GUIDELINES FOR USE
OF
UNDER GROUND CABLE SYSTEM
AND
OVERHEAD CONDUCTOR SYSTEM
ALONG WITH COST BENEFIT ANALYSIS

CENTRAL ELECTRICITY AUTHORITY
2018

1. **INTRODUCTION**

Distribution of electricity involves the transfer of electrical energy from one electric substation to another electrical substation (like from 220/33 KV S/S to 33/11 KV S/S and 33/11 KV S/S to 11/0.4 KV Distribution Transformer S/S etc) through sub-transmission and distribution lines. These lines may be Overhead lines or Underground cables. Each of the two types has its benefits as well as demerits. The choice of Overhead Network or Underground network depends on many factors like safety requirement, Right of way, cost ,aesthetic look and other factors. Despite being expensive, Underground cables have several advantages over OH lines. These are mostly used where safe clearances for Overhead Network is not available as well as in densely populated areas where Overhead Network cannot be used., whereas, Overhead Network is cheaper, easy to install/upgrade and easy to attend the fault etc.

a. OVERHEAD NETWORK

In overhead power lines, a structure based network is used to transmit electrical energy from one point to another. It consists of adequate size of conductors , commonly three conductor in 66 KV , 33 KV or 11 KV lines or four conductor in 11 KV lines or 5 conductor in LT lines (5^{th} conductor for street lighting) for three phase lines and two conductors for single phase lines etc suspended by towers or poles and generally comprising of the items- such as Poles, Conductors, Cross arms, pin insulators, Stay Wires, Stay Rod, Stay Anchor, Guy Insulator, earthing materials, Guard wire, Barbed wire and Danger plate etc

The Poles for the electrical network may be a Steel Poles (Tubular Poles, Rolled Steel Joists and Rails),Concrete Poles (RCCPoles,PCC poles and Pre-Stressed Concrete - PSC) Pole) of various heights of 9 meters to 13 meters (IS: 5613 (Part 1, 2, 3) depending on site location, minimum safety clearance and Voltage (230Volts, 415Volts, 11KV and 33KV etc) of the overhead network system. Along with these poles, Rail poles, which have more strength then other poles, are generally used in overhead network along and across the Road, Public Places, Residential areas, River crossing etc.

Sometimes, for supporting different voltages on the same poles and to maintain the adequate clearance between the different lines of different voltage levels, poles with higher heights are used, and in such cases, guard wires are also provided to prevent

accidental over charging of lines of lower voltage system due to conductor snapping etc.

The conductors for the overhead network can be a bare conductor or an insulated conductor (ABC) depending on the requirement. It is an important component of overhead electrical transmission and distribution systems. The choice of conductor depends on the power carrying capacity, cost, growth of the load, and reliability & efficiency. While selecting an ideal conductor, some of the following features such as -i) maximum electrical & thermal capacity and cost effectiveness etc are considered.

As per CEA(Technical Standards for construction of Electrical Plants and Electric Lines) regulations 2010, as amended upto date, adequate capacity AAC (All Aluminium Conductor), AAAC (All Aluminum Alloy Conductor), ACSR (Aluminum Conductor Steel Reinforced), ACAR (Aluminum Conductor, Aluminum Reinforce) or any new technology higher current carrying conductors (AL-59, HLTS etc) may be used in sub –transmission and Distribution system. Since, the insulations between the conductors is provided by air, overhead power lines are generally the lowest-cost method of power transmission for large quantities of electric energy from one point to another.

In addition to above types of bare conductors, Insulated conductors (Aerial Bunched cables) may also be used in Overhead network system. The use of Aerial Bunched Cables (ABC) is a good concept for overhead power LT distribution where the

electrical clearance is not available or where theft is there. When compared with the overhead distribution system with conventional bare conductors, ABC provides higher safety and reliability and system economy by reducing theft in the area of installation. . This system is ideal for rural distribution and especially attractive for installation in difficult terrains such as hilly areas, forest areas, coastal areas etc. Aerial Bunched Cables is also considered to be the best choice for power distribution in congested urban areas with narrow lanes and by-lanes.

Some other advantages of use of ABC are-

- ABC provide safety to human life when used in congested area and narrow lane areas.
- ABC provides flexibility to use multiple circuits of different voltages strung on the same set of poles without using separate poles.
- ABC provides better adaptability to run concurrently with other overhead system with bare conductor and also with communication lines without any interference.
- ABC provides insulation resistance to earth in all seasons and negligible leakage of currents and thereby, the low losses of leakage.
- ABC is unaffected by pollution in the atmosphere.
- ABC, at the same time also reduces the theft of energy as it can not be tapped i.e it prevents the use of illegal hooks etc on LT lines in the theft prone areas and helps to improve the AT&C losses of the system.

b. UNDERGROUND NETWORK

In Under Ground cable system, the power is transferred from one point to another through underground cables laid in the ground in place of overhead lines on poles/ towers. As these cables are not exposed to the air/ atmosphere, this makes the U/G cabling system less susceptible to outages due to various atmospheric conditions like high wind, storm, thunder storms, heavy snow or ice storms etc. As these cables are not visible on ground, these provide an aesthetic look to the area where these are laid as compare to OH lines. However, the U/G cables have to be laid in the proper tranches and also have more restoration time in case of any fault as compare to OH lines.

While selecting the rating of cables to be used, some of the parameters such as Current carrying capacity, Voltage drop and short circuit rating are important factors to select the economical and optimum size of cable.

The cable generally comprises of the conductor, insulation material, bedding, beading/ armoring, and outer sheath etc. Although, the armoring and outer sheath takes care of the physical safety of cable , adequate care has to be taken by cable manufactures during manufacturing of the cable.

Normally the lifespan of a cable is about 40 to 50 years. But over the time, the insulation of cable may get damaged or weakened due to ageing. Wrong handling of cabals, such as damages due to wrong handling/laying of cable also weakens the insulation of the cables. Normally, some of cable faults may be as-

1. a short circuit fault between two conductor due to failure of insulation between the two conductors
2. a earth fault, i.e., fault between conductor and ground due to failure of outer insulation sheath
3. an open circuit fault, caused due to disconnection of the conductor etc.

The choice of whether to use overhead line (OHL) or underground cable (UGC) must be made keeping in view the safety, reliability and operational constraints.The choice between OHL and UGC is driven by technical, environmental and economic considerations.

2. COMPARISON OF UG SYSTEM AND OH SYSTEM - FEASIBILITY ANALYSIS

Feasibility study of Overhead and Underground line on various points is classified below :

i. COST OF INSTALLATION

Underground network installation is more expensive than OH lines , since the cost of cables include cable charges along with road restoration charges which make the per unit coat of U/G cabling system several times greater than overhead system.

ii. FAULT LOCATION IDENTIFICATION & REPAIRING TIME

The identification of fault finding and repairing on overhead wire is easy as compare to UG cables as UG cables are buried in the ground and it require specialized techniques to find out the fault location as compare to OH lines. Some time, it may take several days or weeks to find and repair the fault in underground system.

iii. COST OF REPAIR A FAULT

In underground cables, when a fault occurs, the cost of finding its location, trenching, cable splicing, and re-embedment is sometimes five to 10 times more expensive than repairing a fault in an overhead line where the conductors are visible, readily accessible and easier to repair.

iv. LINE OUTAGE DURATIONS

As extended repair time is required in underground system, services to customers may be disrupted for a long time in UG system. However, the time duration of customer outages can be reduced by using additional feeders with Ring Main Units (RTUs) in UG system which involves much more cost as compare to OH system.

v. LINE MODIFICATIONS

Overhead power lines are easily tapped, rerouted or modified to serve customers; while underground lines are more difficult to modify after the cables have been laid. Such modifications to underground power lines are more expensive because of the inability to readily access lines or relocate sections of lines.

vi. EFFECT FROM WEATHER CONDITIONS

Overhead Lines are more prone to damage from severe weather conditions (mainly lightning, hurricanes/cyclones/typhoons, tornados, other winds, and freezing) than Underground Network.

vii. RANGE OF ELECTROMAGNETIC FIELDS (EMF) EMISSION

The electric current in the conductor produces a magnetic field around it but the closer grouping of underground power cables reduces the resultant external magnetic field and hence provide less magnetic effect as compare to OH line conductors. Further to reduce the magnetic effect in cables, a shielding is also provided over the cables which further reduces the magnetic effect in surrounding areas.

viii. SPACE REQUIREMENT

Underground cables do not need physical ground space as these are laid under the ground in the dedicated tranches whereas an overhead line requires a corridor on ground along with surrounding clearance strip permanently clear for safety, maintenance and repair.

ix. HAZARD TO WILDLIFE

Underground cables generally pose no hazard to wildlife as compared to overhead network.

x. ILLEGAL CONNECTION/THEFT OF POWER /PILFERAGE

In underground cabling system , it is generally impossible to have illegal connection by tapping the conductor for theft of power. These are also less susceptive for sabotage, and damage from armed conflict.

xi. AESTHETICS

As UG cables are not visible from outside, these provide a clean and aesthetic view of the city /town where UG cables are laid. The above space may be used for any other purposes like making of roads, providing green environment/trees on sidewalks etc having environmental benefits and increase of property values etc.

xii. FLEXIBILITY TO INCREASE LINE CAPACITY

Overhead lines can easily be upgraded/ augmented by modifying line clearances and power poles to carry more power while underground cables cannot be up-rated

and must be supplemented by laying another cables or to be replaced to increase the capacity.

xiii. LINE LIFE

Insulation deterioration takes place in underground cables much faster because of various loading cycles during their lifetimes as compare to OH conductor which do not have any insulation layering. As time passes, the cables insulation weakens, which increases the potential for a line fault.

xiv. SAFETY

As OH conductor are exposed in air, a minimum safety clearance is required for the overhead line from any surrounding like surrounding building /trees etc which may not be available in densely populated areas, while underground cables do not require such clearances . Also, the snapping of the overhead conductors in densely populated areas poses serious safety hazard. Hence, UG cables are preferred in the densely populated areas.

3. COST ANALYSIS

As discussed above, the estimated cost of the UG cabling system is about 3-4 times than the equivalent OH system (like the Est cost of 11 KV OH S/C line with Dog conductor is around Rs 5-6 Lakh/ km while the Est cost of 1 km of 3 x300 sq mm 11 KV cabling system would be around Rs 20 Lakh/km). The tentative unit costs of 11 KV OH lines and UG cabling system are given in Annex. These are only the suggestive figures and the actual costs may vary frm utility to utility based on there technical requirement / schedule rates etc. Following is the cost comparison for installation of one kilometer of underground and Overhead lines:

S No.	Voltage Level	Tentative Est Cost Per km (lacs)		
		OH	UG	ABC
1	LT	3.5	13	8
1	11 kV	5.0	20	13.5
3	33 kV	12.0	35	
5	66 kV	45.0	80	

The above cost may vary depending upon road restoration cost for installation of the underground cables/ overhead poles. The cost is much higher for installation of

underground cables depending on the nature of the road surface to be disturbed and area of installation (Metropolitan/Rural area etc).

4. RECOMMENDATION

It may be seen that both overhead & underground network have their own advantage and disadvantage over each other and also have virtually no cost comparison for cost benefit analysis. As a sub-transmission and distribution line cover the landscape and population structure within the city/town/village throughout its length, the choice between OH and U/G cabling system has be taken based on safety, esthetic look, clearance available, rules and regulations in force and other factors . The sub transmission and distribution lines may also be a mix of both as per actual site conditions. Underground power distribution system is an expensive choice but is mandatory to supply electricity in highly populated areas.

Annex

(NOTE: These are the typical examples of cost estimate of OH line/UG cables.The actual estimates of the Discoms may differ depending upon their schedules cost estimates as approved by their competent Authorities in Discoms)

TYPICAL COST ESTIMATE FOR 1KM 11 KV (SINGLE CIRCUIT) OVERHEAD HT LINE WITH DOG CONDUCTOR ON STEEL TUBULAR POLE					
S. No	**Particulars**	**Unit**	**Qty**	**Rate**	**Amount(Rs)**
1	ST Pole 9 Mtr.	No.	25	2904	72600
2	X-arm M.S. Angle 65x65x6mm V Type	No.	25	597	14925
3	Cross arms holding clamps	No.	25	57	1425
4	11 kV Pin insulators with GI Pins(320CD)	Nos	75	67	5025
5	45 kN disc insulators	Nos	6	533	3198
6	F-bracket for fitting top insulator	No.	25	228	5700
7	ACSR Dog conductor	Km	3.09	59579	184099
8	Jointing sleeve for ACSR DOG	No.	3	171	513
9	Danger Plate	Nos	25	155	3875
10	Barbed wire	Kg.	8	68	544
11	Stay Set Complete	No.	8	1140	9120
12	Sectional D/P on Steel Tubular Pole	No.	1	45593	45593
13	Concreting of supports ST Pole	No.	25	969	24225
14	Stone pad 300x300x75mm	No.	25	182	4550
15	Earthing complete	No.	6	570	3420
	Material Cost in Rs				**378812**
	Misc. Items (Like Nut & Bolts,Clamps,Binding Wire,Aluminium Tape etc) @ 0.5 % of the material cost			0.50%	1894
	Contingency @3% of Material Cost			3%	11365
	Total Material Cost (Part-I)				**392090**
	*Labour Cost for execution of the Scheme, Overhead charges including Transportation, Establishment & Supervision Charges for Erection, Testing & Commissioning **(Part-II)**			14%	54893
	Total Cost (Part-I+Part-II)				447082
	Say in Rs. Lakhs				4.47

TYPICAL COST ESTIMATE FOR 1 KM HT OVERHEAD LINE WITH 11KV ABC CABLE WITH SPAN 30 METERS					
Sl.No	**Particulars**	**Unit**	**Qty**	**Rate**	**Amount(Rs)**
1	PCC Poles 11 M	No.	35	5465	191275
2	ABC Cable 3CX150+150 mm2	Kms	1.02	760013	775213.26
3	Clamp Suspension LT ABC 3X120-150 SQMM	EA	35	244	8540
4	EYE HOOK ANCHOR/ SUSPENSION CLAMP 300MM	EA	35	118	4130
5	Anchor HT ABC 3CX120 TO 150 SQMM	EA	10	349	3490
6	EYE HOOK ANCHOR/ SUSPENSION CLAMP 300MM	EA	10	118	1180
7	Stay Set Complete	No	10	1140	11400
8	Stay Wire GI,7/8 SWG	kg	100	65	6500
9	Full clamp assembly (alongwith Nuts,Bolts and Washers) for stay	No	10	57	570
10	Egg insulators	No	10	13	130
11	Barbed wire	kg	35	68	2380
12	Pipe earth G.I. 40MMX2.5/3 M 'B' CLASS	EA	40	706	28240
13	PIPE HDPE SIZE 25 MM	EA	120	22	2640
14	WIRE STAY GI 7/10 SWG	KG	400	65	26000
15	LUG AL Crimping 70 SQMM XLPE SINGLE HOLE	EA	160	20	3200
16	GI Strip 25x6 mm , 9 meter for earthing	No	7	570	3990
17	Phase plate for each phase set of 3 (on each H-Pole & 4-Pole)	Set	35	57	1995
18	Danger Plate	No	35	155	5425
19	Number Plate	No	35	70	2450
20	JT. KIT O/D HT ABC 3CX150+1CX150 HS ONE	EA	12	1797	21564
21	COVER INSULATION REOPENABLE ON INSULATOR	EA	9	2251	20259
22	CHANNEL MS SIZE 75X40MM	KG	89	65	5785
23	ANGLE MS SIZE 50X50X6MM	KG	41	33	1353
24	FLAT GI SIZE 50X6MM	KG	15	123	1845
	Total Material Cost(Part-I)				**1129554**
	*Labour Cost for execution of the Scheme,Overhead charges including Transportation, Establishment & Supervision Charges for Erection, Testing & Commissioning @14% of Total Material Cost**(Part-II)**			14%	163651
	Total cost in Rs.(Part-I+Part-II)				1332688
	Say(Rs. In Lakhs)				13.33

TYPICAL COST ESTIMATE FOR 1 KM 11KV UNDERGROUND XLPE CABLE (3CX300 SQ.MM.)					
Sl. No.	**Particulars**	**Unit**	**Qty.**	**RATE**	**Amount**
1	HT 11 kV 3CX300 sq.mm XLPE cable	M	1000	1137	1137000
2	11kV outdoor Joint Kit 3X300 Sq. mm.	No.	2	2471	4942
3	11 kV Straigth Through Joint Kit 3X300 Sq.mm.	No.	3	5846	17538
4	RCC Hume Pipe,150MMX2M	Nos.	50	355	17750
5	Collar RCC Hume Pipe 150MM	Nos.	30	55	1650
6	Route and Joint indicating stone	No.	30	130	3900
7	RCC cable cover(2 feet long)	No.	1666	243	404838
8	Sand	No.	250	388	97000
9	Pipe earth G.I. 40MMX2.5/3 M 'B' Class	EA	2	706	1412
10	Pipe HDPE Size 25MM	M	6	22	132
11	LUG AL Crimping 70 SQMM XLPE Single HOLE	EA	8	20	160
12	FLAT GI Size 25x6 MM	KG	7	78	546
13	Cleat HDPE for Cable Support	KG	4	763	3052
14	Pipe G.I. 100MM DIA 'B' CLASS	M	6	716	4296
15	FLAT GI Size 50x6 MM	KG	10	123	1230
16	Channel MS Sixe 75x40MM	EA	60	65	3900
	Material Cost				**1699346**
	Misc Material like nuts & Bolts, Lugs etc. @ 0.5% of the material cost			0.50%	8495
	Contingency Charges @3%			3%	50972
	Total Material Cost (Part -I)				1758557.
	Labour cost for execution of the scheme, overhead charges including Transportation, Establishment & Supervision charges for erection, testing & commissioning Part (II)			14%	246198
	Total Cost (Part I +Part II) in Rs.				2004856
	Total Cost Rs. in Lacs				20.05

Standard cost estimation report mentioned above shows that installation cost of 11 kV Underground cable network is nearly 4 times the cost of installation of overhead network of same voltage rating.

1. CEA (Technical Standards for construction of Electrical Plants and Electric Lines) regulations 2010 as amended upto date

2. Main Indian standards (as amended up to date)

IS 5613 Code of practice for design, installation and maintenance of overhead power lines (Part 1/Sec 1) : 1985 Lines up to and including 11 kV. Section 1 Design (first revision)
(Part 2/Sec 1) : 1985 Lines above 11 kV and up to and including 220 kV, Section 1 design
(Part 2/Sec 2) : 1985 Lines above 11 kV and up to and including 220 kV, Section 2 installation and maintenance
IS 9708 : 1980 Specification for stock bridge vibration dampers for overhead power lines
IS 10162 : 1982 Specification for spacers and spacer dampers for twin horizontal bundle conductors
IS 12360 : 1988 Voltage bands for electrical Installations including preferred voltages and frequency
IS:1554- PVC power cables.
IS:7098- XLPE power cables
IS:9968- Rubber based power cables
IS 3043 : 1987 Code or practice for earthing (first revision)
IS 14255/1995 : ABC cables upto 1100 volts.
IS 8130/1984 : Conductors for insulated cables.
IS 398/Pt.IV/1994: Aluminium alloy conductor.
IS 10418/1982 : Drums for electric cables
IS 1778 - Reels and drums of bare conductor.

IS: 1678, Specification for pre stressed concrete poles for overhead power, traction and telecommunication lines
IS: 2905, Method of test for concrete poles for overhead power and telecommunications lines.
IS: 7321, Code of Practice for selection, handling and erection of concrete poles for overhead power and telecommunication lines

LV CABLE JOINTS & TERMINATIONS - COLD SHRINK, HEAT SHRINK & RESIN

Cable Joints LV Low Voltage | Cold Shrink | Heat Shrink | Resin | 600/1000V 3.3kV XLPE EPR PILC Cables

Cable joints are available from stock in several technologies to suit the low voltage (LV) installation application and cable type to be repaired or jointed; this includes **i) Cold Shrink ii) Heat Shrink** and **iii) Resin**.

CABLE JOINTS

Thorne & Derrick supply **3M**, Prysmian, Filoform and SPS low voltage cable joints suitable for connecting and jointing single and multi-core/pair power, control and instrumentation cables up to 600/1000V (3.3kV) in industrial and **hazardous area locations** – specialist applications include **fire resistant**, low smoke zero halogen, hydrocarbon resistant and utility cable joints.

Jointing kits are available for both unarmoured and armoured type cables including:

- **STA |** Steel Tape Armour (Multi-core)
- **SWA |** Steel Wire Armour (Multi-core)
- **AWA |** Aluminium Wire Armour (Single-core)

Cable Joints
– See how T&D International supply your projects with LV & HV

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JOINTING CABLES EFFECTIVELY TO ELIMINATE FAILURE

Careful consideration must be given to the specification of the cable to be jointed, the installation application and environmental factors to prevent the risk of future failure when specifying LV cable joints.

XLPE, EPR and PILC insulated cables with wire armour or braid and lead sheath cover can be jointed effectively and safely in straight, branch, transition, mains and service arrangement – joints are suitable for direct burial in underground trench, seawater immersion offshore, location on cable tray (vertical/horizontal) and underground rail tunnels where zero halogen specification is required.

Hazardous area cable joints are available from stock for both onshore and offshore cables in the oil, gas and petrochemical industry – suitable for Zone 1 and Zone 2 explosive atmospheres where exposure to corrosive and flammable gases, vapours or mists would cause the degradation and premature failure of standard cable joints.

Pictured opposite is a heat shrink cable joint failure caused by the jointer not providing adequate connection of the earth continuity across a jointed shipwiring braided type cable. Consequently, hydrocarbons contaminated the cable via a pathway along the wire armours and eroded the cable sheath.

LV CABLE JOINTS

Cold shrink, heat shrink and resin type cable joints suit the operating requirements for the jointing of LV cables in industrial, marine and offshore, oil and gas, substation and utilities, rail and electrical construction sectors where high quality and performance joints ensure the continued distribution of power supply to critical circuits.

Contact Thorne & Derrick to discuss your application – we can provide expert technical support and specification advice to ensure the correct supply of electrical LV cable joints to suit your requirement.

Resin Cable Joints – 3M Scotchcast Resin Joints Features & Benefits

SPECIALIST CABLE JOINTS

To meet the performance and specification requirements for planned maintenance, project installations and fault repair work, T&D can deliver from stock LV cable joints to suit:

- Fire Resistant & FP Fire Performance Cables – Fire Alarm, Emergency Lighting & Power BS7846
- Low Smoke Zero Halogen Cables – LSZH, LSF, OHLS & ZHLS
- Flexible & Trailing Cables – Protolon, Panzerflex & Mining
- Utility Cables – Waveform, Mains & Service
- Marine & Offshore Cables – BFOU RFOU IEC NEK606 (Mud Resistant)
- **Medium & High Voltage MV HV Cable Joints**

ZERO HALOGEN HEAT SHRINK JOINTS

In this training video excerpt the Jointer Trainer is shown using a gas torch to heat shrink tubes onto the cable cores and conductors of a rail power cable to complete a **zero halogen cable joint**. The cable joints utilise specialist zero halogen tubing with a low emission of toxic and corrosive gases approved by London Underground and Network Rail to establish cable joints in subsurface applications, such as tunnels.

The XLPE cable insulation has been stripped from the cable conductors and the cores cropped using **ratchet cable cutters**. Connectors have been installed using **hydraulic crimping tools** – note the connector heat shrink insulation tubes are positioned centrally over the compression ferrules within the cable joint, where confined space is a limiting factor the cable connectors can be staggered to provide a more smooth profile joint to reduce footprint of the jointing kit.

London Underground & Network Rail Approved Cable Joints – PADS Listed 600/1000V Rail Cables

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3M NETWORK RAIL COLD SHRINK JOINTS FOR TRACK FEEDER CABLES

3M Cold Shrink Network Rail cable joints are used for the cable jointing and cable terminating of track feeder cables. 3M Cold Shrink cable joints require no hot-work permit or special tools for installation.

Track feeder cable joints are approved for cable jointing Network Rail NR/PS/ELP/21101, BS6360 and BS6899 specification single core copper and aluminium cables, 650/750 DC supply.

CSP sheathed track feeder cables provide power supply from the substation to the rail track side.

3M Cold Shrink Cable Sealing Tubes are specified for rail cable sealing, insulation and protection and are approved by Network Rail for live rail terminations and inline cable joints for DC track feeder cable applications.

3M Cold Shrink provides a permanent radial seal, expanding and contracting with the rail cable under load conditions. 3M Cold Shrink Tubes are made from EPDM rubber, expanded onto a removable supporting plastic core.

As the core is unwound, the 3M Cold Shrink insulating sleeve shrinks to form a tight seal around the cable terminal or splice.

3M LA11 and 3M LO42 form part of the 3M Electrical range of EPDM Cold Shrink tube ranges with LUL TfL Approval – for fire resistance and conformance to S1085 Standard the tube should be covered and over-protected using 3M STFF product.

Cable Joint/Termination Application	Cable Joint Kit	Min Diameter	Max Diameter	Cold Shrink Length
500/630/1000mm^2 3rd Rail Terminations	**LO41**	24.4	98.2	228mm
161/1240mm^2 Inline Joints or Terminations	**LO42**	15.2	61	191mm
500/630/800/1000 Inline Joint	**LA11**	38.1	114	457mm

To assist with the installation of LV Cable Joints visit our online **3M Joints & Termination Video Library** | Jointer Training Available

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PRODUCTS

Resin Cable Joints
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3M Scotch Electrical Tapes
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Cable Repair
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Cold Shrink Cable Joints
View products

Zero Halogen Cable Joints
View products

Cable Cleaning Wipes | 3M Jointers Wipes For Cleaning LV HV Cables
View products

Submersible Cable Joints – 3M Scotchcast 82F 82BF Cable Splices
View products

Cable Caps | Heat Shrink Cable Caps For Sealing Cable Ends
View products

Rail Cable Accessories LV HV
View products

Cable Breakouts | Heat Shrink Breakouts For 3 & 4 Core Cables
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Heat Shrink Cable Joints – XLPE PILC Cables
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Fire Resistant Cable Joints
View products

Live Pot End Kits For XLPE & PILC Low Voltage Cables
View products

Cable Abandonment Kits For XLPE & PILC Low Voltage Cables
View products

Airfield Lighting Heat Shrink Joint Kits
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Traffic Control, Motorway & Communication Heat Shrink Cable Joint Kits
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Cold Shrink Cable Caps
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Cold Shrink Tubes
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Pilot Cable Joints | 3M LVI-1/x-PT Scotchcast Resin Cable Joints (470W Resin)
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Cable Cleats, Clamps & Hangers

Cable Cutting & Cable Crimping Tools

Cable Duct

Connectors (Mechanical Shearbolt & Crimp Types)

Cable Protection

Cable Protection Covers

Cables

Cold Shrink

Cut Outs & Isolators

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Unit 5

Repairing of Cable Joints

171177CH05

Introduction

Electrical joints and terminations provide the required electrical connection as well as the mechanical support and physical protection to the cable. It is important for the Cable jointing system to suit the service and operational requirements for all industrial cable jointing environments and applications. These devices are important for jointing the cables and wires. A good cable jointing and installation provides a better supply of power (Fig. 5.1). Cable jointing has become the preferred pick over conventional systems for cable termination, cable abandonment, low voltage cable jointing and cable repair. The cable termination and jointing kits are often specialised in wire installations worldwide.

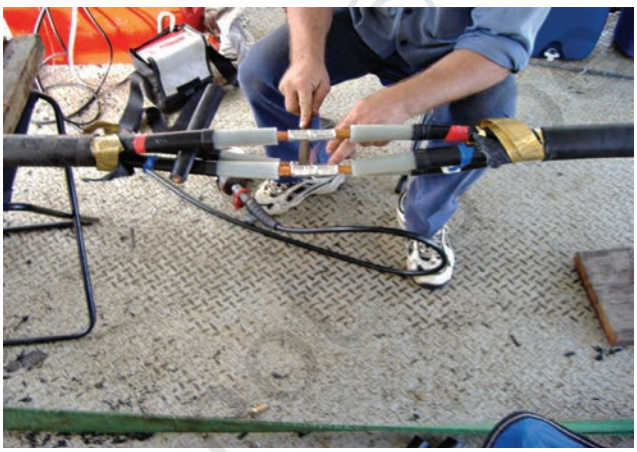

Fig. 5.1 Electrical joint and terminations

Cables play a very important role in the distribution system of power. There are different types of cables like LT cable, 11 KV cable and 33 KV cable. Cables are used in places where bare conductor cannot be used due to narrow roads. Cables are costlier than the conductor and the same cannot be replaced often.

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Session 1: Electrical Cable Jointing Methods

Jointing of power cables should be as simple as twisting and taping the wire. For jointing of a cable variety of in-line adapters and connectors are used. The method used for a cable joint depends on the voltage, type of cable, type of joint, type of connector, application and other factors. Proper tools and equipment are to be used for jointing the cable.

