Plan

Network Performance and Planning Criteria Manual - NNPC (Peel)

27 August 2020

Version 2.0

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- ☐ CEO
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- ☐ Gas Pipeline Victoria
- ☐ Safety & Compliance
- ☒ Peel Renewable Energy
- ☐ COO
- ☐ Corporate Services
- ☐ Finance
- ☐ Network Operations
- ☐ Tas Gas Retail
- ☐ Peel Renewable Energy Genco

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- ☐ Tas Gas Holdings
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- ☐ Other:
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Document Acceptance and Release Notice

Name, Title			Date
Prepared by:			
Accepted by:	Rob Breden	GM Business Development	

Version History

Version No.	Published Date	Description of Change
1.0	June 2020	New document
2.0	27 August 2020	Updated to entity changes.

Amendments in this Version

Section No.	Section Title	Amendment Summary
		New document

References

Cited in this Document

Title	Document Number
Customer Connection and Contribution Guidelines	
Customer Self Supply Guidelines.	
Electricity Networks Access Code (2004) WA (ENAC)	
Electricity Corporations Act 2004 (WA)	
WA Distribution Connections Manual (WADCM)	
WP Technical Rules	
AS/NZS 61000.3.7.	
AS/NZS 61000.3.6.	
AS/NZS 61000.4.15	
AS-3851 (1991).	
AS2067	
IEC 60255	
IEC 60044.	

Additional Reading

Title	Document Number

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1. INTRODUCTION

1.1 Background

The Peel Business Park (**PBP**) is a large industrial and agri-business precinct located near Nambeelup, and approximately 7km north-west of Mandurah, WA. PBP has an overall area of approximately 1,000 hectares and is being developed in several stages. Reticulation of power within Peel Business Park is through a network referred to as the Peel Microgrid, owned and operated by Peel Renewable Energy Pty Ltd (**Peel**) a subsidiary of Tas Gas Holdings Pty Ltd.

Approximate geographic boundaries for PBP and the first precinct are outlined in **Error! Reference source not found.** below.

Figure 1. Peel Business Park Overview (courtesy ofCBRE/Landcorp)

1.2 Definitions

Term	Description
Tas Gas	Tas Gas Holdings Pty Ltd includes, but is not limited to, the following subsidiaries: Tas Gas Holdings Pty Ltd (TGH) Tas Gas Networks Pty Ltd (TGN) Tas Gas Retail Pty Ltd (TGR) Regional Energy Victoria Pty Ltd (REV) Peel Renewable Energy PTY Ltd (Peel) Peel Renewable Energy Genco Pty Ltd (Genco) Gas Networks Victoria Pty Ltd (GNV) Gas Pipeline Victoria PTY Ltd (GPV)
1Ph	Single-Phase.
3Ph	Three-Phase.
Augmentation	means the capital upgrade of the Peel Microgrid or the WP Network required to meet the electrical growth requirements of Customers.
CBF	Circuit-Breaker Fail protection scheme.

Term	Description
Customer	means a person supplied or to be supplied with electricity by Peel Renewable Energy at the PBP.
Distribution Network	means the distribution system components of the Peel Microgrid.
DOL	Direct On-Line starting as typically used for induction motors.
EN	Embedded Network supplying customers within the Peel Business Park.
ENAC	*Electricity Network Access Code 2004* (WA).
HV	meansHigh Voltage (typically 22kV for the PBP). (**kVA**)
LV	means Low Voltage (typically 415V for the PBP).
NP&PCM	means the PBP - Network Performance and Planning Criteria Manual (this document).
PBP	means the Peel Business Park located near Nambeelup, WA.
Peel Microgrid	means the vertically integrated electricity networks and generation assets that are located at the PBP and operated by Peel Renewable Energy and any of its Related Bodies Corporate
PF	Power Factor.
Project Deed	means the contrct between Peel Renewable Energy and DevelopmentWA under which Peel Renewable Energy is entitled to operate the Peel Microgrid.
PU	Per Unit.
RMS	Root Mean Squared (standard measure of magnitude for oscillating electrical quantities).
RMU	means Ring Main Unit.
SWIS	means the South-West interconnected system, as that term is defined int the *Electricity Industry Act 2004* (WA).
THD	Total Harmonic Distortion.
UG	means Underground (ie below ground cable-based infrastructure)
WA	means the state of Western Australia
WADCM	means the Western Australia Distribution Connection Manual
WP Network	Means the Electricity Networks Corporation, established under the *Electricity Corporations Act 2004* (WA) and trading as Western Power

