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BHP NEWMAN TOWNSHIP ELECTRICITY SUPPLY
ANNUAL AUDIT REPORT
2019/2020

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EXECUTIVE SUMMARY

The township of Newman is located approximately 1,200 km to the north of Perth, within the Shire of East Pilbara. The electricity network is owned, governed and operated by BHP Supply Authority. The network encompasses the township of Newman, the Airport, Capricorn Roadhouse, town water supply bore field and connections to the mining infrastructure in the adjacent areas.

In accordance with the Western Australia Electricity Industry Code 2005 (the Code), electricity supply authorities must publish a report setting out the information described in Schedule 1 of the Code for each financial-year (FY). This document, known as the Annual Audit Report, is to provide the detailed report on the Network Quality & Reliability of Supply. The Code also requires the supply authority to arrange an independent audit and subsequent report on the procedures and systems that the distributor has in place for monitoring its compliance to the Code's Part 2. APD were engaged by BHP as the independent consultant to undertake the audit process and prepare the report.

The audit interviews were undertaken on the 27th August 2020 via the Microsoft Teams video conferencing facility, with relevant stakeholders and resources available to APD. As a result of the audit process and interviews, the following key observations were made:

- BHP have secured funding to complete (by December 2020) the installation of permanent fixed SEL735 Advanced Power Quality and Revenue Meters at selected pad-mount substations to improve the logging process by providing year round access to power quality data including harmonics.
- BHP have noted an increase in neutral voltage integrity issues within customer supplies. Currently these issues are identified and actioned reactively as a result of inspections by electrical contractors. BHP are aiming to utilise the functionality of the proposed AMI smart meters to detect neutral voltage integrity issues and action these on a more proactive basis. The work to install AMI will be completed in two parts – part 1 (2020/21) – install service protection devices (SPDs)¹ at dwellings that do not yet have these, and part 2 (2021/22 and beyond) – complete the installation of the AMI proper.

The results for 2019/2020 audit are shown in the table titled 'Audit Scorecard' (presented at the end of this Executive Summary). The evaluation ratings remain consistent with the previous FY audit; BHP are found to be proactively undertaking continuous improvement projects to maintain adequate levels of reliability, power quality and public/personnel safety within the Newman Township. This is evident from several asset upgrade projects either already completed or currently in progress. This includes the following:

- Completed works on the major equipment upgrades at the Township Substation involving the replacement of the two ageing 66/11kV power transformers and neutral earth resistors.
- Completed the conversion of an overhead section of low voltage powerline along Newman Drive (between Mindarra Drive and Nyabalee Road) to underground cable to improve public safety thus mitigating the conductor-to-ground height clearances issue that existed on this section of line.
- Completed the conversion of an overhead section of low voltage powerline along Radio Hill Drive to underground cable to improve public safety thus mitigating the conductor-to-

¹ SPDs allow the isolation of a dwelling's meter box at the meter box itself. It allows the isolation to be easily and safely carried out by an electrical contractor (and without the need for the supply authority to attend and carry out the isolation, which would otherwise be at the connecting green dome pillar box).

ground height clearances issue that existed on this section of line. This followed a “high load versus live conductor” incident early in the 2020 calendar year.

- Continue with improvements driven by the results of investigations, e.g., in 2020/21, the replacement of transformer T7 and pad-mount substation PS61 as part of asset lifecycle ‘end of useful life’ replacement work, as well as the replacement of an aged low voltage switchboard at PS113 ‘Fortescue Flats’.
- Planning for the replacement of sections of HV overhead line with HV underground cabling within the Township of Newman, part of an upcoming project for the upgrade of a main road overhead crossing to prevent oversize loads accidentally connecting with the powerline.
- BHP is considering the replacement of existing line interrupters (which cannot be switched on load) with air-break switches (which can be switched on load). This will improve reliability of supply experience for the customers during the day-to-day operation of the network.