Given below are some important factors to ensure reliable connections, such as

- proper size of connectors should be used for a particular cable,
- proper tools and equipment are to be used,
- cuts and stripping should be very clean,
- proper technique is to be used for cable jointing and
- restoring the insulation, outer-sheath and armour.

Western Union Splice Joint

The cables are manufactured for a particular length. To increase the length of a cable a straight joint is used for small solid cables (Figs. 5.2 and 5.3).

1. Remove the insulation of cable
2. Bring the two conductors to a crossed position and then make a long bend or twist in each wire.
3. Wrap the end of one of the wires around the straight portion of the other wire, and then do the same for the other wire. Repeat this for about four or five times.
4. Press ends of the wires down close to the straight portions of the wire to prevent the ends from piercing through the insulation tape.
5. Insulate the joint using the insulation tape

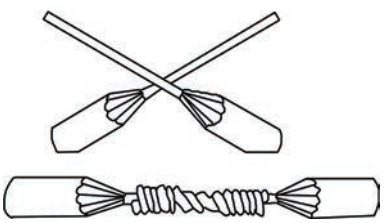


Fig 5.2 Western union splice and straight joints

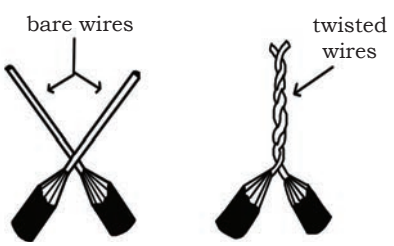
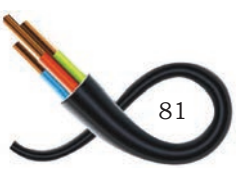


Fig. 5.3 Rattail joints

Fixture Joint

This is a type of branch joint connecting a thin wire (for branch line) to the thick wire (main line), such as those used in lighting fixtures.



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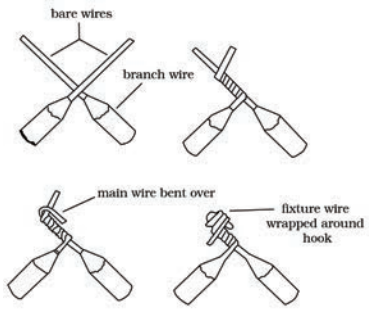

Fig. 5.4 Fixture joint

1. Remove the insulation of wire
2. Wrap the fixture wire around the branch wire
3. Bend the branch wire over the completed turns
4. Wrap the remaining fixture wire over the bent branch wire
5. This can be followed by soldering and taping, or simply taping of the joint (Fig. 5.4).

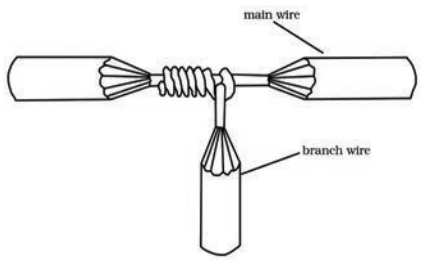

Fig. 5.5 Knotted tap joint

Knotted Tap Joint

The knotted tap joint is also used for branch joints to connect a branch wire (thin wire) to a continuous or main wire (thick wire) (Fig. 5.5).

1. Remove about 1 inch of insulation from the main wire and about 3 inches from the branch wire.
2. Place the branch wire behind the main wire so that three-fourths of its bare wire extends above the main wire.
3. Bring the branch wire over the main wire, around itself, and finally over the main wire so that it forms a knot. Wrap the wire around the main conductor in short, tight turns and trim the end

Joints Using Wire Nut and Split Bolt

The rattail joint is replaced by wire nut. The nut is usually housed in a plastic insulating casing. To make a joint.

1. Strip the conductors
2. Place the two joints to be joined into the wire nut
3. Twist the nut

Split Bolt Connector

The split bolt is used to join big sized conductors. This replaces the knotted tap joint and can be used to join three ends or join a branch conductor to a continuous (main) conductor (see Fig. 5.6).

The bare wires are placed through the space between the two bolts, after which the nut is tightened to ensure

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a sound joint. The material required for making straight or branch joints for steel wired armour cables are as follows:

- Connectors
- Copper mesh tape
- Constant force springs for holding the wire armour and copper mesh tape
- Standard PVC/Vinyl tape, which provides a mechanical barrier between the over sheath layer and the armour layer.

Fig. 5.6 Split bolt

Preparing the Cable

Preparing the cable before jointing includes the following steps (Fig. 5.7):

1. Remove the over sheath and the wire armour
2. Separate the wire armour and bend the wires away from the cable, place the support ring under the armour at each side of the joint
3. Cut back the cable insulation
4. Remove the insulation from each of the conductors

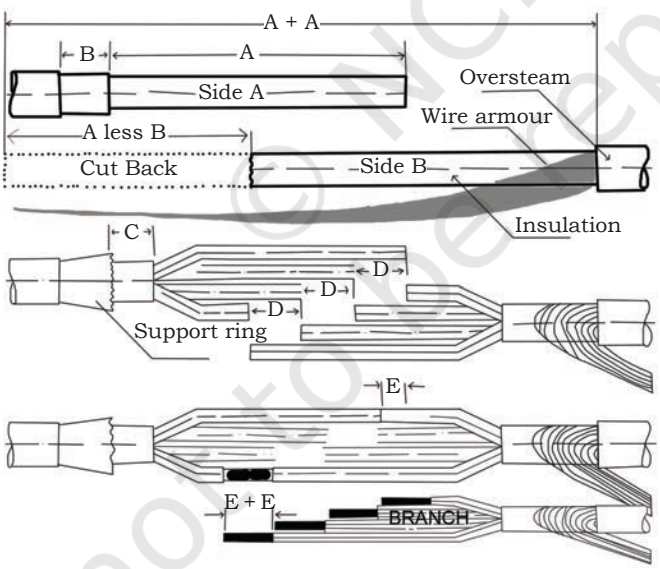

Fig. 5.7 Preparation of a three-core armoured cable

Crimping and Insulating Each Cable

Once the cable is ready, connect each end of the three conductors to a suitable connector (copper or

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aluminium). Suitable-sized connectors are to be used. Tightly fix the suitable connectors and test the connection.

Tape the crimped connectors, wrap around and extend to cover at least 25mm of the cable insulation of the conductor entering the connectors (Fig. 5.8).

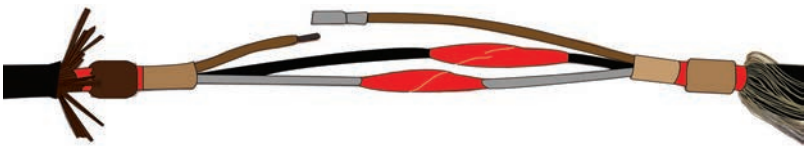

Fig. 5.8 Taped, crimped connectors on individual cables

Fig. 5.9 Wires taped together

Binding the Cables

Bind the wires tightly and then tape them together (Fig. 5.9).

Restoring Armour and Applying Mesh Tape

1. Tightly wrap the cable from armour to armour while applying adequate tension around the insulation.
2. Join the wire armour from one end to the other end and cut excess wire to the correct length. Ensure the armour spreads evenly over the entire joint.
3. Wrap the cable with the mesh tape and then use the standard vinyl/PVC tape to wrap over the mesh to provide a insulation against stray wire ends. For the branch joint, bring both the main and branch cables together before wrapping.

Fig. 5.10 Wrapping the cable with mesh tape

Next, use standard vinyl or PVC tape to wrap over the constant force springs placed over the under-armour rings. The tape provides a barrier against sharp edges (Fig. 5.10).

Re-establish the Over Sheath

1. Use a self fusing tape to wrap over the cable and establish the outer sheath. Start in the center and apply one layer of tape to one end, wrapping

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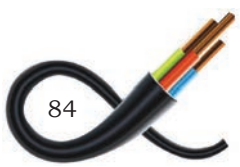

over the jacket for at least 25 mm. Apply the tape from the end towards the center so that you have two layers on each side.

2. For branch joints, wrap over the insulation for both the main and the branch cable, by at least 50mm. Bring the two together and fill it in with the insulating putty from both sides. Do this up to 25 mm away from the place where the branch and the main cables are joined.
3. Put the two cables together and bind the main and branch tightly over the filling. Finally, wrap the crotch while pulling the branch away from the main cable (Fig. 5.11).

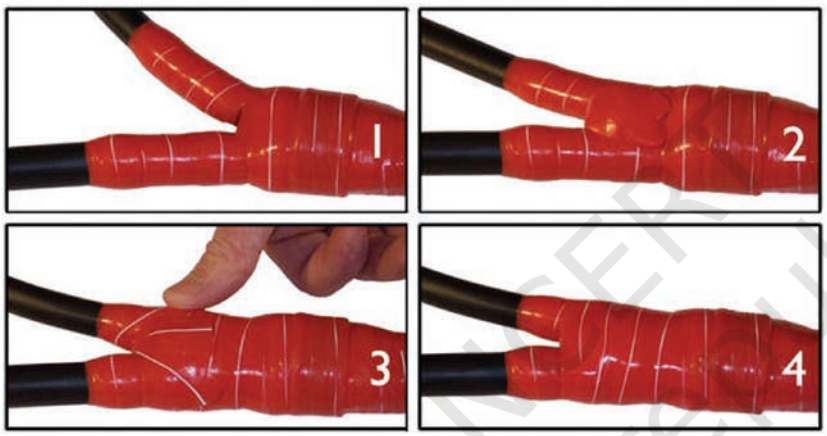

Fig. 5.11 Restoring the over sheath on a branch joint

Electrical Power Cable Terminations

The electrical cable termination is a cable end that connects to the terminal of the equipment or another cable to extend the length (Fig. 5.12).

The method used for termination of the cables varies according to the type of cable, type of connector and application. Some common types of terminations are

- crimp connection
- soldered connection
- compression termination
- wire-wrapping connection
- direct connection
- loop or eye connection

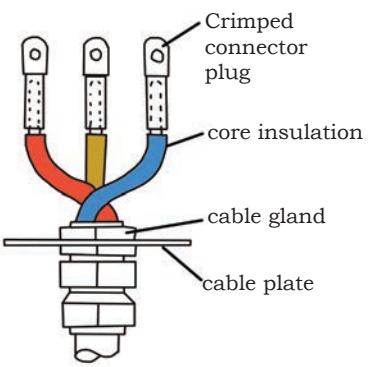

Fig. 5.12 Low voltage cable termination

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Some of the factors which are considered for termination of cables are:

- Outdoor or indoor cable
- Voltage of the line
- Overhead or underground cable
- Type of connector on the equipment where the cable will be connected

Cable Joints

A power cable consists of two or more electrical conductors, held together wrapped with insulation and outer surface with an overall sheath (Fig. 5.13). The cables are used for transmission of electrical power. Power cables is being used for permanent wiring within buildings. The cable can be run under ground, run overhead, or exposed. Cables consist of three major components: conductors, insulation and protective jacket. The structure of individual cables varies according to application. Power cables use stranded copper or aluminium conductors, although in some cases solid conductors is used.

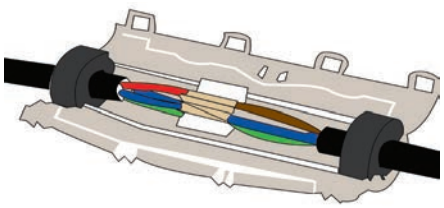

Fig. 5.13 Cable joint

After the introduction of electric cables in electrical circuit the problem of how to join them together arises in order to achieve the degree of insulation, tensile and crushing strengths, conductivity and accessibility. To cope up the requirements a junction box is introduced. The junction box typically incorporates:

- a method of securing the cable conductors (usually by soldering, screw-clamps or compressed ferrules).
- a method of insulation, which may be air, oil, bitumen or insulation applied in the form of tapes.
- a method of enclosure and protection applicable to the environment.

As per The Electricity Regulations every joint and connection should be mechanically and electrically suitable for its use. In this respect the joint or connection should be of proper construction as regards conductivity, insulation, mechanical strength and protection.

Joints in Non-flexible Cables

Underground cables are joined by ferrules or lugs (crimped) and the outer protection enclosure or box is

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usually filled with a plastic or bituminous compound. Such joints are often used above-ground for non-flexible cables and are adequately protected and supported. Other cables which are fixed wiring installations enclosed junction boxes are used to making a joint between two cables. These junction boxes are not securing the cable against strain.

Joints in Flexible Cables

Joints in flexible cables are not usually satisfactory because:

1. stranded conductors are not suitable for certain methods of jointing.
2. mechanical tensile strength and resistance are difficult to maintain.
3. fatigue damage may occur when rigid joint is being done.

Some joints and cable connectors are much more acceptable these incorporate terminals or compression fittings suitable for stranded conductors. Cable clamps are used for plugs to reduce the flexing. Heat-shrinkable or pre-stretched sleeving may be adequate in some cases but other circumstances may demand additional protection.

Types of Cable Joints and Equipment

A great majority of failure in cable network is associated with faulty cable jointing. It is, therefore, essential to use proper jointing technique, good quality insulating material and standard accessories for cable jointing. Cable joints are of three types:

Straight through Joint

Straight through Joints are an important part of today's power cable networks (Fig. 5.14). These joints offer reliability and flexibility to meet the demands of cable network.

Straight through Joints provide

- quick cable preparation
- high electrical insulation
- no moisture ingress

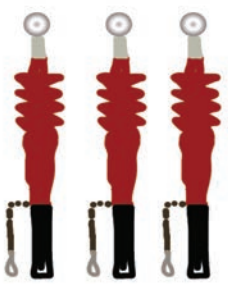
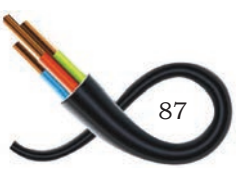


Fig. 5.14 Single Core Straight through Joint Kits



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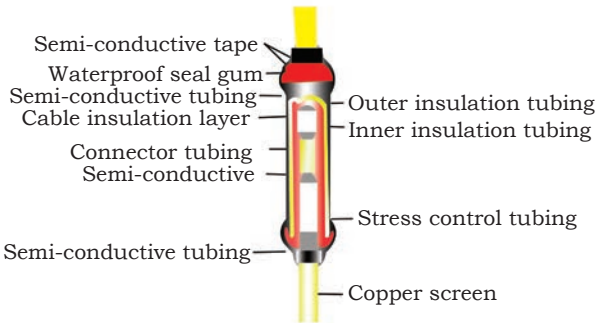

Fig. 5.15 Straight through Joint

- good mechanical strength
- compact dimensions and is suitable for all conductor, shape and material

Straight through Joints are made by metal joining processes, such as welding and soldering (Fig. 5.15).

T-Joint

These types of joints are used for branching of a service cable from a main cable. T-joints are helpful as turning and twisting of cable damages its outer core (Fig. 5.16).

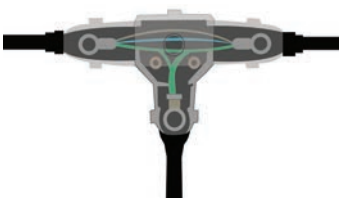

Fig. 5.16 T-Joint

Terminal Joint

These type of joints connect cable to switch gear, transformer terminal or to an overhead line (Fig. 5.17).

Fig. 5.17 Terminal Joint

Conductor Joint

The length of distribution lines are in kilometers and one coil of conductor is unable to solve the length problem. Hence, jointing the conductor is necessary.

Britannia Joint

This type of joint is made only on solid conductors and cannot be made on stranded conductor. Two conductors to be joined are brought in front of each other of about 6 inch (150 mm) of length. Both the conductors should be clean. If the conductor is of copper; it should make good electrical connection. Then ends of both conductors are bent through half centimetre and placed on each other. The length of contact portion should be min. 100 mm. This joint should be bound by 14 mm copper wire as shown in Fig. 5.18.

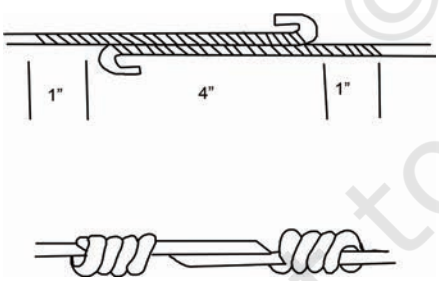

Fig. 5.18 Britannia Joint

Telephone Joint (Western Union)

This joint is used only for solid conductors. It is used for conductors of size 8 SWG or higher size. First, bend is given at 100 to 125 mm from the edge and are placed over each other. Then each one is twisted with another conductor.

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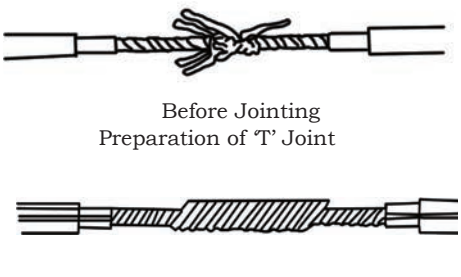
Married Joints

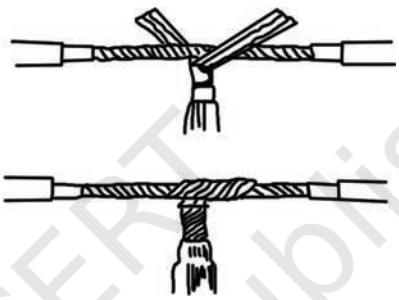
This joint is made between copper conductors having central strand of GI wire (Fig. 5.19). It should not be made between aluminium (Al) conductors. Approximately 175 to 200 mm length conductor strands are unwound. The GI strand of both conductors should be broken up to 175 mm in length. Both conductors should be brought in front of each other and their strands should be woven in each other. The strand of one conductor is twisted on other conductor, and strand of other conductor is twisted on the first. Likewise all the strands twisted and then soldered. This is used only for small span length.



Before Jointing
Preparation of 'T' Joint

After Jointing

Fig.5.19 Married Joint



'T' Joint After Completion

Fig. 5.20 'T' Joint

Sleeve Joint

It can be made with any type of aluminium conductor. Graphite Greece is applied over the conductor and as shown in Figs. 5.20 and 5.21 sleeves should be taken. These sleeves should be placed on the conductor as shown. Sleeves should be twisted by twisting wrench. This joint is made for LT, HT, ACSR, AAC conductor up to 0.06 cm^2.

Fig. 5.21 Sleeve Joint

Compression Joint

This joint is used for conductors of more than 0.06 cm^2 sizes. For jointing, two different sleeves are used. Steel sleeve is used for steel conductor strands and aluminium. sleeve is used for Al. conductor strands. There are two holes in Al. sleeve. Rebating is done

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through these holes. Then Al. sleeve to be mounted on one side. The length of steel sleeve is then measured. Its half distance is taken. Suppose it is 'X' cm. Then the ends which are to be joined and more to 'X' cm distance is taken on the conductor is banded there. The Al. strands are opened up to that point and cut. Steel strand should not be touched during this. They are placed in the steel sleeve. They should be kept in front of each other. Then the center of steel sleeve is compressed through compression machine. Then on the half portion of the right side sleeve be compressed and then on the left half portion. Due to compression the length of sleeve will be increased by 6mm on both sides and it will reach Al. strands. Then Al. sleeve should be measured. It should be halved. Suppose it is 'Y' cm then 'Y' cm should be measured and marked on both sides of conductor measured from center of steel sleeve. Both parts of conductor are brought in sleeve in front of each other. The filler parts should be filled in the sleeve by Grease until it comes out of the holes. Both the holes are then closed by rivets and hammered by hammer. There is one stencil mark on Al. sleeve. The first compression will be there; afterwards it will be compressed up to one end. Similarly the other part is compressed up to the other end.

Jumpering

Connecting two conductors or wires is called jumpering (Fig. 5.22).

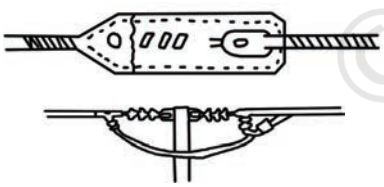

Fig. 5.22 Jumpering

Jumper should not be connected to the main conductor. The jumper should always be connected by PG clamps.

When the jumpers are near metallic portion, all such jumpers are covered with alkathane pipe.

Conductor joints are marked on ACSR conductor when dispatched. Mid-span joint should be made before stringing as the steel strand is not kept continuous. Hence, it is necessary to replace the company joint.

Care should be taken that mid-span joint is not less than 40 ft. from pole. Every joint should be done carefully.

Where conductor strands are cut, repair sleeve is used. Conductor joint strength should be 95% that of conductor, and resistance should be that of a main conductor.

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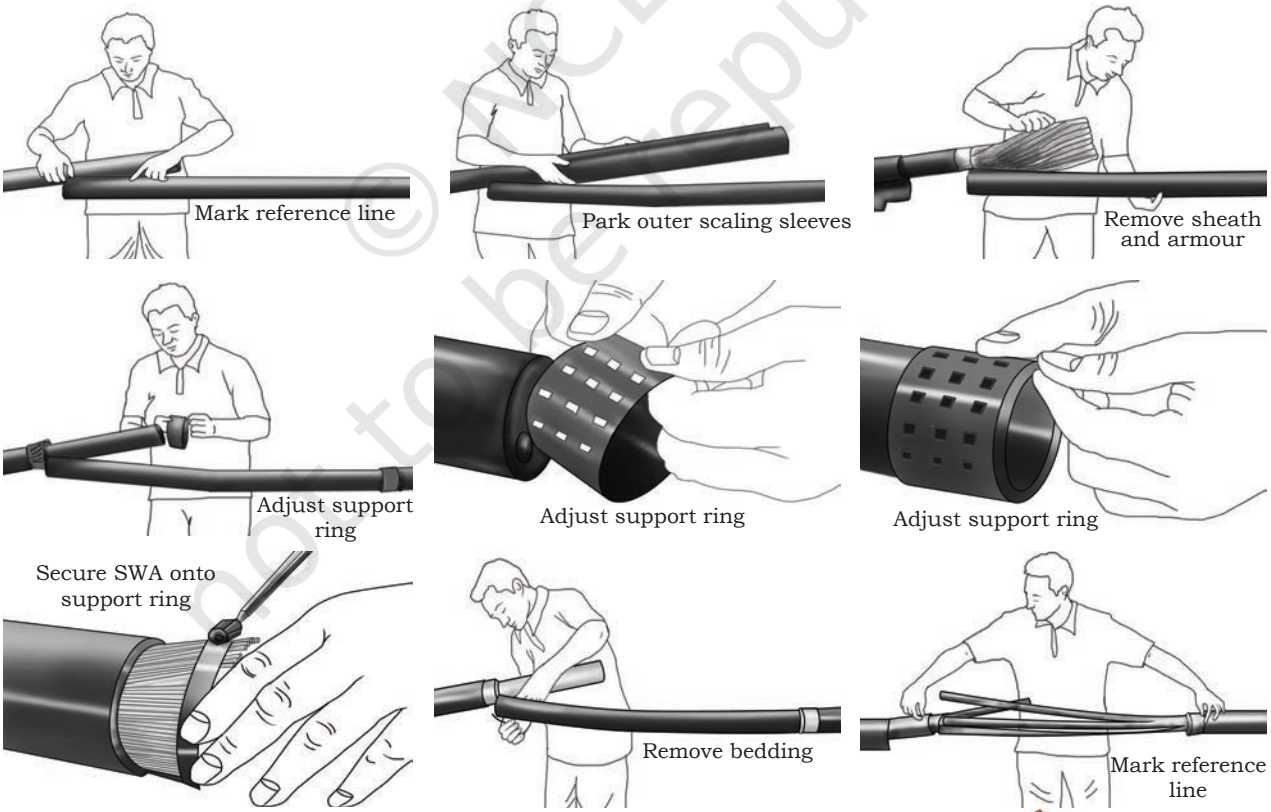
HV Cable Jointers Tools

Using the correct cable tools to prepare industrial and utility cables before cable jointing and terminating reduces catastrophic cable failures. Some of the important cable jointer tools include:

- Cable cutting tool
- Cable crimping tool (hydraulic, battery, ratchet) copper/aluminium cables
- Cable spiking tools for LV-HV cables (cartridge/ hydraulic)
- Heat shrink gas torches for LV-HV jointing
- Screen scoring tools for bonded/easy peel HV cables
- Outer sheath stripping tools, LV-HV cables
- Insulation (XLPE) stripping tools, HV cables
- Insulated tools for live-working
- Cable laying rollers, socks, jacks and pulling equipment
- Conduit duct rods

Procedure for Heat Shrink Straight through Joint



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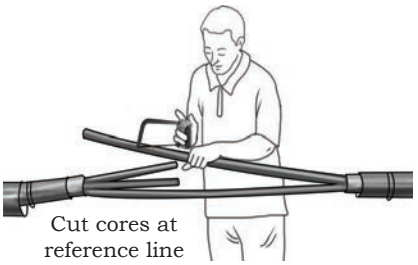
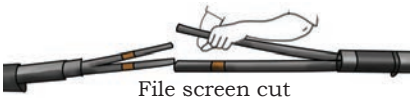


Cut cores at reference line

Remove copper tape shield



File screen cut

Remove conductive layer

Remove insulation

Shrink stress control tubing

Park insulation tubing

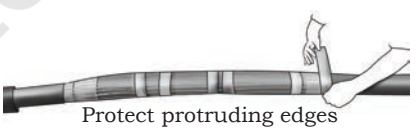
Apply filler putty

Apply stress control patch

Position insulation tubing

Apply copper mesh shielding

Position and secure armour case



Protect protruding edges

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Check Your Progress

A. Write short notes on

1. LT cables Joints
2. Straight through joint
3. Britannia Joint
4. T-joint

B. State whether the following statements are True or False

1. Western Union joint are used for all conductors.
2. Meried joint should not be made between aluminium conductors.
3. Crimping is necessary for jointing the cable.

C. Short answer questions

1. List the steps used in preparing of the cable.
2. Explain the different types of joints.
3. Differentiate between fixture joint and western union splice joint.
4. Explain the procedure for heat shrinking straight through joint.

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You are not allowed to print preview this page, Thank you

NP001.2
General Specification for Underground Electrical Reticulation

This document is extracted from Network Policy NP 001, Design and Construction of Network Assets.

Other documents in this series include:

- NP001.1 Design and Construction of Network Assets – General Requirements
- NP001.3 General Specification for Overhead Electrical Reticulation
- NP001.4 General Specification for Overhead Rural Residential Subdivisions
- NP001.5 General Specification for Overhead Commercial and Industrial Subdivisions
- NP001.6 General Specification for URD Subdivisions
- NP001.7 Reliability Criteria for Distribution Networks
- NP001.8 Handover Documentation
- NP001.9 Electricity Supply to Large Customers
- NP001.10 Documentation Requirements

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Authorised by	Prepared by:	Issue Date: 14 Feb 2008	Status: Approved
Bertram Birk General Manager Power Networks	Chris Pemberton Manager Network Projects	File No: F2007/6260	Version: 2

Document Valid on day of printing only: Printed on Monday, 25 February 2008

General Specification for Underground Electrical Reticulation

Power and Water's Standards Volume 2 sets out the standard arrangements for the installation of underground cables and equipment. From time to time Power and Water may vary these arrangements, either permanently or on a trial basis.

Where a developer wishes to vary any standard arrangements, a formal application, setting out full details of the proposed variations, shall be submitted to the Manager Network Engineering, PO Box 37471, Winnellie, NT, 0821.

This document summarises, and should be read in conjunction with, the Electricity Supply Association of Australia publication C(b)2 1989, "Guide to the Installation of Cables Underground".

1 Scope

This document sets out the basic requirements for the installation of high and low voltage underground cables and related equipment. It covers XLPE and MIND paper insulated cables. Generally "low voltage" refers to cables operated at a nominal voltage not exceeding 500 volts, while "high voltage" refers to 11 or 22 kV.

2 Safety

New underground cables that are separated from existing parts of the network by virtue of missing sections of cable are not treated as power lines in respect of Power and Water's *Electrical Safety Manual (Green Book)*.

However, it is a requirement that all construction work complies with the *Work Health (Occupational Health and Safety) Regulations*.

It should also be noted that the construction of underground power systems is classified as "electrical work" by the *Electrical Contractors and Workers Act*, and can only be carried out by licenced persons.

Where work is required to be carried out on cables or equipment that have been, or can be, energised, then strict compliance with the *Electrical Safety Manual* and the *Regulations* will be enforced by Power and Water.

3 Cable Types

Only cables supplied by approved manufacturers may be connected to Power and Water's network. Power and Water always reserves the right to inspect and test any cable purchased by a developer or contractor to ensure compliance with the relevant standards. In any event, the developer shall provide copies of the suppliers' offer to confirm manufacturer and manufacturing standard. Cables that are found to not comply with Power and Water standards will be rejected, including all cables from that particular batch or order.

Generally Power and Water does not use wire armouring, but may require this in certain circumstances, such as where a particularly long pull is required.

(a) Paper/Lead

Power and Water has both high and low voltage paper/lead cables in service. Where existing cables are to be jointed or terminated, the cable jointer will need to familiarise him/herself with the construction of the particular cable.

