

# Indigenous Community Engineering Guidelines

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# Introduction

These Engineering Guidelines should be read in conjunction with the document titled “Policy Guidelines and Operational Guidelines for Levels of Service to Remote NT Communities”.

This document outlines Engineering Guidelines for planning, design and construction of new Power and Water Corporation (PWC) services on remote communities. This document is a guide to the minimum level of service to be provided on the different remote communities in the Northern Territory.

The Guidelines are not intended to cover all aspects of design for Power, Water and Sewerage Infrastructure on remote communities. Where material is not covered or amended in this document, the user should refer to the PWC Guidelines for Developers and Consulting Engineers for the provision of Water and Sewerage Infrastructure in Subdivisions or the standard Power Distribution Design Brief and Speciation. Refer to ‘Operational Guidelines’ for general practices and Operational Procedures for connections of new services. The Indigenous community asset handover guidelines should be adhered to when carrying out design, construction and hand-over of infrastructure for PWC operation. Additional information should be obtained from manufacturers’ design guidelines, product manuals and the like as necessary for individual applications.

While PWC will endeavour to ensure that all customer relations are conducted efficiently and effectively and that services are delivered equitably in a prompt and courteous manner, the financial and logistical restraints associated with the location of most remote communities means that compromises on the level of service to some PWC customers is necessary. For the purposes of this document remote communities only are covered and not outstations.

## 1.1 Planning horizons

This section examines forward planning guidelines for infrastructure design and construction.

A planning period of twenty (20) years would usually be appropriate. A long-term services strategy will normally lead to a decision to carry out construction in stages. The design capacity of any components will then depend on the economics and practicability of duplication, replacing or enlarging that component within the overall strategy.

### 1.1.1 Current and future population data for design purposes

The population on most remote communities in the Northern Territory is subject to seasonal and ceremonial fluctuations.

The previous Australian Bureau of Statistics (ABS) Census figures are used as a guide for current population figures. This data should be compared with Department of Lands Housing and Local Government (DLH & LG) data, which can often provide more recent population figures.

For future population predictions and where possible, local knowledge and historical data should be used to predict design population levels for each community. Population growth figures of 2 to 5% per annum are currently experienced in most communities.

In the absence of more reliable data the designer is to use the DLH&LG planning division data.

Consideration should be given to the possibility that infrastructure development will result in migratory population growth and a change to community demographics.

### 1.1.2 Infrastructure Construction

Any planned expansion and / or infrastructure construction (power, water, sewerage) should consider the following:

- a) Analysis of the existing system and the degree of utilisation;
- b) Projected demands;
- c) All alternative options;
- d) Future town plan (DLG & LG SLAP Report, ATSI Regional Plan and Community Development Plan);
- e) Construction and subdivision work being carried out by others;
- f) The effect of additional load on existing infrastructure (especially peak loads);
- g) Restrictions on development due to cultural and environmental constraints;
- h) The option of staging construction in 3 to 5 year intervals to match housing or commercial demand requirements;
- i) Economic evaluation – including assessment of capital and operating costs, use of standard products in use by PWC; and
- j) Suitability of Technology options when used on remote communities.

### 1.1.3 Design and Construction Process, PWC Requirements

The design process for Power, Water or Sewerage infrastructure on remote communities must follow the steps as detailed in “Indigenous Community Asset Handover Guidelines” and the requirements of individual or general project briefs.

### 1.1.4 Defect Liability Period

The period for the defect liability shall be not less than 12 months and is to be confirmed with PWC Remote Operations Planning Section, during the 90% design review. A longer period for the defect liability may be required based on risk assessment of the infrastructure in question.

### 1.1.5 Economic Evaluation

An Economic Evaluation should include, but is not limited to, the following:

- Initial Feasibility Study of all options;
- Net Present Value Analysis incorporating;
- Economic Life of Asset;
- Operating and Maintenance Cost Analysis;
- Sensitivity Analysis;
- Environment impact considerations;
- Cost of maintenance to remote and isolated location; and
- Skills of available local staff to maintain systems or plant.

### 1.1.6 Household Occupancy Rates

The average household occupancy rates on Indigenous communities are much higher than for non-indigenous communities. The current average occupancy rate is 9 persons per dwelling while the average non-indigenous occupancy rate is 3 per household. It is recognised that the high occupancy rate is not always by choice and as housing stock is increased the levels may fall. The actual current household occupancy rate for each community should be confirmed. The design occupancy rates or equivalent population should be based on detailed projections considering the above factors.

A minimum EP of 9 per dwelling is to be used for residential lots. EP loading for non-residential areas is to be determined in accordance with the Sydney Water Board (SWB) Sewer Design Manual, December 1993.

## 1.2 Service locations

The location of Power, Water and Sewerage services in new subdivisions is to be confirmed with PWC remote operations planning section, a detail of the proposed service locations is to be included in the design and construction drawings. The alignment should conform to PWC standard alignments.

A drawing nominating corridors for installation of PWC services and other utility services within road reserves as offset from property boundaries is to be included in the design documentation for approval by PWC. Normally the property boundary will be identified prior to design of service locations being carried out. Where property boundary information is unavailable, the property boundary will generally be accepted as ten metres off the road centre line.

Where services are laid in easements outside road reserves, Australian Standard AS3500 is referred to for installation of PWC services relative to each other.

## 1.3 Standards and materials

All materials and installations will be approved by the PWC Standards Branch. The PWC product manual shall be used. The use of alternative materials is to be considered only where no approved product is available. Materials should nevertheless be consistent with the design life of the installation. Deviations from PWC standards are to have prior written approval by the PWC Remote Operation planning section.

#### **1.4 Design reviews**

As the main stakeholder of service infrastructure in remote communities PWC should be consulted at the design investigation or concept stage of all projects.

Design reviews are required when drawings and specifications are at the initial draft stage, 30% completed and when documents are 90% complete.

Design reports shall be submitted to PWC for review and acceptance. Detailed documentation should not proceed until stakeholder approvals have been obtained. The contractor/developer proceeds at their own risk of having to rework documentation of an unacceptable standard.

Works are not to proceed until drawings are stamped as approved for construction by PWC Remote Operations Planning Staff. Ten working days should be allowed for the review of documents and return from a PWC Remote Operation's office.

# Water guidelines

## 2.1 General design criteria

### 2.1.1 Water Quality

The criteria for drinking water quality objectives and water quality monitoring in the NT are outlined in the 2004 publication “**guidelines for drinking water quality in Australia**”, published jointly by the National Health and Medical Research Council (NH&MRC) and the Australian Water Resources Council (AWRC). Design and construction of a water supply should emphasise securing a safe and reliable source. If a community’s drinking water fails to satisfy the criteria as outlined in the guidelines, then tripartite discussions between the community, PWC and the Department of Health and Community Services (DH&CS) may reach agreement on an “acceptable” drinking water supply. The endorsement of the NT Potable Water Committee will be sought. As a last resort, treatment of drinking water may be considered.