With respects to the holistic electrical network, the recent PQ metering data indicates that Newman’s electrical network has undergone noteworthy improvements to maintain its reputation as a robust and inherently good network. The average electrical parameters of voltage, frequency and voltage total harmonic distortion were generally consistently stable and well within compliance-levels, but with the below notes to consider:

- RMS Voltage Magnitude: In the 2019/20 logging period, the number of voltage magnitude breaches (5) represented a decrease compared to the 2018/19 logging period (8), but was slightly higher than in the 2017/18 logging period (4). This presents no practical concern.
- Power System Frequency: A total of four frequency breaches were recorded for the 2019/20 logging period. This is an increase from the single event in 2018/19.
- The recorded individual order harmonics showed a number of temporary and random breaches on all feeders that are not deemed of a practical concern at this stage. The magnitude of the breaches on one of the feeder appears to follow a typical daily demand pattern and the root-cause of this issue is to be further investigated to eliminate the problem.
- U-THD: Three U-THD breaches were recorded during the 2019/20 logging period. This is a relative increase from the single event recorded in the 2018/19 logging period.
- Voltage Flicker: A notable increase in the number of long-term voltage fluctuation limit breaches was observed (36 in total³); however, all associated with PS25 sub and all within 2 hours of the start of measurements (given the nature of the recorded results, this could be an anomaly due to a forced event in the network).

The number of short-term voltage fluctuation limit breaches was reduced from the level measured in 2018/19 but still deemed as sizable. The most affected feeders were TC2 (5 breaches), STS2 (4 breaches) and STS1 (3 breaches).

Finally, no major areas for continued development were identified in this audit, however it is recommended that BHP monitors the above-mentioned breaches and identifies the root causes if the issues persist or worsen in coming years.

³ There were 12 breach events involving all three network phases, thus giving a total of 36 breaches.

The monitoring of the power quality parameters will be greatly facilitated with the installation, by December 2020, of the sixteen SEL 735 fixed power quality meters throughout the network. These facilities will greatly reduce the dependence on the annual audit to provide power quality data and will make such data readily available, effectively on demand, to assist in decision making.

AUDIT SCORECARD FOR 2019/20

AUDIT SCORECARD		
AUDIT DESCRIPTION	AUDIT OVERALL RATING	
	2018/2019	2019/2020
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 System 290 Minutes)		



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1. INTRODUCTION

BHP 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 1,200 km 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 Supply Authority. 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 2,501 premises comprised of a mixture of residential and commercial customers.

In accordance with the 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: BHP 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 BHP to undertake the required audit and report on the current compliance monitoring processes and systems that BHP 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 BHP 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 3 – 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 and the town water supply bore field. The electricity network supplying the Newman Airport, mining infrastructures at Mt Whaleback Iron Ore mine and all other mine leases in the surrounding area of the township of Newman were not required to form part of 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:

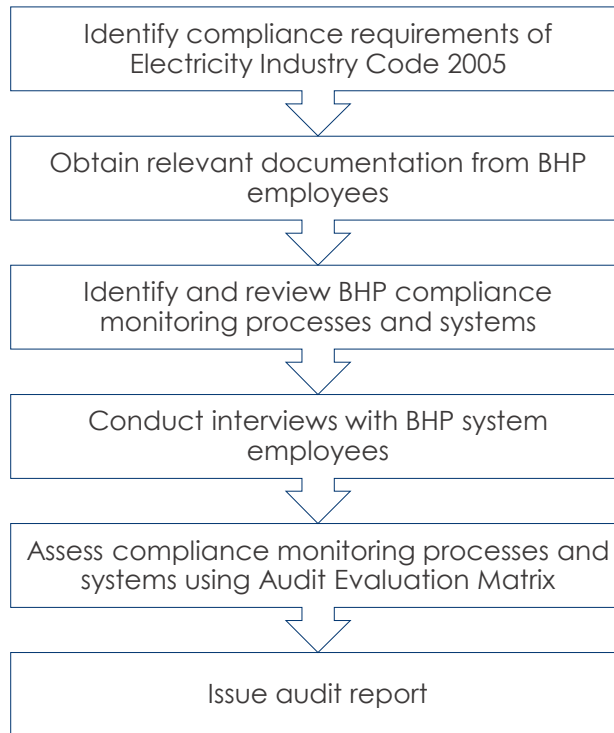


Figure 1 | Audit Methodology Flowchart

3.2. AUDIT EVALUATION MATRIX

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

1. Review if BHP 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 as a percentage. A 33% improvement means the overall rating has increased either from Low to Medium, or from Medium to High. An increase from Low to High is equivalent to a 66% improvement.

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






ITEM	CATEGORY/DESCRIPTION	DESCRIPTION OF RANKING			
		LOW	MEDIUM	HIGH	
1	Process	Documented Process	Process is poorly documented and requires major development	Process is documented and shows evidence of updates/revisions	Strong process documentation in place which may comply with ISO9001
2		Process fully integrated with corporate management systems	Poorly integrated systems in place which requires development	Adequate level of integration with management and reporting systems	Comprehensive integration with IT based corporate management and reporting systems
3		Demonstration of operator understanding of the documented process	Little or no demonstration of operator training and understanding	Employee understanding of the process demonstrated	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 are not in place or are underdeveloped	KPIs are in place with some understanding by operators	Well reviewed KPIs are in place and comprehensively understood by all operators
6		Reporting system supports continuous improvement	Little or poorly detailed reporting systems in place	Reporting systems exist at some levels and shows evidence of supporting continuous improvements	High level reporting systems in place clearly showing gaps and trends of performance
7		Evidence action taken	Little or poorly detailed evidence of reactive actions taken	Evidence of reactive and requisite responses	Highly detailed and reviewed 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 and integrated into the network management control on a real time basis.
11	Overall Ranking		Refer to Table 2 for descriptions.		

4. AUDIT RESULTS

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

The overall ratings are as detailed below in Table 2.

Table 2 | Overall Compliance Rating Definitions

OVERALL COMPLIANCE RATING	DESCRIPTION	
	High	High level, developed quality processes and systems
	Medium-High	Above average quality processes and systems
	Medium	Adequate quality processes and systems in place
	Low-Medium	Quality systems and processes but require further development
	Low	Quality systems and processes are not in place or require major development

4.1. PART 2, DIVISION 1: 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 $P_{st}=1.0$ and $P_{it}=0.8$ 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 supplies is a distortion level that is less than the compatibility levels set out in a table in the same section.
- In accordance with AS/NZS 3000:2018, the voltage levels of the electrical network must be maintained at +10% and -6% of the supply voltage.
- According to Section 8, the frequency must be maintained at +/- 2.5% of 50 cycles per second.

Appropriate processes and systems 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 shows the evaluation matrix for BHP in relation to Part 2 Division 1 Section 6(2), 7 & 8 (a)(b) of the Code.

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

ITEM	CATEGORY/DESCRIPTION		RANKING			% CHANGE COMPARED TO 2018/2019 RESULTS	COMMENTS
			LOW	MED	HIGH		
1	Process	Processes in place and documented			✓	0%	Consistent with previous FY
2		Process fully integrated with corporate management systems			✓	0%	Consistent with previous FY
3		Demonstrated operator understanding of the process			✓	0%	Consistent with previous FY
4		Evidence that the process is followed, and records are kept as per process			✓	0%	Consistent with previous FY
5	Continuous Improvement	KPIs are in place		✓		0%	Consistent with previous FY
6		Reporting system supports continuous improvement		✓		0%	Consistent with previous FY
7		Evidence action taken - continuous improvement			✓	0%	Consistent with previous FY
8	Measurement Tools	Suitability of PQ measurement devices			✓	0%	Consistent with previous FY
9		Data collection methodology of the PQ measurement devices		✓		0%	Consistent with previous FY
10		Method of PQ measurement devices deployment	✓			10%	Refer to Note 10:
11	Overall Ranking						

4.2. PART 2, DIVISION 2: SECTION 9 & 10

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

Requirement: 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 BHP to interrupt the supply of electricity to a customer for the purpose of maintaining or altering the network if the length of the interruption does not exceed 4 hours and BHP 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 the interruption.