No new paper/lead cables are to be used. However, Power and Water may approve the replacement of a short section of existing cable like-for-like where it is not practicable to use XLPE cable. Paper/lead cable shall comply with the following:

- Mineral Insulated Non Draining (MIND) to AS/NZ 1026 and AS/NZ 4026.
- Lead alloy sheathed to AS/NZ 2893
- Belted
- Stranded sector-shaped aluminium conductors to AS/NZ 1125
- Nylon jacketed or double brass taped

(b) XLPE

Most low voltage and high voltage cables are XLPE insulated. Power and Water generally uses single-core cables for ease of installation, but 3 or 4-core cables may also be used.

Such cables are generally:

- Low voltage to AS/NZ 4026, 4961 and 5000 as appropriate
- High Voltage to AS/NZ 1429 and 4026
- Nylon jacketed and sheathed, (or "Termitex" or equivalent) except in fully ducted systems where the entry of termites is completely excluded by approved means
- In the case of high voltage, fitted with conductors impregnated with water-blocking compound
- In the case of high voltage, fitted with a water-blocking (HDPE) sheath

4 Protection of Cable

It is essential to ensure that during transport, storage and handling, cable sheaths and/or armouring are not damaged. In particular, any cable found to have damage to the nylon protective sheath or water blocking sheath will be rejected.
Cable ends shall be sealed against moisture at all times with an effective cap.

5 Types of Cable Installation

(a) Direct Buried

With this system, the cable is laid directly into a trench bedded in sand. A cable warning strip or mechanical protection is used to provide a measure of mechanical protection.

Direct burial has the advantage that heat is transferred more efficiently into the soil than in ducted systems, thus maximising current rating. It has the disadvantage that cables may only be replaced by excavating the route; this can be very expensive in an established area.

(b) Ducted

Ducting allows for replacement of faulty cables, and facilitates construction in cramped locations. Ducting is required by Power and Water in all cases where the cable route passes through private land, across roads or concrete footpaths; Power and Water may also require ducts in any area where it believes that future access may be restricted. In particular, in commercial areas where future paving is likely, all cables (including street light cables) shall be ducted.

Ducting has the disadvantage that the cable is derated in comparison to direct burial.

Power and Water may require the installation of spare ducts to allow for future cable installations.

(c) Shared Trenches

Trenches may be shared with telecommunications cables such as telephone and cable TV. Typical arrangements are set out in Drawing No. S2-2-6-2. Generally 450 mm separation is required between power and communications cables.

Note that where telecommunications cables are installed in the same trench as power cables, all power cables shall be installed in ducts.

Note the requirements for separation and mechanical protection between power and telephone cables. When a telephone line crosses a power cable, or a power cable passes underneath a Telstra pit, a 50 mm concrete slab is required between the two.

6 Excavation and Trenching

(a) Safety

The *Work Health (Occupational Health and Safety) Regulations* require (Clause 145(b)) that trenches be shored when a "..worker is required to work in an excavation or opening in the ground that is 1.5 metres or more in depth."

Compliance with this Clause can be achieved either by shoring "..of a standard that will prevent the collapse of the excavation or the movement of the earthwork" (Clause 145(3)) or by sloping the trench walls at a sufficient angle to provide stability. Shoring is also not necessary where the ground is stable (e.g., solid rock).

The ESAA publication C(b)2 describes typical arrangements for shoring.

The *Work Health Regulations* also require safe means of access/egress to the trench, and require that plant or excavated material be kept clear of the edge of the trench. Clause 61 of the *Regulations* discusses the identification of, and measures to be taken to combat dangers associated with, confined spaces, such as cable tunnels.

Power and Water requires that personnel who need to work in confined spaces attend an accredited course and be equipped with, and use when required, the necessary protective equipment. A current first aid certificate is required from an accredited training authority.

(b) Trench Alignment

This shall be in accordance with the S2-4-1 series of Drawings in Volume 2 of the Standards Manual. The typical trench alignment is 0.75m from the property boundary unless approved otherwise by Power and Water.

(c) Existing Services

When excavating in an area where there are existing services, it is a requirement that all existing services be accurately plotted, all relevant Authorities consulted, and appropriate permits issued. Always ring Dial Before You Dig on 1100 if there is any doubt about location of services. If excavating within 3m of any cable, Power and Water shall be notified on 1800 000 254 and a cable location requested.

Where unforeseen services or site conditions are found during excavation, proposed design changes shall be documented and approved by the Design Officer before proceeding.

When working within 1 metre of an existing high or low voltage cable, Power and Water is to be notified at least 7 days in advance. Power and Water will notify the contractor of the measures to be taken to limit the dangers associated with excavation close to live cables. Typically hand tools must be employed for excavation within 1 metre of a cable.

Attention is drawn to the Electricity Reform (Safety and Technical) Regulations, which imposes severe penalties upon persons who carry out work close to power infrastructure without the approval of Power and Water. Approval takes the form of an "Approval to Work in the Vicinity of Electrical Apparatus" or "AWV".

Power and Water also runs a training course at regular intervals covering the basics of excavating near existing services.

Care should be taken when working close to existing buildings or structures to ensure that foundations are not damaged by the work.

Where excavation work is likely to damage or require removal of any tree on Crown Land, the relevant authority should be approached and grant permission for the work prior to proceeding.

(d) Direct Laid Cable

The trench shall be completed with a smooth and level bottom, with no protruding rocks. Spoil should be deposited at least 600 mm from the trench to prevent material

from falling back into the trench. Spoil containing rocks larger than 50mm diameter shall be removed and not used as backfill. The quality of the spoil shall be approved by the Project Officer before it may be used as backfill.

The trench shall be partially filled with sand to ensure that, after cable laying, there is a minimum of 50 mm of sand between the cable and the bottom of the trench. All foreign material that could attract termites, such as scraps of timber or plastic, shall be removed.

The cable/s and earth conductor shall be laid out carefully to avoid damage. After placement of the cables, any rocks or similar hard material that may have fallen into the trench shall be removed.

The trench shall then be backfilled to the required depth with sand, compacted in layers not exceeding 150 mm.

Finally the trench is to be backfilled to surface layer with clean backfill material, laying marker tapes as required. The backfill material is to be free of boulders or rocks greater than 50 mm in diameter, and is to be compacted in layers not exceeding 150 mm to match the adjacent undisturbed material.

Generally, the installation shall comply with Drawing S2-2-6-1. Single core high voltage cables should preferably be laid in a close trefoil arrangement. Single core low voltage cables shall be separated slightly to assist cooling, and to limit damage to neighbouring cores when one core is faulted.

(e) Ducted Cabling

Trenching and backfilling for ducted systems shall be carried out in a similar manner to direct buried systems as described above.

Ducting shall generally be orange PVC heavy duty conduit to AS/NZ 2053, complying with the requirements of the Wiring Rules for Category A enclosures. Alternatively, heavy duty continuous HDPE orange conduit may be used with the approval of Power and Water.

In certain circumstances Power and Water may consider the use of other ducting systems where it is satisfied that a combination of depth, location and/or mechanical protection provides enclosure equivalent to Category A.

A ducted cable run shall be designed to ensure that permitted cable tension is not exceeded during construction. This may require the installation of additional sand pits to permit the use of "caterpillar" type cable pulling equipment.

Ducts entering concrete pits shall be cut flush with the pit wall and carefully rounded internally to prevent edges damaging the cable. Bell mouths must be used at the start of any pull to prevent damage to the cable sheath. Entering and exit holes in a pit must be exactly lined up (±10mm max).

Duct runs shall be as straight as practicable to minimise pulling tensions. Joints may be glued; however, there shall be no visible glue on the surface of the joint, as the softening of PVC by glue facilitates termite entry. Conduits shall be laid so that the "belled" end is at the leading end of each length in relation to the direction of pull.

Pits shall be installed at each change in direction of a high voltage cable run, unless otherwise approved by Power and Water. Ducts shall be positioned to maximise the bending radius as the cable/s enter and exit the pit. Under no circumstances shall the manufacturer's recommended minimum bending radius be exceeded (i.e., the cable shall not be bent to a radius smaller than recommended).

Where there is a change of height at, for example, road crossings, the change shall be gradual to minimise pulling tensions. Where a conduit diversion is required for any reason, a radius bend of at least 2.3m radius shall be employed.

Where spare ducts are installed, they shall be capped to prevent ingress of foreign material. Spare ducts that start and/or finish away from a pit, pillar or substation shall have locating devices installed at each end. These shall be the 3M radio marker type specified from time to time by Power and Water. (Power and Water may consider GPS bearings provided that these are accurate to 10cm). A synthetic draw wire shall be installed in all spare ducts; there shall be at least 2 m spare coiled just inside the cap.

Where spare conduits are installed across a road, the curb shall be marked with the letter "E" in accordance with Drawing S2-2-6-1. Note the requirement to run such a conduit at least 450mm past the curb and any other service or obstruction. Generally such conduits shall be run to within 1 metre of the street cable alignment.

Duct diameter is generally 150 mm for high voltage and 100 mm for low voltage cables.

7 Boring

Where required, thrust or directional boring may be used to avoid surface excavation.

In such cases, it is essential to adequately locate all existing cables and services, and obtain relevant permits, prior to commencement of work.

When using directional boring methods, it is usually necessary to utilise continuous conduit for pulling back into the hole. Orange HDPE is acceptable for this purpose.

When using 125 mm HDPE ducting, adequate means shall be provided for connections into 150 mm PVC duct.

With thrust boring, the casing shall be adequate in size to permit the appropriate duct (150 or 100 mm, or multiples) to be installed.

8 Trench Width and Cable Spacing

The trench width is dependent on the number and size of cables and/or conduits to be installed, and possibly on the type of excavating equipment to be employed.

High and low voltage cables and/or ducts shall be separated as much as practicable in the trench, preferably at least 150 mm apart. This may be reduced to 75 mm where cables/ducts cross.

Note that where telecommunications cables or other services are installed above power cables, the power cables shall be installed in a ducting system.

9 Barriers, Signs and Covers

Where any trench is left unattended, barriers or similar means shall be fitted to prevent inadvertent falls into the trench by members of the public.

In existing residential suburbs, trenches shall not be left open at night-time. This may require the complete covering of the trench, or the erection of a fence capable of prevention of access by children. Preferably, the job should be arranged so that the trench is backfilled each day after installation of cables or ducts.

Cover boards or plates shall be designed to take the maximum likely load, be maintained in good condition, and shall be large enough to overlap the trench adequately. If necessary, stakes or other means shall be employed to prevent movement of the covers.

In existing residential areas, barriers, covers, dumps of spoil, and other obstructions shall be lighted with hoarding lamps or similar.

Roadway excavations shall be carried out only with the approval of the Department of Infrastructure, Planning and Environment or local Council, as appropriate. Work within road reserves shall, in lieu of specific instructions from the local authority, be carried out in accordance with AS 1742, Manual of Uniform Traffic Control Devices. Warning signs shall be to AS 1743, Road Signs.

10 Cable Installation

(a) General

The pulling arrangement used shall subject the cable to minimum stresses. Pulling tensions shall be minimised by considering the location of bends and the relative heights at each end of a pull.

Adequate lubrication shall be employed in duct systems to minimise tension. Lubricant shall be non-corrosive, and contain no solvents likely to affect PVC. A record shall be maintained of lubricant usage.

(b) Induced or Transferred Voltages

When working on cables that are close to energised cables, particularly if they are running in parallel, precautions shall be taken to minimise the risk of injury to personnel. Similar precautions are required when working within 100 metres of a Zone Substation. Reference should be made to the ESAA publication "Guide for Working on Cables and Ancillary Equipment under Induced Voltage Conditions and Transferred Earth Potentials".

(c) Cable and Cable Drum Inspection

Before use, the cable drum/s shall be visually inspected for damage. The manufacturer's seal on the two cable ends shall be examined, the condition of the sheath inspected for damage and, in the case of paper/lead cables, inspected for oil leaks.

Cables showing damage to the lead sheath, brass tapes, nylon sheath or water-blocking sheath shall be rejected. Only minor damage to the outer sheath is acceptable.

If it is necessary to roll the cable drum, it shall be rolled only in the direction indicated by arrows on the drum.

Drum holding rods are to be tightened before use.

(d) Cable Drum Mounting

Drums should be mounted on a stand, cable trailer or jacks. Except in the case of a purpose-built braking trailer, the drum shall be mounted such that the cable is pulled from the top.

When pulling from drums larger than 2 m in diameter, the cable should be supported from the drum to ground level by a suitable ramp. The drum should be checked to ensure that it is level, and that it rotates freely and evenly.

During pulling, slack shall be prevented from accumulating by applying moderate braking to the drum.

The inner end of the cable shall be constantly observed where it protrudes through the side of the drum. It will have a tendency to protrude further as the cable is played out. It is advisable to free any restriction on movement, and to attach a retaining rope to prevent contact between the cable end and the equipment.

During pulling the cable shall be carefully examined for any sign of damage as it leaves the drum.

(e) Cable Pulling Equipment

Cables are either fitted with pulling eyes, or stocking grips are used. Pulling eyes are to be specified for longer runs of larger multi-core cable. In some cases, pulling eyes may be necessary on larger single core cables if the run is long or has numerous deviations.

Various types of pulling ropes may be used. However, only fibre or synthetic ropes may be used when pulling cables through duct systems. The rope diameter shall be such as to prevent significant damage to the duct at radius bends.

(f) Pulling Tension

In lieu of permissible tension data provided by the cable manufacturer, the following maximum tensions shall be used:

Single core unarmoured XLPE		**Three core unarmoured XLPE**	
400 mm^2 HV	7.0 kN	400 mm^2 11kV al	20 kN
240 mm^2 HV	5.3 kN	300 mm^2 11kV cu	21 kN
95 mm^2 HV	3.0 kN	500 mm^2 22kV al	22 kN
35 mm^2 HV	1.8 kN	240 mm^2 11kV al	12 kN
185 mm^2 LV	3.2 kN		
240 mm^2 LV	3.7 kN		

Cables fitted with pulling eyes may be pulled with tensions up to 50 N per square mm of conductor area for aluminium and 70 N per square mm for copper; however, the maximum pulling tension in any pull through 150mm PVC conduit shall not exceed 22kN without prior approval and supervision by Power and Water staff.

For runs exceeding 200 m, or involving more than one radius bend, a dynamometer shall be used to measure pulling tension. This shall be constantly monitored during each pull, and the maximum tension recorded. Power and Water may require the

contractor to provide records (see Appendix K) of pulling tensions for each pull during a project.

Swivels should be used to prevent build-up of torsion during a pull.

Rollers should be placed at intervals not exceeding 3m in trenches. Corner rollers shall be set up at changes in direction to prevent abrasion between the side of the trench and the cable. Rollers should be set up at the trench entry to prevent cable contact with ground.
Appendix A of C(b)2 provides a method for calculating pulling tensions.

When pulling single core cables, additional care is required to prevent twisting of the cores, which can add to stress at bends. The cores must be fed smoothly into the run from multiple drums so placed and handled that the cores do not cross prior to entry. The tension in each core shall be maintained as close as practicable to each other.

(g) Pulling Speed and Control

A cable pull requires planning, with personnel aware of the requirements to maintain a smooth, steady pull throughout the run.

Pulling speed should ensure that the drum/s rotates smoothly. Speed should not be so high that a sudden stop causes excessive overrun. Personnel must be positioned at every caterpillar site, and at bends, to ensure that the cable is running correctly on rollers, and **is not bunching**.

When laying in a trench, an observer with a 2-way radio should follow the nose of the cable to ensure that snags and cable damage do not occur, and to stop the process and make adjustments to roller positions (particularly at corners) as necessary.

(h) Bending Radii

The manufacturer's recommended minimum bending radii shall not be exceeded (i.e., not bent further than the minimum). In any event, on long runs with high pulling tensions, considerably larger bending radii (typically twice minimum) should be used to minimise the risk of cable **flattening**.

(i) Pulling Methods

Pulling shall be carried out in a workmanlike manner so as to minimise risk of cable damage.

The methods discussed in Sections 6.8 to 6.10 in C(b)2, including Figure 10, are recommended. If methods other than those depicted are proposed, prior approval of Power and Water must be obtained.

(j) Cable Location and Recording

Where the depth and alignment of a cable run is not within 100 mm of the standard depth and alignment shown in the relevant Standards drawing, the contractor shall record the offset and depth of each cable and include this information in the "As Constructed" drawing. Cable marker plates and/or marker posts shall be installed as required by the Standards Manual.

The exact location and type of each joint shall also be recorded and marked with a 3M radio marker. Alternatively, Power and Water may consider GPS locations as in

A6(e) above.

The contractor shall provide a report, attached to the "As Constructed" drawing, listing the following details in relation to each high voltage cable:

- size
- type
- voltage rating
- length of each run
- drum number
- cable manufacturer and country of origin
- year of purchase

(k) Direct Laying Method

This may be used in green field sites where there is ready vehicle access to the trench, and there are no obstructions.

Generally, the cable drum is mounted on a truck or trailer, and is payed out while the vehicle moves along the trench. In this case the cable must be carefully placed in the trench without sustaining abrasion damage, and without allowing rocks etc., to fall into the trench.

If it is proposed to use this method for high voltage cables, prior approval of Power and Water must be obtained, and sufficient notification given to permit witnessing of the laying out process.

(l) Cable Loops

Provision shall be made at every cable pole for a loop of cable at the pole foot. This is to enable cable termination replacement. The preferred method is to increase depth by an additional 0.5m for the metre or so immediately before the pole. The last 2 metres of trench shall be completely backfilled with sand. The cable shall have a metallic tag fitted 2.5m above ground with the loop details stamped on it.

(m) Qualifications of Persons Installing Conduits and Cables

Persons installing conduits shall demonstrate competency in conduit installation. Persons pulling in cables shall demonstrate suitable experience in cable installation; Power and Water may require an applicant to sit for an examination to determine the level of knowledge.

11 Substations and Switchgear

(a) General

After installing cables, ducts and earthing, the pit/s are to be filled with sand to within 50 mm of the slab surface level. The sand is to be compacted by mechanical means in layers not exceeding 150 mm.

After compaction, an approved moisture barrier such as 0.50 mm black nylon sheeting is to be carefully placed on the sand so as to completely cover the entire surface. The barrier is then to be covered with approximately 50 mm of 8:1 sand/cement mixture and finished to the surface level. Care shall be taken to ensure that this layer provides a complete and continuous barrier to termites.

An alternative to sand/cement is the material "Granite Guard" marketed by the CSIRO. This material is preferred in low voltage pits.

Where it is intended to run future services from a substation, ducts shall be installed initially running outside the foundation area. These shall be capped. The number and orientation shall be as directed by Power and Water.

(b) Fuses

Attention is drawn to the need to de-rate low and high voltage fuses in certain circumstances. Generally, low voltage fuses in Striple S/F units operate at ambient temperatures up to 65^0C, and must be derated by about 25%.

High voltage fuses in air-insulated switchgear such as Magnefix MD4 units are also derated because of the thermal insulation properties of the fuse chambers. Refer to Standards Bulletin S1-020 for details.

12 Jointing of Cables

(a) Jointing Pits

Jointing pits should be large enough to allow jointers to work freely, without undue restrictions to movement. Earth-sided pits shall have a concrete base at least 75mm thick. The sides should be covered with tarpaulins or similar to prevent soil from being dislodged while working in the pit.

Pits must be kept dry; if necessary a weatherproof canopy should be used. Pits shall be backfilled with clean sand after work is complete.

The exact location of each jointing pit shall be included in the "As Constructed" drawing and marked with a cable marker plate or post. In addition, except for pits with Gatic covers, they shall be marked with a 3M radio marker buried near the surface above the joint; alternatively, with Power and Water approval, GPS coordinates to 10cm accuracy can be provided.

When pulling in cables, an overlap of 1 metre is required at each pit for jointing.

(b) Jointing of High Voltage Cables

Jointing of high voltage cables shall only be carried out by personnel trained and accredited for a particular joint type. The contractor shall maintain a register of personnel, recording details of training and qualifications of all jointers employed by them. This register will be made available to Power and Water on request.

Prior to jointing, each cable section shall be meggared and the results recorded. The minimum voltage is 500 V for low voltage cables and 1000 V for high voltage cables.

Joints shall be carried out in a workmanlike manner in accordance with the manufacturer's recommendations and Power and Water's Standard Drawings – refer S2-2-2 series.

Underground joints shall be protected from termites by the use of "Termimesh" or similar applied continuously from the nylon jacket or double brass tapes each side of the joint.

Joints and terminations in paper-lead cables with HDPE sheaths shall be designed for elevated pressures – typically 100psi or 690kPa.

Through joints shall employ compression sleeves for conductor jointing.

Conductors shall be carefully cleaned of oil, compound, etc., prior to crimping.

No high voltage through joints are permissible in new installations except in exceptional circumstances and with the prior approval of Power and Water. No low voltage joints are permissible in new installations.

Joints shall be in an accessible location. Under no circumstances may joints be located under carriageways, driveways or the like where repair crews could be endangered by vehicles.

Jointing of high voltage cables is not permitted if it is raining. Furthermore, during the wet season the jointer shall employ methods to ensure that perspiration is prevented from contacting the insulation material. These measures may be audited by Power and Water.

Measures such as the covering of prepared cable with "cling wrap" shall be employed to reduce moisture contamination.

The contractor shall provide to Power and Water at least 2 working days' notice of intention to carry out any high voltage joint.

(c) Testing Paper Insulation

At every joint in a paper/lead cable, the insulation shall be tested for the presence of moisture. This is done by immersing samples of inner and outer paper from each core and section in oil heated to about 120^0C.

Paper sections should be held with tweezers to prevent perspiration contamination. Moisture is present if crackling is heard, and/or a yellowish froth appears on the surface of the oil. If moisture is detected the jointing must not proceed, and measures are to be taken to remove the contaminated section of cable.

(d) XLPE Insulation

At every joint in XLPE cable, each core shall be inspected for moisture. Immediately after removal of the cap and outer sheaths, the core insulation should be completely dry.

If moisture is observed, the joint is not to proceed, and measures are to be taken to remove the contaminated section of cable.

(e) Earthing of Cable Screens

As a general rule, cable screens of single core cables should only be earthed at one end. This is because current flow in the conductor will induce a voltage in the screen around it. Earthing both ends can result in a significant circulating current, which can derate the cable. Advice on particular projects should be directed to the Power and Water Project Officer.

Earthing is normally at the source end. At the load end of the cable, the three screens should be kept isolated from each other and adequately insulated. It should be borne in mind that a fault anywhere on the high voltage network will cause a voltage rise on the zone substation earthing system. A remote cable screen connected to the zone substation earth can transfer large voltages, resulting in a hazard to staff working in the vicinity of the cable termination.

Where it is important to earth the far end of a cable (e.g., at an overhead termination), and the cable run can be broken into three sections of similar length, transposition of earthing along the route will minimise problems. A more practical approach is to bond all three screens at regular intervals (cross bonding) to minimise voltages. Advice on this technique must be obtained from Power and Water before proceeding.

Generally, three core cables may be earthed at both ends, as the screens of each core are in continuous contact with each other.

13 Testing

High voltage cables and switchgear shall be electrically tested before commissioning. All readings shall be recorded on approved test sheets and provided to Power and Water. Testing shall be carried out as follows:

(a) High Voltage XLPE Cables

1. Earth continuity test
2. Check of phasing
3. 5 kV meggar test for each core, holding until reading is stable. Minimum test values are 2400 MΩ/km for 11kV and 4000 MΩ/km for 22kV cables.
4. hipot test at 2.7x rated voltage to ground for 15 - 30 minutes, using a low frequency AC tester, or
5. alternatively, soak the cable at rated voltage for 24 hours
6. 5 kV meggar test for each core, holding until reading is stable
7. Note that, for cables other than new cables, the hipot test should be at 2.0x rated voltage for not more than 15 minutes, using a low frequency AC tester

(b) Paper/Lead Cables

Generally the same as for XLPE cables, except that phase-phase tests are also carried out on 11kV belted cables at 20 kV for 15 minutes, in lieu of soaking.

(c) Low Voltage Cables

1. Earth continuity test (if not covered in the HV test)
2. Check of phasing and polarity
3. 1.0 kV meggar test each phase to neutral, holding until reading is stable

14 Ferroresonance

This is a phenomenon associated with the single phase switching of high voltage networks. While it occurs with overhead networks, it is most pronounced with underground networks because of the large capacitance associated with the use of screened cables.

Any circuit containing capacitance (cables) and inductance (transformers) can resonate. Ferroresonance occurs when the right combination of capacitance and inductance causes an initial resonant over-voltage. The over-voltage causes saturation of the iron core of the transformer, causing a change in the inductance. The change of inductance causes a change of state of the resonance, increasing the voltage, which in turn further changes the saturation of the core, etc. Over-voltages of 20+ kV to ground have been recorded on 11 kV cable systems, leading to flashover in switchgear, or cable puncture.

Refer to drawings S2-4-2-9 and 10 for data on the critical lengths of cable associated with different transformer sizes.

15 Cable Terminations in Holec Magnefix MD4 Series Switchgear

These units are designed for a maximum cable size of 240 mm^2. Larger cables are not to be used.

Each cable core shall be positioned so as to, as far as practicable, prevent contact between the core and the nylon spacing tube.

16 High Voltage Fuses

The derating of fuses mentioned in A11(b) also applies in Holec Magnefix switchgear. Heat dissipation is limited to about 25 watts. The fuse sizes listed in the S2-4-2 series for "Hazemeyer" RMUs shall be adhered to for Magnefix switchgear. (Holec was previously known as "Hazemeyer-Holec").

High voltage fuses normally contain several elements in parallel, contained in a quartz powder. Rough handling of fuses can cause fracture of an individual element or elements, leading to increased losses. This can result in catastrophic failure of the RMU.

Consequently, high voltage fuses must be handled with great care, preferably by carrying them in the field within foam-lined boxes. Power and Water may test the resistance of any fuse, and may reject all fuses used in a project if evidence of poor handling is found.

Generally other types of switchgear are more capable of dissipating heat from fuses, but the same problems can occur if fuses are mishandled.

17 Fault Indicators

These are to be fitted to all incoming and outgoing circuits in each substation and/or RMU. Care must be taken in their selection and installation to ensure that they operate correctly. If the installing contractor is not familiar with their installation, advice from Power and Water should be sought.

18 Maximum Demand Indicators

All package substations shall be fitted with an MDI. These shall utilise a single 0.2 class metering CT, securely mounted, and arranged to record the total low voltage output current of one phase. The MDI shall be mounted in a readily accessible location.

19 Construction Program

The contractor is required to submit an Electrical Installation Program as per Network Policy NP001.1 before commencement of construction. It shall be submitted to the Manager Distribution Development in Darwin (PO Box 37471 Winnellie 0821, Fax 89245121). For centres other than Darwin the Manager Distribution Development will determine the auditing process and notify Regional staff accordingly.

Cable Pulling Record

Name of Contractor: .....

Project: .....

Cable type: ..... Size: ..... No. Cores: .....

Drawing No./s .....

Pull 1: Date: ...../...../.....

Start Reference: ..... Finish Reference: .....

Direction of pull: ..... Max. tension: .....kN

Details of Dynamometer: .....

Winch Description: ..... Type of Rope: .....

Pull 2: Date: ...../...../.....

Start Reference: ..... Finish Reference: .....

Direction of pull: ..... Max. tension: .....kN

Details of Dynamometer: .....

Winch Description: ..... Type of Rope: .....

Pull 3: Date: ...../...../.....

Start Reference: ..... Finish Reference: .....

Direction of pull: ..... Max. tension: .....kN

Details of Dynamometer: .....

Winch Description: ..... Type of Rope: .....

Pull 4: Date: ...../...../.....

Start Reference: ..... Finish Reference: .....

Direction of pull: ..... Max. tension: .....kN

Details of Dynamometer: .....

Winch Description: ..... Type of Rope: .....

Document Valid on day of printing only: Printed on Monday, 25 February 2008

PFISTERER

JOINTING OF HIGH VOLTAGE CABLE SYSTEMS

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Introduction

Premoulded slip-on cable accessories are nowadays the most common and most reliable technology for the jointing of polymeric high voltage cables up to voltages of 500kV.
The big advantages of this technology versus older technologies – like taping or field moulding - are the constant production quality, the easy and safe installation procedures and also their reliability during service. As this technology was already introduced in the early 70ties, the experience gathered in the meantime prove, that the lifetime of the premoulded accessories is adequate to the lifetime of high quality polymeric cables, which is more than 40 years.
In order to perform well during their whole service-life, the design of these premoulded accessories has to meet electrical, mechanical and thermal criterias. Further it must be insured that a constantly high quality of all the products installed in cable system can be achieved.
This paper gives some technical background information about the design and the quality control of premoulded high voltage joints and highlights some aspects for an appropriate earthing concept of the cable screen.

