there is seemingly little accountability over the information scribbled on paper at the crews' head office. If an information technology based system were implemented then field service personnel could affix photos and audio /textual notes associated with the works.
2. If the existing paper-based scheme is to be continued, then linesmen should be given clear guidelines on how to fill out the fault details in the Level 1 fault sheets correctly. The following information is essential:
    - Accurate recording of time in order to properly and actually account for outage duration or fault restoration times.
    - Exact details of the events' network voltage level: 11kV or 0.415kV network.
    - Accurate location information: pole number or transformer number; name of upstream distribution transformer; street address;
    - Results of fault investigation: eg bird strike, lightning etc.
    - Switching events performed to reconfigure the LV network. This information will allow disconnected customer to be calculated more accurately.

6.2.Power Quality Monitoring System

It is evident that the PQ of the sub-transmission network is adequately monitored via dedicated DIgSILENT PQ monitoring devices and to a lesser extent statistical metering (via SCADA) and the oscillography recording capabilities of protection relays. As per Part 2 Section 5, the power quality *at the point of connection* should comply with prescribed PQ compatibility levels, yet there is little

visibility of the PQ within the LV distribution network. Reduced visibility of LV networks is a common weakness of most utilities as there is minimum existing communication resources distributed amongst the LV distribution network which can be leveraged, however monitoring the LV network is important in order to monitor the magnitude and/or source of harmonics (and other parameters) at the *point of connection.*

It is recommended that:

1. Where possible, smart meters be installed at commercial or residential customers' tariff metering points. Initially, even a small pilot scheme would be beneficial where 1 smart meter is installed at the end of each of the 7 feeders in order to gain some visibility into the PQ at the extremities of the LV network.
2. Power quality devices that are compliant to AS61000.4.30 be implemented to collect power quality data on an ongoing basis. It is recommended that the current level of HV PQ monitoring be maintained, and the quantity of LV PQ monitoring be increased.
3. The viability of permanently installed PQ meters in future pad-mounted substations be investigated. It is acknowledged that if PQ meters were permanently installed in distribution kiosks, it would require committing human resources to periodically retrieve logged data manually; or communications connectivity and master station infrastructure to annunciate and store the PQ data remotely.
4. A record system be developed to keep track of non-compliant power quality issues on a regular basis so that the engineering team can carry out investigations and implement adequate solutions in a timely manner, rather than relying on customer complaints to initiate an inquiry.

6.3. Total Number of Customers and Their Distribution Throughout the Network

It is recommended that:

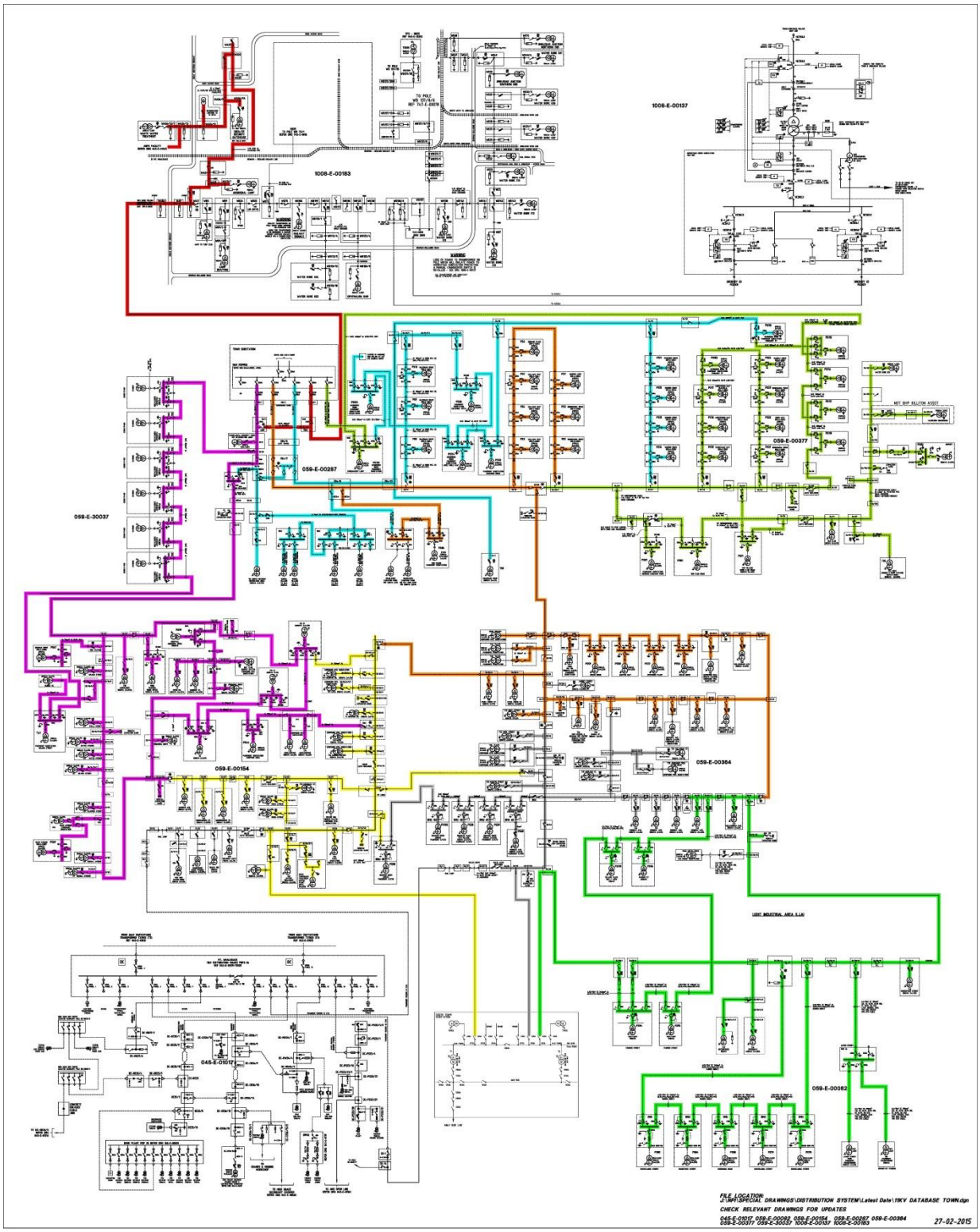
1. BHPBIOSA implement a process and/or a record system to keep track of the number of customers being supplied by each of the township feeders.
2. The electronic CAD or DGN copy of the township electrical reticulation plan be updated whenever a new customer or network equipment is connected to the network, or when the open points on the network are altered. Each premise on the site plan should be annotated with the name of the supply transformer with each 11kV feeder identified with a unique colour.