Table 4 shows the evaluation matrix for BHP in relation to Part 2 Division 2 Section 9 & 10 of the Code.

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

ITEM	CATEGORY/DESCRIPTION		RANKING			% CHANGE COMPARED TO 2018/2019 RESULTS	COMMENTS
			LOW	MED	HIGH		
1	Process	Processes in place and documented			✓	0%	Consistent with previous FY
2		Process fully integrated with corporate management systems			✓	0%	Consistent with previous FY
3		Demonstrated operator understanding of the process			✓	0%	Consistent with previous FY
4		Evidence that the process is followed, and records are kept as per process			✓	0%	Consistent with previous FY
5	Continuous Improvement	KPIs are in place			✓	0%	Consistent with previous FY
6		Reporting system supports continuous improvement			✓	0%	Consistent with previous FY
7		Evidence action taken - continuous improvement			✓	0%	Consistent with previous FY
8	Overall Ranking						


4.3. PART 2, DIVISION 2: SECTION 11 & 12, 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 BHP plans to undertake 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 shows the evaluation matrix for BHP in relation to Part 2 Division 2 Section 11, 12 & Division 3 Section 13 of the Code.

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

ITEM	CATEGORY/DESCRIPTION		RANKING			% CHANGE COMPARED TO 2018/2019 RESULTS	COMMENTS
			LOW	MED	HIGH		
1	Process	Processes in place and documented			✓	0%	Consistent with previous FY
2		Process fully integrated with corporate management systems			✓	0%	Consistent with previous FY
3		Demonstrated operator understanding of the process			✓	0%	Consistent with previous FY
4		Evidence that the process is followed, and records are kept as per process		✓		0%	Consistent with previous FY
5	Continuous Improvement	KPIs are in place			✓	0%	Consistent with previous FY
6		Reporting system supports continuous improvement			✓	0%	Consistent with previous FY
7		Evidence action taken - continuous improvement			✓	0%	Consistent with previous FY
8	Overall Ranking						

5. AUDIT OBSERVATIONS & RECOMMENDATIONS

The following observations were made throughout the audit process:

- Note 1: BHP personnel that are involved in managing power quality understand the need to:
- Ensure compliance with The Code's requirements;
 - Expediently rectify network disturbances that affect the quality of supply to customers; and
 - Extend the monitoring capability of the LV network.
- Note 2: BHP demonstrated a clear understanding of their roles and responsibilities in maintaining supply reliability and minimising the duration and frequency of interruptions to the customers.
- Note 3: BHP demonstrated a clear understanding of the systems and processes involved in managing planned and unplanned outages.
- Note 4: BHP understand their obligation to provide customers with a minimum 72 hours' notice prior to a planned outage. This notification is provided in the form of a 'letter drop' at the impacted addresses.
- Note 5: Relevant BHP interviewees demonstrated a concise understanding of their responsibilities under Part 2 Division 2 Section 12 of the Electricity Code to remedy the causes of interruptions to small use customers or enter into alternative arrangements if the supply has been interrupted for more than 12 hours continuously, or more than the permitted number of times.
- Note 6: BHP currently supply six customers with special health needs who rely on electricity for life support and are well aware of their responsibilities in this area, and so far as is reasonably practical, continuity of electricity supply to these houses is maintained. If supply to the premises cannot be maintained, alternatives such as temporarily relocating the resident may be considered to help maintain their well-being. From interviewee discussions, BHP are proactive in securing the welfare of special health needs customers by ensuring that prior to each planned outage these residents have sufficient resources in place for the duration of the outage as well as closely monitoring these customers during forced (unplanned) outages.
- Note 7: As evident from interviewee's discussions, BHP have portable standby generators available to cater for extended planned or unplanned interruptions. In 2019/20, a mobile generator was deployed for an outage that exceeded 12 hours due to a transformer failure. BHP was able to provide supply to customers via the standby generator about 3 hours after the incident occurred. Generally, the deployment of the mobile generators is rare because of the high back-up capabilities of the Newman Township LV network.
- Note 8: BHP have demonstrated a clear understanding of their responsibility to provide the residents of the Newman Township with a reliable electricity supply. As such BHP are continuing the process of migrating from their current retailing and billing contractor (Agility) to Horizon Power, with one of the key driving factors behind the migration being the installation of Advanced Metering Infrastructure (AMI). These AMI smart meters are