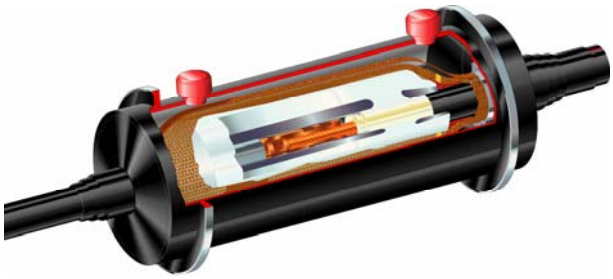
Design of High voltage cable joints

General

A premoulded cable joint consists normally of one elastomeric body, where all the stress control elements are integrated (see picture 1). For the stress control, basically the following methods are known:

- Geometrical, where the contour of conducting elements is controlling the electrical field at the end of a high voltage cable
- Resistive, where the resistance of a semiconducting material is used to reduce the electrical stress in high field regions
- Refractive, where material with a high permittivity is used for “pushing” away the field from high stress regions

While the resistive and refractive method is successfully used for medium voltage applications up to 72.5kV maximum, the geometrical field control method is the standard method for high voltage and extra high voltage applications. Controlling the field by a well defined contour still offers the best quality from design and production point of view.
To install a premoulded joint they are normally slipped-over the prepared cable on site by using grease and special push-on tools. Another technology, widely used in the medium voltage range, is the cold shrink technology. With this technique a premoulded joint body is pre-expanded on a support tube, which can be removed while being placed around the cable on site. It has the advantage that no push-on tools must be used. For high voltage application there is the disadvantage that the forces of a pre-expanded joint body are very high on this support-tube due to the required wall thickness and during the pre-expansion – which can be 1 year and more – there is a relaxation of the elastomeric joint body occurring resulting in a loss of contact pressure, which is a crucial factor for the reliability as will be explained later. Hence for high voltage application the slip-on procedure is still the preferred way to install the joint.



Picture 1: high voltage joint MSA123DO.G produced by Sefag ixosil Ltd.

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Electrical Design

One basic function of every termination or joint is to control the electrical field at the end of a cable or between two cables.
As explained in the previous section for high voltage applications the common design is to use the geometrical field control method. This means that the electrical field is controlled by the contour of conducting elements integrated into the joint body. During design stage FEM (=Finite Element Method) calculation programs are an important tool as the latest versions of these programs offer a vast range of possibilities like

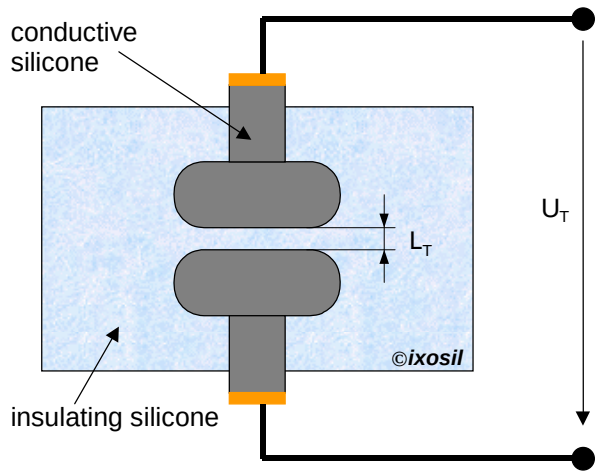
- Calculation of the electrical field in any direction of the joint body
- Optimisation tools for calculating the optimum shape of stress control elements
- Solving of coupled fields, like thermo-mechanical stresses
- Models for non-linear behaviour of materials, like stresses in polymeric materials
- Simulation of slip-on procedures

As nowadays aeroplanes and cars are fully designed and optimised with such powerful calculation and simulation programs, they are also the ideal tool for the design of high voltage cable accessories.
However all calculation and simulation programs need to be fed by reliable data. These data, which we call “design criterias”, can be obtained from model investigations and also from the service experience.
In order to apply such design criterias we must distinguish different regions of the joint having different dielectric strengths. These regions are as follows:

1. Dielectric strength of the elastomeric material in combination with the semiconducting layers forming the electrodes
2. Dielectric strength of the interface between cable and joint body

To 1: Dielectric strength of elastomeric material:

The breakdown voltage of a stress cone arrangement, consisting of a compound of con-ducting and insulating materials, does not only depend on the properties of the insulating material itself but also on the material of the electrodes, the compatibility of electrode and insulating material and the surface properties of the electrodes formed by the semiconducting elastomeric material. Therefore test arrangements for determining the breakdown field strength according IEC 60243 are not very useful in this case.
Further the dielectric breakdown field strength depends also on the volume (and surface) of the material involved due to statistical and physical volume effect. Practical experiments have shown, that the statistical effect is dominant, while the physical volume effect is normally neglectable [1].When results from small test arrangements are used for dielectric systems with bigger volume or surface, the dielectric strength has to be reduced according to the statistic distribution functions ([1] and [3]).
From a test arrangement, which design take into account the above mentioned aspects (see picture 2), the dielectric strength of the insulation can be determined (for example by step tests). This has to be done for AC and impulse voltage.
Further reductions for temperature, ageing and safety margins have to be applied



Picture2: Test arrangement to determine the dielectric strength of elastomeric material

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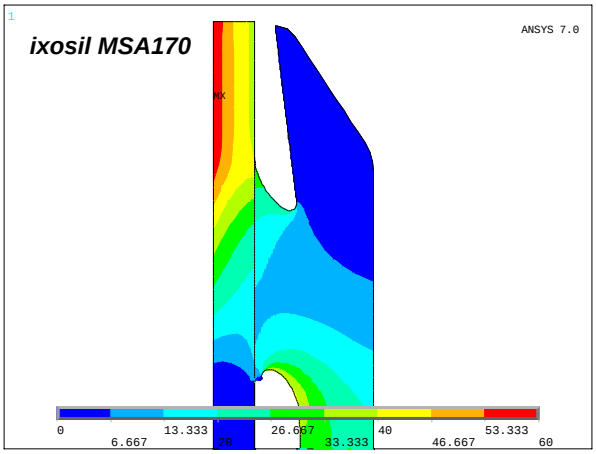
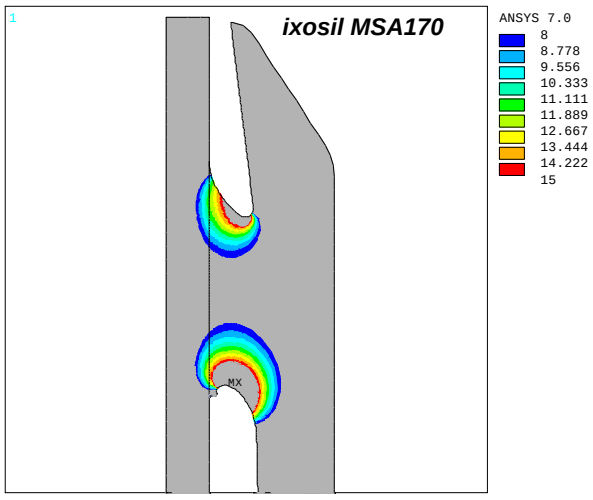
In the picture 3 the size of the total field is shown on the output of an electrical field calculation. The values indicate the electrical field at impulse voltage.



Picture 3: Value of total field at impulse voltage in joint body and cable.

To 2: **Dielectric strength of interface**

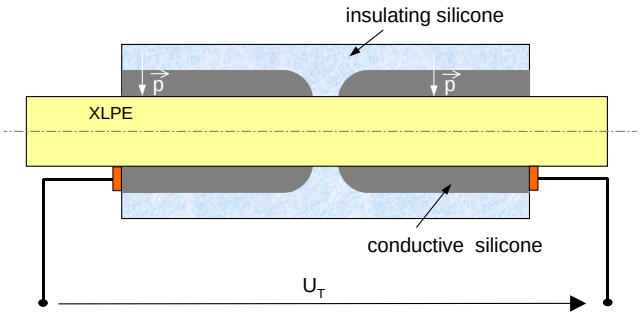
Special attention must be paid to the interface between cable and joint body. The electrical field along this interface (part of the field parallel to the interface) is always a critical issue as the dielectric strength of this interface is practically lower than the strength of an insulating body. Therefore the stress control elements must be designed that way, that the field along this interface stays within the permissible limits (picture 4).



Picture 4: Value of electrical field along interface at impulse voltage.

The electrical strength of this interface depends strongly on the mechanical design of the joint, which will be treated in the next chapter.

To determine the design criterias for the interface a special model arrangement was developed, where a high electrical field can be generated in the interface between cable and a polymeric sleeve. By inserting different cable sizes into the elastomeric sleeve, different expansions and contact pressures can be simulated (picture 5).



Picture 5: Test arrangement to determine the dielectric strength of the interface between cable and elastomeric sleeve for different contact pressures.

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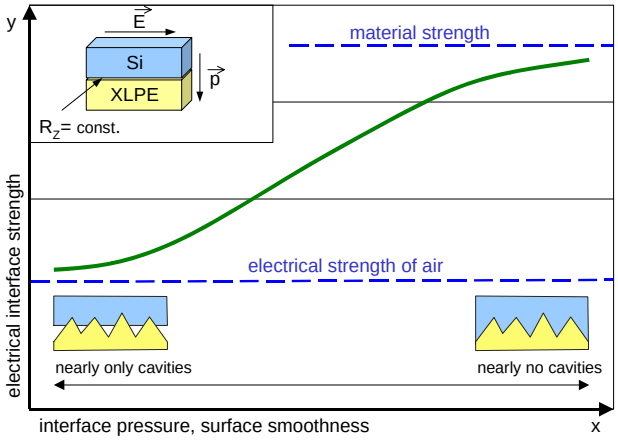
Mechanical Design

An important issue with respect to the mechanical design of a joint body is the interface between joint body and cable insulation. The dielectric strength of this interface depends strongly on the interface pressure and smoothness as shown in picture 6.



Picture 6: Dielectric strength of interface versus interface pressure and surface smoothness
Source: Cigré Joint Task Force 21/15

In this picture it can be seen that in case of a very small pressure the dielectric strength of the interface is going down to the strength of air as the interface consists to a large extend of enclosed air. For a very good interface – high pressure and perfect smoothness – the strength of the interface is theoretically reaching the strength of the material as in this case the remaining cavities in the interface will be theoretically of the same size as the distance between molecules in the bulk material.

When designing the interface between cable and joint body the real situation during the installation must be considered carefully as the cable insulation is prepared only on site. In order to have a sufficient safety margin even under non perfect conditions at site, the contact pressure must be chosen big enough to ensure a sufficient dielectric strength. This consideration leads finally to the minimum allowable expansion of the joint body in order a sufficient interface pressure is maintained, which has to be normally above 10%

The use of grease, which is necessary for the slip-on procedure is theoretically increasing the strength of the interface as the grease is filling-up the remaining small cavities in the interface. However it must be considered that the grease is normally dissipating into the elastomeric joint body or into the XLPE cable after a few weeks. Only with special greases it can be insured that the grease will stay in the interface for the whole service life. It is therefore recommendable to design the interface in this way that even without grease the dielectric strength is reaching sufficient values by taking care on the surface roughness of the cable surface and inner part of joint body. Practical experiments had shown, that due to the creeping of elastomeric materials small cavities in the interface will be filled out with polymeric material. Hence the effect of the dissipation of the grease can be counteracted at least partially by the creeping effect of the joint body.

The maximum expansion of the stress cone is mainly given by the feasibility for installation as the mechanical properties of the elastomeric materials used are normally much higher than the practical range of slip-on cable accessories. If the expansion is choosen too big, the force to slip-on the silicone sleeve will be very high, which can cause problems on site during installation. Therefore the maximum expansion should be in the range of 40%.

Special attention needs to be paid to load cycling conditions. During operation a cable system is subjected to heating and cooling processes. During the heating phase the diameter of the cable is enlarges and therefore the expansion of the stress cone is also increased, while during the cooling period the diameter is reduced. In order to maintain a sufficient contact pressure in the cooling phase of the load cycles, the tension set of the used materials must be taken into account for the calculation of the minimum required contact pressure. Further the relaxation of the elastomeric material must be considered as the elastomeric material is loosing its mechanical strength while being expanded over a long time period.

The above explanations show that the careful selection of the appropriate material is essential as electrical and mechanical properties are vital for the quality of the finished product.

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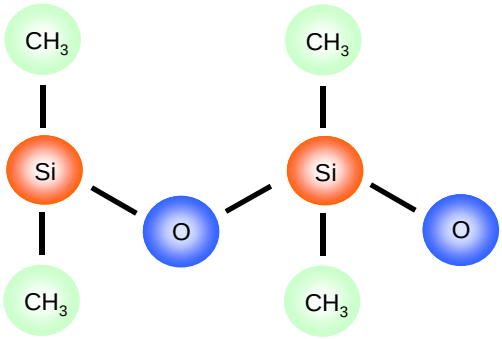
Choice of Material

Nowadays the materials used for high voltage joints are silicone rubber and EPDM. The basic requirements for an elastomeric material are as follows:

- Sufficient mechanical properties in order being expandable in the required range
- Capability to withstand the required temperature range
- Availabilty of material with constant quality and constant purity
- Low ageing with respect to electrical and mechanical properties

According the requirements given above silicone rubber is an ideal and preferred material for cable joints.
Silicone rubber is a semi-inorganic material consisting of an inorganic backbone with organic sidegroupes as schematically shown in picture 7.



Picture 7: Basic chemical structure of silicone rubber

Due to this special chemical structure and the high bonding energy of the Si-O connection, which is 30% higher than the bonding energy of the C-C connection of organic molecules like EPDM, silicone rubber has the following outstanding properties:

- high thermal stability up to 200°C with respect to electrical and mechanical properties
- long life, very little ageing (life exponent N=70, see chapter below)
- low Shore A hardness in the range of 40 and excellent mechanical properties

Therefore it can be concluded that silicone rubber is an excellent material for the use in cable accessories as it can fully cope with the electrical, mechanical and thermal requirements given by nowadays polymeric cables.

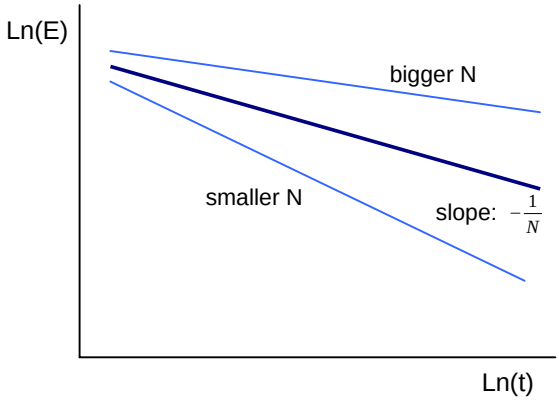
Ageing

In important aspect, which we still have to consider is the ageing factor of insulating material and interface. The ageing can be described by the life time law as follows

$$E^N * t = const.$$

Where as : E = Electrical field in the insulation
t = Time, where the electric field is applied
N = Lifetime coefficient

If the above equation is ploted in a diagram with the logarithm scale, it will lead to the following graph:



Picture 8: Graph showing life time law

The bigger the N value, the smaller is the ageing of the material. Silicone rubber with a life time coefficient of N=70 ([1] and [3]). is one of the best polymeric materials available. For XLPE for example lifetime coefficients of only 15 to 20 are achievable.
For the interface the ageing is faster than in a perfectly produced joint body. In the interface the mean distance between molecules is generally bigger than in the bulk material. Hence the mean free path of the electrodes is bigger, resulting in higher energies and faster decomposition of molecule chains. According Kunze [1] and Österheld [2] the life time coefficient is in the range of 40, which is

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significantly lower than in the silicone rubber materiel but still much higher than the XLPE material.
Example
If we assume that the remaining withstand voltage of a cable joint has to be 1.7 Uo in order no failure occurs, already the passing of a typetest, where 2.0 Uo is applied for 30 days gives a theoretical lifetime of few thousand years.
The above stipulated lifetime law is only applicable if there are no severe contaminations in the insulation material used. A contamination in an insulating system will increase the local electrical fields drastically, thus accelerating the ageing. Due to this increase of the local electrical field the considerations made during the design stage by applying the design criterias are not any more valid. Therefore a clean raw material of constant quality is essential to guarantee a constant quality of the finished product. This is another advantage of silicone rubber versus EPDM as the production process and basic materials of silicone rubber are better controllable than with EPDM

Quality Assurance

General

A new product has to undergo different tests before it can used in real applications. After internal design tests are passed successfully an important part to check the integrity of the design and to get the acceptance by customers are typetests as specified in IEC60840 (60kV up to 170kV), IEC62067 (for voltages ≥ 170kV) or alternatively in IEEE404. However all the type tests specified above give only information about the design and the quality of a limited amount of samples. When a typetest is passed it does not automatically mean that all the products produced afterwards in series are of sufficient quality
In order to guarantee a constant and outstanding quality of high voltage cable joints, the following measures should be taken

1. Regular check of dielectric strength of raw material by destructive step-tests
   In these tests samples of silicone rubber are subjected to a dielectric test, where the voltage is increased step by step until the samples fail. This test is up to now the only reliable test to determine the quality of an insulating system
2. Clean room environment for entire production
3. Optical check of products during different stages of the production
4. Electrical routine tests according IEC60840 or IEEE404 regulations
5. Installation of the products only by trained and certified fitters

Picture 9: Sample test of stress cone in Sefag ixosil high voltage laboratory

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Production

The production of the complete silicone joint should be fully integrated in a clean room environment of class 1000 or better as it is also state of the art for the production of high voltage cables.
In addition it must be insured that the production of the insulating and conducting elements are fully separated as any conducting contaminants in the insulating body would be fatal for the quality of the silicone sleeve.

Picture 10: View of a production station for insulating material in clean room environment

Installation

The very compact design of premoulded joints offer shortest installation times, while increasing the safety of the installation procedure on site.
Due to the soft material silicone rubber the installation of the joint body can be achieved by simple handcrancks. Therefore very little special tools are required for the installation of silicone rubber joints.

Picture 11: Installation of a 245kV joint supervised by instructor

Although the installation of premoulded high voltage joint is very simple, all fitters, who install high voltage cable joints, should be thoroughly trained in order they understand the correct preparation of a high voltage cable and know about the sensitive and critical steps. Before certification of any installation staff it must be verified by tests that the fitters having attended the training understood the basic issues. Only certified fitters should be allowed to work on high voltage cable equipment.

Earthing concepts

General

Fundamentally the screen of a high voltage cable can be treated in the following way:

- Sheath bonded at one side only
- Sheath bonded at both sides
- Application of a cross bonding system

The practical implications of the choice of a specific earthing system are manifold and must be taken into account when a cable system is designed. The following aspects are influenced by the earthing concept of a cable system

- Current rating of a cable circuit
- Overvoltages in the cable screen
- Magnitude of the zero and positive sequence impedance
- Appearance of stray currents in the earth
- Earthing impedance of (remote) substations

Both sides bonding

If the screen of a cable is bonded at both sides, the following effects will appear (see also picture 12)

- Due to the magnetic field of the main cable and the closed loop of the cable screen, a circulating current is flowing in the screen. This circulating current is causing additional losses. The losses are increasing strongly with increasing spacing between cables.
- The ampacity of the cable system is changed due to these extra losses in the screen. The best ampacities are reached

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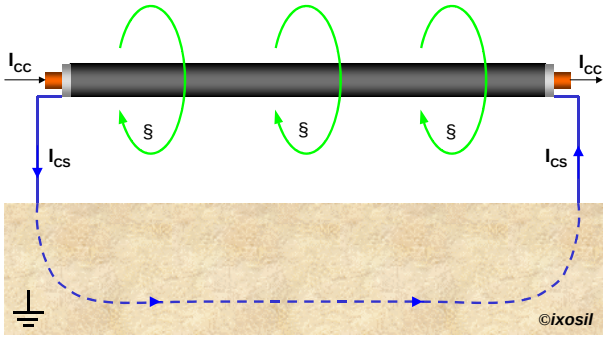
with a touching trefoil formation as this arrangements gives the lowest losses in the cable screen.

- There is no induced voltage appearing in the cable screen (as it is compensated by the circulating current) nevertheless of the length of the section (as section we understand the cable circuit between two earthing points of the cable screen)
- The earthing impedance of (remote) substations can be improved by the screen of the cable.
- The zero-sequence impedance has normally lower values than with one side bonding and can be calculated more accurately



Picture 12: Both sides bonding

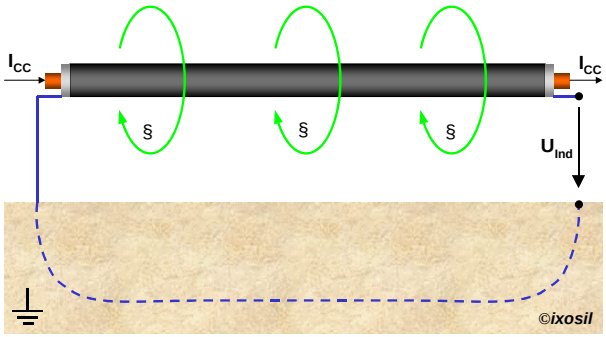
I_{CC} : current in conductor
I_{CS} : current in cable screen
§ : Magnetic field

One Side bonding

If the cable screen is bonded at one side only, the following effects are appearing (see also picture 13):

- As the screen is open, there are no circulating currents, but there is an induced voltage appearing at the open cable screen, where sheath voltage limiters must be installed in order to protect the cable outer jacket against transient overvoltages
- The ampacity is higher compared with both sides bonding, as there are practically no losses in the screen
- The length of one section is limited as the magnitude of the induced voltage is increasing with length.
- The zero-sequence impedance is bigger than for both sides bonding. This is due to the fact, that the mean return distance of the current in earth, which depends on the conductivity of the ground, is normally in the range of 1000m, which gives high values for the inductivity of the zero-sequence impedance. Practical measurements, which we have performed in the past for a Swiss power utility, showed, that the effective zero-sequence impedance differs a lot from the theoretical value, as the ground is normally "disturbed" by additional conductors like water and drainage pipes, railway lines, gas pipelines etc. Hence if single side bonding us used, the zero-sequence impedance needs to be measured for each cable system in order to have accurate values.
- Stray currents in the ground from earth faults can cause disturbances to neighbouring low voltage and data cables.

In order to improve zero-sequence impedance and the general earthing situation it is recommendable to install a parallel conductor along the cable route. The losses in this additional can be prevented by transposing it along the cable route ([2]).



Picture 13: Both sides bonding

I_{CC} : current in conductor
U_{ind} : induced voltage at the open side
§ : Magnetic field

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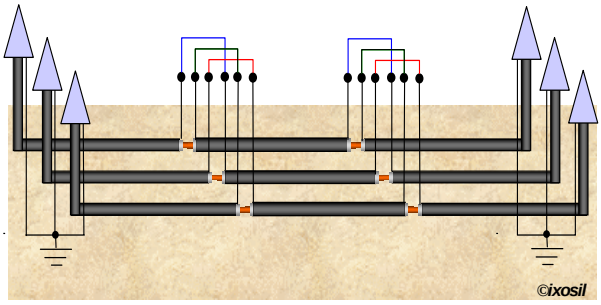
Cross Bonding

In a cross bonding system (see picture 14) the whole cable circuit should be divided in three sections with the same length. After every section the screen of the cable is cross bonded to a different phase. This is preferably done in positions, where joints (with screen interruption) are placed. Like this the connected screen will see the same amount of induced voltage from every phase, hence the induced voltage is becoming zero. If the cables are laid in plain, the cables itself need to be transposed at every joint bay, as the screen impedance is different for the inner cable and the outer cables. In order the sum of the induced voltage is really becoming zero, the connected screen must run always on the same position of the cable circuit (for more details see [2])
A cross bonding system can be considered as combining the advantages of single- and one side bonding, which are as follows:

- In a cross bonding system the cable screen can be earthed on both sides without having circulating currents and additional losses (as long as every section has the same length).
- Earthing impedances and zero-sequence impedances are improved due to both sides bonding.

However the disadvantage of the induced voltage appearing on every cross bonding point - similar to one side bonding - is still remaining. Hence the length of one section is limited. Further there is additional equipment needed like cross bonding boxes, earthing cable, cross bonding joints.



Picture 14: Crossbonding bonding system

Recommendations

Earthing concept in or near a substation, where an earthing grid is in the ground

- single side bonding in order to reduce the losses in the cable screen.

Earthing concept outside of a substation

1. For short cable lengths , where less than three sections of cables are needed, we recommend single side bonding together with an additional earth conductor to improve the zero-sequence impedance and the earthing impedance
2. For long cable lengths, consisting at least of three cable sections, we recommend implementing a cross bonding system as it increases the ampacity and improves the zero-sequence impedance
3. For cable circuits, where the number of cable sections is unequal to three or unequal to a multiple of three, the recommendations one and two can be combined.

If for any reason both sides bonding (without cross bonding) is applied, the spacing between cables should be minimised and trefoil formation should be chosen in order to reduce the losses in the screen and to maximise the ampacity of the cable.

Conclusion

If a premoulded joint is designed in a proper way, it is a very reliable component of a complete cable system. An important aspect is however to insure an integral quality of every joint from raw material to installation.
The proper engineering of the earthing concept is an important aspect in the design of a complete cable system and has to be made carefully for every project.

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References

[1] Oesterheld, J.
Dielektrisches Verhalten von Silikonelastomer-Isolierungen bei hohen elektrischen Feldstärken, Reihe 21, Nr. 196, Düsseldorf, 1996.

[2] ANSI/IEEE Standard 575-1988
IEEE Guide for the application of sheath-bonding methods for single-conductor cables and the calculation of induced voltages and currents in cable sheaths“

[3] Dirk Kunze
Untersuchungen an Grenzflächen zwischen Polymerwerkstoffen unter elektrischer Hochfeldbeanspruchung in der Garniturentechnik VPE isolierter Hochspannungskabel, Dissertation, Shaker Verlag, Aachen 2000

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Construction & Maintenance of Underground Mains (240V > 66kV)

U PR 0003

This Standard Work Procedure (SWP 2) outlines the Service requirements for the provision of services for the construction and maintenance of underground mains (240V to 66kV) on the UE network.

TABLE OF CONTENTS

APPROVAL AND AMENDMENT RECORD

Document № UE PR 0009 – Workplace HSE Inspection

SPONSOR			
Name:	Adam Beel	Signature:	
Title	Work Practices Manager	Date	09/09/2011

APPROVER			
Name:	Daniel Santos	Signature:	
Title	Head of HSE & Work Practices	Date	09/09/2011

VERSION	DATE	AUTHOR
1	September 2011	Adam Beel

Amendment overview	
Version	Comment
October2014	Update Green Book references to newest version Update induction processes
September 2016	Add new Section 16 Customer Notification Procedure
March 2013	Re-brand

1 SCOPE

This Standard Work Procedure 2 (SWP 2) outlines the requirements for the provision and undertaking of construction and maintenance services of underground mains (240 Volts to 66kV) on the United Energy (UE) electricity distribution network.

1.1 Application

The application of services under this Standard Work Procedure includes, but is not limited to, the following functions for construction and maintenance of underground mains (240 Volts to 66kV):

a) Worksite preparation and reinstatement
b) Underground cable and infrastructure preparation
c) Underground infrastructure maintenance
d) Recovery of cables and underground infrastructure and worksite reinstatement
e) Installation of underground cables and infrastructure

Recording of data related to the worksite and services provided under this SWP.

2 OBJECTIVE

The aim of this SWP is to ensure the construction and maintenance of the UE underground mains infrastructure (240 Volts to 66kV) is in accordance with UE policies and construction and maintenance standards.

Contractors must have in place documented systems that ensure:

a) the safety of personnel, (employees and subcontractors) and the public
b) that all legislative requirements are met
c) that their workforce is qualified, licensed/registered, competent, authorised and inducted for the tasks being performed
d) the safe undertaking of the works, including procedures, work instructions and safe work method statements
e) the efficient use of plant, personnel and machinery
f) the identification and control of workplace and environmental hazards
g) the safe undertaking of high risk construction activities
h) the reduction of material waste
i) minimisation of customer inconvenience and reduces network outage times
j) the best practice standards of diligence, skill, care and efficiency

3 NETWORK ACCESS FOR WORKERS PERFORMING SERVICES

Network access requirements described in this SWP are mandatory and are established by national, VESI and UE standards. Contractors performing UG construction and maintenance services must undertake training and assessment in accordance with all applicable laws and the requirements set out in this SWP and the UE procedures for network access and technical training.

Contractors must at all times, assume full responsibility for ensuring all staff (employees, subcontractors and persons performing associated functions) are assessed as competent in accordance with AQTF or other established standards.

3.1 Qualifications and Licensing

Unless they are employed under a training contract (apprentice or trainee), all persons performing UG construction and maintenance services shall be qualified for the functional role they are undertaking.

Under no circumstances shall non-qualified persons perform any UG construction and maintenance services tasks without the written permission of UE.

Where required all workers shall be licensed or registered for the functional role they are performing or plant they are operating.

3.2 Skills and Competency

Unless they are employed under a training contract and performing an allowed task under supervision, all persons performing UG construction and maintenance services shall be assessed as competent for that task.

Areas of competency relevant to the performance of UG construction and maintenance services tasks are established by the VESI Skills and Training Reference Committee.