1.3 About the Peel Microgrid

The Peel Microgrid takes supply at 22kV from the WP Network under a conventional customer arrangement. The Peel Microgrid incorporates an internal 22kV cable network supplying several 22kV/415V distribution substations. Individual sites within the PBP are typically supplied via radial low voltage supplies from these distribution substations.

Electricity is supplied to Customers at the Peel Microgrid from, variously:

- the WP Network by Synergy, under an electricity supply agreement between Synergy and Peel Renewable Energy
- local renewable generation and storage infrastructure connected directly to the Peel Microgrid.

Because the Peel Microgrid is connected to the WP Network by means of a conventional Western Power customer connection, the Peel Microgrid is subject to a range of technical, safety, regulatory and related obligations that are imposed by law or under arrangements between Peel Renewable Energy and Western Power and Synergy, respectively.

Peel Renewable Energy is required to comply with these overarching obligations in relation to the connection of Customers, the modification of Customer equipment and facilities and the Augmentation of the Peel Microgrid and, in some circumstances the Augmentation of the WP Network.

2. COMPLIANCE AND REGULATIONS

2.1 Regulation of Electricity Industry in WA

Key players in Western Australia's electricity sector in the South West, include:

- Energy Policy WA
- Synergy
- Western Power
- AEMO
- the WA Rule Change Panel
- Economic Regulation Authority of Western Australia
- Energy and Water Ombudsman Western Australia (**Energy Ombudsman**).

In summary, Energy Policy WA is responsible for the delivery of energy policy and transformation strategy to the Minister for Energy.

Synergy is the Western Australian Government owned gentailer responsible for supplying all "small customers" connected to the Western Power Network, as well as owning the majority of generation capacity in the South West.

Western Power owns and operates the Western Power Network, to which the Peel Microgrid is electrically connected.

AEMO is the market operator and system manager of the Wholesale Electricity Market, which is established in in the South West while the Rule Change Panel is responsible for assessing rule change proposals to the rules that govern the Wholesale Electricity Market.

The Economic Regulation Authority:

- regulates third party access to the WP Network under the Electricity Networks Access Code (2004) WA (ENAC)
- administers the electricity licensing regime
- monitors and reports on the compliance of electricity wholesale market participants.

The Energy Ombudsman receives and resolves complaints relating to electricity providers across WA.

2.2 Regulation of the Peel Microgrid

Peel Renewable Energy operates the Peel Microgrid pursuant to the Project Deed between it and DevelopmentWA.

Peel Renewable Energy also holds a distribution licence and a retail licence under the Electricity Industry Act (2004) WA (Electricity Act), under each of which it is required to comply with a range of legislative and regulatory obligations in relation to the operation of the Distribution Network and the supply of electricity to Customers.

The Peel Microgrid is not subject to pricing regulation of the Economic Regulation Authority as is the case with Western Power.

2.3 Consideration of WA Distribution Connections Manual

This document has been prepared to maintain consistency with the WA Distribution Connections Manual (**WADCM**). This is to help ensure Customer's within PBP have a comparable set of conditions, processes and requirements to those connecting to the WP Network.

3. STEADY STATE CRITERIA

3.1 General

This section defines the steady state limits applying to the PBP embedded network, including associated voltage, frequency, power quality and rating parameters.

Adherence to applicable power quality limits shall be assessed as necessary and in response to user requests/complaints with measurements undertaken over a continuous period of at least one week. Measurements shall be undertaken in accordance with clause 2.3.9 of the WP Technical Rules and at the maximum intervals specified in Table 1.