The water source shall be protected from contamination by the provision of a development buffer zone. Surface or near surface (i.e. soakages) supplies should be upstream of local development i.e. the Hydraulic Grade Line (HGL) should be at a higher elevation than the community. In the absence of detailed evaluations, bores with a static water level of less than 50m should have a buffer zone of not less than 200m. Bores with a static water level greater than 50m could have the buffer zone reduced to 100m.

### 2.1.2 Water Treatment

Treatment of a water supply should only be considered when the only feasible source does not comply with the guidelines and when agreement on an acceptable level of non-compliance is not possible.

The appropriate treatment process will depend on local conditions and the nature of non-compliance with the NH&MRC guidelines.

Any instances where water treatment is required will need to be reviewed and treatment requirements developed in conjunction with PWC Remote Operations and other stakeholders.

### 2.1.3 Water Quality Monitoring

Requirements for monitoring of water supplies are specified in the NH&MRC guidelines. Design of water supply infrastructure must provide accessible sampling points to allow compliance with the NH&MRC monitoring guidelines.

### 2.1.4 Security of Supply

The aim of the security of supply should be such that frequency of restrictions does not exceed an occurrence rate of 1 in 3 years. The duration should not exceed a period of 10 days per occurrence.

Severity of restrictions should be such that 70% of normal demand can be supplied through a repeat of the worst drought starting at the restriction level.

With regard to peak day supply, a restriction for about 10 days per year is considered reasonable. Restrictions would normally take the form of partial loss of system pressure due to the high flow rates.

### 2.1.5 Demand Management

While the water quantity design criteria detailed in the following pages are considered adequate, many existing communities may not meet these criteria for short periods of unusual demand.

Design criteria should not take into account unusually high demands caused by construction works, maintenance of mains, excessive leakage or gross wastage.

Where existing data indicates that demands consistently exceed the quantity design criteria in the following sections, then a community water conservation program should be implemented. Where the community intends to implement projects requiring high levels of irrigation (e.g. market gardens, large ovals etc), then an alternative water source besides the reticulated potable water supply should be considered. Alternative sources and systems for such needs would normally be a community initiative and responsibility.

### 2.1.6 Dual Supply Networks and Ring Mains

Where practical all new designs will include dual supply networks and ring mains in the water supply network for the community to improve water quality (removal of dead end mains), operational outcomes and improved networking.

PWC guidelines also require water main networks to be set out such that lot isolation is kept to a maximum of 25 lots at any one time during repairs and maintenance.

Where the cost to provide dual supply or to ring a new main into an existing water main is excessive due to services being remote from the parent network, these requirements may be waived in negotiation with PWC Remote Operations Planning Section. In such cases, terminate the water main with a fire hydrant discharging to a stormwater drain for PWC to flush the main as per the PWC standard drawing for water main temporary dead ends.

### 2.1.7 Metering and Backflow Prevention

All lots shall be supplied with a single water service connection from the water supply main. All services will be provided with individual water meters. The designer shall supply to PWC relevant information for each lot including proposed demand, number of plumbing fixtures, backflow hazard assessment.

Low backflow hazard rated lots PWC will supply at cost to constructor a new water meter with integrated backflow prevention device. PWC will be responsible for the maintenance of the water meter (including the integrated backflow prevention device).

Medium to High Backflow hazard rated lots the designer and constructor shall ensure a suitable backflow prevention device, in accordance with AS 3500, is fitted to the meter arrangement. The lot owner/governing body is responsible for the maintenance and servicing of the backflow prevention device. PWC will be responsible for the maintenance of the water meter only.

All metering arrangements shall confirm with PWC Standard Drawings with application and approval from PWC.

### 2.1.8 Water Supply Marking

All water supply mains and fittings are to be marked in accordance with PWC standard drawings.

All valves, fire hydrants and changes of directions are to be marked clearly on the as constructed drawings with updated survey coordinates tied to the SLAP Map.

### 2.1.9 Flanged Joints

Flanged joints are to be used where valves are connected to tees, where vertical bends are used and where two or more fittings are used in a single installation.

### 2.1.10 Mechanical Protection

Where underground electrical services cross a water main, provide mechanical protection (via concrete pavers) above the electrical services 1m either side of the water main.

## 2.2 Detailed water design criteria – remote communities

### 2.2.1 Quantity – Water Supply Levels

Annual Average Daily Demand	800 litres/EP/day
Peak Day Factor (Domestic)	1.5 x average day (1200 l/EP/day)
Peak Hour Factor (Domestic)	3.0 x peak day (pop. = 100 – 500) 2.5 x peak day (pop. > 500)

*Comments*

- The Annual Average Daily Demand is based on consumption data and supported by Queensland Design Guidelines
- Commercial demand should be calculated as per PWC Guidelines for Developers and Consulting Engineers for the Provision of Water and Sewerage Infrastructure in Subdivisions
- Average Daily Demand consists of 40% garden watering components and 60% 'in house' component
- Peak Daily Demand consists of 70% garden watering and 30% 'in house' component.

This breakdown is provided to allow for dual water supply design assessments (ie untreated bore water or 'greywater' reticulation).

**2.2.2 Fire Fighting – Design Criteria**

Design fire flow calculations are to be based on supplying flows and pressure at the hydrant as detailed in Table 1 below, when combined with 67% of normal peak hour demand.

Table 1 Fire Fighting Design Criteria

	<b>Residential (2)</b>	<b>Commercial (1)</b>
Minimum flow	7.5L/S	10L/S
Residual pressure	>2.5m	10m

*Comments*

- A locally operated and maintained fire truck complete with fire pump is considered an essential component of the community's fire protection strategy
- Residential areas require the specified Fire Flow with sufficient residual head to supply positive pressure at a mobile fire pump inlet
- Residential is defined as low-density housing
- Commercial is defined as the cluster development of council offices, schools, workshops, stores and the like of maximum two stories in elevation
- Where Fire Flows are the determining factor and the existing system is unable to conform to design criteria, then consideration should be given to the installation of a diesel powered booster pump for the reticulation system.

**2.2.3 Source**

The reliability, extent and capacity (sustainable yield) of the water resource must be considered in any water supply system. Pumping equipment should be able to supply peak daily requirement in a 20 hour period with the largest pumping unit out of service. Each individual source must be metered. Where bores provide the water source, equipping of the bore should be in accordance with PWC Standards.

**2.2.4 Storage**

Storage is provided in order to balance inflow and outflow, and provide reticulation pressures.

Ground Storage	Equal to 1 days Design Peak Day Demand
Elevated Storage	Equal to 6 hours of Design Peak Day Demand
Transfer Pumps	Transfer rate to equal Peak Day Demand with 100% standby capacity.