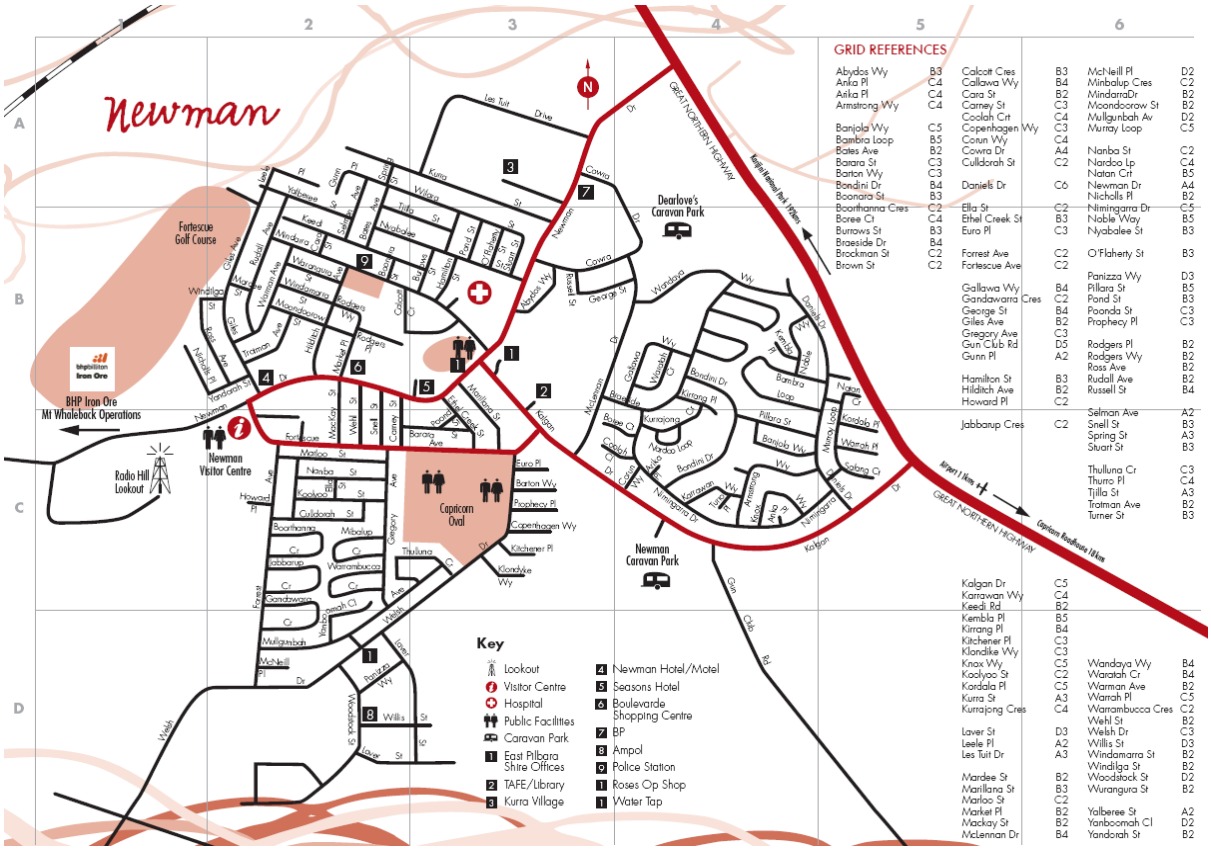
6.4. Formal documentation and key performance indicators (KPI)