Table 1: Power Quality Measurements

Description	Maximum Interval between Measurements
Steady State Voltage Magnitude	10 minutes
Short Term Voltage Flicker (Pst)	10 minutes
Long Term Voltage Flicker (Plt)	2 hours
Harmonics	10 minutes
Negative Sequence Voltages	10 minutes

3.2 Steady State Voltage Limits

3.2.1 High Voltage

The HV network within the PBP takes supply and operates at a nominal three-phase voltage of 22,000V (22kV). Under normal operating conditions and excluding contingency events on the upstream network, the steady state HV limits in **Error! Reference source not found.** shall apply:

Table 2: Steady State HV limits

Description	PU (Per Unit)	3-Ph Voltage
Minimum Steady State HV	0.90	19.8kV
Maximum Steady State HV	1.10	24.2kV

3.2.2 Low Voltage

LV supplies with the PBP are provided at a nominal voltage of 415V for three-phase supplies, or 240V for single-phase. Under normal operating conditions and excluding contingency events on the upstream network, the steady state LV limits in **Error! Reference source not found.** shall apply:

Table 3: Steady State LV limits

Description	PU (Per Unit)	3Ph Voltage	1Ph Voltage
Minimum Steady State LV	0.94	390V	226V
Maximum Steady State LV	1.06	440V	254V

3.3 Abnormal or Emergency Conditions

During abnormal or emergency network operating conditions (including contingency events on the upstream South West Interconnected System) the voltages limits given in **Error! Reference source not found.** below shall apply:

Table 4 : Abnormal and Emergency Voltage Limits

Condition	Description	PU (Per Unit)	3Ph Voltage	1Ph Voltage
Abnormal Conditions *(e.g. during planned maintenance or network switching)*	Minimum Steady State HV	0.90	19.8kV	-
	Maximum Steady State HV	1.10	24.2kV	-
	Minimum Steady State LV	0.92	382V	221V
	Maximum Steady State LV	1.08	448V	259V
Emergency Conditions *(e.g. during significant unplanned events on the upstream network)*	Minimum Steady State HV	As determined by Western Power		
	Maximum Steady State HV			
	Minimum Steady State LV	0.90	374V	216V
	Maximum Steady State LV	1.10	456V	264V

3.4 Step Change Voltage Limits

Switching operations on the PBP embedded network and upstream WP network may cause short duration step changes to steady state voltages. Associated, step change voltage limits applying to the PBP embedded network are outlined in Table 1 below:

Table 1: Step Change Voltage Limits

Condition	Regularity (per hour)	Initial Step Change %
Regular/Periodic Operational Switching	$r \leq 1$	±4.0%
	$1 < r \leq 10$	±3.0%
	$10 < r \leq 100$	±2.0%
	$100 < r \leq 1000$	±1.25%
Irregular/Infrequent Contingencies	$r > 1$	-10% to +6%

Note: *Voltage regulation systems on the upstream WP network are required to re-establish the pre-existing (set-point) voltage levels following an initial step change (as described in clause 2.2.2 of the WP Technical Rules). The PBP embedded network does not incorporate on-line voltage regulation systems. Accordingly, associated voltages will generally follow WP for all switching on the upstream WP network.*

3.5 Rapid Voltage Fluctuations(Flicker)

The planning levels to be adopted for rapid voltage fluctuations (flicker) within the PBP embedded network are consistent with the WP Technical Rules and given in Table 2 below:

Table 2: Rapid Voltage Fluctuation Planning Limits

Measurement*	LV	HV
Pst (short term)	1.0	0.9
Plt (long term)	0.65	0.7

**as defined in AS/NZS 61000.3.7.*

These limits apply during normal operating conditions and not applicable under abnormal or emergency system conditions.

3.6 Harmonic Distortion

The planning limit for total harmonic distortion (THD) on the PBP embedded network is 6.5%. In addition, individual harmonics shall be maintained within the planning limits given in Table 3, while inter-harmonics limits shall be determined from the methodologies described in Clause 9 of AS/NZS 61000.3.6.