*Comments*

- Tank design is not to rely on galvanising alone for corrosion protection unless it can be demonstrated that the water is non corrosive under service conditions
- Elevated Storage to provide minimum reticulation pressures as determined in Section 2.2.5
- Storage Reservoirs should be operated so that a minimum of 30 Litres/persons or 20kL for fire flows whichever is higher, is always available to support emergency demands.

### 2.2.5 Pipelines

The pipeline should be designed to meet required capacity during peak consumption months at the community.

#### *Reticulation Mains*

- Reticulation mains shall be provided by the developer
- All service and meter locations for lots shall be in accordance with PWC standards
- Any metering point or otherwise defined point of supply that is located 25m or more from the reticulation main shall not be considered serviced, and will require reticulation extension by developer
- Designed to carry Peak Hour Demand
- Absolute Minimum residual pressure at peak hour demand = 10 meters
- Hydrant location – to be not more than 90m spacing
- Where possible hydrants are to be located at low points, high points and at the end of mains
- Peak Operating pressure = 50 meters
- All water reticulation mains to be a minimum DN150.

#### *Reticulation and Ring mains*

Pipe class is to suit reticulation pressures, but not less than Class 12.

Reticulation pipe location is to comply with the PWC drawing titled 'Service Allocations in Road Reserves – Remote Communities'.

#### *Transmission/Rising Mains*

Gravity – designed to transfer Peak Day Demand in a 24 hour period (long transmission mains can be reduced in size if accompanied by a corresponding increase in storage, economical analysis required).

Pumped – Designed to transfer Peak Day Demand in a 20 hour period.

Design should be such that water hammer is removed from the system.

# Sewerage guidelines

## 3.1 General design guidelines

### 3.1.1 Introduction

Adequate and safe sanitation is a basic requirement of any community for protection of the inhabitants' health and to safeguard the environment.

Selection of appropriate disposal systems will depend on a number of factors. This document is not suitable as a guide to Sewerage Disposal system selection, and the reader is advised to consult one of the many sewerage scheme selection guides available.

*This guideline covers the requirements for 2 basic systems:*

- 1) Conventional or water borne reticulated Raw Sewerage with 'off site' disposal systems.
- 2) Septic tank treatment with treated effluent removal and disposal (Common Effluent Drain Systems).

The other system of disposal – Septic Tank Treatment with 'on site' disposal, is covered by Northern Territory code of practice for small on-site sewage and sullage treatment systems and the disposal or reuse of sewage effluent (THS).

Combinations and alternatives to these three systems are to be investigated by the designer.

### 3.1.2 Criteria for Selection of a Sewerage Disposal System

#### *General Criteria*

- Cost per capita
- adequate protection of Public Health
- acceptable protection of Environment
- acceptable protection of community water source (protection of water table)
- acceptable to the community.

#### *Additional Remote Area Criteria*

- Reliability and ease of operations – flexibility to cope with seasonal population fluctuations and having regard for future development – low potential for mosquito breeding – ability to cope with different types of waste, i.e. one system to manage commercial, residential and recreational waste.
- Effluent reuse capability.

*Prior to the identification of a suitable alternative, the following basic information needs to be gathered, including:*

- Possible treatment/disposal sites and Existing Sewerage Disposal practices;
- Allotment sizes, types and distribution;
- Soil Types and Typical topography, geology and hydrology; and
- Climatic data (temperatures/rainfall/evaporation).

### 3.1.3 Existing Wastewater Disposal Systems in the NT

#### *On Site Disposal Systems*

Wastewater is treated and disposed of on individual allotments. Treatment can involve either Pit Latrines with virtually no treatment or Septic Tanks that involve limited on site treatment. Disposal is either by subsurface soil absorption or by evapotranspiration. Regular removal and disposal of sludge produced by the treatment process is necessary. This system is susceptible to failure in indigenous communities.

*Types of On-Site Disposal Systems used in the NT include:*

- Dry Pit Toilets
- Septic Tank/Absorption Trench Systems

#### *Off-Site Disposal Systems*

Wastewater is collected by a common pipework system and conveyed to a remote area for treatment and disposal. Collection of wastewater can involve one of many systems.

Listed below are some of these systems used successfully in the NT.

- Gravity Reticulated Sewerage (GRS) System where untreated or raw household waste is collected in a water borne gravity reticulation system and then transferred off site for treatment usually via a pump station and rising main system.
- Common Effluent Disposal (CED) where Septic Tanks collect and pre-treat wastewater prior to common gravity removal of effluent. The effluent is either further treated or disposed at a centralised point.
- Septic Tank Effluent Pumping (STEP) where again waste is pre-treated in 'on site' Septic Tanks and removal of the waste is via individual pump stations via a common rising main and again is either further treated or disposed of at a centralised point.

At this stage PWC does not provide guidelines on STEP systems. The 'off site' treatment process used on all PWC managed systems is via waste stabilisation ponds or evaporation disposal. Supplementary technology may be utilised where extreme effluent quality is required for particular environmental or reuse applications.

Final effluent disposal is by evaporation and infiltration or to the environment. Disposal methods include land/canal/estuary/ocean discharge or effluent reuse schemes.

### 3.1.4 PWC's Position

The provision of conventional or water borne sewage disposal systems in remote communities provides the best health and environmental outcomes for the community.

PWC encourages the use of appropriate treatment and disposal systems on remote communities.

The designer should review all options and submit recommendations to PWC Remote Operations Planning Section.

The most common justifications given for construction of reticulated sewerage schemes include:

- density of development not allowing sufficient room for construction of absorption trenches;
- elevated water tables and inappropriate soil types or rock for absorption of effluent;
- possible contamination of water supply; and
- where the population is large enough, and an 'off site' treatment system is economically comparable to 'on site' treatment on a per capita basis.

Before PWC will consider supporting a move toward upgrading an existing 'on site' system to a reticulated water borne system:

- There must be a demonstrated need to address a potential health problem. A sanitary and engineering survey would be required by the Department of Health and Community Services (DH&CS);
- An investigation must include an assessment of whether the problems are being caused by poor construction and/or maintenance practices of the existing sanitary system;
- The survey must include an engineering assessment of whether a properly designed and maintained on site system would safely dispose of a reasonable volume of effluent and whether existing systems are overloaded because of excessive water use or improperly sized septic tanks and trenches. Costs to rehabilitate existing 'on site' systems should be included; and
- The water supply must be capable of supporting the increased demand [Note: Records indicate that Remote Communities which have converted from 'on site' sewage treatment systems to reticulated systems have experienced a considerable increase in the per capita water consumption].

### 3.2 Hydraulic loading

The method employed for design of sewers is to convert residential, commercial and industrial sewage loads into an equivalent residential population, i.e. as base unit known as EP. This method is in accordance with most water authorities in Australia.