capable of two-way communication which in-turn will provide a number of benefits including:

- Improved accuracy of meter readings – reducing billing errors arising due to estimation;
- Early detection of power quality issues; and
- Improved monitoring of power outages to assist maintenance crews in reducing restoration times.

Similar to the arrangement with the existing billing contractor (Agility), complaints made through Horizon Power will be filtered through to BHP as required.

Please note that there were no power quality related complaints received in 2019/20.

Note 9: BHP are still proactively undertaking continuous improvement projects to maintain adequate levels of reliability, power quality and public/personnel safety within the Newman Township. This is evident from several asset upgrade projects either already completed or currently in progress. This includes the following:

- Completed works on the major equipment upgrades at the Township Substation involving the replacement of the two ageing 66/11kV power transformers and neutral earth resistors
- Completed the conversion of an overhead section of low voltage powerline along Newman Drive (between Mindarra Drive and Nyabalee Road) to underground cable to improve public safety thus mitigating the conductor-to-ground height clearances issue that existed on this section of line.
- Completed the conversion of an overhead section of low voltage powerline along Radio Hill Drive to underground cable to improve public safety thus mitigating the conductor-to-ground height clearances issue that existed on this section of line. This followed a “high load versus live conductor” incident early in the 2020 calendar year.
- Continue with improvements driven by the results of investigations, e.g., in 2020/21, the replacement of transformer T7 and pad-mount substation PS61 as part of asset lifecycle ‘end of useful life’ replacement work, as well as the replacement of an aged low voltage switchboard at PS113 ‘Fortescue Flats’.
- Planning for the replacement of sections of HV overhead line with HV underground cabling within the Township of Newman, namely an upcoming project (previously scheduled for the 2018/19 FY period, and subsequently deferred to beyond the 2019/20 FY period) for the upgrade of a main road overhead crossing to prevent oversize loads accidentally connecting with the powerline.

Note 10: The following additional feedback and items were conveyed through the audit process:

- BHP are currently finalising the installation of 16 permanent SEL735 Advanced Power Quality and Revenue Meters at selected pad-mount substations. This work is to be completed by December 2020 and will improve the logging process by providing “any time” access to power quality data including harmonics.
- BHP have noted an increase in neutral voltage integrity issues within customer supplies. Currently these issues are identified and actioned reactively as a result of

inspections by electrical contractors. BHP are aiming to utilise the functionality of the AMI smart meters to detect neutral voltage integrity issues and action these on a more proactive basis. AMI is expected to be in place commencing in FY 2021/22 and continuing to completion in the immediate subsequent years.

- BHP are conducting a risk assessment of using the auto-reclose functionality of their reclosers to reduce the impacts (duration) of outages the causes of which are temporary (intermittent) in nature, for example, lightning, falling objects, wildlife, etc.
- BHP is considering the replacement of existing line interrupters (which cannot be switched on load) with air-break switches (which can be switched on load). This will provide a better reliability of supply experience for the customers during the day-to-day operation of the network.