Contractors must at all times ensure that persons performing UG construction and maintenance services tasks are holders of an Australian ESI Skills Passport.

Contractors must at all times ensure that persons employed under a training contract, only perform tasks under appropriate supervision and where permitted by the relevant VESI Apprentice Supervision Guideline.

3.3 Authorisation

Contractors must at all times ensure that persons performing UG construction and maintenance services are Authorised according to the relevant requirements of the Electrical Safety Rules for the VESI Distribution Networks (the Green Book) and UE policies and procedures.

The Green Book is applicable to all employees of UE, contractors and their employees and subcontractors working on, near, or in the vicinity of electrical apparatus controlled by UE.

3.4 Induction

Contractors must at all times ensure that persons performing UG construction and maintenance services are:

a) inducted onto the UE network according to established procedures and
b) inducted into the contractors business

Inductions shall be performed by the Contractor and shall address:

a) Applicable Acts and Regulations
b) OHS responsibilities

c) UE manuals, procedures applicable to this SWP
d) network access
e) network safety
f) incident and emergency management and response
g) environmental management systems
h) hazard identification and control
i) HSE committee's
j) site specific requirements (where required)

4 FUNCTIONAL ROLES FOR UG WORKS

Contractors must at all times ensure that persons performing UG construction and maintenance services shall be Authorised according to the relevant requirements of the Electrical Safety Rules for the VESI Distribution Networks (the Green Book).

4.1 Electrical Workers

Contractors must at all times ensure that persons performing UG construction and maintenance electrical services shall meet all requirements described in Section 3 of this SWP.

4.2 Safety Observers

Contractors must at all times ensure that when necessary, a worker shall be nominated to perform the role of Safety Observer under this SWP who shall meet all requirements described in Section 3 of this SWP.

A worker who may be required to perform the role of a Safety Observer must receive appropriate training and be competent in the task being observed and the safe operation of the plant and equipment they may be exposed to during performance of work and/or the requirements to perform the role of a Safety Observer under this SWP. The nominated Safety Observer shall be documented on the site risk assessment and shall not undertake any other task while carrying out this role.

4.3 Plant / Equipment Operators

Contractors must at all times ensure that plant or equipment operators:

a) meet all requirements described in Section 3 of this SWP
b) are initially trained and regularly reassessed in the particular design, operating and safety characteristics of each item of plant or equipment they shall be required to operate for the purpose of the provision of services under this SWP and
c) have appropriate, licence(s) and are competent to operate the relevant plant or equipment and hold any additional competencies as required

4.4 Traffic Controllers

Contractors must at all times ensure that persons performing traffic and pedestrian control activities for UG construction and maintenance works shall be trained according to the requirements described in the current version of:

a) The Road Management Act 2004 (VIC) and

b) The Code of Practice for Worksite Safety – Traffic Management, (VIC)

4.5 Other Workers

Contractors must at all times ensure that unless they are effectively supervised, all other persons performing UG construction and maintenance services shall be Authorised according to the relevant requirements of the Electrical Safety Rules for the VESI Distribution Networks (the Green Book).

5 VEHICLES AND PLANT

Contractors must at all times ensure that vehicles and plant used for the provision of services under this SWP are fit for purpose, serviced and maintained in accordance with the manufacturer's specifications and/or Australian Standards.

Risk assessments, pre-use inspections and periodic maintenance inspections in accordance with the laws including the Victorian Occupational Health and Safety Act must be undertaken and in place prior to utilisation for the provision of services under this SWP. Operators of plant, vehicles and equipment must be assessed as competent and Licensed (licence to perform high risk work) to operate that plant, vehicle or piece of equipment prior to utilisation for the provision of services under this SWP.

5.1 Compliance

Contractors must at all times ensure that vehicles and plant used for the provision of Services under this SWP comply with all Australian Standards, State and Commonwealth Laws and Codes of Practice relating to transport, holding or shifting plant, loads and component assemblies, EWP utilisation and material handling.

5.2 Lifting Equipment

Contractors must at all times ensure that all lifting equipment used for the provision of Services under this Standard Work Procedure complies with the Laws including relevant Australian Standards and that test/certification certificates are available for all lifting equipment.

5.3 Elevating Work Platforms (EWPs)

Contractors must at all times ensure that EWP's used for the provision of Services under this SWP comply with the laws and the current version of Australian Standard AS 1418 and:

a) have the appropriate controls fitted and instruction provided to ensure that the ground operator / Safety Observer can, in an emergency, move the basket clear of overhead conductors and lower the basket to the ground using the battery backup system
b) for live line works include an appropriate insulated boom and stabilising devices, as required by the above Australian Standard
c) an EWP daily check sheet must be completed daily and available with each EWP vehicle at all times
d) the EWP shall be clearly marked with due dates for weight and electrical tests

6 MATERIALS, TOOLS AND EQUIPMENT

6.1. General

Contractors must at all times ensure that materials, tools and equipment are fit for purpose to undertake all tasks safely when used for the provision of services under this SWP and must comply with all Laws (as amended from time to time).

The Contractor must provide all goods, equipment, spare parts, labour and services necessary to perform the services unless otherwise provided by UE or stated in this SWP.

6.2. Tools and Equipment at Worksites

Contractors must at all times ensure that appropriate tools and equipment are available on each worksite for the provision of services under this SWP. All tools and equipment must be inspected and maintained in accordance with any electricity industry or Australian or International Standard.

6.3. Calibrated Tools, Instruments and Equipment

Contractors must at all times ensure that calibrated tools, instruments and equipment (including all types of safety equipment) used for provision of services under this SWP which require periodic testing and/or calibration must be tagged with a 'Test Due' label to verify currency of calibration and/or in test. Testing must be performed by an authorised competent person in accordance with manufacturer's requirements, the Laws and relevant Australian or International Standards.

7 WASTE MANAGEMENT

Contractors must at all times ensure that the disposal of any waste material, chemical or control of any spill is in accordance with:

a) the Laws
b) manufacturer's (generally detailed in the Material Safety Data Sheet) requirements
c) Authority requirements and
d) the contractors Environmental Management Systems and Standards

All waste materials from the provision of services provided under this SWP will be collected and stored securely and/or be removed from the worksite daily.

Preference must be given to recycling before disposal of any waste material occurs.

Contractors:

a) are directly responsible for the prevention of all littering by their workers
b) must cause all litter (including papers, tins, bottles and rags) to be cleaned up daily from areas where it is performing the Services and disposed of in the nearest approved refuse disposal area

Hazardous waste (including asbestos containing materials) must be handled, stored and disposed of in accordance with the Laws, the regulatory Authority and/or UE requirements.

8 SAFETY

8.1 Safety Management Systems

The Contractor:

a) is responsible for providing their own safety management system complying with AS/NZS 4801:2001.
b) must ensure that sub-contractors are managed according to their safety management system
c) must ensure persons performing services under this SWP follow safety procedures and practices consistent with this SWP, and established industry, UE and Contractor procedures
d) must verify the application of this SWP by their workers and subcontractors
e) must advise UE as soon as practicable of any occurrence of an incident or injury

8.2 High Risk Construction Activities

Contractors must at all times ensure that a Safe Work Method Statement (SWMS) is in place when a person is performing a high risk construction activity. An activity is a high risk construction activity if it is part of the work for the provision of services under this SWP and as defined in the Victorian UGS Regulations 2007, Part 5.1; s5.1.3 and Schedule 3.

SWMS must be developed by the Contractor in control of the work and persons performing UG construction and maintenance services under this SWP must comply with the SWMS.

Contractors must at all times ensure and provide evidence when requested that persons who may be exposed to high risk activities have been fully briefed on the hazards and control measures detailed in the SWMS to ensure a safe work environment.

8.3 Hazard Identification and Management

Contractors and/or persons performing UG construction and maintenance services under this SWP must understand their safety obligations and strictly comply with the requirements of the Laws and UE procedures.

Contractors and/or persons performing OH construction and maintenance services under this SWP must assess the hazards present at each work site and implement effective controls according to the contractors established procedures, e.g. Job Safety Assessment (JSA) / Site Risk Assessment (SRA).

All personnel must be responsible for ensuring their individual actions do not endanger the health and safety of themselves or others. This outcome shall be based on full utilisation of a person's skills and competency and compliance to relevant standards and work procedures.

8.4 Worksite Conditions and Monitoring\

Person/s in control of a worksite must monitor conditions at the worksite to maintain a safe work environment and assess and control any significant change.

During and following completion of services provided under this SWP, the worksite must be maintained and left in a safe, hazard free condition at all times and must be reinstated and maintained to at least a condition satisfactory to UE.

When working on and around customer's premises it is important to consider the security of the site. All gates shall be left as they were found, or closed where deemed necessary for safety, such as providing access to pool and spa areas. Workers shall not prop open pool, spa or livestock gates.

8.5 Safety Incident at Worksite

In the event of any incident that is reportable, Contractors and/or persons performing UG construction and maintenance services under this SWP must STOP OPERATIONS IMMEDIATELY, follow the Contractors' own emergency procedures and contact their supervisor immediately. Escalation to UE shall follow established procedures.

8.6 Personal Protective Equipment

Contractors and/or persons performing OH construction and maintenance services under this SWP must utilise all Personal Protective Equipment (PPE) as required according to Law, ENA Guidelines, Australian Industry, Green Book or UE Standards and established good practice.

Contractors and/or persons performing OH construction and maintenance services under this SWP must be clothed in a manner consistent with these requirements and maintain a neat and tidy appearance.

8.7 Communications Cables

Many UE poles now also support communications cables and associated infrastructure. An earthed/bonded strand (catenary) supports many of these cables. When working in proximity to such communications assets, contractors and/or persons performing OH construction and maintenance services under this SWP must ensure all conductive parts within reach, including strand wires, which are not actually being worked on, are covered with approved insulating line covers.

8.8 Asbestos Containing Materials

Where there is a likelihood of Asbestos Containing Materials (ACM), contractors and/or persons performing OH construction and maintenance services under this SWP must meet the requirements of the Victorian OHS Regulations 2007, Part 4.3; and Schedules 6, 7 & 8 and shall:

a) refer to any asbestos register where available
b) consider the presence of ACM before commencing any task, which includes the potential to disturb the ACM
c) not perform any work directly on ACM and which disturbs the ACM unless the person has undertaken suitable training and has sufficient knowledge, experience and skill to perform the work safely and is wearing and utilising appropriate PPE

8.9 Drop Zone

Contractors and/or persons performing UG construction and maintenance services under this SWP must ensure an area with controlled access is established to safe guard pedestrians, motorists and ground workers against injury or damage by falling material, tools or items of equipment.

8.10 Working at Heights

Contractors and/or persons performing OH construction and maintenance services under this SWP and in control of the work must Victorian OHS Regulations 2007, Part 3.3 and shall:

a) develop their own safe system of work (including Safe Work Method Statement(s)) for working at heights

b) workers must not perform any work at heights unless the worker has undertaken suitable training and has sufficient knowledge, experience and skill to perform the work safely and is wearing and utilising appropriate Personal Protective Equipment (PPE)

8.11 Radio Frequency

Contractors and/or persons performing UG construction and maintenance services under this SWP must ensure that workers are aware of the possible presence of Radio Frequency Radiation (RFR), emanating from energised telecommunications antenna(s) located on existing UE worksites or other adjacent worksites and the hazard this poses to persons working in front of these antennas. Contractors must ensure that workers have sufficient skills to identify antenna worksites and are aware of RFR avoidance procedures.

9 ENVIRONMENT

9.1 Environment Management Systems

The Contractor:

a) is responsible for providing their own environmental management system and plan complying with AS/NZS ISO 14001:2004

b) must ensure persons performing services under this SWP (including sub-contractors) follow procedures and practices consistent with this SWP and the Contractor's Environmental Management Plan, and established UE and Contractor procedures

c) must advise UE as soon as practicable of any occurrence of a reportable environmental incident

9.2 Monitoring Environmental Conditions

Contractors and/or persons performing UG construction and maintenance services under this SWP must take all reasonable and practicable measures not to cause environmental harm while providing services under this SWP by monitoring the following (but not limited to) environmental conditions:

a) land (Worksite Management), containment of materials and waste including excavated soils and excavation water

b) sediment and dust control

c) vegetation (Declared Noxious Weeds)

d) noise management

e) hazardous substances

f) oil spills

g) acid sulphate soils

h) creosote treated poles and surrounding soils

i) Aboriginal cultural heritage

j) contaminated storm water (compliance to the Environmental Protection Act)

9.3 Noise Management

Contractors and/or persons performing UG construction and maintenance services under this SWP must be sensitive to the concerns of residents and local businesses. Quantitative limits on noise should be considered and complied with while providing services under this SWP.

9.4 Oil Spills

Contractors and/or persons performing UG construction and maintenance services under this SWP must have an oil spill kit available at worksites in the event of a fuel or hydraulic oil leak. Any hydraulic oil or fuel leak is to be contained and cleaned up and the waste and contaminated soil disposed of in accordance with the Laws and EPA requirements for its disposal.

9.5 Aboriginal Heritage

Contractors and/or persons performing UG construction and maintenance services under this SWP must comply with the Laws, the Aboriginal Heritage Act 2006 and take all reasonable and practicable measures to ensure an activity does not harm Aboriginal cultural heritage.

10 PERFORMANCE OF WORKS

10.1 General

Construction components must be installed following safe construction practices and to the standards outlined in the UE Construction Standards and must be the appropriate size and fit for purpose.

10.2 Contractor Responsibilities

1. Contractors and/or persons performing UG construction and maintenance services under this SWP must ensure that services are performed such that only the minimum of disruption to the business community, general public, residents and vehicular and pedestrian traffic will be caused. The duration of site works; construction or maintenance must be kept to a minimum through careful programming and suitable arrangements must be made for access to abutting properties.
2. For worksites located within restricted areas under the control of others such as, but not limited to mine sites, railway property, corrective services institutions or indigenous lands; it is the responsibility of the contractor to obtain required entry permits and entry conditions prior to entering the restricted areas to undertake the Services. Contractors and/or persons performing UG construction and maintenance services under this SWP must strictly comply with all conditions of entry.
3. Contractors performing UG construction and maintenance services under this SWP must be responsible for:
    a) ensuring the performance of the services does not materially interfere with the performance of works being undertaken by any other contractors on the worksite. (Provide coordination with any other works associated with the project)
    b) ensuring its activities do not materially interfere with the activities of businesses or persons occupying land adjacent to or in the vicinity of the worksite
    c) investigating and resolving to the reasonable satisfaction of UE any complaint made by a member of the public about the way in which the contractor performs any element of the services

d) any damage to the property of UE resulting directly or indirectly from any deficient or defective services or the re-performance of those services provided

e) giving prior notice to occupiers of private property that it will perform services and must ensure that the occupiers are not inconvenienced by the services being performed

f) ensuring its staff on worksites carry and produce upon request their approved identification cards

g) ensuring that any vehicle being used to enter a worksite or to travel from one worksite to another has approved signage attached to the vehicle in a prominent position

h) all things necessary to obtain the required approvals from Authorities to obtain access to the worksite (including traffic control permits, with / without conditions)

   i. notifying all Authorities of services to be performed

   ii. notifying all Authorities of commencement / completion of services

i) ensuring availability of sufficient quantities of materials, plant, tools and equipment for the uninterrupted progress of services

j) notification to UE (according to established requirements), in the event of the following:

   i. any reportable network, electrical, safety or environmental incident; or any injury requiring medical attention and or lost time occurred

   ii. receipt of a complaint from a member of public or any Authority

   iii. any significant disruption to programme of services being provided

   iv. any damage to UE or other parties' property or services

   v. any requirement to amend the scope of services being provided

   vi. any traffic incidents

   vii. caused a fault that results in an unplanned outage to the network

11 MATERIALS

11.1 General

Unless otherwise contracted, contractors and/or persons performing UG construction and maintenance services under this SWP must provide all goods, equipment, spare parts, labour and support functions necessary to perform the services.

All materials and equipment purchased and used for construction of UG electricity distribution infrastructure must be specified, approved and fit for service products.

11.2 Scrap Materials

The value of all recovered material(s) and equipment shall remain the property of UE and must be taken into account when reconciling material(s) and equipment and comply with scrap materials recovery and recycling processes. The contractor must return all of the material(s) and equipment to the relevant store or nominated location at the completion of services being provided.

12 PREVENTION OF DAMAGE

Contractors and/or persons performing UG construction and maintenance services under this SWP:

a) shall undertake work in accordance with WorkSafe guidance material and in a manner that prevents damage to third party property, in-road infrastructure and other utility assets
b) are solely responsible for repairs resulting from any damage attributable to its performance of the services, including but not limited to damage to water mains, drains, gas mains, roads, fences, gates, culverts, grids, structural foundations, significant vegetation, electric power cables and mains, communication cables/lines/infrastructure and any other utilities
c) must carry out repairs to the satisfaction of UE, the property owner and any relevant Authority
d) must notify UE (according to established requirements) after occurrence with details of damage to utilities, services or private property and the agreed restoration plan with the relevant Authority or property owner
e) when heavy or tracked plant and equipment is used, must take appropriate steps to prevent damage to infrastructure such as road surfaces, footpaths, lawns and driveways

13 MAINTENANCE OF BARRICADES AND ENVIRONMENTAL CONTROLS

Contractors and/or persons performing UG construction and maintenance services under this SWP must ensure all excavations for services being provided are barricaded to the standard requirements of all Laws including Victorian UG&S regulations and the additional requirements set out below:

a) necessary signs, barricades and lights, for vehicular and pedestrian management and environmental management must be maintained in place until services being provided (including restoration works) are complete and the hazard ceases to exist
b) no material recovered from the services being provided shall be placed where the material or any leachate from the material can enter water course or storm water drainage
c) inspection and rectification work shall be undertaken to make the worksite safe and prevent environmental harm outside normal working hours

14 SURFACE REINSTATEMENT

a) Permanent reinstatement of surfaces must be carried out as soon as practicable after completion of backfilling
b) surfaces removed or damaged during the provision of the services must be reinstated to the original surface levels (within agreed tolerance) with similar material such as concrete, turf, bitumen, asphalt, paving, tiles or as agreed with the Authority or owner and must include the re-establishment of street furniture and gardens

15 WASTE DISPOSAL

Contractors and/or persons performing UG construction and maintenance services under this SWP must ensure:

a) all waste material is disposed of in accordance with Authority requirements and the worksite must be restored to a clean and safe condition in accordance with the Laws
b) all waste construction materials from the provision of services provided under this SWP will be collected and stored securely or removed from the worksite daily
c) the prevention of all littering by their workers and
d) must cause all litter (including papers, tins, bottles and rags) to be cleaned up daily from areas where it is performing the services and disposed of in the nearest approved refuse disposal area

16 CUSTOMER NOTIFICATION

Contractors and/or persons performing UG construction and maintenance services under this SWP must:

a) perform written notifications where required by the UE Customer Charter and the Electricity Distribution Code which states:

> *Planned interruptions*
>
> *5.5.1 In the case of a planned interruption, the distributor must provide each affected customer with at least 4 business days written notice of the interruption. The notice must:*
>
> *a) specify the expected date, time and duration of the interruption and*
>
> *b) include a 24 hour telephone number for enquiries*
>
> *5.5.2 The distributor must use best endeavours to restore the customer's supply as quickly as possible*

Additional requirements regarding the notification of life support customers, small businesses and community organisations impacted by supply interruptions are described in document № U PR 0027 UEMG Customer Notifications Procedure.

a) attempt to notify (present to) the person in control of the worksite the reason for entry to the worksite (customer's premises) as soon as practical upon arrival. Where this is not practical the worker must notify the customer at the first available opportunity that arises while on the worksite.

b) display identification according to procedures

c) where practical, comply with customer's reasonable requests, such as a customer wishing to be advised prior to the worker leaving the premises, taking extra care and complying with customer's safety or security requirements while on the customer's property.

17 POLES AND ATTACHMENTS

17.1 General

Refer to the following for detailed information regarding poles, pole positions, foundations, stay wires, pole mounted steel work and insulators.

a) UE Construction Standards Manual

b) SWP 1, Construction & Maintenance of Overhead Mains. (240V > 66kV)

18 UNDERGROUND CABLES

a) Cables must be installed using methods that prevent damage to cables, plant and equipment

b) Unless being immediately terminated, heat shrink end caps shall encapsulate the ends of all cables at all times to prevent the ingress of moisture and other foreign matter

c) Tension hauling shall be used in some cases when specified

d) Other methods to run out the cables shall be allowed, provided that acceptable measures are taken to ensure cables will not be damaged

e) The work group must endeavour to make the most efficient use of cable to keep the number of joints and wastage to a minimum. All cable joints must be made in accordance with the UE Construction Manual

f) Cables must only be installed with suitable tools and in a manner preventing damage, compromising the bend radius, or any other deformation or damage to the cable from occurring

g) Any damage to the cable must be repaired in accordance with the UE Construction Manual

h) The work group must ensure that all fittings/application tools and cables are correctly sized and matched

19 CABLE DEPTH AND MARKING

a) All underground cables shall be installed in accordance with the UE Design Manual

b) Some UE cable depths differ from those prescribed in the 2009 Electricity Safety (Installations) Regulations, shown in Table 1 below. Where it is impractical to lay an underground line at the design depth, refer to the UE Safety Case, Document № 4200-23, Construction of UG Lines

c) All underground cables shall be clearly marked at the points where the underground line enters or exits the ground

d) When cables are laid in conduit or direct buried, an orange marker tape to AS/NZS 2648.1 shall be installed at least 150mm over the top of the conduit or cable respectively

e) Where the cables are installed using boring or drilling techniques, a marker tape is not required to be installed, but constructions drawings shall be noted

f) For detailed information regarding the marking of UG lines, refer to the UE Safety Case, Document № 4200-25, Marking of UG Lines

TABLE 1 - Minimum regulatory depths for underground lines from the surface of the ground

Type of underground line Nominal voltage ('U')	Directly Buried	Directly buried and covered with a mechanical cover	Buried enclosed in a conduit or pipe
U <1500V direct current	750mm	600mm	500mm
Alternating current U ≤ 1kV	750mm	600mm	500mm
Alternating current 1kV < U ≤ 22kV	900mm	750mm	750mm
Alternating current 22kV< U ≤ 66kV	1000mm	750mm	750mm
Alternating current 66kV<U≤ 220kV	1000mm	1000mm	1000mm

20 EARTHING

Contractors and/or persons performing UG construction and maintenance services under this SWP must ensure:

a) Earthing systems are installed, tested and maintained in accordance with UE's Construction Manual

b) Earthing systems must be tested and results recorded

21 ELECTRICAL CONNECTIONS

Contractors and/or persons performing UG construction and maintenance services under this SWP must ensure:

a) All electrical connections are installed in accordance with the UE Construction Manual and or manufacturer's installation instructions

b) All cables must be prepared for connection by approved methods

c) Only suitably sized and fit for purpose compression fittings, connectors and compression dies must be used to connect the various types and sizes of conductor(s)

d) All Insulation Piercing Connections (IPC's) must be "Depth Checked" (where possible) and the cable "Tug Tested" immediately after termination in the IPC

e) Whenever a pole is ascended to undertake works associated with this SWP, then a visual inspection of all existing cables attached to the pole must be performed. Should any cable appear corroded, damaged, evidence of heating or any termination unsecured, repairs shall be carried out to ensure the cable's serviceability or they shall be replaced

f) Where required, the bridging in or connecting of new low voltage mains or the reconnecting of augmented sections of the LV network, testing to confirm correct polarity and phase rotation must be undertaken

22 TESTING

Contractors and/or persons performing UG construction and maintenance services under this SWP must ensure that where required and prior to being placed into service, that cables are tested according to established procedures.

23 AUDIT AND INSPECTION

Contractors and/or persons performing UG construction and maintenance services under this SWP must ensure:

a) the continuous auditing of services being provided under this SWP; ensuring all workmanship, materials and equipment utilisation for construction and maintenance of underground mains strictly complies with this SWP and related procedures

b) that audits and inspections review all aspects of the work to verify key requirements of the work and maintenance of quality and safety standards

UE will undertake audit and inspection of the services being provided under this SWP; ensuring all workmanship, materials and equipment utilised for construction and maintenance of underground mains strictly complies with this SWP and related procedures.

24 RECORDS

Contractors and/or persons performing UG construction and maintenance services under this SWP must maintain full and accurate, records including but not limited to:

a) electronic records

b) correspondence

c) instructions

d) internal quality audit inspection reports
e) plans
f) drawings
g) regulated waste tracking documentation
h) receipts
i) hazard management measures carried out as part of the services being provided
j) any complaints and environmental incidents that occurred while providing the services
k) all work process assessments undertaken
l) all final product assessments undertaken
m) accurate and immediate records of any accidents or near-misses must be maintained

25 REFERENCES

UE Construction Standards Manual	UE 4162
UE Network Access	UE PR 0001
UE Standard Work Procedure № 1	UE PR 0002
UE Qualification and Training Standards for Network Access	UE PR 0006
Audit and Inspection of United Energy Field Work Sites	UE PR 0007

26 DEFINITIONS

Authority
Any government or regulatory body, instrumentality, minister, agency, court, tribunal or other Authority with jurisdiction over the activity or thing about which the reference to an Authority is made.

Contractor
Any person, company or organisation engaged to perform any part of the services under this Standard Work Procedure

DBYD
Dial Before You Dig

Green Book
Electrical Safety Rules for the VESI Distribution Networks (the Green Book)

High Voltage or 'HV'
Means a nominal voltage exceeding 1000 volts AC. or exceeding 1500 volts DC

Low Voltage or 'LV'
Means nominal voltage exceeding 50 V AC or 120 V DC but not exceeding 1000 V AC and 1500 V DC

Near
Means a situation where there is a reasonable possibility of a person either directly or through any conducting medium (e.g. via mobile plant) coming within the relevant safe approach distances

Safety Observer
A person with the role to observe work undertaken by others, warn the worker or workers of hazards / danger (particularly in relation to electrical work), to stop work should a hazardous situation develop, as well as to perform rescue and resuscitation as required. This person must comply with all the requirements of the Green Book.

Note: A Safety Observer must be used when performing live electrical work unless the work involves testing electrical equipment. A Safety Observer must also comply with any additional requirements set out in other UE SWP or manual when performing the role of Safety Observer.

UE
United Energy Distribution Pty. Ltd.

Worksite (Workplace)
Clearly defined immediate area in the vicinity of where services are being provided, or are to be performed by Contractors / Subcontractors including all vehicles, plant and equipment being utilised.

Safe Approach Distance
Means the minimum distance that shall be maintained by a person, vehicle or mobile plant (including its load, controlling ropes and any other accessories) when approaching electrical apparatus other than for work in accordance with an access authority

Service Provider
Means a contractor who has an established Operational and Maintenance Services Agreement with United Energy.

SWP
Standard Work Procedure

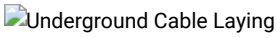
Vicinity
Means a situation where it is unlikely that a person will, either directly or through any conducting medium (e.g. via mobile plant), come within the relevant safe approach distances.

VESI

Victorian Electricity Supply Industry

Underground Cable Laying: All You Need to Know

20 May 2022 , Admin



Nature conservation, natural objects, aesthetics and space make laying cables underground unavoidable and necessary. Underground cable laying has added benefits in the form of reduced transmission loss and reduced risk of service supply loss in cases of extreme weather.

What is underground cable laying?

In areas where space for cables is limited and crunched, especially the urban regions, underground laying of cables is an efficient method. Telecommunications or electric power can be transmitted through underground cables. Data is transmitted from one point to another using cable laid on the ground instead of the ones hanging from poles and towers in an underground cable system.

In comparison to overhead cables, underground cables are not visible to the naked eye and hence, retain the location's aesthetic beauty. To ensure this, proper trenches need to be dug and the entire process needs to be carried out systematically to ensure success and minimum service requirements.

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Benefits of underground cable laying

Climate change has made extreme weather conditions more common. In order to have an uninterrupted power supply and telecommunication in place, it is important that our infrastructure is planned and equipped to survive the harsh weather conditions. The following benefits make underground cable systems the preferred choice:

- **Longer lifespan –** Underground cables have a much greater life expectancy than aerial cables.
- **Reduction in maintenance costs –** Less exposure to nature's fury like falling tree branches, strong winds and rain lead to fewer maintenance requirements.
- **Accident prevention-** Aerial cables can collapse on buildings and cars and put anyone near them at the risk of electric shocks. In this regard, underground cable laying is safer.
- **Continuous service –** Protected from external factors, underground cables provide uninterrupted power or service.
- **Zero obstruction –** Underground cable systems are completely out of sight and cause zero obstruction to properties.
- **Minimum space requirement –** Aerial cables require a lot of space for installing poles whereas underground cables require a much-limited band of land.

The Procedure & Installation of Underground Cable Laying

The effectiveness and efficiency of an underground cable system depend on proper cable laying, quality of cable joints and branch connections. There are three methods of underground cable laying. The procedure followed in each method is as follows:

Direct laying

This method requires digging a 1.5m deep and 0.45m wide trench which is then covered with a layer of sand. The cables are laid in the trench and covered with a 10 cm thick layer of sand. To protect against mechanical injury the trench is then covered with bricks and other materials.