Generally, sewers shall be designed to ensure:

- Adequate hydraulic capacity at Peak Wet Weather Flow ( $Q_w$ ); and
- Self cleansing velocity at Most Probable Peak Dry Weather Flow ( $Q_{dmp}$ ).

The hydraulic load on sewerage systems shall be designed in accordance with the Sydney Water Board (SWB) Sewer Design Manual, December 1993, with the exception of the design parameters stipulated below:

- Residential Loading                      9 EP per Dwelling (refer Section 1.1.5)
- Dilution Factor                            3.0 Tropical Areas  
    2.0 Arid Areas
- One Residential EP = 300L/day (ADWF)
- Pipeline design and analysis should take account of the high water temperatures and resultant lower viscosity of many bore sourced water supplies. [Note: high water temperatures in tropical areas do contribute a significant factor in pipeline design – this is often overlooked].
- Systems should be checked for self-cleansing at EP=4 per residential dwelling.
- Capacity and self cleaning calculations need to be submitted and approved by PWC Remote Operations Planning section prior to design being approved for construction.

### 3.3 'On site' treatment and disposal

For design and construction and Septic Tank treatment and Disposal, refer to:

**Northern Territory code of practice for small on-site sewage and sillage treatment systems and the disposal or reuse of sewage effluent (THS).**

For additional information on arid area septic tanks installation refer to;

**Septic tanks and effluent disposal systems in Southern and Barkly Regions of the Northern Territory (Department of Local Government and Housing, Indigenous programs branch).**

Septic tank designers should be careful to allow for the high levels of occupancy in houses in remote communities.

The information contained in the above documents will override calculations on Hydraulic load from Section 3.2.

Septic tanks or septic tank absorption trenches must not be constructed within five metres of a water main. If the tank absorption trench is upslope from a water main the clearance should be at least ten metres.

### 3.4 Common Effluent Drain (CED)

The criteria below refer to reticulation of sewage effluent after preliminary Septic Tank treatment.

#### 3.4.1 Pipeline Design

Minimum velocity in pipe	0.45m/s at half full	
Minimum pipeline diameter	DN 100	
Minimum Pipe Grades	100mm	0.4%
	150mm	0.25%
	225mm	0.15%

#### Comments

- Pipes shall be designed to carry design flows at no more than 60% capacity
- Use Manning's formula for calculation of flows – (Refer to SWB Sewer Manual Table #5 in Section 1 Appendix)
- The minimum pipe grades should not be used as a standard, but as an extreme
- The last 30 meters of the terminal end of all gravitational drains shall have a minimum grade of 1%
- Pipe of DN100 and less may be glued. All fittings and pipes over DN100 to be Rubber Ring Joined.

#### 3.4.2 Maintenance Holes

- Maintenance Holes will be constructed at the major intersections of 2 or more common or major drains;
- Minimum maintenance hole diameter on CED schemes shall be 1.2 meters;
- There shall be a minimum of 35mm fall through a maintenance hole; and
- Otherwise maintenance holes are constructed in accordance with PWC Standard Drawings.

#### 3.4.3 Inspection Opening (IOs)

Inspection openings are used instead of maintenance holes at changes in pipeline direction, to assist in pipeline location and to allow inspection and regular flushing of the drain.

*IOs are to be installed as follows:*

- At the terminal end of drains;
- Immediately before changes in drain directions (not including pipe deflection); and
- Otherwise an IO or maintenance hole every 60 meters.

*Construction IOs to be in accordance with PWC Standards as detailed in:*

- Drawing No. W2-1-05 'Connections – Standard Inspection Openings', and
- Drawing No. W2-1-06 'Connections – Terminal & Intermediate Inspection Shaft Details'.

#### 3.4.4 Service Connections

The minimum size of all connections to a CED system shall be 100mm in diameter but not greater than the diameter of the CED.

Connections shall be laid on a minimum grade of 1% between the Septic Tank and the CED.

### 3.5 Conventional gravity sewage system Or a reticulated raw sewage system

#### 3.5.1 Service Connections

Sewer reticulation mains shall be provided by the developer. Construct residential sewerage services in accordance with PWC standard drawings. Residential sewer services are generally constructed with 100NB uPVC pipe at a minimum grade of 1.7% as per AS 3500. Responsibility for operation and maintenance of the service becomes PWC responsibility at the point as highlighted on PWC Standard Drawings. On remote communities this point must also include a change in sewer pipe diameter from 100mm to 150mm.

#### 3.5.2 Gravity Reticulation – Sizing, Grading and maximum Depth

- Generally, refer to the Sydney Water Board Sewer Design Manual December 1993.
- Manning's formula is to be used for hydraulic calculations of flow in pipe.
- Note that Table 12 and Figures 1 and 2 of the Sydney Water Board Design are not applicable in the Northern Territory due to different Design criteria used in calculating average dry weather flow.
- The minimum pipe size for gravity sewers (raw wastewater) is DN150.
- Maximum Velocity 2.5m/s at Q<sub>w</sub>. Where these maximums are to be unavoidably exceeded, special design of downstream Maintenance holes may be required.
- Pipe Grades of a particular component of the system should allow for future development.
- Maximum depth of gravity sewers is to be no more than 6m.
- Gravity Reticulation is historically located in the rear of residential lots, however PWC preference now is for sewer mains to located in the road reserve.

#### *Pipeline Materials*

The following pipes are approved for use in sewer systems.

#### *Reticulation Sewers*

- uPVC
- DICL
- Ultra Rib uPVC

#### *Trunk Gravity Mains*

- GRP (Glass Reinforced Plastic)
- VC (Vitreous Clay)
- DICL
- MSCL – 'Sintacote' or similar

#### *Rising Mains*

- DICL
- PVC (Min. Class 12. Note: consideration of dynamic fatigue is essential.
- MSCL – 'Sintacote' or similar
- HDPE

Pipelines proposed for use other than those listed above are to be submitted for approval to PWC prior to design proceeding.

### 3.5.3 Maintenance Holes (MH)

Maintenance Holes will be constructed according to PWC standard drawings, with the exception that ladders are not to be installed in any new MH for a remote community. All sewer MH are confined spaces regardless of their construction or operational status, and as such confined space access is required for entry to the MH. Use of protective coatings in MH and pump stations is to be reviewed on all projects, not just trunk mains and pump stations.

*Maintenance Holes for raw sewerage systems are required at:*

- All changes in direction.
- Changes in pipe size or grade – Changes in Elevation – Line junctions.

Otherwise, Maintenance Holes are installed at regular intervals as detailed below:

Sewer Size	Maximum Spacing
DN150 – DN300	100m
DN300 – DN450	120m
>DN450	150m

These distances may be increased on long straight pipelines if approved by PWC.