Table 3: Harmonic Voltages Planning Limits

Harmonic Order (h)	Magnitude (% of Nominal)	Harmonic Order (h)	Magnitude (% of Nominal)	Harmonic Order (h)	Magnitude (% of Nominal)
2	1.6	15	0.3	28	0.2
3	4	16	0.2	29	0.63
4	1	17	1.6	30	0.2
5	5	18	0.2	31	0.60
6	0.5	19	1.2	32	0.2
8	4	20	0.2	33	0.2
9	0.4	21	0.2	34	0.2
10	1.2	22	0.2	35	0.56
11	0.4	23	1.2	36	0.2
12	3	24	0.2	37	0.54
13	0.2	25	1.2	38	0.2
14	2.5	26	0.2	39	0.2

These planning limits are consistent with WP Technical Rules and apply under normal operating conditions only.

3.7 Negative Sequence Voltages

Negative sequence voltages are a consequence of an unbalance in voltages across three-phase supplies. Negative sequence voltages shall be limited to the values given in Table 4 (where $V_{neg}(10)$ is the average over any given 10 minute period).

Table 4: Negative Phase Sequence Voltage Limits

Measurement*	LV (% of Nominal)	HV (% of Nominal)
V_{neg} (10)	2%	1.5%

WP are also obliged to maintaining negative sequence voltages within these limits on their network.

3.8 Temporary Over-Voltages

Temporary over-voltages based on mean RMS at fundamental frequency, shall be maintained within the limits given in Table 5.

Table 5: Temporary Over-Voltage Limits

Measurement*	LV (% of Nominal)	HV (% of Nominal)
t ≤ 1	30%	30%
1 < t ≤ 10	20%	20%
t > 10	6%	10%

These limits apply to all credible contingency events and also reflect associated WP limits for the upstream supplies.

3.9 Frequency Limits

While-ever the PBP embedded network is connected to Western Power the supply frequency will have a normal operating frequency range of 49.5Hz to 50.5Hz as determined by the SWIS. Section 2.2.1 of the WP Technical Rules should be referred to for further details of associated frequency standards under various contingency conditions.

In the event PBP is disconnected from the Western Power network for an extended time, it may be necessary to use available local generation to supply part or all of the PBP in an islanded state. Under these conditions' frequency range limits of 48Hz to 52Hz shall apply.

3.10 Short-Circuit Fault Current Limits

Potential maximum short-circuit fault currents within the PBP embedded network shall be maintained below the values given in Table 6.

Table 6: Fault Current Limits

HV	LV- where supplied by a single transformer	LV- where supplied by two transformers in parallel
16kA	31.5kA	63kA

Maximum fault currents shall not exceed 95% of associated equipment fault ratings or withstand capacities, with due consideration for associated fault protection clearing times where applicable.

3.11 Thermal Current Rating Limits

Equipment thermal ratings shall be sufficient to ensure currents under all defined operating conditions (including credible contingencies), can be suitably withstood in accordance with good electricity industry practise.

4. LOAD AND MODEL REQUIREMENTS

4.1 General

This section outlines network performance, planning criteria and related model requirements relevant to electrical loads and facilities within the PBP embedded network.

Loads connecting to the PBP network shall be assessed and required to operate in accordance with these requirements through applicable connection processes and agreements. Further details of PBP connection processes and related requirements are covered in the following documents:

- PBP – *Customer Connection and Contribution Guidelines (CCG) (Peel)* BMSDOC-18-2203
- PBP – Customer Self Supply Guidelines.

In general, all connected loads and associated facilities shall be capable of operating normally under the various steady state criteria detailed in Section **Error! Reference source not found.**. Furthermore, all connected loads/facilities shall be suitably managed to ensure the steady state criteria are adequately achieved under all applicable operating conditions.

4.2 Power Factor

The overall power factor (PF) for the Microgrid is required to be maintained between 0.9 lagging and 0.9 leading (unless otherwise agreed or specified by WP). Overall PF shall be based on half-hour averages measured at the point of common coupling with the WP network

Individual connected loads within PBP will also generally need to maintain their PF between 0.9 lagging and 0.9 leading unless otherwise agreed/specified. This differs from the WP Technical Rules, whereby installations with a load of less than 1MVA may generally operate between 0.8 lagging and 0.8 leading.

The more stringent requirement for 0.9 lagging to 0.9 leading, is necessary to help maximise efficiency and comply with upstream WP requirements. Noting, Peel Renewable Energy may consider deviations where appropriate on a case by case basis.