With respects to the holistic electrical network, the recent PQ metering data indicates that Newman's electrical network has undergone noteworthy improvements to maintain its reputation as a robust and inherently good network. The average electrical parameters of voltage, frequency and voltage total harmonic distortion were consistently stable and generally well within compliance-levels. This is supported by the fact that there were no customer complaints related to power quality in 2019/20. However, the following compliance issues were identified:

- Voltage Flicker (AS61000:2001): There was a large increase in the number of long-term voltage fluctuation limit breaches (up from 4 in the 2018/19 logging period to 36 in the 2019/20 logging period). All were associated with PS25 sub and all occurred within 2 hours of the start of measurements. Given the nature of the recorded results, this occurrence may be an anomaly and should be monitored in case it re-occurs. The number of short-term voltage fluctuation limit breaches (15) was reduced slightly from the 2018/19 logging period level (17) but was still considered significant. The most onerous feeders were TC2 (5 breaches), STS2 (4 breaches) and STS1 (3 breaches). Given the results presented, there appears to be a relative deterioration of the flicker issues in 2019/2020 compared to the logging periods from the previous three years. However, as mentioned, part of this may be an anomaly, due to an unusual occurrence. It is recommended that this parameter is monitored over the next year and if the issue worsens, further investigations should be considered to identify and mitigate the root-cause.
- RMS Voltage Magnitude: (AS/NZS 3000:2007): Within the 2018/2019 FY logging period eight separate voltage limit breaches were recorded, all of which were undervoltage events (below -6% of 240 V). While the number of breaches reduced to five (all undervoltage) in the 2019/20 logging period, it was still higher than the number of breaches recorded in the 2017/18 logging period. Given the trend experienced, it is recommended that this parameter be monitored in the upcoming year and if the issue persists, investigations should be undertaken to resolve the matter.
- Power System Frequency: A single over-frequency and three under-frequency breaches of the limits described in the Electricity Act of 1945 Section 25 (1)(d) were recorded during the (2019/20) logging period. This is an increase from the single event in the 2018/19 logging period. Given the trend in increasing number of breaches over the last three years, it is recommended that this parameter be monitored in the upcoming year and, if the trend persists, an investigation should be made into the possible causes for mitigation purposes.