Where maintenance holes are located outside developed areas, the finished surface level of the maintenance hole shall be 150mm above the natural surface level.

Where a sewer rising main discharges into a MH it shall be protected against corrosion. The designer is to submit proposed protection methodology with the rising main design.

Precast polyethylene “Polypits” or similar may be considered for MH installation only where the water table is permanently at a level below the bottom channel invert and approval is to be obtained from PWC remote operation during preliminary design review and confirmed in writing prior to construction.

All fittings used inside maintenance holes to be stainless steel or of approved non metallic construction.

All concrete to be class SR sulphate resisting, minimum class N40 (40 MPa with 20mm max. aggregate). The cement type will be in accordance with AS3972. The concrete shall be in accordance with AS 3600.

All maintenance holes and pump stations are to be marked clearly on the as constructed drawings with updated survey coordinates tied to the SLAP Map.

#### *Maintenance hole covers*

Metal “Gatic” type framed covers, or similar, filled with concrete, and providing a gas tight seal are to be used on all reticulation maintenance holes. A light checker plate style aluminium cover is recommended for maintenance holes where access is restricted and regular inspection is required, such as at pump station collection pits, or treatment lagoon pits (these locations are to be approved by PWC prior to design). Where the maintenance hole is possibly subject to total immersion under floodwaters, the cover will be bolted to the maintenance hole.

#### *Maintenance hole numbering*

All Maintenance Holes are to have the designated identification number etched into the concrete in the lid at least 5mm deep.

#### *Gas trap*

A Gas trap is to be installed on all reticulation sewers just prior to connection to a Trunk sewer or Maintenance Hole on sewers of DN300 or larger. Gas traps standard drawings are not available and design is necessary to suit each location.

### 3.6 Sewerage Pump Stations

Sewerage Pump Stations (SPS) shall be designed to suit the particular application using PWC drawings as a reference document. Use of macerators in collection maintenance holes and overflow storage for the pump station are to be confirmed with remote operations planning staff at the pump station design investigation stage.

SPS should only be considered if the installation of a gravity reticulation system proves uneconomical or unachievable. The maximum invert of an Indigenous community sewer pumping station shall not exceed six (6)m deep and a depth of five (5)m recommended as a preferred working depth.

Design of a SPS intended for operation and maintenance by PWC must include detailed economic analysis.

All pumping units are to be controlled by level sensing equipment located in the wet well. Start/stop levels should be set to limit the number of starts per hour to a maximum of 8. In the case of large motors, this limit may be reduced.

To ensure adequate life, pump motors should be 15% greater than the maximum theoretical power required.

Where a new SPS is to be added to an existing sewerage system, investigation into the capacity of downstream gravity reticulation and SPS is essential as part of the design process. Investigation report must be included in the submission to PWC Remote Operations Planning section for approval.

Refer to the PWC document 'Safety in Sewerage Systems' as a guide to working in and around sewerage pump stations, maintenance holes etc.

*Each SPS should include the following information as a minimum:*

- Catchment Plan and load estimate;
- Design Report indicating design philosophy and parameters;
- 100% standby (2 pumps – single pump meets PWWF);
- Macerators;
- Overflow storage capacity and risk based assessment of possible overflow discharge;
- Mag-flow metering of all outlet flows including pump discharge and emergency overflow;
- Operation and maintenance manuals (including pump curves);
- Commissioning and testing information (pump test, hydrostatic testing); and
- Whole of life analysis of options for different depths, and possibly number of pump stations in a system, coatings, pump selection.

### 3.7 Waste stabilisation ponds

Given the low operation and maintenance requirement of remote area sewerage systems in the NT, waste stabilisation ponds or treatment lagoons are used extensively in the treatment of wastewater prior to final disposal. This section is not intended as a detailed design source and all designs are to be in accordance with the **PWC waste stabilisation ponds design manual**.

Ponds are to be located where possible a minimum of 2km from populated areas, refer to **"Guidelines for Buffer Zones: Sewage treatment, sludge management and reuse schemes" Power and Water Corporation NT**.

Given the ever increasing sensitivity of environmental and health issues associated with design and operation of waste stabilisation ponds, the design of all new ponds must conform with PWC, Health and Environment regulations or procedures. Designers are to contact PWC Remote Operations Planning Section at the start of the design investigation process to confirm the lagoon requirements.

## Power guidelines

### 4.1 New power stations

PWC will become involved in the provision of power to remote population centres when the minimum criteria, as defined in the Policy Guidelines, are met.

### 4.2 Siting of power stations

New Power stations should be sited at least 500m and preferably over 1500m from the nearest planned residential development. This distance may be influenced by topography at individual sites. A community in a narrow valley may require a greater buffer zone, whereas the ability to site a power station behind a hill or sand dune may facilitate a reduced buffer zone. With careful attention to noise reduction, the development buffer zone may be reduced to 250m if cost savings to PWC are significant. The reduced noise buffer zone would only be considered where decisions between upgrading a power station on an existing site or relocation of the power station are being made.

*Facilities such as those listed below may be permitted within the buffer zone:*

- Workshops
- Garages
- Storage Tanks
- Ablution Blocks
- Morgues and Cemeteries
- Refuse Disposal
- Sewerage Treatment Works
- Sports Grounds
- Agriculture and Horticulture

Community consultation, NT WORKSAFE approval and PWC endorsement is essential before developments which encroach on the buffer zone are constructed.

*The proposed power station site must:*

- Be endorsed by the community council;
- Be included in the Service Land Availability Plan or Land Use Structure Plan with the development buffer zone clearly identified;
- Have protection from flooding, local ponding, and sea storm surge to less than 1:100 probability;
- Have all weather 4WD access for the local operator;
- Have access for fuel delivery with less than 1 year in 50 probability of interruption for longer than reserve fuel supply period; and
- Be sited so that prevailing winds will not carry noise into the community.

### 4.3 Configuration of generating sets

#### 4.3.1 General

The number and size of generating sets shall take into account ease of replacement, response time, reliability requirements and fuel economies.

#### 4.3.2 Load Determination

In determining loads for sizing of generating plant, actual load profiles and historical growth rates should be used. Where this data is not available, then data for existing sites with similar infrastructure should form the basis of load forecasts. It has been found that community loads determined by calculation to AS3000 have been overly conservative (load overestimated) and it should be noted that the standard does allow other methods of load estimation.

The forecast period will be dependent on the anticipated engine life, however, consideration should be given to the feasibility of genset relocation should predictions not eventuate. Attempts to forecast beyond five years should be treated very cautiously.

### 4.3.3 Small Power Stations

Power stations of less than 300,000kWh annual output should be provided with two generating sets. These power stations may be automatic or manual, with or without synchronising capability. Where response times are less than four hours, (ie. road access unlikely to suffer the interruptions of more than two weeks and within 300km of a service centre) then the sets should be sized unevenly.