4.3 Fluctuating Loads

Maintaining voltages and voltage flicker within planning limits described in Section **Error! Reference source not found.** may require allocation of specific limits to fluctuating loads for individual users connected to the embedded network.

Appropriate allocations shall be determined in consultation with WP and using the evaluation procedures described in AS/NZS 61000.3.7. Compliance shall also be verified and monitored through measurements undertaken in accordance with AS/NZS 61000.4.15.

4.4 Harmonics

Measures necessary for maintaining harmonic distortion within planning limits detailed in Section **Error! Reference source not found.**, shall be determined in consultation with WP, and may require specific emission allocations for individual users connected to the embedded network.

User limits shall be determined through the evaluation procedures described in AS/NZS 61000.3.6 with compliance verified and monitored through measurements undertaken in accordance with AS/NZS 61000.4.7.

4.5 Phase Unbalance

In order to meet overall negative sequence voltage limits given in Section **Error! Reference source not found.**, it may be necessary for users within the PBP to manage or mitigate any phase unbalance issues caused by their installation/equipment. This will generally require all connected loads to be suitably balanced across all three phases unless otherwise agreed. Where necessary phase balance

shall be maintained through appropriate distribution of any connected single-phase loads as well as associated consultation with WP.

4.6 Large Step or Transient Loads

In order to meet step-change voltage limits detailed in Section **Error! Reference source not found.** it may be necessary for users within the PBP to manage or avoid large step, short duration or transient load events within their installation/equipment. This will generally require large and frequent transient loads (such as large DOL motor starting) to be identified and agreed when reviewing individual connection proposals.

4.7 Model Information

Suitable information relating to the PBP embedded network and associated loads/facilities shall be maintained to enable steady state studies and other power system simulations to be undertaken if/when required, or if requested by WP, including and not limited to:

- A set of up-to-date single line diagrams of the PBP embedded network
- Suitable parameters, including current/fault withstand ratings, impedances, operating voltages, earthing and phasing/vector group details for all key network elements such as conductors/cables, switchgear, power transformers and any locally connected generation
- Real and reactive loading details as well as details of applicable power quality emissions where required (e.g. flicker, harmonics, phasing, negative sequence and step-load parameters)
- Details of protection related equipment/devices, including fuses, CT's, VT's, protection relays and associated settings.

5. PLANNING CRITERIA

5.1 General

This section outlines the criteria to be used in planning the development and electrical layout of the PBP embedded network (Note: The criteria to be used for individual user connections to the PBP network are subject of negotiations during the connection process).

While these planning criteria are generally consistent with the relevant requirements contained in the WP Technical Rules, they account for specific arrangements and philosophies intended to be adopted within PBP. Planning criterial for the upstream WP supplies and network are detailed in clause 2.5 of WP Technical Rules.

The PBP embedded network shall be designed to adequately supply the foreseeable load accounting for applicable restrictions on land use and anticipated electricity consumption patterns.

5.2 Contingency Criteria

Under the Technical Rules a contingency criterion of N-0 generally applies to the PBP embedded network. This means an interruption of supply to one or more users may result from a fault or outage on a single item of equipment.

However, where an underground HV feeder cable section supplies an installed transformer capacity of 1MVA or more, then capability shall be provided to restore supply to affected distribution substations in the event of fault or outage on the applicable HV cable section. Restoration of supply shall generally be achieved through manual or remote HV switching operations (referred to here as "switched N-1").

5.3 HV Network Configuration

The "switched N-1" capability described in section 5.2 will generally involve the PBP HV network being configured as one or more open HV feeder rings with primary RMU switching capabilities at each distribution substation. Under this arrangement supply to all distribution substations may still

be possible, following switching, with a single section of interconnecting cable faulted or out-of-service.

Measures shall be adopted to ensure HV feeder rings are never closed and any parallel operation of outgoing HV circuits at the PBP Main HV Switchboard is always avoided.

5.4 LV Network Configuration

Low voltage network shall generally be planned to N-0 utilising underground cabling systems. Where technically and commercially feasible, and subject connection negotiations with users, alternative or backup low voltage supplies may be provided.