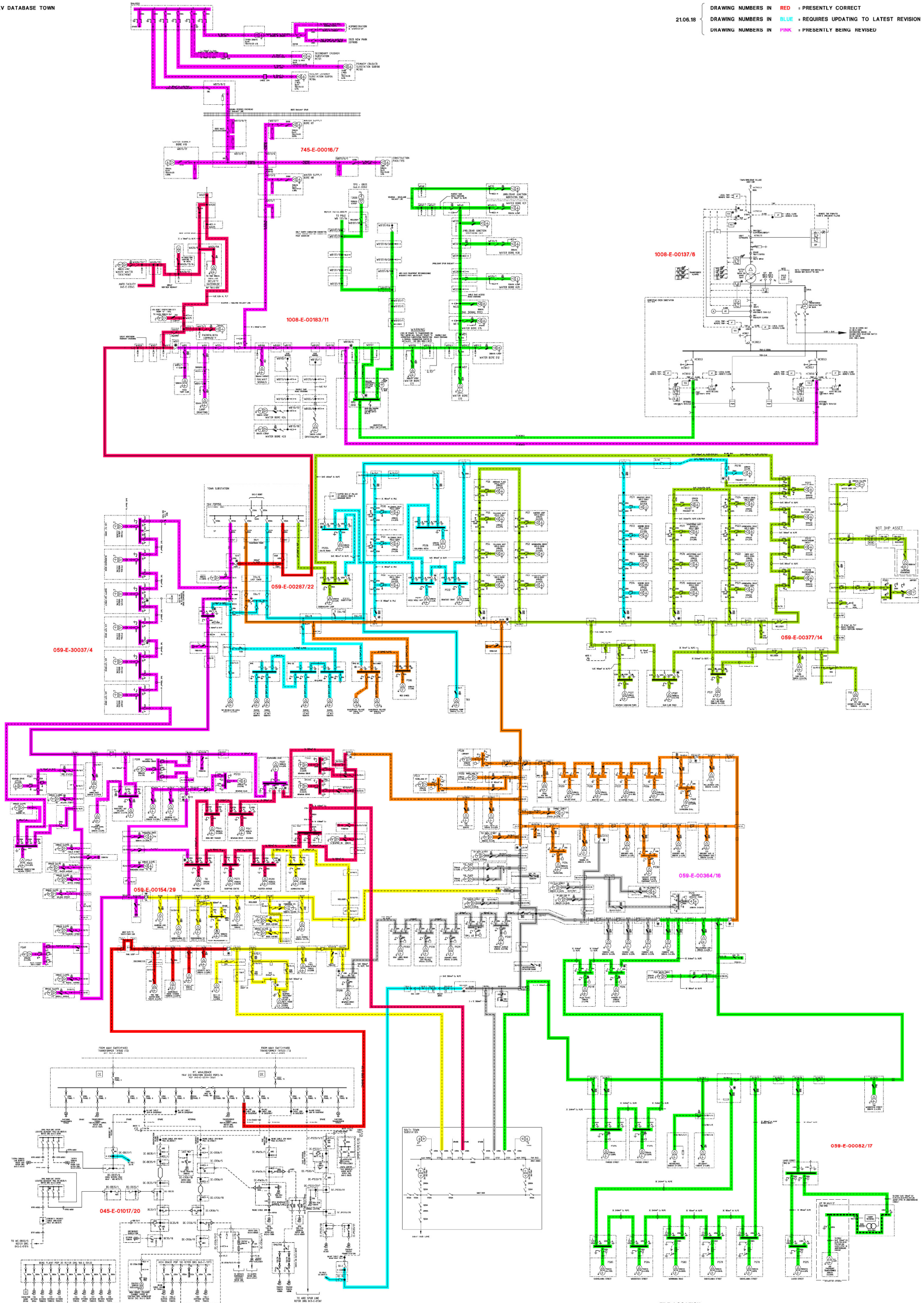
- U-THD: Three U-THD breaches of the limits described in Part 2, Division 1, Section 7 of the Code were recorded during the 2019/20 logging period. This is an increase from the single event recorded in the 2018/19 logging period. Given the trend in increasing number of breaches over the last three years, it is recommended that this parameter be monitored in the upcoming year and, if the trend persists, an investigation should be made into the possible causes for mitigation purposes.
- The recorded individual order harmonics showed a number of temporary and random breaches on all feeders that are not deemed of a practical concern at this stage. However, a large number of 21st order harmonic level breaches were recorded on the STS4 Feeder at PS44. The magnitude of these breaches appears to follow a typical daily demand pattern, and it is recommended that the cause of these breaches is investigated.

No major areas for continued development were identified in this audit, however it is recommended that BHP investigate the above-mentioned breaches and identify the root causes, in particular the individual 21st harmonics at PS111. Additional PQ logging at both the transformer secondary side and downstream customer connection(s) is recommended to determine the potential source of the harmonics.

TKV DATABASE TOWN

21.06.18

- DRAWING NUMBERS IN RED = PRESENTLY CORRECT
- DRAWING NUMBERS IN BLUE = REQUIRES UPDATING TO LATEST REVISION
- DRAWING NUMBERS IN PINK = PRESENTLY BEING REVISED



FILE LOCATION:
J:\TMPSPECIAL DRAWINGS\HV DISTRIBUTION SYSTEM\Latest Date\TKV DATABASE TOWN.dgn
CHECK RELEVANT DRAWINGS FOR UPDATES
045-E-01017 059-E-00082 059-E-00184 059-E-00287 059-E-00364
059-E-00377 059-E-30037 1008-E-00137 1008-E-00183 745-E-00016

21.06.2018