The standby genset should be sized to carry the forecast peak load with an additional allowance of up to 50% for starting loads depending on feeder configuration. The base load genset should be sized at 50% to 70% of the larger genset. This arrangement could be expected to provide standby capability for 90% of the time. It has been found that the low diversity of small power supply grids with consequent high load factors results in large peaks which occur infrequently.

Whilst not providing 100% standby capability the above arrangement will result in an efficient and cost effective arrangement. In small communities, it is not unreasonable to require operators to manually shed load or step the starting loads by liaison with individual large consumers on the rare occasions when capacity of the smaller genset is exceeded and the larger genset is out of service.

Where response times would regularly exceed four hours both generating sets should be sized to carry peak loads together with starting loads. In order to avoid grossly over sized and inefficient plant the loads should be carefully assessed. Consideration should be given to the purchase of a generating plant capable of being operated at minimal expense.

### 4.3.4 Large Power Stations

Power stations of between 300,000 and 2,000,000 kWh annual output should normally be provided with three generating sets. These power stations would normally also be capable of automatic operation with synchronising/ parallelling and load sharing.

Forecast peak loads and starting loads should be capable of being carried with the single largest genset out of service.

Genset sizing should be based on detailed modelling of overall power station efficiency using known load and performance data. In general, it would be found that three gensets of unequal size provide the most economical arrangement. The largest genset should be capable of carrying peak loads and the smaller units progressively at 60% to 70% of the large unit but with the combined capacity to be equal to or greater than the largest genset (N-1 philosophy).

Normally only one genset would be in operation at anyone time. With a configuration as outlined above, significant changes in demand can be accommodated by either replacing the smallest genset with a new larger unit or replacing the largest with a new smaller unit.

Where power station outputs exceed 2,000,000 kWh units per annum, detailed economic modelling should be used to determine the most efficient and cost effective configuration of the generating plant.

### 4.3.5 Genset Standardisation

Effort should be made to standardise the makes and models of generating plant in use within communities.

Gensets should be purchased based on life cycle costs that shall include an appropriate cost penalty on tenders for generating plant that differ from those generally in service within the region. The cost penalty would normally take the form of a requirement for supply of spare parts.

Whilst it may not be possible to standardise on plant within individual power stations, it is expected that each region would ultimately have no more than two models of genset in each size range.

The policy of standardisation should remain open to new developments in engine technology and bids received must be competitive, in accordance with the Procurement Manual, however there must also be good dealer support for engines purchased.

## 4.4 Control systems

### 4.4.1 Diesel Generator Control Philosophy

#### Automatic vs Manual Operation

When in manual mode all automatic signals to the generator panel are ignored.

*When in auto mode all manual inputs except the:*

- Emergency stop;
- Manual reset push button; and
- Lamp test push button

are ignored.

#### Manual Mode Starting

For the engine to start there must be no critical faults. When the start push button is pressed for more than 0.25 seconds the following procedure is followed:

- the fuel solenoid is energised;
- the governor is energised;
- the run retry (instrumentation) is energised; and
- the starter solenoid is energised.

The starter solenoid is de-energised when either the start push button is released, or the cranking speed has been achieved.

Assuming the engine attains speed then:

- undervoltage is set;
- underspeed is set;
- oil pressure is set; and
- after 10 seconds the engine running signal is set.

If the engine does not attain running speed within 15 seconds, failed to start will be set and the engine stopped, following the shutdown procedure.

If the start push button is pressed, and the engine does not reach cranking speed, then the fuel solenoid, governor, run relay and cranking solenoid are de-energised when the start push button is released, and the engine is returned to the stopped state.

#### Stopping

When the Stop push button is pressed for more than 0.25 seconds the following shutdown procedure is followed:

- the circuit breaker is tripped (if closed);
- the fuel solenoid is de-energised;
- the Governor is de-energised; and
- the Run Relay (instrumentation) is de-energised.

If the Emergency Stop push button is pressed, the circuit breaker is to be tripped and the engine stopped immediately, allowing the shutdown procedure. A lamp is to be lit showing the Emergency stop button has been pressed. While the Emergency Stop is not reset the generator shall be inhibited from starting in Auto and Manual modes. The engine shall be deemed to be at standstill when there is undervoltage and the cranking speed input has reset.

#### Reset

The reset push button when pressed for more than 0.25 seconds allows the reset of any faults and alarms, resets the circuit breaker and restores the Engine Healthy indication in any stage of generator operation. Reset shall have no effect if the generator is running and the circuit breaker is closed.

*Breaker Close/Open*

The breaker can be closed when the close push button is pressed and the sync check relay indicates synchronism is within limits. A delay of 5 seconds is to be allowed after opening before a closure can be performed, to allow time for the breaker to fully reset.

*Auto Mode*

Start Stop The engine can be started and stopped with the Auto Run signal, a High signal for Run and Low signal for Stop. If Auto Run is High, for more than 0.25 seconds, the following procedure is to be followed:

- the fuel solenoid is energised;
- the Governor is energised;
- the Run Relay (instrumentation) is energised; and
- the Starter solenoid is energised.

Assuming the engine attains speed then:

- undervoltage is set;
- underspeed is set;
- oil pressure is set; and
- after 10 seconds the engine running signal is set.

The starter solenoid is de-energised when the cranking speed has been achieved.

If the engine does not attain running speed within 15 seconds, “Failed To Start” will be set and the engine stopped, following the shutdown procedure.

When Auto Run is low, for more than 0.25 seconds the following shutdown procedure is followed:

- the circuit breaker is tripped;
- the fuel solenoid is de-energised;
- the generator is de-energised;
- the Run Relay (instrumentation) is de-energised; and
- the air flap (if installed) is energised.

The engine shall be deemed to be at standstill when there is undervoltage and the cranking speed input has been reset.

*Close/Open Breaker*

Closing of the circuit breaker is allowed with the Auto Breaker Close signal, High for breaker close and Low for breaker open. A delay of five seconds shall be allowed after opening before a closure. Breaker closure shall only be allowed when the sync check relay indicates that synchronism is within limits. Warm up time is to be allowed by the Auto Control System.

*Auto Reset*

No provision is made for Auto Reset. Reset is to be performed manually. It is not required that the generator be in manual mode. [Note that if the generator is in Automatic then the engine may start immediately].

*Start Warning*

No indication is given to the generator panel that the engine is about to start in response to request from the auto control system. Any warning can be given through the auto control system.

*Critical Faults*

Critical faults when maintained for more than 0.25 seconds shall initiate the shutdown procedure as follows:

- the circuit breaker has tripped;
- the fuel solenoid is de-energised;
- the governor is de-energised;
- the Run Relay (instrumentation) is de-energised; and
- the air flap (if installed) is energised, for overspeed fault only.