If more than one cable is required to be laid in a trench then a horizontal or vertical inter-axial spacing of 30 cm is provided to prevent mutual heating.

Advantages:

- The simplest and cheapest method of underground cable laying
- The heat generated gets dispersed in the ground.

Disadvantages:

- High maintenance cost
- Pointing out accurate locations of faults is difficult
- Cable network alterations are difficult.

Draw in system

Ducts or conduits of cast iron or concrete or glazed stone with manholes are placed at suitable locations along the cable route. The manholes are used for pulling the cable in position.

Advantages:

- Manholes make additions, repairs and maintenance easy
- Low maintenance cost
- Mechanical protection lowers the occurrence of faults.

Disadvantages:

- Installation cost is high
- Low heat dispersion due to grouped cables.

Solid system

Underground cables are laid in open pipes or troughs along the cable route. The troughs are usually made of asphalt, stoneware or cast iron. Asphaltic compound is used for filling the troughs once the cable is laid in position.

Advantages:

- Strong mechanical protection

Disadvantages

- Skill and labour requirements result in high costs

Challenges of underground cable laying

The various challenges in the process of laying underground cables are as follows:

1. **High installation cost:** The initial installation cost for an underground cable system is high as costs for restoration of roads and surrounding infrastructure add to the total cost.
2. **Permissions and approvals:** Before starting with the digging process, a range of approvals need to be obtained from relevant authorities.
3. **Cumbersome modifications:** Inability to locate lines and particular sections makes making additions or modifications to the line tedious.
4. **Obstacles in cable route:** The cable route needs to be designed keeping in mind any obstacles that may be there in the route.
5. **Insulation requirements:** Layers of insulation are needed for underground cables to withstand the high voltage flows.

FAQs

What is the minimum depth for cable laying below the ground?

The minimum depth for cable laying below the ground varies according to the voltage capacity of the cable. The depth should be atleast 0.9m for 3.3kV to 11kV cables, 1.05m for 22kV to 33kV cables. The minimum depth of a low voltage cable should be 0.75m.

What is the cable laying method?

The dependability of a cable network depends on the laying method and attachment of fittings like cable end boxes, joint, branch connectors, etc. Laying method defines the approach that will be followed in terms of digging of trenches, fitting of ducts and positioning of cables. There are basically three methods of laying cables underground which are direct laying, draw-in and solid system.

How deep should the cable be buried underground?

The depth requirements vary according to the topography of the terrain. For road crossings and drainage ditches that are yet to be finished, the standard depth varies from 30 to 42 inches. If the ground remains frozen for extended periods of time, then the depth should be at least 30 inches. Roadway crossings require deeper digging with a standard depth of 42 inches.

What should be the normal depth of laying cables?

The normal depth of laying cables is influenced by climate conditions and terrain. It ranges from 30 inches to 42 inches depending on the conditions.

What is the advantage of direct laying of underground cables?

Direct laying of underground cable systems has the following benefits:

- Fast construction of cable network
- Low investment
- Fast heat dispersion
- Clean and safe method with cable protected from external disturbances.

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Underground Cable Laying: All You Need to Know

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Underground Distribution Schemes Manual

25 November 2019

Issue Date: November 2019

Content Owner/Custodian: Distribution Grid Strategy

This Revision: Eleventh Edition (Revision 3)

Date for Next Review: November 2022

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ABN 18540492861

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Document release information

Client	Distribution Grid Strategy
Document number	3384127 Word - 3573985 PDF
Document title	Underground Distribution Schemes Manual
Revision status	Eleventh Edition (Revision 3)

Revision history					
Edition/revision number	**Issue date**		**Description**	**Endorsed by**	**Approved by**
First	Nov 1995	3384127	DSB 95/2 Handbook for Developer & General Conditions for Developer July 1995		
Second	Mar 1996	3384127	Revised from First Edition		
Third	Feb 2002	3384127	Issued as UDS Manual – Policy and Installation Options		
Fourth	Jul 2005	3384127	Updated and reformatted		
Fifth	Apr 2007	3384127	Updated and rewritten (DMS#3384127)		
Fifth Rev 1	May 2007	3384127 v8	Section 5.3.2 - Design Load Section 5.3.2.1 - Residential, single-phase, Diversified Loads		
Fifth Rev 2	Aug 2007	3384127 v9	Section 2.8 - Treatment of existing assets Section 3.8.12 - Economic re – test		
Sixth	May 2008	3384127 v11	Changes noted in summary of review issues. Refer DM# 4244043 v3		
Seventh	Dec 2008	3384127 v13	Changes noted in summary of review issues. Refer DM# 4277066 v7		
Eighth	June 2010	3384127 v17	Changes noted in summary of review issues. Refer DM# 6901197 v3	S Grose	M Wilshusen
Ninth	July 2011	3384127 v20	Changes noted in summary of review issues. Refer DM# 8173227 v4 Refer Appendix 18 for details of changes in this edition.	G Pearce	R Rogerson
Tenth	Sep 2013	3384127 v26	Refer Appendix 18 for details of changes in this edition.	R Rogerson	A Kondola
Eleventh	Dec 2015	3384127 v29	Refer Appendix 14 for details of changes in this edition.	R Rogerson	A Kondola
Eleventh Rev 1	Oct 2017	3384127 v30	Refer Appendix 14 for details of changes in this edition	N Chivers	M Cheney
Eleventh Rev 2	May 2019	3384127 v31	Refer Appendix 14 for details of changes in this edition	B Bristow	M Cheney
Eleventh Rev 3	Nov 2019	3384127 v32	Refer Appendix 14 for details of changes in this edition	N Kirby	B Bristow

An appropriate citation for this paper is:

UDS Manual

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FOREWORD

Welcome to Western Power's 3nd Revision of the 11th edition, as revised (November 2019), of the Underground Distribution Schemes (UDS) Manual.

This document has been developed to reflect all aspects of Western Power's involvement in the land development process for both large and small subdivisions.

Content includes independent stand-alone sections for policies, processes, design requirements, installation requirements and materials and is further supported by Western Power's web page.

The structure also allows the user easier access to other Western Power documents referenced within the Manual, including the Distribution Design Catalogue (DDC), Distribution Substation Plant Manual (DSPM), Underground Cable Installation Standard (NS 14) and the WA Distribution Connections Manual.

The Manual is a 'living document', reviewed and updated on a regular basis to meet the evolving needs of industry. Western Power works closely with industry groups as part of this review process. I would like to acknowledge the valuable input from such groups, including the Urban Development Institute of Australia, Civil Contractors Federation, Subdivision Designers Forum and the Western Australian Planning Commission.

The information in this Manual is intended to be useful to all stakeholders and I hope you find it easy to read and understand. It reflects Western Power's commitment to continuous improvement and our desire to work closely with all participants in the land development industry. In keeping with this, we value your feedback on any aspect of this Manual and ongoing support.

Ben Bristow

Head of Grid Transformation

Western Power

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1. Introduction

1.1 Purpose and Scope

This Manual sets out the procedure for every Underground Distribution Scheme (UDS) relating to subdivisions that are or have the potential to be supplied with electricity from Western Power's network and governs the relationship, between:

- Western Power as the network operator, whose network a UDS will become a part of; and
- Every Developer, as the proponent of a subdivision, who requires a UDS to provide a reticulated supply of electricity to the lots in a subdivision
- Requirements for an electrical distribution system for a survey strata subdivision within a freehold lot to be undertaken by others outside the UDS processes as non-Western Power reticulation.

This Manual also informs land developers, designers and installation contractors of the policies, processes, practices and requirements and equipment relating to the provision of electricity services in all new subdivisions on Western Power's network including:

- Western Australian Planning Commission subdivision processes of creating, fulfilling and clearing conditions.
- Requirements for subdivision electricity reticulation, Lot power supplies, interface connection to the existing Western Power network and possible reinforcement thereof to support the anticipated load increase.
- Removal or relocation of overhead distribution power lines that are adjacent to or within a proposed subdivision.
- Restriction of land use associated with existing transmission power lines.
- Responsible parties to undertake small and large subdivisions design and construction.
- Subdivision design and construction requirements.
- Residential financial equalisation arrangement for large residential subdivisions (HV pool)
- Large subdivision Developer handover of the installed UDS to Western Power for final testing, commissioning and acceptance enabling connection to the network and energisation.

The Manual describes subdivision requirements for both greenfield and brownfield arrangements and defines small and large subdivisions to indicate whether Western Power or Developer is responsible for the design and construction of the works. The responsible party in practice may vary on a case by case basis as agreed by Western Power considering such issues as appropriateness of:

- Developer's contractors working near existing electricity infrastructure in brownfield areas;
- Western Power undertaking small subdivisions within a larger greenfield development involving the same Developer.

1.2 Definitions

In this document, the following words and expressions have the meanings given to them below:

Acceptance of Quote	This is the acceptance by the Developer of the Quote made by Western Power to provide Electricity Infrastructure. This normally takes place upon receipt of payment from the Developer.
Boundary re-alignment	The boundary between two existing lots is shifted by less than one metre.
Boundary relocation	The boundary between two existing lots is shifted by more than one metre.
Bypass reticulation	Reticulation installed to provide an alternate route or prospective alternate route between two points on the electricity distribution network. One of the two points may be on a proposed part of the network.
Cable Jointer	A person appropriately qualified to undertake the type of cable jointing and termination described.
Contract	The formal agreement between the Developer and the Contractor for the execution of the works.
Contractor	The person or organisation that has contracted with the Developer for the execution of construction works.
Construction Manager (CM)	The officer appointed by Western Power as Western Power's representative to whom all site contractual and technical matters are referred.
Decoupled large subdivision	Construction of a subdivision stage that is permitted to commence prior to issue and payment of interface works quote.
Distribution Design Catalogue (DDC)	This catalogue identifies how the majority of distribution structures are assembled.
Design Conformance Review (DCR)	Review by Western Power to ensure all design document and certificates are included in the Engineer's submission; and all design parameters provided by Western Power through the Design Information Package have been incorporated into the UDS design.
Design Information Package (DIP)	A package of distribution network information unique to a UDS or development that a Developer must use in the preparation of its design for Electricity Infrastructure.
Designer	The person engaged by the Developer or employed by a Designer organisation to design Electricity Infrastructure for a UDS.
Designer Organisation	The organisation engaged by the Developer to design Electricity Infrastructure for a UDS.
Developer	The person or organisation that develops land as owner or by any other authority and provides Electricity Infrastructure for a UDS.
Distribution Headworks Charge	Charges payable by the Developer for subdivisions located in the Distribution Headworks Scheme to fund power capacity upgrades in regional and remote locations within the electricity network. The scheme applies only to those areas as defined in the Distribution Headworks Scheme Policy.
Distribution Quotation Management System (DQM)	A system to enable entry and tracking of customer work requests, in addition to the calculation and generation of quotes for the resultant work.
Electricity Infrastructure	Electricity apparatus provided within a subdivision and associated reinforcement of and connection to Western Power's network.

Engineer	A person who is eligible for corporate membership with Chartered status of Engineers Australia and is a professional electrical engineer registered on National Engineer Register (NER).
HV	High voltage: Exceeding low voltage, but not exceeding or including 66kV. This includes Medium Voltage (MV) equipment.
Interface Works	Works external to the subdivision including required reinforcement, extension and connection to Western Power's network.
Large subdivisions	Considered in this UDS Manual to comprise more than four lots. This number may vary by agreement with Western Power on a case by case basis.
LES	Live End Seals
LGA	Local government authority
LV	Low voltage**:** As defined by AS/NZS 3000 Clause 1.4.128 'Voltage'.
LV Design	A Western Power program to calculate voltage drops, line loads, kilowatt losses, transformer loads and fuse reach in underground and overhead low voltage radial networks.
MEN	Multiple Earthed Neutral
MPS	Modular Package Substation.
Must	A mandatory requirement.
Offer, Quote	Means an offer by Western Power to the Developer setting out the costs, terms and conditions upon which the Electricity Infrastructure of a subdivision will be constructed in a conformed design.
Practical Completion	The completion of works such that they can be used for the purpose for which they were designed, without restriction.
Prefer	A choice to be adopted unless circumstances justify a variation.
Reinforcement Works	Strengthening of Western Power's network as required to provide capacity for the subdivision.
PAW	Public access way
POS	Public open space
Scheme	All equipment and components associated with distribution electricity services within a subdivision.
Service Pillar	Distribution enclosure owned by Western Power provided on a customer's property which provides a connection point to the electricity network for the customer's electrical installation.
Service Connection	The final part of the electricity network owned by Western Power provided on a customer's property to which the customer's electrical installation is connected.
Shall	A mandatory requirement.
Should	A requirement to be adopted unless circumstances justify a variation.

Site	The Developer's workplace which includes all parts of the development that are the subject of the offer and acceptance between Western Power and the Developer for the provision of Electricity Infrastructure for a subdivision.
Site Superintendent/Project Engineer	The person appointed by the Developer to direct and administer the contract and site construction work on his behalf.
Small subdivisions	Considered in this UDS Manual to comprise not more than four lots. This number may vary by agreement with Western Power on a case by case basis.
SWIS	The electricity network in the South West corner of Western Australia as shown on the map in Appendix of the manual.
SPUD	Single Phase Underground Distribution.
SPURS	Single Phase Underground Rural Supply
SUDL	Serviced Un-Cleared De-energised Lots (SUDL's)
Australian and New Zealand standards	AS/NZS prefix refers to standards developed by Standards Australia and Standards New Zealand. SA/SNZ prefix refers to international standards (e.g. ISO, IEC) adopted by Standards Australia and New Zealand.
Subdivision	The total area of land included in the WAPC subdivision boundary. This includes all stages and the amalgamation of lots.
Substation	A collection of switchgear and/or a transformer/s on a single site (which may or may not be screened or enclosed).
Supervisor	The person employed by the Construction Contractor to be responsible for the supervision of the works. This person's qualifications shall satisfy the requirements of the "Electricity Act of Western Australia 1947" and "Electricity (Licensing) Regulations 1991".
Transmission Voltage	Including 66kV and above.
UDIA	Urban Development Institute of Australia.
UDS	Underground Distribution Scheme
UPCoP	Utilities Providers Code of Practice
WAPC	Western Australian Planning Commission.
Western Power	Electricity Networks Corporation of 363-365 Wellington Street, Perth, Western Australia, trading as Western Power, a statutory corporation pursuant to the Electricity Corporations Act 2005.
Will	A mandatory requirement.
Working Day	Any day from Monday to Friday excluding public holidays but including Western Power's rostered day off.
Works	The electricity works associated with the provision of Electricity Infrastructure to the development that is the subject of the offer and acceptance.

1.3 Reference Documents

This Manual should be read in conjunction with but not limited to the following:

State Law Publisher	• Electricity (Network Safety) Regulations 2015 • Electricity (Licensing) Regulations 1991 • Energy Operators (Powers) Act 1979 • Land Administration Act 1997 • Occupational Safety and Health Act and Regulations • Planning and Development Act 2005 • Transfer of Land Act 1893
Western Power's Website	• Clearance of WAPC Conditions • Contractor Safety Guidelines • Deciding between overhead and underground construction in road reserves • Details of the material hotline • Developer's Authorisation and Design Information Package (DIP) Request • Distribution Construction Standards Handbook • Distribution Customer Connection Requirements • Distribution Design Catalogue • Distribution Equipment Labelling Standard • Distribution Pole to Pillar Network Standard • Distribution Overhead Line Design Manual • Distribution Substation Plant Manual • Electrical System Safety Rules (ESSR) • Enquiries and Contacts • Environmental policy • FAQ on Earthing Standards • HV System charges • Map of the South West Interconnected System • Material selection guidelines • Network and Subdivision Charges • Network Standard NS 11 - Testing & Commissioning • Network Standard NS 05 Distribution Equipment Labelling • Network Standard NS 14.2 – Underground Cable Installation Manual, Part 2 • Noise Compliance Requirements for Distribution Transformers • Our facilities - Power Training Services • Planning for Works near Overhead Powerlines • Recovering tax cost on capital contributions • Request for Quote on work associated with WAPC application • Roadside Power Pole Policies • Street light Information • Subdivision Design Guideline – No 4 • Subdivision Developer's Authorisation and DIP Request • Subscribe on-line • Technical Rules • Telecommunication equipment located in the vicinity of proposed distribution HV earths • UDS Manual feedback

	• Un-metered Supply Network Standard • Western Australian Distribution Connections Manual • Western Power Charges • Western Power Environmental Policy • Western Power Group Commercial, 'Terms and conditions of sale of materials' • Work Practice Manual • Work near electricity

Australian Standards

AS 2067	Substations and high voltage installations exceeding 1kV a.c.
AS 4799	Installation of underground utility services and pipelines within railway boundaries
AS/NZS 1158	Lighting for roads and public spaces
AS/NZS 2053	Conduits and Fittings for Electrical Installations
AS/NZS 3000	Australian/New Zealand Wiring Rules
AS/NZS 3835	Earth Potential Rise – Protection of telecommunications network users, personnel and plant
AS/NZS 4853	Electrical Hazards on Metallic Pipelines
AS/NZS 7000	Overhead line design – Detailed procedure
ESAA C(b)2	Guide to the Installation of Cables Underground
SA/SNZ TS IEC 61000.3.5	Electromagnetic compatibility (EMC) - Limits - Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 75 A

External references and publications

Dial Before you Dig	• Utility Providers Code of Practice for Western Australia
Western Australian Planning Commission (WAPC)	• Model Subdivision Conditions Schedule Review • WAPC Planning Bulletin Number 33 (Right of Way or Laneways in established areas guidelines) • WAPC Policy No. DC 2.6 (Residential road planning)
Department of Mines, Industry Regulation and Safety	• Code of Practice: Excavations • Energy Safety • Guidelines for work in the vicinity of overhead power lines • Western Australian Electricity Requirements (WAER) • WorkSafe

1.4 Scope

This Manual explains the administrative, design and installation requirements of the provision of Electricity Infrastructure for subdivisions that to be integrated into Western Power's network and taken over by Western Power.

The Electricity Infrastructure works consist of but are not limited to the following:

- Low voltage electricity reticulation within a subdivision.
- High voltage network extension within a subdivision.
- Street lights within a subdivision.
- Distribution substations within a subdivision.
- High voltage Reinforcement and Interfacing Works outside a subdivision.
- Low voltage Reinforcement and Interfacing Works outside a subdivision.
- Upgrade of existing distribution substations outside a subdivision for that subdivision.
- Developer requested replacement of overhead with underground infrastructure in the road reserve adjacent to the subdivision

1.5 Roles and responsibilities of Developers

The Developer is the applicant of the Electricity Infrastructure works and pays Western Power the quoted price to carry out Western Power's part of works on the Developer's subdivision site that is the developer's workplace to create serviced lots that the Developer can sell to prospective land purchasers.

For large subdivisions, the Developer is responsible for:

- Carrying out the requirements of this UDS Manual for Electricity Infrastructure works.
- Requesting DIP from Western Power.
- Appointing and authorizing an Engineer, a Designer Organisation, Cable Laying Contractor, a licensed Electrical Contractor and a Site Superintendent/Project Engineer to carry out the Electricity Infrastructure works in accordance with this manual.
- Installing Electricity Infrastructure for the provision of reticulated supply of electricity to subdivision developments.
- Ensuring a reliable and quality electricity network is designed and constructed for end user customers of electricity for the life of the asset. The life expectancy of the asset is 50 years.
- Site safety for the whole subdivision site.

1.6 Roles and responsibilities of Western Power

Western Power is responsible for:

- Advising the WAPC and the Developer of the requirements of Electricity Infrastructure works needed to provide reticulated supply of electricity to each lot of a subdivision.
- Carrying out Western Power's part of works in accordance with the Quote.
- Site safety at locations where Electricity Infrastructure works are being carried out by Western Power.
- Carrying out quality assurance work in accordance with this manual. When Western Power carries out quality assurance work, it will work on the Developer's workplace in accordance with the Developer's site safety requirements and will comply with the directions of the Developer's site safety manager.

1.7 Types of subdivisions

1.7.1 Subdivision types based on land use and classification

Subdivisions in general can be categorised into residential, rural residential, commercial and industrial subdivisions. Rural-residential subdivision developments are generally approved on land zoned “Rural” or “Special Rural”.

These categories can be further broken down to classifications of:

- Green title (freehold) lot subdivision.
- Vacant and survey strata subdivision.
- Built or building strata subdivision.

The subdivision of green title and survey-strata lots requires the approval of the Western Australian Planning Commission (WAPC).

Built or building strata lots do not require the approval of the WAPC if the appropriate local government certifies that a given strata plan is exempt from the need to obtain the WAPC’s approval. (Reference: WAPC Policy No. DC 1.3 Strata Titles)

It is common to have a mixture of residential, commercial and/or industrial freehold lots in a subdivision development. Multi-storey (vertical) vacant strata subdivisions, with a mixture of commercial units at lower levels and residential apartments on upper levels, are also becoming popular.

1.7.2 Subdivision groupings

Western Power classifies the above subdivision types into two groups that have different processes and responsibilities. The groups are small subdivisions and large subdivisions.

Refer to Clause 1.1 ‘Purpose’ regarding flexibility of responsible parties to undertake some smaller subdivision electricity infrastructure works.

1.7.2.1 Small subdivision

The following subdivision developments, referred to in this manual, are classified as small subdivisions:

Subdivisions that require WAPC clearance include those:

- Where the number of freehold lots being created is not more than four.
- Vacant strata or survey-strata lots in a strata plan/scheme.
- The re-alignment of lot boundaries and the amalgamation of lots into one single lot.

Subdivisions that do not require WAPC clearance include those:

- Built strata titles in a strata scheme/plan which are exempt from the need to obtain WAPC approval.

The design and installation of Electricity Infrastructure will be carried out by Western Power. Refer to Clause 1.1 ‘Purpose’ regarding flexibility of responsible parties to undertake some smaller subdivision electricity infrastructure works.

1.7.2.2 Large subdivision

Large Subdivisions for the purposes of this Manual are subdivision developments where the number of freehold lots being created is more than four.

The design of the Electricity Infrastructure within a UDS must be carried out by an external Designer, which the Developer must engage. Underground Electricity Infrastructure within the subdivision is supplied and installed by the Developer.

1.8 The land development process with reference to Western Power and WAPC

1.8.1 High level land development process for subdivisions that require WAPC clearance

The high level land development process for subdivisions that requires WAPC clearance is given in Figure 1.

Note: For both small and large subdivisions, the WAPC process is identical. However, as discussed in Clause 1.7, the responsibilities and internal Western Power processes are different. The process and Western Power's involvement in the process are described overleaf.

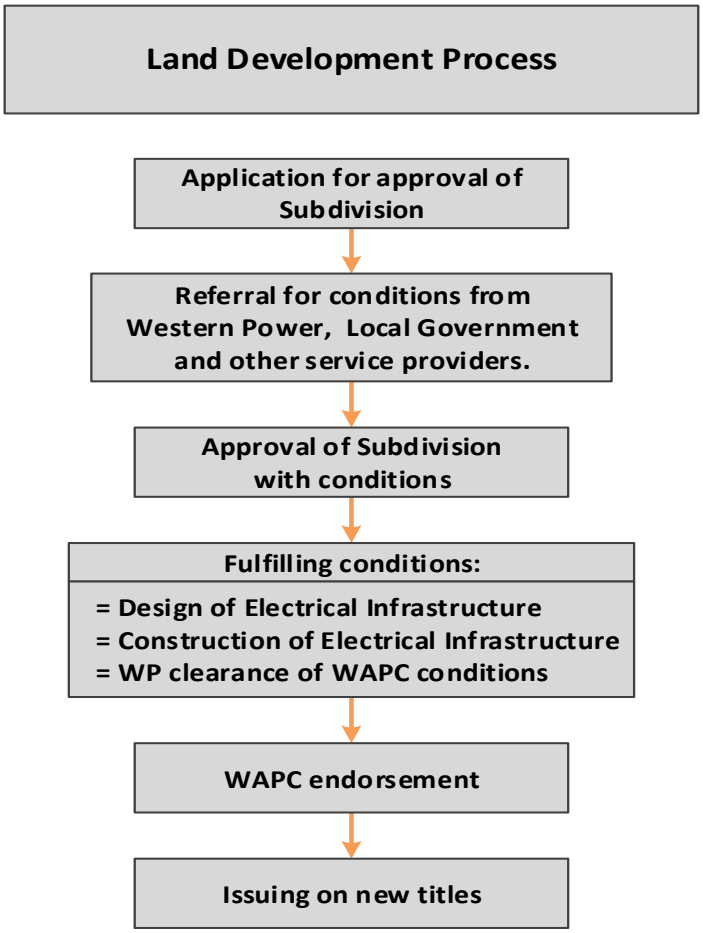

Figure 1: Land Development Process

1.8.1.1 Application for approval of subdivision

The Developer submits an appropriate application form to WAPC for a subdivision development with subdivision plans and any supporting documentation.

Responsibility: The Developer

1.8.1.2 Referral for conditions

WAPC refers the application to Western Power, other service providers and the relevant local government for recommendations of relevant servicing requirements.

Western Power will recommend conditions on reticulation, removal of asset and easements etc. as required.

Responsibility: WAPC and Western Power

1.8.1.3 Approval of subdivision with conditions

WAPC issues a consolidated set of conditions, including Western Power's for the subdivision to proceed. The approval period is four years for subdivisions creating more than five lots and three years for subdivisions of five lots or less.

Responsibility: WAPC

1.8.1.4 Fulfilling conditions

The Developer is responsible for fulfilling all conditions in the WAPC approval, including those associated with Western Power.

Design of electricity infrastructure of a UDS (Large subdivisions)

The Developer engages an electrical Designer to design Electricity Infrastructure to serve the subdivision development in accordance with the requirements of Western Power. The Developer engages an Engineer to oversee the design and certify the UDS design complies with the requirements of this manual. The Engineer or the Designer will submit the design drawing to Western Power for Design Conformance Review (DCR).

Responsibility: Developer, Designer and Engineer

Construction of Electricity Infrastructure: (Large subdivisions)

When the design drawing is confirmed as conforming, the Developer will proceed to construction of the network asset in accordance with the requirements for small or large subdivisions whichever is applicable (See Clause 6.2).

Responsibility: Developer

Western Power clearance of conditions

When all Western Power conditions have been met, the Developer then sends a request for clearance to Western Power who will confirm conditions as being met and then issue a clearance certificate.

Responsibility: Developer,

Developer's Surveyor and

Western Power

1.8.1.5 WAPC endorsement

The Developer will submit deposited plan(s) to WAPC after collecting clearance certificates from Western Power, other service providers and the relevant local government authority (LGA). The WAPC will endorse its approval on submitted deposited plans if satisfied those deposited plans are in accordance with the approved plans and the conditions are met.

Responsibility: Developer and WAPC

1.8.1.6 Issuing of new title

With the endorsement of the WAPC, the Developer can then apply to Landgate for new titles.

Responsibility: Developer and Landgate

1.9 Non-WAPC referred subdivisions

Small subdivisions that do not require WAPC clearance are handled by a different Western Power development process and the simplified process as shown in Figure 2 below.

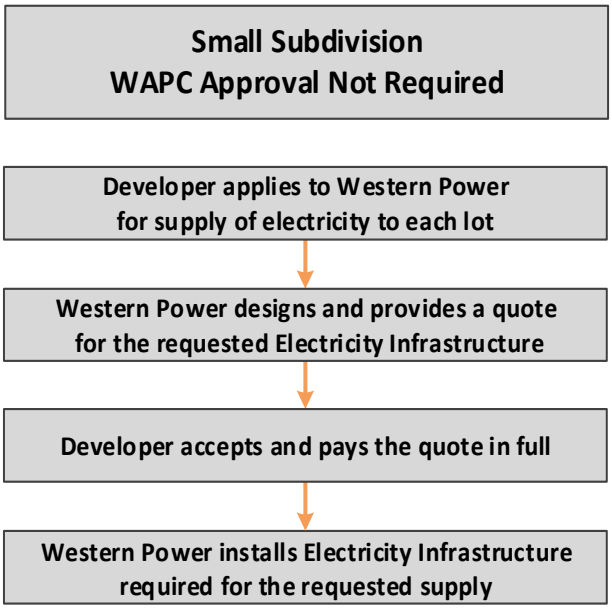

Figure 2: Small Subdivision Process WAPC Approval Not Required

2. General design policies

2.1 Western Power's policy and design principles of network extension in subdivision

Western Power is required to ensure that its network is safe, fit to supply electricity to consumers and the quality of supply meets statutory requirements.

In order to fulfil the statutory requirements, the design of network extension and electricity reticulation for subdivisions must comply with the following major design principles:

2.1.1 Safety

Safety is Western Power's priority value. Western Power's network must be designed, constructed, maintained and operated to ensure safety of consumers, the public and Western Power personnel.