It is recommended that:

1. BHPBIOSA establish formal PQ-related KPI (e.g., flicker levels) and proactively monitor and assess the quality of supply on an ongoing basis.
2. Training is provided to new BHPBIOSA employees so that they understand the Electrical Code 2005 requirements and their roles and responsibilities in ensuring the network's compliance with the Code.

APPENDIX A Newman Township (SLD & Map)

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BHP Iron Ore
Mt Whaleback Operations
Radio Hill Lookout
Newman Visitor Centre
Capricorn Oval
Dearlove's Caravan Park
Newman Caravan Park
GREAT NORTHERN HIGHWAY
Karijini National Park 145km
Capricorn Roadhouse 185km
Key
Lookout
Visitor Centre
Hospital
Public Facilities
Caravan Park
1 East Pilbara Shire Offices
2 TAFE/Library
3 Kurra Village
4 Newman Hotel/Motel
5 Seasons Hotel
6 Boulevarde Shopping Centre
7 BP
8 Ampol
9 Police Station
1 Roses Op Shop
1 Water Tap
GRID REFERENCES
Abydos Wy B3
Anka Pl C4
Anka Pl C4
Armstrong Wy C4
Banjola Wy C5
Bambra Loop B5
Bates Ave B2
Barara St C3
Barton Wy C3
Bondini Dr B4
Boonara St B3
Boorthanna Cres C2
Boree Ct C4
Burrows St B3
Braeside Dr B4
Brockman St C2
Brown St C2
Calcott Cres B3
Callawa Wy B4
Cara St B2
Carney St C3
Coolah Crt C4
Copenhagen Wy C3
Corun Wy C4
Cowra Dr A4
Culldorah St C2
Daniels Dr C6
Ella St C2
Ethel Creek St B3
Euro Pl C3
Forrest Ave C2
Fortescue Ave C2
Gallawa Wy B4
Gandawarra Cres C2
George St B4
Gilles Ave B2
Gregory Ave C3
Gun Club Rd D5
Gunn Pl A2
Hamilton St B3
Hilditch Ave B2
Howard Pl C2
Jabbarup Cres C2
Kalgan Dr C5
Karrawan Wy C4
Keedi Rd B2
Kemble Pl B5
Kirrang Pl B4
Kitchener Pl C3
Klondike Wy C3
Knox Wy C5
Koolyoo St C2
Kordala Pl C5
Kurra St A3
Kurrajong Cres C4
Laver St D3
Leele Pl A2
Les Tuit Dr A3
Mardee St B2
Marillana St B3
Marloo St C2
Market Pl B2
Mackay St B2
McLennan Dr B4
McNeill Pl D2
Minbalup Cres C2
MindarraDr B2
Moondoorow St B2
Mullgunbah Av D2
Murray Loop C5
Nanba St C2
Nardoo Lp C4
Natan Crt B5
Newman Dr A4
Nicholls Pl B2
Nimingarra Dr C5
Noble Way B5
Nyabalee St B3
O'Flaherty St B3
Panizza Wy D3
Pillara St B5
Pond St B3
Poonda St C3
Prophecy Pl C3
Rodgers Pl B2
Rodgers Wy B2
Ross Ave B2
Rudall Ave B2
Russell St B4
Selman Ave A2
Snell St B3
Spring St A3
Stuart St B3
Thulluna Cr C3
Thurro Pl C4
Tjilla St A3
Trotman Ave B2
Turner St B3
Wandaya Wy B4
Waratah Cr B4
Warman Ave B2
Warrah Pl C5
Warrambucca Cres C2
Wehl St B2
Welsh Dr C3
Willis St D3
Windamarra St B2
Windilga St B2
Woodstock St D2
Wurangura St B2
Yalberee St A2
Yanboomah Cl D2
Yandorah St B2