The engine shall be deemed to be at a standstill when there is undervoltage and the cranking speed input has reset. Some faults will require a cool down time as defined below:

Fault      Cool down Time (Min)

Generator Power Factor is to be used to determine the kV A and current loads.

Lube Oil pulses are to be scaled, counted and logged.

Fuel Oil pulses are to be counted scaled and stored, and to be used for calculating fuel efficiency.

kWh pulses are to be counted, scaled and logged to determine average load over 15 minute interval. To be used to determine fuel efficiency an alarm is to be provided if fuel efficiency is too low (i.e. fuel consumption rate is too high), by giving generator unhealthy signal and lighting an alarm lamp. All logging and storing of this data is to be in internal memory and accessible by remote communications. [Note: these may not be used in some situations, or may be used by the Auto Control System.

#### Engine Signal Status

Signal	Engine Stopped	Engine Running	Engine Fault
Under Voltage	0	1	0
Over Voltage	1	1	0
Under Speed	0	1	0
Over Speed	1	1	0
Cranking Speed (Starter Cut-out)	1	0	N/A
Oil Pressure (Critical)	0	1	0
Oil Pressure (Alarm)	0	1	0
Water Temp (Critical)	1	1	0
Water Temp (Alarm)	1	1	0
Water Level (Critical)	1	1	0
Reverse Power	1	1	0
Over Current	1	1	0
Lube Oil Temp (Critical)	1	1	0
Lube Oil Temp (Alarm)	1	1	0
Cooling Fail (Remote Radiator)	0	0	1
Sync Check	0	1	N/A
Charger Fail	1	1	0
Emergency Stop	1	1	N/A
Breaker Auxiliary	0	1	0
(Breaker closed)	(online)		

**Outputs**

Fuel Solenoid	0	1	N/A
Air Flap	0	0	1
Governor	0	1	0
Heaters	1	0	N/A
Run Relay (Instruments)	0	1	0

Oil Pressure Low	None
Water Temp	None
Overcurrent Fault	5 minutes
Underspeed	None
Overspeed	None
Overvoltage	None
Undervoltage	None
Reverse Power	None
Lube Oil Temperature	None
Water Level	None

The first critical fault to be detected shall initiate the shutdown sequence and light the appropriate fault lamp. All subsequent faults shall be ignored and not displayed which also includes the Emergency Stop. The engine healthy signal shall be removed. The engine shall not be allowed to restart until a reset has been initiated.

**Alarms**

Alarms are to be indicated with the appropriate lamp, and the Engine Healthy indication set low. The Engine Health is set low to invoke the Auto Control System to take action, generally to lower the load on the engine. Alarms will not stop the engine, only critical shutdown will carry out this function.

**Remote Signals**

Signals to the Station control system shall be:

- Signal Status
- Circuit Breaker Closed            1 = Closed
- Engine Faults (normally closed) 1 = No Faults
- Automatic Mode Selected        1 = Auto
- Engine Healthy                    1 = Healthy
- Engine Running                    1 = Running

**Remote Control**

Signals from Station Control System shall be:

- Signal Status
- Auto Run                            1=RUN
- Breaker Close                    1=RESET

### *Metering*

- Metering inputs provided are:
  - Generator kilowatts (4-20 mA)
  - Generator Power Factor (4-20 mA)
  - Lube Oil Pulses (optional)
  - Fuel Oil Pulses (optional)
  - kWh Pulses (optional)
- Generator kilowatts are to be used for instantaneous load.

Note: 0 = Low or Open 1 = High or Closed N/ A = Not Applicable

\* Air Flap used only for overspeed shutdown if installed

#### **4.4.2 Small Power Stations**

Power stations of less than 300,000 kWh annual output should typically have a control system incorporating the following features:

- Capable of synchronised parallel operation (essential);
- Data logging of (at least) output, fuel consumption, duration of shutdowns and number of outages;
- Manual or automatic changeover with outages normally restricted to certain hours in order to reduce customer inconvenience; and
- Local power station operation.

Community consultation and acceptance of short scheduled shutdowns up to twice daily is required. Consumers should be advised to install UPS equipment on sensitive appliances.

#### **4.4.3 Large Power Stations**

Power stations of greater than 300,000 kWh annual output would normally be provided with an automatic control system, possibly incorporating the following features:

- Capable of synchronised parallel operation (essential);
- Unattended power station operation (for periods of at least two weeks);
- Optimisation of genset selection and scheduling to extend service visits and obtain peak efficiency;
- Data logging of (at least) output, fuel consumption, duration of shutdowns and number of outages;
- Remote fault reporting;
- Control of feeders;
- Load management to reduce the load factor; and
- Fuel isolation on smoke detection.

#### **4.4.4 Hybrid Systems**

Hybrid systems incorporating some or all of the following features may be considered:

- Battery storage;
- PV input;
- Solar thermal input; and
- Wind turbine input.

Experimental or prototype systems are only to be constructed with the approval of Managing Director Operations.

#### **4.4.5 Station Control Standardisation**

New control system shall be one of the following:

- Northern Region PC in-house system;
- Powercorp (endorsed versions); or

Other systems may be specifically approved from time to time.

## 4.5 Buildings

Power station buildings will generally be all steel framed and metal sheet clad. Internal lining is generally not provided unless specifically required for noise attenuation. Buildings should have design life of (at least) 25 years.

### 4.5.1 Engine Rooms

Engine rooms shall have provision for up to three generating sets. Foundations suitable for set sizes up to three times larger than currently used should be provided. Floor slope shall facilitate wash down of engines and drainage.

### 4.5.2 Control Rooms

Power stations are normally unattended but control rooms are to be provided to ensure reliable operation of control equipment in a climate-controlled area.

### 4.5.3 Ancillaries

Ancillaries may be provided as follows:

- Earthing to achieve required levels;
- Water supply service of DN50;
- Rainwater storage of not more than 1,000 litres;
- Ablution facilities if no other PWC facilities within 500m;
- Evaporative cooling in arid areas;
- Cable trays (preferably overhead);
- GPOs;
- Lighting;
- Fire extinguishers;
- Storage cabinets;
- Statistics desk and chair;
- Cleaning equipment including pressure pump if required;
- Winching and anchor points (generally no overhead crane);
- Waste oil drainage and collection pit; and
- Fuel supply lines.

### 4.5.4 Fuel Storage

Fuel storage shall be provided such that the following minimal reserve levels are obtained:

- The minimal economic fuel delivery and maximum frequency shall be 30,000L not more than monthly for road deliveries;
- Based on individual assessments for barge fuel deliveries. Fuel tanks, ladders and elevated walking shall comply with the Australian Standards. To determine fuel storage needs any unusable storage must be disregarded;
- Fuel bunds should be designed in accordance with Australian Standard 1940-1993 with LFO taken as a class C 1 fuel.