6. SHORT-CIRCUIT RATINGS

6.1 Fault Ratings

All equipment and associated devices used within the PBP embedded network to isolate and clear short-circuit faults (such as circuit-breakers and fuses) must be suitable for applicable fault levels and capable of breaking, without restrike or damage, all associated fault currents.

Equipment shall generally be designed and installed to be suitable for potential maximum short-circuit fault currents detailed in Section **Error! Reference source not found.** unless otherwise determined using the appropriate methodologies as outlined in section 6.2 below. Equipment fault ratings should exceed potential maximum fault currents by at least 5%, with due consideration for maximum protection clearing times where applicable.

All applicable fault levels within PBP should be made available to existing and prospective users, including sufficient information upon request, to allow users to determine maximum fault levels and applicable ratings for their facilities.

6.2 Calculation Methodology

Where fault calculations are used to help determine required fault ratings (as an alternative to the values detailed in Section **Error! Reference source not found.**), they must consider potential future maximum fault levels of WP supplies as well as all credible embedded network configurations and foreseeable future requirements. Associated calculations shall be based on the standard methodologies detailed in AS-3851 (1991).

Where relevant, maximum fault clearing times shall also be determined and taken into account when assessing fault withstand ratings, to ensure specified rating parameters are suitable and applicable for each situation.

7. SHORT-CIRCUIT PROTECTION REQUIREMENTS

This section describes the functional requirements for short-circuit protection on the PBP embedded network. Details of the protection requirements relating to user/customer installations and generators are provided in the following documents:

- PBP – *Customer Connection and Contribution Guidelines (CCG) (Peel)* BMSDOC-18-2203
- PBP – Customer Self Supply Guidelines.

7.1 General

Suitable protection systems shall be provided to ensure short-circuit electrical faults are cleared/isolated within a sufficiently short period of time to avoid unnecessary damage to electrical equipment and related facilities. The extent of these isolations should ensure disruption to supply and impacts on the upstream electrical network are minimised as far as practical.

Protection systems shall be suitably designed, implemented and maintained to ensure, when called upon they operate as required, and comply with the relevant standards, including but not limited to, AS2067, IEC 60255 and IEC 60044.

7.2 Main and Backup Protection

Equipment within the PBP HV network shall be protected by at least two independent protection systems, such that a malfunction within one protection system does not affect the integrity or operation of the other. For each item of equipment (e.g. cable, busbar, transformer) this shall generally involve:

- A main protection system: that operates quickly to remove the supply and isolate a fault, while limiting the extent of isolation to a minimum
- A separate backup protection system: located further upstream, that will operate to isolate a fault in the event the main protection system fails to operate.
- Time-grading of the main and backup protection to avoid simultaneously operation for the same fault.
- Provision of a Circuit-Breaker Fail scheme (CBF) in situations where the main and backup protection system use common circuit-breaker(s). The CBF scheme shall ensure all fault current will be cleared by alternative circuit-breakers if the common circuit-breaker(s) fails to operate.

7.3 Protection Availability

Main and backup protection systems should be designed, installed and maintained such that they are never simultaneously taken out-of-service while-ever the protected equipment remains in-service. Situations where either the main or backup protection is out-of-service shall be kept to a practical minimum and not exceed 48 hours (unless all of the applicable protected equipment is also taken out-of-service).

Suitable supervision of protection systems (including any related DC supply and tripping systems) shall be provided where necessary to ensure protection systems will operate as/when required.

7.4 Protection Sensitivity and Settings

All short-circuit protection systems shall have sufficient sensitivity settings that ensure suitable operation under all applicable operating conditions, including minimum steady state operating voltages, minimum upstream fault levels and minimum levels of local generation (where islanded operation is proposed).

Applicable settings for protection systems shall also be determined with due consideration for the following:

- All applicable operating/switching conditions within PBP and WP networks
- Fault withstand capabilities of all applicable equipment
- Applicable electrical arcing hazards
- Suitable discrimination between successive lines of protection (including the upstream WP protection)
- Operating limits of related protection devices/systems (e.g. CT's, VT's fuses, circuit-breakers and relays)
- Applicable earthing systems and arrangements
- Any other applicable technical requirements (e.g. related WP requirements).