The Developer must ensure the design and construction of all Electricity Infrastructure meets the following requirements:

Electrical safety

The design scheme of a subdivision must provide a safe and efficient connection of all consumers' installations to Western Power's network. It must meet the requirements of Electricity (Network Safety) Regulations 2015, Western Australia Electrical Requirements, AS/NZS Standard 3000-Australian/New Zealand Wiring Rules and all applicable standards.

Construction safety

Subdivision construction work must be carried out in a safe manner and conform to the Electricity (Network Safety) Regulations 2015, Occupational Safety and Health Act and Regulations and all applicable standards.

Operational safety

All subdivision Electricity Infrastructure design and construction must conform to Electricity (Network Safety) Regulations 2015, Occupational Safety and Health Act and Regulations and all applicable written laws and standards.

Developers shall also give due consideration to the Safety in Design principles to enable Western Power personnel to establish appropriate safety processes in the identification and management of hazards, when carrying out network operational and maintenance functions.

2.1.2 Extension of high voltage feeders for now and future

The HV network is not only extended or reinforced to meet the requirement of a subdivision, but also to meet any planned future growth. HV feeder cables must be extended to meet the requirements of Western Power distribution development plans.

The Developer must install HV feeder cables according to the Western Power specified plan provided to meet the long term planning requirement.

HV feeder cables must also be designed either in a 'Y' or 'radial' configuration (See Figure 3 below) so that:

a) Within a minimum length of exit cable from the zone substation or upstream of the Y split, the HV feeder cable must be 400mm² XLPE AL cable. Where 400mm² XLPE AL cable cannot be suitably installed due to installation or site constraints owing to its large bending radius, 240mm² XLPE CU cable is allowed subject to approval by Western Power.

   The minimum length of exit cable and the location of the Y-split from the zone substation are dependent of the type of feeder, load size, distance of the load centre from the zone substation and the surrounding network configuration. It must not be less than 2km; and

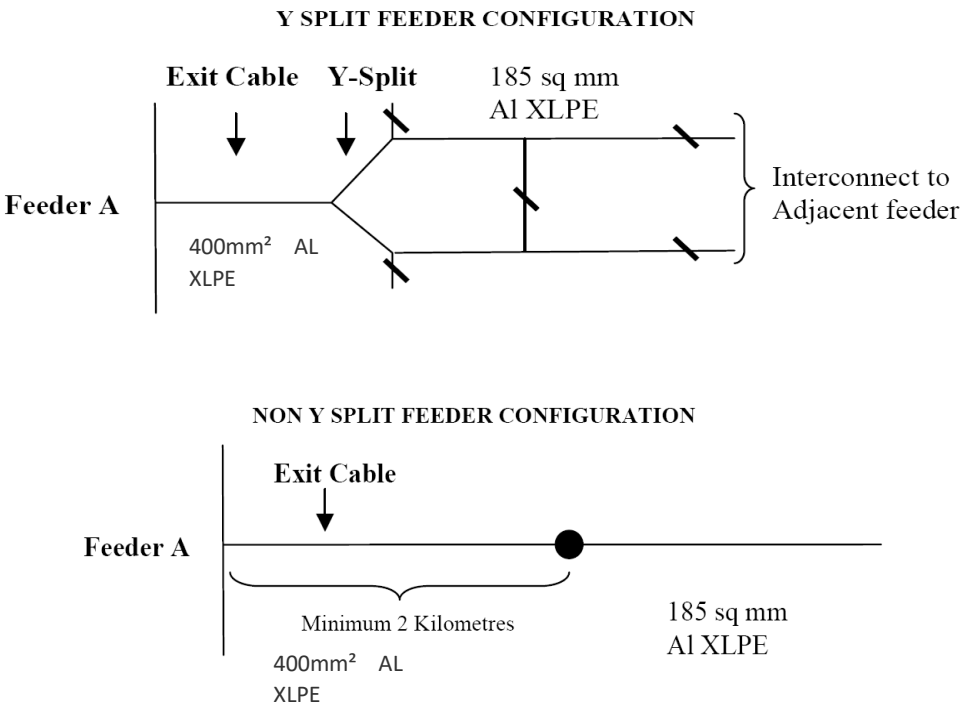

Figure 3: Y Split and non Y Split Feeder Configurations

b) The Y-split is normally placed at an un-congested point where the feeder cable is split into two separate radial spurs via a ring main unit. HV cable of 185mm² XLPE AL is used once the feeder cable has been split for the remainder of the feeder; and

c) Interconnection between the HV feeder cables is close to where the feeder splits and at the end of the feeder where appropriate; and

d) All backbone feeders through new subdivisions must be 400mm² XLPE AL cable. A backbone feeder is primarily a radial feeder emanating directly from a zone substation circuit which supplies all the loads of the feeder, including the loads of its tee-off feeders along its length. HV feeders through a subdivision, which is of remote distance from existing zone substations and is in proximity to a proposed future zone substation, will become backbone feeders emanating from that zone substation; and

e) In accordance with Technical Rule 2.5.5, any new underground distribution feeder, or portion of a new underground feeder that has an installed transformer capacity of 1 MVA or more, must be designed so that, as soon as adjacent developments permit, an alternative source of supply that is normally open, can be closed to provide supply if a fault occurs on the normal supply.

2.1.3 Power quality

The Developer shall ensure that:

- The design scheme of a subdivision provides Western Power's network customers and all other customers who will take supply from Western Power's network with a quality of electricity supply within the limits below.

2.1.3.1 Voltage level

- For low voltage (i.e. 240V single-phase or 415V three-phase) - plus or minus 5% of the nominal voltage at and downstream of the point of supply (See Clause 5.3.4).
- Western power will determine acceptable volt drops for medium and high voltage (i.e. 6.6kV, 11kV, 22kV and 33kV three-phase).

It should be noted that the voltage levels specified in this Manual are the five minute average values measured at the customer's point of supply. Voltage levels may vary for short periods of time.

2.1.3.2 Voltage fluctuations and flicker

The voltage fluctuation which occurs at the customer's point of supply shall be within limits defined in SA/NZS TS IEC 61000.3.5: "Electromagnetic compatibility (EMC) – Limits - Limitation of voltage fluctuations and flicker in low voltage power supply systems for equipment with a rated current greater than 75A."

Subdivision designers shall undertake this evaluation where the power supply of the lot being developed is being undertaken as part of the subdivision works. The evaluation for lots developed independently of the subdivision shall be undertaken by that customer and Western Power.

Evaluations that form part of the subdivision shall be in accordance with SA/NZS TS IEC 61000.3.5, undertaken and signed by an engineer as described in Clause 5.1.1 'Engineer' and submitted to Western Power for review as part of the DCR process.

2.1.4 Network reliability

The Developer shall ensure the subdivision Electricity Infrastructure is designed to provide Western Power's network customers with a reliable supply of electricity by:

a) Providing interconnections with other feeders both the HV and LV feeders of the subdivision, so that in the event of loss of one feeder, the other feeders can continue to supply customers and ensure a high level of reliability and expectations are maintained. To permit flexibility, LV connections may not be required for broadacre subdivisions with transformer sizes 63kVA or less and generally greater than 100 metres between the closest associated network pillars; and

b) Including interconnection of HV feeders. For both Urban Distribution Feeders and Radial Distribution Feeders in the Perth Metropolitan Area depending upon load and arrangement and number of residences respectively. The requirements shall be in accordance with the requirements of Technical Rules for the South West Interconnected Network Clauses 2.5.5.3(b)(2)(C) and 2.5.5.4 Interconnection between Rural Distribution Feeders shall be provided in accordance with Technical Rules Clause 2.5.5.5.

c) To enable the full utilisation of transformer capacity in residential subdivisions the design load on each transformer is to be as close as possible to the nameplate rating of the transformer without exceeding that rating. Refer to Clause 5.3.21.

2.1.5 Network maintainability

The Developer shall ensure that all Electricity Infrastructure is designed and constructed to minimize the cost of maintenance during its life.

2.1.6 Environmental management

The Developer must ensure the network in the subdivision is designed and constructed to comply with all written laws that govern environmental and Western Power requirements etc. This includes but is not limited to noise, clearing, soil, management, rare flora, fauna, fire safety etc.

2.1.7 Meeting community expectation

The Developer must ensure the network in the subdivision is designed and constructed to meet all applicable requirements of the relevant statutory authorities.

2.2 Requirements for the provision of underground or overhead power

2.2.1 Electrical reticulation

The following defines subdivision requirements of underground reticulation and service connections and where overhead services may be retained or provided. The requirements consider greater expected intensity of land use, especially of building construction and vehicular movement and the subsequent increased safety hazard of overhead reticulation on smaller lots. These requirements have been agreed in principle with Energy Safety.

These requirements apply to Western Power's electrical reticulation servicing freehold subdivisions and private distribution systems servicing survey strata lots and common property

Underground electricity reticulation is mandatory in all new freehold and survey strata subdivisions with lot sizes up to 10 hectares and applies to all subdivisions, including residential, rural residential, commercial and industrial.

Subdivisions with all lot sizes between 10 hectares and 50 hectares may have overhead electricity reticulation but the service connection for each lot must be from an underground service pillar. Underground reticulation is preferred.

Subdivisions in which all lot sizes are over 50 hectares may be sold without any electricity reticulation. When electricity reticulation is to be installed, underground service connections are preferred although overhead service connection will be allowed.

2.2.2 Freehold title subdivisions

2.2.2.1 Reticulation internal to freehold subdivisions

a) All new reticulation within a freehold title subdivision must be underground unless the lot size is greater than 10 hectares.

b) All existing overhead reticulation within a freehold title subdivision must be removed unless the lot size is greater than 4 hectares.

c) Existing overhead reticulation within a freehold title subdivision on a lot of area between 4 hectares and 10 hectares must be removed from the lot unless it meets various criteria (refer Clause 2.8).

d) Where a freehold title subdivision incorporates a new through road or section of an existing or proposed through road then bypass reticulation may be necessary in the road or road section.

2.2.2.2 Reticulation external to freehold subdivisions

a) All new reticulation in road reserves bordering a freehold title subdivision must be underground unless the lot size is greater than 4 hectares.

b) Normally, existing overhead reticulation bordering a freehold title subdivision will be removed but may remain in situ even if new reticulation is installed electrically parallel to it.

c) New low voltage mains cable reticulation must be installed if more than 2 freehold titled lots are created fronting the same road and the combined lot frontages span an existing bay of low voltage overhead mains. This requirement may be applied where more than one subdivision is occurring simultaneously and the combined lot frontages of the subdivisions span an existing bay of low voltage overhead mains.

d) New reticulation may be required in order to bring a suitable supply to the subdivision.

2.2.2.3 Service connections in freehold subdivisions

a) All lots in freehold title subdivisions must be connected underground unless the lot size is greater than 50 hectares.

b) No connection is required for lots greater than 50 hectares.

c) If the boundary of a freehold titled lot of area less than 4 hectares is realigned or relocated then an underground connection is required to be installed if there is no existing connection to the lot.

d) If the boundary of a freehold titled lot of area between 4 hectares and 50 hectares is relocated then an underground connection is required to be installed if there is no existing connection to the lot.

e) If the boundary of a freehold titled lot of area less than 4 hectares is realigned and the realignment results in an existing overhead connection traversing another lot than the one it is servicing then an underground connection is required to be installed in lieu of the overhead connection.

f) If the boundary of a freehold titled lot of area greater than 4 hectares is realigned and the realignment results in an existing overhead connection traversing another lot than the one it is servicing then the overhead connection is required to be re-routed.

g) New freehold title commercial/industrial lots that have an existing overhead connection must be connected underground if more than two lots are being created.

h) New freehold title residential lots that have an existing overhead connection must be converted to underground connection unless the lot size is greater than 50 hectares.

i) Freehold title lots that have an existing overhead connection must be converted underground if the boundary is relocated.

2.2.3 Survey strata subdivisions

2.2.3.1 General

Reticulation within the survey strata subdivision is the responsibility of the Developer and it will not become part of Western Power's network. The following information details the reticulation and connection guidelines.

2.2.3.2 Reticulation internal to survey strata subdivisions

a) All new reticulation within a survey strata subdivision must be underground unless the area of the survey strata lot or common property that the reticulation is located in is greater than 10 hectares.

b) All new reticulation within common property with an area greater than 10 hectares must be underground when it is installed in or adjacent to roads passing and servicing survey strata lots of area 10 hectares or less.

c) All existing overhead reticulation within a survey strata subdivision must be removed unless the area of the survey strata lot or common area that the reticulation is located in is greater than 4 hectares.

d) Existing overhead reticulation within a survey strata subdivision on a survey strata lot or common property of area between 4 hectares and 10 hectares must be removed from the lot unless it meets various criteria (refer Clause 2.8).

e) Where a survey strata subdivision requires internal installation of HV reticulation, then bypass reticulation may be necessary.

2.2.3.3 Reticulation external to survey strata subdivision

a) All new reticulation bordering a survey strata subdivision must be underground unless the area of the survey strata lot or common area is greater than 4 hectares.

b) Generally, existing overhead reticulation bordering a survey strata subdivision may remain in situ. However if more than two lots are being created and more than one point of supply is being provided then new mains cable reticulation must be installed.

c) New low voltage mains cable reticulation must be installed if more than 2 strata titled lots are created fronting the same road and the combined lot frontages span an existing bay of low voltage overhead mains. This requirement may be applied where more than one subdivision is occurring simultaneously and the combined lot frontages of the subdivisions span an existing bay of low voltage overhead mains.

2.2.3.4 Service connections in survey strata subdivisions

a) All survey strata lots and common property in survey strata subdivisions must be connected underground unless the area of the survey strata lot or common property that is being connected is greater than 50 hectares.

b) New survey strata lots that have an existing overhead connection must be converted to underground connection unless the lot size is greater than 50 hectares.

c) If the boundary of a survey strata lot of area less than 4 hectares is realigned or relocated and the realignment results in an existing overhead connection traversing another freehold title or survey strata lot than the one it is servicing then an underground connection is required to be installed in lieu of the overhead connection.

d) If the boundary of a survey strata lot of area greater than 4 hectares is realigned and the realignment results in an existing overhead connection traversing another freehold title or survey strata lot than the one it is servicing then the overhead connection is required to be re-routed off that lot.

e) If more than two strata lots or built strata lots are created on a freehold lot then a main switchboard (MSB), suitable for supplying all of the strata lots, shall be established at the point of supply. For 3 and 4 strata lots created within a freehold lot a dedicated point of supply may be provided in lieu of a main switchboard. Consideration shall be given to the maximum permissible consumer mains cable route length from the point of supply to the meter position. (Refer to Section 11 and 12 of the WADCM)

f) Survey strata lots that have an existing overhead connection must be converted underground if the boundary is relocated.

g) WAPC's model condition (E3) and associated advisory notes relate to "service access rights" for strata schemes. This condition requires that a 1 metre wide 136C easement is applied to ensure access to the electrical point of supply through other survey strata lot/s where building connections do not exist or access cannot be obtained via common property. Refer Clause 5.3.14

h) Where details of a proposed survey strata development on a freehold lot are known at the time of subdivision the design load shall be determined in accordance with Clause 5.3.2.5 and the point of supply may be located as part of the subdivision to suit the future development

2.2.4 Amalgamations

A lot created by amalgamation of two or more lots is considered a new lot. A new underground connection is required as per Clause 2.2.2.3 unless either:

a) The WAPC apply conditions that prevent the lots being sold or developed without further subdivision; or

b) The amalgamated lot is being created to allow the immediate subdivision into smaller lots and this is guaranteed to Western Power's satisfaction.

2.3 Three phase power

Due to increasing demand for three-phase power to supply high power use equipment, it is a requirement that, wherever practicable, all new subdivisions supply three-phase power to each lot.

Where single-phase power is the closest to the subdivision, but three-phase power is available within 500m of a subdivision, the Developer must extend that three-phase power to each lot of the subdivision.

Where single-phase power is the closest and three-phase power is no more than one kilometre away from the subdivision, Western Power may elect to extend its three-phase system to within 500m of a subdivision. The Developer will then be required to extend the last 500m to the subdivision.

However, in some urban fringe and country areas it may be impracticable to obtain three phase-power. In these situations, a single-phase power supply is allowed.

2.4 Headworks to subdivisions

The community recognizes the benefits of underground power reticulation include improved aesthetics, and a safer and more reliable power supply. To meet community expectations, Western Power will extend new headworks in underground in urban and urban fringe areas. However, Western Power will consider the extension of the overhead distribution network on a short term basis across vacant land to the subdivision, provided that the vacant land will be developed into a subdivision in the near future (within five years).

2.5 Increasing existing overhead transformers and switchgear

Western Power will not increase the capacity of existing aerial transformers to meet the needs of subdivisions. This means underground cables, ground mounted switchgear and transformers will be installed to supply the subdivision.

The reinforcement and infrastructure works associated with the proposed underground Electricity Infrastructure will be done to meet the subdivision's power requirement and any planned or logical future growth.

2.6 Network capacity augmentation

Network capacity at each lot of a subdivision may be limited by the existing capacity of the network. The Developer may be required to reinforce the network to achieve the design capacity of its proposed Electricity Infrastructure in the subdivision.

Major subdivisions, e.g. multiple stage large residential subdivisions and large industrial subdivisions for resource processing plants, may have substantial power requirements. These subdivision loads may require new distribution infrastructure, and in the event of significant accumulated loads a new zone substation and new transmission lines to provide the network capacity needed to supply the subdivision.

The Developer must ensure that a site for the zone substation is provided at no cost to Western Power. In addition, major upgrade to the existing HV network (e.g. construction of a new feeder) may be required to service these subdivisions. Typically, Western Power will pay for the Transmission works, i.e. 66kV and above including lines and zone substation. The Developer will have to pay for all the distribution augmentation.

The Developer must consult Western Power at the subdivision development planning stage to ensure Transmission and Distribution infrastructure reinforcement is considered. It should be noted that the need for a new zone substation will vary with different subdivisions and their locations.

Note, in urban fringe, remote and country areas, there may be constraints on the existing network such as network capacity and geographical distance from a zone substation. These can have a significant effect on the cost of extending and reinforcing distribution network.

These costs can be substantially higher than would be experienced for a similar level of reinforcement within a metropolitan network. The Developer is advised to consider these additional costs in the feasibility study stage of developments.

2.7 Future transmission power equipment

Currently, the installation of underground Electricity Infrastructure is limited to the distribution system. While the technology exists for underground transmission power lines, i.e. power lines operated at 66kV and above, it is generally cost prohibitive.

An area built with the distribution network underground may need to route an overhead transmission line through or install new zone substation in the area. Western Power will normally advise the Developer of the potential line corridor and zone substation at the time of subdividing. The Developer must inform prospective land purchasers of Western Power's future development.

Where Western Power has advised of future transmission equipment the Developer must ensure this is shown on all marketing documents and other materials for prospective land purchasers.

2.8 Treatment of existing assets within or adjacent to a subdivision

This policy applies to all land development proposals, including but not restricted to all subdivisions, amalgamations and strata title developments.

The treatment of existing Western Power overhead power lines that traverse or are adjacent to such development proposals shall be as below.

2.8.1 Transmission power lines (i.e. operating at 66KV or above)

Transmission power lines are those that operate at 66,000 volts and above.

For an overhead transmission power line that traverses or is adjacent to the development, generally the power line can remain in situ. However, an Easement in Gross is to be provided for the power line at the proponent's cost. The power line is to be considered adjacent to the development if the development is within the prescribed safety clearance zone (the easement) applicable to the particular transmission line. This is determined in accordance AS/NZS 7000 Overhead line design – Detailed procedures.

There may be circumstances where it is impractical for the overhead transmission power line to remain in situ. Each case will be dealt with on its merits.

2.8.2 Distribution power lines that traverse lots of size 10 hectares or less

For an overhead distribution power line that traverses lots of 10 hectares or less within the development, the following options are available:

2.8.2.1 Rebuild underground through the development in road reserves

The overhead distribution power line can be rebuilt in underground construction in gazetted road reserves through the development.

2.8.2.2 Relocate off the development

If no gazetted road reserves are created in the development or, at Western Power's discretion, the gazetted road reserves that are created are deemed not suitable for rebuilding the line, then the overhead distribution power line can be relocated entirely off the development. In this case, the power line must be rebuilt in underground construction.

However, provided none of the following circumstances exist, then the power line can be rebuilt in overhead construction:

a) Where the surrounding Electricity Infrastructure is already installed underground;
b) Where the local government authority has a requirement for underground electricity in the area;
c) Where there is an underground scheme proposed or in place for the area;
d) Where clearing required for overhead construction would cause unacceptable environmental impact or excessive maintenance costs to Western Power; or
e) Where an objection has been made by an affected member of the community and has not been resolved.

Note that whenever a power line is to be relocated off the development, it is the responsibility of the proponent to perform all negotiations with all affected members of the community and relevant departments and bodies. Western Power will not be an active participant in these negotiations.

2.8.2.3 Rebuild underground through the development outside of road reserves

In circumstances where, in Western Power's opinion, it is impractical to achieve one of the previous two options, the overhead distribution power line can be rebuilt in underground construction through the development outside of gazetted road reserves.

However, in such circumstances, the rebuilt underground power line must be installed within one metre of a property boundary if the area of the lot is less than 2 hectares. Where the area of the lot is 2 hectares or greater than the underground power line may be installed away from the boundary provided all of the following conditions are met.

a) A local government authority has restricted the construction of buildings on the lot to a local government authority nominated building envelope;
b) The building envelope is at least two metres from the underground power line easement;
c) The cable is installed in ducts to Western Power's requirements;
d) A spare duct is installed to Western Power's requirements;
e) Permanent above ground markers are installed along the cable route to Western Power's requirements; and
f) Cable pulling pits are installed to Western Power's requirements along the spare duct route if the duct length is in excess of the cable drum length.

In all cases a Planning and Development Act 2005 Section 167 easement is to be provided at the proponent's cost. The section/s of the power line installed underground through the development off gazetted road reserves is to be kept to an absolute minimum.

To minimise the impact of undergrounding the overhead line on adjacent landowners, the line to cable transition pole and its stay may be located within the development. The transition pole will also be located within the subdivision to minimise the impact on future landowners, i.e. not block driveways, PAWs, etc. In general, the transition pole shall be located within 0.5m of the lot boundary.

2.8.2.4 Rebuild overhead through the development outside of road reserves

In circumstances where in Western Power's opinion it is impractical to achieve one of the previous three options, the overhead distribution power line can be rebuilt in overhead construction through the development outside of gazetted road reserves provided:

None of the following circumstances exists:

a) Where any appropriate Authority has a requirement for new electricity lines in the property to be underground;

b) Where clearing required for overhead construction would cause an unacceptable environmental impact;

c) Where an objection has been made by an affected member of the community and has not been resolved; and

All of the following conditions are met:

d) The lot size is 4 hectares or larger;

e) The edge of any existing or proposed building or building envelope for the lot is at least 10 metres from the centre line of the overhead line;

f) Ongoing ready access will be provided to the line for construction, operation and maintenance; and

g) Vegetation will be cleared and kept clear from the line in accordance with Western Power Network's requirements;

And either:

h) The overhead line runs parallel to a roadside boundary;

i) The overhead line is within 10 metres of the roadside boundary;

Or

j) The overhead line runs parallel to the lot boundary;

k) The local government authority requires a firebreak of minimum width 3 metres in the lot along the boundary, and

l) The line located between the lot boundary and the firebreak;

Note that whenever a power line is to be relocated within a property, it is the responsibility of the proponent to perform all negotiations with, and obtain the approval of, all affected members of the community and relevant departments and bodies. Western Power will not be an active participant in these negotiations.

2.8.2.5 Leave in-situ

In circumstances where, in Western Power's opinion, it is impractical to achieve one of the options outlined in Clauses 2.8.2.1, 2.8.2.2 or 2.8.2.3 then the existing overhead distribution power line can remain in situ provided it meets the conditions stated in Clause 2.8.2.4.

2.8.3 Distribution power lines that traverse lot of sizes greater than 10 hectares

For an overhead distribution power line that traverses lots of greater than 10 hectares within the development, generally the power line can remain in situ provided that no building envelope or structure is proposed underneath or near the line. There may be circumstances where it is impractical for the overhead distribution power line to remain in situ. Each case will be dealt with on its merits.

2.8.4 Cost responsibilities

The cost of all work associated with relocating or undergrounding distribution power lines, including vegetation clearing and the cost for provision of easements etc, is the responsibility of the proponent.

However, in some cases the replacement of an aging overhead line with underground construction may result in a partial cost benefit to Western Power. Where Western Power determines that this is the case it will contribute to the cost of underground construction, equivalent to the partial cost benefit.

2.8.5 Basis philosophy

This policy formalises the long-standing practice that has been embodied in land development clearance conditions that have been agreed between Western Power and Department of Planning and in use for a considerable period of time.

The basic philosophy behind this policy is that as land is developed, there is an increase in the pressure to maximize utilisation of the available area. Where an overhead line is permitted to remain over such land, the end result is often conflict between future landowners' land use requirements and the overhead power line. The principal problems that arise, which this policy is intended to mitigate are:

- Risk to public safety and security of supply. Pressure to maximize land usage can result in unregulated construction under or close to overhead power lines (e.g., metal sheds, sea containers and stored equipment). These often breach safety clearances from overhead power lines, which not only jeopardises the security of the supply, but also more importantly, poses a serious risk to public safety.
- In built-up areas, building setback requirements have been progressively relaxed since the introduction of Department of Planning Residential Design Codes "R Codes". This allows construction of buildings much closer to property boundaries than was previously permitted. In many cases, new setbacks would permit buildings to be constructed within the safety clearance zone (easement) of transmission lines that are located on their normal road reserve alignment. The conditions imposed by the easement would require such buildings to be located outside of this zone. Similarly, the safety clearances from overhead distribution lines may affect or impose construction constraints on adjacent buildings or defined building forms of future buildings. Refer Clause 2.8.6.2.
- Increased difficulty of access for operation and maintenance. Development of land usually results in the construction of fences, gardens, walls and other improvements. These can cause difficulty in gaining access to the power line for operational or maintenance purposes if not properly managed.
- Satisfaction of public expectations. There is a growing public expectation that overhead power lines will be removed from properties or placed underground – particularly at the distribution voltage level. Implementing this at the subdivision stage simplifies this and ensures that the user pays.

The reasons for the difference in policy for transmission and distribution power lines are summarised as follows:

In the case of transmission power lines, it is generally cost prohibitive to relocate or underground them. The only alternative is to protect them with an easement. Because they are significantly fewer in number (and more important in terms of the network) compared to distribution lines it is practical to patrol them on a regular basis to ensure that easement conditions are being complied with. Subdivision planners are advised to discuss with Western Power effects of transmission power line on land use at preliminary planning stage.

In the case of distribution power lines, easements are a limited practical deterrent but are required to provide Western Power with the appropriate power to have infrastructure removed. With such a vast network of distribution power lines throughout the state, it is not possible to patrol all lines to ensure that easement conditions are being complied with.

Easements are often forgotten or ignored by property owners, hence the need for relocation or undergrounding of power lines. A lot size of 10 hectares has been chosen as the limit below which the pressure to maximise the available land begins to jeopardise the integrity of an overhead distribution power line.

2.8.6 Relocation or removal of existing poles adjacent to subdivisions

The following sub clauses shall be read in conjunction with Western Power's guideline for Placement of Power Poles within Road Reserves in Built-Up Areas.

2.8.6.1 Relocation

a) Lots with less than 30m frontage:

   Poles shall be relocated to align with lot boundaries where necessary, or removed and replaced with underground reticulation. Where it can be demonstrated to Western Power that the pole will not cause an issue with future lot use, Western Power may permit the pole to remain in situ.

b) Lots with frontages greater than 30m:

   Poles may remain in present locations if they do not hinder the ability to provide a driveway demonstrated by provision of at least 20m of suitable frontage.

2.8.6.2 Removal

The Developer shall consider the following in determining the need to replace existing overhead with underground infrastructure as an addition to project Infrastructure works scope.

a) The effect that subdivision works including changes to ground levels and structures such as retaining walls have on safety clearances to existing Western Power overhead lines; and

b) Constraints that overhead distribution lines may impose on adjacent building developments as referred to in Clause 2.8.5.

Safety clearance considerations include:

c) OHS Regulations 1996 where working in the vicinity of overhead power lines; and

d) AS/NZS 7000 clearance of power lines from structures.

Refer to Clause 2.2.3.3 for undergrounding requirements of existing overhead reticulation adjacent to survey strata subdivisions.

3. General charging policies

3.1 Distribution headworks charges, reinforcement and interface works

All Distribution Headworks Charges, Reinforcement and Interface Works that include extensions, removals, moving or upgrades to the network external to subdivision shall be fully funded by the Developer. This work may include the construction of a new HV feeder from a zone substation, distribution transformers, LV networks etc for a subdivision. The moving of network includes the relocation of transmission line protection pilot cables affected by the subdivision.

3.2 Small residential subdivision in existing underground areas (not more than 4 lots of any sizes)

The Developer will be charged with the estimated full cost of the design and construction of all Electricity Infrastructure installations, including trenching and laying of cable. The Developer by agreement with Western Power may undertake their own trenching and cable laying in accordance with the installation requirements (Section 6) in this Manual. Western Power's cost for this work will be deducted from its Quote.