### 4.5.5 Security and Safety

Power stations should be security fenced with an appropriate hazard sign on the gate and at specific hazards.

Fire hoses and hydrants are generally not provided at unattended power stations, however installations should comply with the Australian Standard 1940-1993 as appropriate. Fire extinguishers are provided to extinguish small fuel, oil engine or electrical fires.

Smoke detectors in the engine cabling air flow and control room should be considered.

## 4.6 Power distribution

### 4.6.1 Introduction

This section describes the level of service required for power reticulation for rural communities, for both new installations and extensions to existing systems.

### 4.6.2 Whole of Life

The designer is to submit to PWC Remote Operations planning section a whole of life analysis for the design as outlined in section 1.1.5. Issues such as the use of blot up or welded pole construction.

Note: Hot dipped galvanised steel hard wear to be use in all seaward communities. (I.E. communities within 25km of the NT coastline.)

### 4.6.3 Reliability Criterion

Where possible, the N-I criterion should be achieved to provide a suitable level of service. In many instances this will not be able to be achieved due to constraints such as geographical location, load, economics, size of installation and physical factors.

The system shall be designed to achieve the following reliability indices where possible:

- System average outage frequency 10 per annum;
- System average outage duration < 400 mins per annum; and
- Customer average outage duration < 40 mins per interruption.

### 4.6.4 Number of Feeders

The number of feeders to be installed to supply the reticulation will depend on a number of factors:

- Size of load; and
- Geographical constraints.

The minimum preferred level is two feeders, both HV, to allow interconnection. Where larger loads exist, three or four feeders may be necessary. Where multiple feeders exist, the feeders should be sized to allow total system load to be supplied with the heaviest loaded feeder out of service.

### 4.6.5 LV Reticulation

All new LV reticulation should be aerial bundled conductor. Where voltage drop problems occur, this may be alleviated by use of parallel conductors in initial spans from the substation. Extensions to existing open wire reticulation should also be done in ABC. Minimum clearance under LV reticulation shall be 5.5 metres at conductor temperature of 55°C.

### 4.6.6 HV Feeders

HV feeders should be sized to suit the projected 10 year growth of the community. Initial sizing of the step up transformer may be to suit the expected 5 year load growth. Open wire construction to 22 kV standard is required with variations to suit specific local problems such as bats and birds. Standard ASCR conductors stocked by PWC are to be utilised such as raisin, apple and cherry. AAC conductors are not recommended for rural areas.

### 4.6.7 Interconnection of Feeders

Feeders shall be interconnected wherever possible (subject to economic/practical/geographical factors) to achieve reliability needs. This should include means of interconnecting both the HV with appropriately located air break switches and LV with appropriately located links, subject to achieving voltage drop and load transfer requirements.

Where interconnection of the HV feeders cannot readily be achieved in the field, then the feeders should be interconnected at the step up transformers.

#### 4.6.8 Sizing of Feeders and Step Up Transformers

The load assessment of the feeders for Greenfield sites should utilise one or more of the following considerations, one lot subdivision and developments will have calculated electrical demands:

- (a) Comparison of similar communities of similar structure/size;
- (b) Historical data for the community load; and
- (c) Calculation utilising the following ADMD's as a guide.

	KVA
Clinic/Police Complex	75 to 150 depending on size
Store – large	150
Store – small	75
School – large	300 to 500 depending on size
School – small	75
Large houses/duplex	10
Small houses	6
Shelters/transportable	4
Workshop	25
Bores/transfer pumps	50% of rating
Offices-community	25

Step up transformers should be sized to achieve an average load of greater than 25% of its rating and a maximum continuous load under single contingency outage conditions of not more than 100% of its rating.

Starting loads and short duration overloads (eg after restoration of power) are not to exceed 150%.

Feeder cables shall be rated to 100% of the step up transformer size where possible, otherwise to the maximum predicted feeder load under single contingency outage.

#### 4.6.9 Metering

**Feeder** Each feeder should incorporate the following:

- Amps & MDIs
- Kw
- Pf
- Number of closures
- Outage time (accumulated)

#### *Substation*

Where practical, maximum demand indicators shall be installed to monitor loads. This information should be used to correlate calculated demands and, allow feeder loading and sizes to be optimised.

#### 4.6.10 Electrical Performance

##### *Standard Voltage*

For standard low voltage supply to the consumer the voltage at the point of connection shall be:

- for a three phase supply, a voltage of 415 volts between any two phases and 240 volts between any phase and the neutral conductor; and
- for a single phase supply, a voltage of 240 volts between the phase and neutral conductor.

### *Voltage Drop*

The variation in steady state voltage at the consumer's terminals shall not exceed 6% of standard voltage.

The maximum allowable voltage drop on various sections of the distribution system shall not exceed the following values:

- HV Distribution (including feeder cables, step up substation and HV conductors) – 2%;
- LV feeders and LV distributors from substations – 4%; and
- Consumer's mains – 2% using nominated ADMD x 3.

### *Voltage Unbalance*

The voltage unbalance factor at the consumer's terminals shall not exceed 2%.

### *Voltage Change*

The permissible magnitude and rate of occurrence of voltage changes at the consumer's terminal shall not exceed the threshold of irritability as defined in Australian Standard 2279.4 (Disturbances in Mains Supply Networks) Figure 1.

### *Harmonics*

The harmonic distortion at the consumer's terminals shall not exceed the design limits set out in AS2279 Parts 1 and 2.

### *Frequency*

The steady state frequency of the supply to the consumer should be maintained at 50 Hz +/- 0.1 Hz and should not vary outside 50 Hz +/- 0.5 Hz for large load swings.

### *Common Multiple Earth Neutral System (CMEN)*

The Common Multiple Earth Neutral system shall be used for all feeders. Where poles are not bonded by the LV neutral conductor, an aerial earth is to be installed.

### *Design Guidelines*

The reticulation shall be designed in accordance with the PWC design brief for Overhead Line Design

### *Service Connections*

All service connections shall be overhead for:

- Services up to 80 amps three phase standard service conductor shall be utilised; and
- Three phase services above 80 amps per phase are to utilise ABC.

### *Serviced Sites*

A site is classified as serviced if low voltage reticulation of adequate capacity for the zoned site is available along the block frontage in accordance with the following:

Where the LV reticulation is on the same side of the road as the site, there is to be a line pole located in front of the block and the point of connection for the consumer's installation shall be within 25 metres of the pole, and

Where the LV reticulation is on the opposite side of the road to the site - a service pole will be located in front of the site where the distance from a line pole to the service pole does not exceed 50 metres and such that normal road clearance may be obtained with the consumer's point of attachment within 25 metres of the service pole.

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# Appendix 1 – Design Project Flow chart