Refer to Clause 1.1 'Purpose' regarding flexibility of responsible parties to undertake some smaller subdivision electricity infrastructure works.

3.3 Small residential subdivision in existing overhead areas (not more than 4 lots)

For small subdivision developments located within an overhead reticulated power area, the Developer will be charged for the full cost of all design and construction of Electricity Infrastructure, including Reinforcement and Interface Works, trenching and laying of cables.

However, a Pole-to-Pillar fixed price will apply if the subdivision meets the requirements of Western Power's Pole to Pillar Network Standard.

3.4 Large subdivision of residential lots of size of 1,000m² or less in urban areas

The Developer shall be responsible for the design, supply, installation and testing of the subdivision Electricity Infrastructure (Refer Clause 4.3.3) and payment of Western Power's quotation for the associated Infrastructure Works (Refer Clause 4.3.2.10).

In order to provide equity between developments, a Residential Subdivision High Voltage Pool has been established (see Clause 3.8). This pool is mandatory for all large residential subdivisions with lot sizes of 1000m² or less.

For each lot in an applicable residential subdivision, a system charge per kVA of the After Diversity Maximum Demand (ADMD) is levied to the Developer and paid into a pool. This pool then reimburses the cost of the high voltage infrastructure required for all applicable subdivisions.

The latest HV system charge is published on Western Power's website.

The provision and installation of Low Voltage (LV) Infrastructure and street lighting is not part of the HV Pool Mechanism and is to be paid for in full by the Developer.

The Residential Subdivision HV Pool does not include 33kV subdivisions. Design and construction of all 33kV infrastructures must be fully funded by the Developer.

The operation of the HV Pool policy is explained in detail in Clause 3.8.

3.5 Large subdivision of residential lots of size greater than 1000m² in urban areas and areas zoned "rural" or "special rural" (Broadacre subdivision)

The subdivision HV Pool does not apply to residential subdivisions with lots larger than 1000m² as they are too variable for a pool to operate.

3.6 Commercial and industrial subdivisions

The subdivision HV Pool does not apply to industrial and commercial subdivisions.

When a subdivision has a mixture of residential, commercial and industrial freehold lots, the subdivision is considered as a commercial or industrial subdivision, if the total design load of the commercial and industrial lots is greater than 50% of the total design load of the subdivision. Likewise is considered as a residential subdivision when the total design load of the residential lots is greater than 50% of the total design load of the subdivision.

For the purpose of assessment, schools are considered to be commercial lot.

3.7 Changes to existing assets that need to be altered

The cost of all work associated with removing, relocating or undergrounding transmission or distribution assets including zone substations, distribution substations, power lines, vegetation clearing and the cost for provision of easements etc, is to be fully funded by the Developer.

However, in residential subdivisions with lot size not more than 1000m² the subdivision HV Pool will apply to the undergrounding of one HV overhead distribution line that traverses the subdivision. The undergrounding of any additional overhead distribution line will be fully funded by the Developer.

3.8 High voltage pool policy and operation

3.8.1 Background history

The High Voltage (HV) Pool was introduced by Western Power in 1999. The mechanism of the HV Pool was developed as a joint initiative between The Urban Development Industry of Australia (UDIA) and Western Power.

Due to the use of standard size components and for network planning purposes, the HV Electricity Infrastructure of a subdivision often provides capacity in excess of that required by the subdivision.

It was often the case that the first Developer in an area paid for the entire HV Electricity Infrastructure required to service the area. The excess capacity was then utilised by subsequent Developers without contribution to its cost.

The cost of low voltage (LV) Electricity Infrastructure of a particular subdivision is closely linked to the need of that subdivision; and its capacity is mostly used by that subdivision.

The HV Pool mechanism was introduced as part of Western Power pricing strategy to address inequities between Developers in the application of the Western Power's full cost policy for providing Electricity Infrastructure in subdivisions.

Initially, two HV Pools were established, viz. Residential HV Pool for residential subdivisions of lot sizes not more than 1000m² and Commercial/Industrial HV Pool for commercial and industrial subdivisions. The Commercial/Industrial HV Pool failed to achieve an equitable result and it was subsequently agreed with UDIA to discontinue its use.

The Residential HV Pool provides the land development industry with a cost equalising mechanism for Electricity Infrastructure for a UDS for residential subdivisions.

The provision of Electricity Infrastructure to new subdivisions remains a full cost policy; however, Western Power has agreed to operate the Residential HV Pool for residential subdivisions provided it remains cost neutral to Western Power.

3.8.2 High voltage pool administration

Western Power administers the Residential HV Pool and, by agreement with UDIA, recovers the cost of administering the HV Pool by recouping 4% of the HV Pool Charge (See Clause 3.8.6) of each proposed subdivision.

Western Power's administration work on the HV Pool includes:

- Day-to-day maintenance of the scheme.
- Training of HV pool administrators and industry users.
- Management of the pool integrity including auditing.
- Financing the inherent lagging nature of the HV Pool income, and
- Provision of I.T. support to develop and maintain the required technology systems.

The administration fee is collected by adding 4% to the system charge each time it is reset. This fee is not to be included in the HV Pool but is directed to a separate account to pay for Western Power's administration of the HV Pool.

The operation of the HV Pool does not create the relationship of:

- Employer and Employee;
- Principal and Contractor;
- Partnership; or
- Joint venture;

And between Western Power and the Developer in respect of a UDS.

3.8.3 System charge

The system charge is the cost per kVA ($/kVA) to fund HV Pool Payments (see Clause 3.8.7).

The System Charge in $/kVA is inclusive of the 4% HV Pool administration fee. The latest HV system charge is published on Western Power's Web site.

The system charge is required to be reset either every six months or when the HV Pool balance is trending away from neutrality.

3.8.4 Subdivision design load

The design load used to calculate the system charge for the proposed subdivision includes all residential and commercial/industrial design loads within the WAPC subdivision boundary. The design load requirements are in Clause 5.3.2.

3.8.5 Schedule of rates

The Western Power design process and cost estimating package is based upon a suite of compatible units (CU). Each CU is a physical network component broken down into its individual parts with associated estimated material cost and estimated installation costs.

The schedule of rates (SOR) of each CU in the HV Pool is estimated using the Western Power material costs and industry installation rates. The Western Power material costs are automatically updated weekly and the industry installation rates are updated by industry representatives annually.

The schedule of rates is used to calculate the HV Pool Payment of each subdivision (see Clause 3.8.7).

3.8.6 HV pool charge

The HV Pool Charge of a proposed subdivision is the system charge multiplied by the proposed Design Load of that subdivision ($/kVA x Design Load).

The HV Pool Charge is the amount paid into the Pool by the Developer for the provision of HV Electricity Infrastructure of a UDS for a proposed subdivision based on the "Design Load" of that subdivision.

3.8.7 HV pool payment

The HV Pool Payment is the amount paid to the Developer by the HV Pool for the provision of the HV Electricity Infrastructure of a UDS for a proposed subdivision.

The HV Pool Payment is estimated by adding up the schedule of rates of all the CUs required for the HV Electricity Infrastructure of the UDS of the proposed subdivision.

3.8.8 High voltage pool mechanism

The HV Pool mechanism is independent of the cost of Installations. The HV Pool mechanism equalises the HV Electricity Infrastructure costs by requiring Developers to pay the HV Pool Charge into the HV Pool and the HV Pool then pays the Developer the HV Pool Payment.

The net result is that the Pool collects funds from Developers who contribute under their share of HV Electricity Infrastructure and compensates Developers who pay over their share, with the objective of keeping the HV Pool in balance.

A complying residential subdivision that meets the economic criteria can participate in the HV Pool (see Clause 3.8.11).

The Developer will install both the HV and LV Electricity Infrastructure at its own cost. However, the Developer pays Western Power to carry out other works. The payment to Western Power includes the following:

a) The payment from the Developer to Western Power to carry out all the HV and LV Electricity Infrastructure installation works excluding civil works.

b) The payment from the Developer to Western Power to carry out other works such as network interfacing work, additional work requested by the Developer and DCR.

c) The net difference between the HV Pool Payment paid to the Developer by HV Pool and the HV Pool Charge paid into the Pool by the Developer.

{Payment = (Other costs) + ($/kVA x Design Load – Total of SOR of CUs)}.

A balance of HV Pool Payment will exist when the amount of payment is negative. The balance of HV Pool Payment is available to the Developer only upon successful completion of handover inspection of the subdivision.

3.8.9 Subdivisions and assets included in HV pool

The following subdivisions and assets are included in the Residential HV Pool:

a) Large subdivisions of residential freehold lots of size not exceeding 1000m^2 processed through the WAPC land development process.

b) The provision of the high voltage overhead and underground Reinforcement and Interfacing Works necessary for the proposed subdivision, provided they are carried out in accordance with Western Power's Policy Statement, "Deciding Between Distribution Overhead and Underground Constructions in Road Reserves".

c) The provision of underground HV Electricity Infrastructure within the proposed subdivision boundaries.

d) The removal of one HV overhead distribution line with transformers and pole top switches is included in the HV Pool. However, the relocation or removal of any additional HV Electricity Infrastructure is not part of the HV Pool.

e) Large subdivisions of residential lots with a mixture of lots greater than and less than 1000m^2 of which the loads of the lots exceeding 1000m^2 is not more than 50% of the total subdivision load.

3.8.10 Subdivisions and assets excluded from HV pool

The following subdivisions and assets are excluded from the Residential HV Pool;

a) Small (not more than 4 lot) subdivisions of residential lots.

b) Large subdivisions of residential lots of size exceeding 1000m^2.

c) Large subdivisions of residential lots with a mixture of lots greater than and less than 1000m^2 of which the load of the lots exceeding 1000m^2 is more than 50% of the total subdivision load.

d) Subdivisions supplied from the 33kV distribution network.

e) HV Infrastructure that is not associated with the permanent supply of the Design Load such as more than one HV network relocation, temporary installations or additional works required by Western Power for network reinforcement purposes.

f) The provision of Low Voltage (LV) Electricity Infrastructure is not part of the HV Pool mechanism and is paid for in full by the Developer outside the HV Pool process.

3.8.11 Economic test

The HV Pool Mechanism is designed to accommodate the vast majority of residential subdivisions, but there are some occasions when the inclusion of a subdivision into the HV Pool would increase the system charge unreasonably, to the detriment of all other HV Pool participants.

To manage this issue two economic tests have been included in the HV Pool process. A subdivision that fails in either one of the two following tests cannot participate in the HV Pool.

The two tests are:

3.8.11.1 System charge impact test (Economic % Test)

The system charge impact test is a measure of the impact on the baseline system charge when the proposed subdivision is included in the Pool.

It is determined by comparing the sum of the HV Pool Payment for the proposed subdivision and the baseline accumulated HV Pool payment, divided by the sum of the proposed Design Load and the baseline accumulated design load with the baseline system charge (see formulae below).

$$\text{Baseline System Charge} = \frac{\text{Baseline Acc HV Pool Payment}}{\text{Baseline Acc Design Load}}$$

$$\text{Economic \%} = \frac{(\text{Acc HV Pool Payment} / \text{Acc Design Load})}{\text{Baseline System Charge}} - 1 \times 100\%$$

Where:

a) Baseline Acc HV Pool Payment = Accumulated HV Pool Payment used in the determination of the last system charge reset

b) Baseline Acc Design Load = Accumulated Design Load used in the determination of the last system charge reset

c) Acc HV Pool Payment = Baseline Acc HV Pool Payment + HV Pool Payment of the proposed subdivision

d) Acc Design Load = Baseline Acc Design Load + Design Load of the proposed subdivision

e) If the test result indicates that the system charge would increase by more than 2% (i.e. Economic % > 2%) then the proposed subdivision fails the system charge impact test.

3.8.11.2 Ratio test (Economic kVA Test)

The Economic kVA Test is a measure of the cost effectiveness of providing HV Electricity Infrastructure for the proposed subdivision.

It is determined by comparing the HV cost per kVA (i.e. total of SOR of CUs divided by the Design Load) of the proposed subdivision with the baseline system charge (see formula below).

$$\text{Ratio} = \frac{\text{HV Pool Payment of the subdivision} / \text{Design Load of the subdivision}}{\text{Baseline System Charge}}$$

If the result is equal to or greater than four times (i.e. Ratio ≥ 4) then the proposed subdivision fails the ratio test.

3.8.12 Economic re-test

When the first stage of a subdivision development in an area or any stage of a large subdivision development scheme fails the economic tests, that stage cannot participate in the HV Pool.

If within five years or as otherwise agreed by the Committee, of the Acceptance of Quote of that stage the Developer does further stages of the subdivision development, or other Developers do subdivisions that are adjacent to the original subdivision, the economic tests will be redone by using the combined HV Pool Payment and Design Load for all stages.

Developers shall be responsible for initiating any re testing of stages that have previously failed.

If the subdivision with the combined stages or subdivisions subsequently passes the tests, the HV Pool pays the Developer the HV Pool Payment and the Developer pays the HV Pool the HV Pool Charge for the subdivision under re-test.

When the system charge is reset, no subdivisions that previously failed the economic tests are eligible for an economic re-test until a further stage of subdivision or another subdivision is connected to them. The economic re-test will be done using the SOR appropriate at the time when the connection of a further stage of subdivision or another subdivision takes place.

3.9 'Per-lot fee' system

The per-lot fee replaces the bond scheme and will apply to all subdivision energisation quotes issued by Western Power from 1 July 2007.

The per-lot fee will provide funds for Western Power to consider calling upon to undertake selected subdivision works resulting from Developer default. A component of the fee will also be used to cover related administration costs. For example, debt recovery fees for defaults.

a) Terms and conditions – These terms and conditions comprise the per-lot fee arrangements for subdivision energisation, unless specifically excluded or modified in writing by an authorised representative of Western Power.

b) Applicability – The per-lot fee will apply to large subdivisions of 5 or more green (freehold) titled lots. The fee is applicable to residential and commercial lots and includes public open space. Un-serviced lots e.g. balanced lots, will not be charged.

c) The per-lot fee has been revised to $0 per-lot.

d) Revision – The per-lot fee will be reviewed on an annual basis. At each review Western Power will assess the total cost of land developments defaulted in the prior 12 month period. Western Power will set the revised fee to ensure reasonable risk is covered within the next 12 month period.

e) Payments – Where a per-lot fee quote supplied by Western Power payment options and deadlines will also be provided. Please note that Western Power must receive the per-lot fee payment in full prior to enabling Western Power processes to proceed.

f) Modifications or Amendments – Western Power will require an additional per-lot fee payment when a Developer increases the number of lots being developed. The Developer is required to finalise additional payment where required, in advance of works commencing, or if they have commenced, then before those works continue. Where a Developer reduces the number of lots being developed, they can apply to Western Power for a refund of the appropriate per-lot fee payment.

g) Early Clearance – Payment of the per-lot fee will not by itself secure early clearance. Early Clearance will only be given after the design DCR has been accepted by Western Power (Refer Clause 4.3.2.6) and the subdivision quote and per-lot fee quotations where required have been paid in full and deposited plan accepted by Western Power. Also refer Clause 4.1.5 Clearance Request Submission and Clause 6.2.3 for time to complete the subdivision where early clearance granted. For early clearance requests it is recommended that MGA94 files be provided with the deposited plan to assist with the later energisation process.

4. Land development process

This section details the Developer's and Western Power's involvement in the WAPC's land development process. It then details Western Power's processes and responsibilities for both small and large subdivisions.

4.1 Western Australian planning commission subdivision process

The Planning and Development Act 2005 requires plans of subdivisions to be approved by the WAPC. Under the Act, the Registrar of Titles shall not create or register a Certificate of Title for land within a subdivision plan unless it has been endorsed with the approval of the WAPC. The high level process from the application of subdivision development through to issuing new titles has been described in Clause 1.9.

4.1.1 WAPC subdivision process

a) The Developer submits an application for a freehold (green title) subdivision or survey strata to WAPC.
b) WAPC refers the application to Western Power, other service providers and the relevant local government to determine its conditions for a subdivision development.
c) Western Power reviews the present network (both distribution and transmission) to determine the conditions that it will recommend be applied to the subdivision application.
d) Western Power then replies to the WAPC with the recommended conditions.
e) WAPC sends the applicant approval for the subdivision, subject to conditions being met.
f) Western Power receives a copy of the approval and advises the applicant of the appropriate next steps to meet the conditions, which may include an application for Small Residential Connection.
g) All conditions are fulfilled.
h) The surveyor representing the Developer requests clearance of the conditions from Western Power.
i) Western Power issues a clearance certificate when WAPC's conditions are met.
j) The Developer submits deposited plan(s) to WAPC after collecting all clearance certificates. The WAPC endorses its approval on submitted deposited plans if satisfied the deposited plans are in accordance with the approved plans and the conditions are met.
k) The Developer applies to Landgate for new Titles.

An application guide for approval of freehold subdivisions or survey strata is available at WAPC's web site.

4.1.2 Conditions of subdivision development

Why does Western Power impose conditions on subdivision applications?

As the responsible network operator and a public utility, Western Power imposes conditions on any subdivision application to ensure the following:

a) Lots being created will have adequate underground electricity services.
b) Any potential impact on Western Power's network, for now and the life of the subdivision is addressed.
c) The network is extended in a proper and safe manner that will meet the long-term power requirement of the network.
d) The extension of the network will meet all safety and legal requirements and standards.
e) Suitable quality electricity supply is provided to any customer connected to the network.
f) The reliability of the network is maintained or improved.

When and where will Western Power conditions be imposed?

Western Power will generally impose conditions on subdivision applications in accordance with the following table:

When & Where	Summary of Conditions
Freehold title subdivision	Provision of underground electricity supply, one connection per lot.
Survey strata title subdivision	Provision of underground electricity to survey strata lots, one connection per strata plan.
Existing or future transmission/ distribution network asset	Provision of electricity service supply easement.
Network infrastructure on or near to subdivision being affected	Relocation/removal/replacement of Electricity Infrastructure.
Substation sites required	Provision of land as road reserve.

Table 1: Summary of Conditions of Subdivision Development

When underground power is required WAPC may also require any existing overhead mains on the same side of the road as the lot being subdivided and consumer services within property boundaries be converted to underground.

In the development of subdivision conditions for approval, WAPC takes recommendations only from Western Power but may add or delete conditions as it sees fit.

Model Conditions Schedule of WAPC can be obtained from the WAPC website.

4.1.3 When will Western Power issue a clearance certificate on WAPC applications?

Western Power will issue a clearance certificate when:

a) a clearance request is received from the Developer or the Developer's surveyor;

b) all Western Power conditions have been met;

c) other conditions as required based on the situation of each subdivision application that has a potential impact on Western Power's network, e.g. road widening, are addressed to the satisfaction of Western Power;

d) all Western Power's requirements in the DIP are met; and

e) overhead network and connection services which form part of the subdivision or affected by the subdivision are converted to underground;

f) the issuing of a clearance certificate will not compromise community or network safety.

4.1.4 How can Western Power conditions be met?

4.1.4.1 Small Subdivisions

For small subdivisions of not more than four lots, the following items need to be completed to meet Western Power's conditions:

a) The applicant/Developer of a subdivision completes and returns to Western Power the "Request for Quote on work associated with WAPC application", which can be obtained from Western Power's website.

b) Western Power will provide a design and quotation for the work required to meet the conditions.

c) The Developer pays for the Quote and completes its work in accordance with the terms and conditions in the Quote.

d) Overhead network and connection services are converted underground.

e) Other conditions as required, based on the situation of each subdivision application, that have potential impact on Western Power's network, e.g. road widening, are addressed to the satisfaction of Western Power.

4.1.4.2 Large subdivisions

For large subdivisions of more than four lots, the following items need to be completed to meet Western Power's conditions:

a) A Developer will request a Design Information Package (DIP) from Western Power.

b) The Developer will need to engage a Designer to develop an electrical design for the subdivision.

c) The Developer will submit the electrical design in accordance with the requirement in the DIP and this Manual to Western Power for Design Conformance Review (DCR).

d) Western Power will issue a Quote for Interface Works.

e) The Developer pays for the Quote and completes its work in accordance with the terms and conditions in the Quote and the requirements of this manual.

f) Overhead network and connection services are converted underground.

g) Other conditions as required, based on the situation of each subdivision application that has potential impact on Western Power's network, e.g. road widening, are addressed to the satisfaction of Western Power.

4.1.5 Clearance request submission

Once the financial and installation requirements have been met, the Developer's surveyor can submit a request for clearance to Western Power. The form for this purpose can be found on Western Power's website

All clearance requests should be submitted to

Western Power
GPO Box L921
PERTH WA 6842

Or

wapc@westernpower.com.au

4.1.5.1 Requirements

WAPC conditions on approved subdivision plans for both freehold and survey strata developments are only cleared after the following requirements are met:

a) Payment in full of Western Power quote including where appropriate a Per–Lot Fee (Refer Clause 3.9) and

b) Submission of a copy of the deposited and or survey strata plan of the subdivision to Western Power showing substation sites, easement, restrictive covenant and Notification requirements, and

c) Compliance with other easement and/or special requirements that may include provision of Main Switchboards and Completion Notices for survey strata developments and

Either,

d) Western Power receipt of As Constructed drawings for large projects

Or,

e) For early clearance request a copy of Approved for Construction drawing being part of the DCR submission and compliance with Early Clearance requirements of Clause 3.9.

4.1.5.2 Clearance

Western Power will approve clearance and endorse the submitted deposited plans provided all conditions and requirements are met. A clearance certificate letter, along with the endorsed deposited plans, will be forwarded to the Developer's surveyor. In a case where clearance is not provided, the surveyor will be advised of the reasons by Western Power.

4.1.6 Clearance of special subdivision lots

Developers may elect to develop subdivisions in progressive stages.

The formation of new lots in stages may result in the creation of a parcel of un-serviced land (balance lot) of substantial size or smaller serviced lots that are similar in size to the adjacent lots.

Designs must be electrically holistic, inclusive of all serviced lots, network supplies, switching points within the boundaries of the subdivision.

Creation of a balance lot, or LES must be done so sparingly to ensure the efficient and safe electrical control and management of the subdivision.

Western Power will review the inclusion of any un-serviced lot or serviced/un-energised lot or LES on a case by case basis and reserves the right to reject any application or design where safety in design principles have not been applied.

4.1.6.1 Balance lots

4.1.6.1.1 Serviced

Where a lot that can be used "as is" and is of a similar size to adjacent lots within the subdivision, the lot must be serviced and Electricity Infrastructure installed. Design and As Constructed drawings including deposited plans must show all serviced lots and payment for the Electricity Infrastructure must be made.

Where the serviced lot is not to be included on the deposited plan:

a) The installed LV Electricity Infrastructure to that lot or lots shall be secured in a non-energised state.

b) The Serviced Un-Cleared De-energised Lot shall be identified on the plan as a [SUDL]

c) Energised Electrical Infrastructure (Substations, HV/LV circuits, street lights etc) shall be contained within the road reserve. Any energised serviced lot must be supplied from the primary/initial stage.

d) A un-energised LV circuit shall be reinspected prior to energisation

e) Customer consumer main cables shall not be connected to an un-energised pillar or UMS pit. Refer to Section 12 of the WADCM

f) A copy of the stamped deposited plan is to be provided to Western Power with the "As Constructed" drawings and records. Refer to clauses 6.2.2.7 and 6.2.2.10 for additional information.

4.1.6.1.2 Un-Serviced

Where a lot is substantially bigger and in Western Power's opinion will not be sold as is, then servicing of the lot may be deferred subject to agreement with Western Power, or a financial provision for an appropriate supply is made as determined by Western Power.

Western Power will consider all or some of the following in lieu of a financial contribution:

a) A Letter of Undertaking from the Developer agreeable to Western Power stating its intention for further subdivision and development for any balance lot, that is WAPC identified to or zoned for future urban purposes and that is not to be sold before it is serviced must be submitted to Western Power.

b) Provision of a Notification 70A imposed on the title noting that the lot owner will liaise with Western Power to provide a suitable power supply or make a financial contribution for same prior to the sale of land.

c) Evidence that planning authority identified or zoned the land for future subdivision purposes and have approved a future structure plan.

d) Lot identified as a lot 9000 series.

e) Letter of Agreement suitable to Western Power stating the intention of future subdivision and in the event of prior sale of the land will request and pay for a suitable power supply or an agreed financial contribution with Western Power.

f) The balanced lot is to be developed by a state or local government body.

Where a financial contribution is required:

g) In situations where specific supply requirements are unknown, Western Power will only require the cables installed for clearance (where appropriate[1]).

h) Transformers, switchgear and other infrastructure will not be installed until the customer's requirements are known and they are ready to construct their premise. Refer also Clause 4.1.6.2.

Design and As Constructed drawings including deposited plans must show the un-serviced balance lot.

4.1.6.2 Multi residential and/or commercial/industrial subdivision lots where installation of a required distribution substation is not considered appropriate at subdivision stage.

Required substations to be provided as part of subdivision are preferably located within public owned land. Refer Clause 5.3.18. Alternative arrangements may be agreed between Western Power and the Developer if the installation is not appropriate at the time of subdivision for the following reasons.

- **Situation 1**: Local Planning Scheme built form building setback requirements or the proposed building development does not provide adequate land for an external substation including consideration of fire clearance requirements. It is expected that the substation would be installed within the building as part of the subsequent building development.

[1] Cable will not be installed in situations where a high degree of uncertainty exists regarding the suitable location and size of the cable

- **Situation 2**: The proposed site building development and subdivision are not undertaken concurrently and it is considered inappropriate to nominate a substation location that may not suit the future development. Should the substation be installed external to the future building then an extension of road reserve for the substation site is preferred.

Western Power may accept a deferment of the substation installation subject to the following:

a) A financial provision paid to Western Power to contribute to the future works, being the present estimate cost of the works.

b) Additionally for Situation 1 provide approved local planning scheme and associated built form conditions applying to the lot demonstrating setback and other requirements preventing an external substation installation.

c) A letter of access offer agreement suitable to Western Power prepared to describe the arrangement.

4.1.6.3 Homestead lots

Homestead lots are part of a proposed residential subdivision development. They are usually being serviced with overhead electricity supply. In general, they should only be cleared with the whole subdivision as they will obtain underground supply via the network that will be constructed in that subdivision.

In some instances, a Developer may require the clearance of homestead lots prior to the construction of the subdivision. Western Power will provide clearance to homestead lots subject to the following conditions being met:

a) The homestead lots front an existing road where existing network connection is available.

b) A DIP request for the subdivision has been received by Western Power.

c) The Developer provides a letter of undertaking that the underground supply of the homestead lot will be incorporated into the design of the subdivision and converted as part of the subdivision.

d) The Developer is to provide an undertaking (Clause 4.1.6.1) for the balance of the lot.

e) The existing aerial supply of the homestead lot must be converted to underground power at full cost to Developers prior to clearance being issued.

f) The electrical contractor has submitted a Notice of Completion with a copy to Western Power (accompanying the request for clearance application) indicating that site electrical works are complete enabling the aerial to underground conversion to be undertaken by Western Power.

Note: Where an individual rural lot is to be created or excised from a larger rural lot and access to a network connection is not available or Western Power determines is not practical in terms of distance and or accessibility, the customer may seek to be exempted from the provision of a network connection. Where the application is supported by Western Power, an appropriate notification/statement shall be placed on the Certificate of Title.

4.1.7 Clearance charges

There is no charge on the initial submission of a request for clearance. However, re-submission of a request for clearance, resulting from insufficient or incorrect detail in the original application, will incur a charge in accordance with the 'Network service charges' – published on the Western Power's website.

4.1.8 Electronic land development process (eLDP)

Electronic Land Development Process (eLDP) is one of the activities of the Shared Land Information Platform (SLIP) initiated by the Department of the Premier and Cabinet. The eLDP being developed by DLI is an "end to end", case-managed system encompassing the whole of the land development process, from lodgement of the application of subdivision approval, to the issue of new titles.

4.1.8.1 Project aim

The project aim is to develop an electronic, automated process based on best practice that will facilitate harmonisation and integration of agencies of differing roles and objectives within the land development process.

The process (when fully developed) will be implemented by DPI, WAPC, referral authorities (e.g. Western Power) and local government. Developers are out of scope of the electronic process being developed.

4.1.8.2 Pilot process and role of Western Power

Western Power is actively participating in the scoping, analysis and design phases. A pilot process "WAPC Short Track Referrals" on simple subdivision applications subdividing one lot into two has been running since the end of October 2005. In the pilot process, WAPC advises Western Power via e-mail of any new referrals of subdivision applications. Western Power's Work Administration will login to the DPI Short Track Referral web page to download applications into Western Power's system for work administration purposes. Western Power's Work Administration will submit Western Power's conditions to WAPC through the Short Track Referral web page.

4.2 Development of small subdivision up to four lots

Small subdivisions are defined in Clause 1.7.2. Essentially there are two processes to provide power. The processes vary slightly depending on whether or not they need WAPC clearance. Details and responsibilities for each stage are given in the following sections.

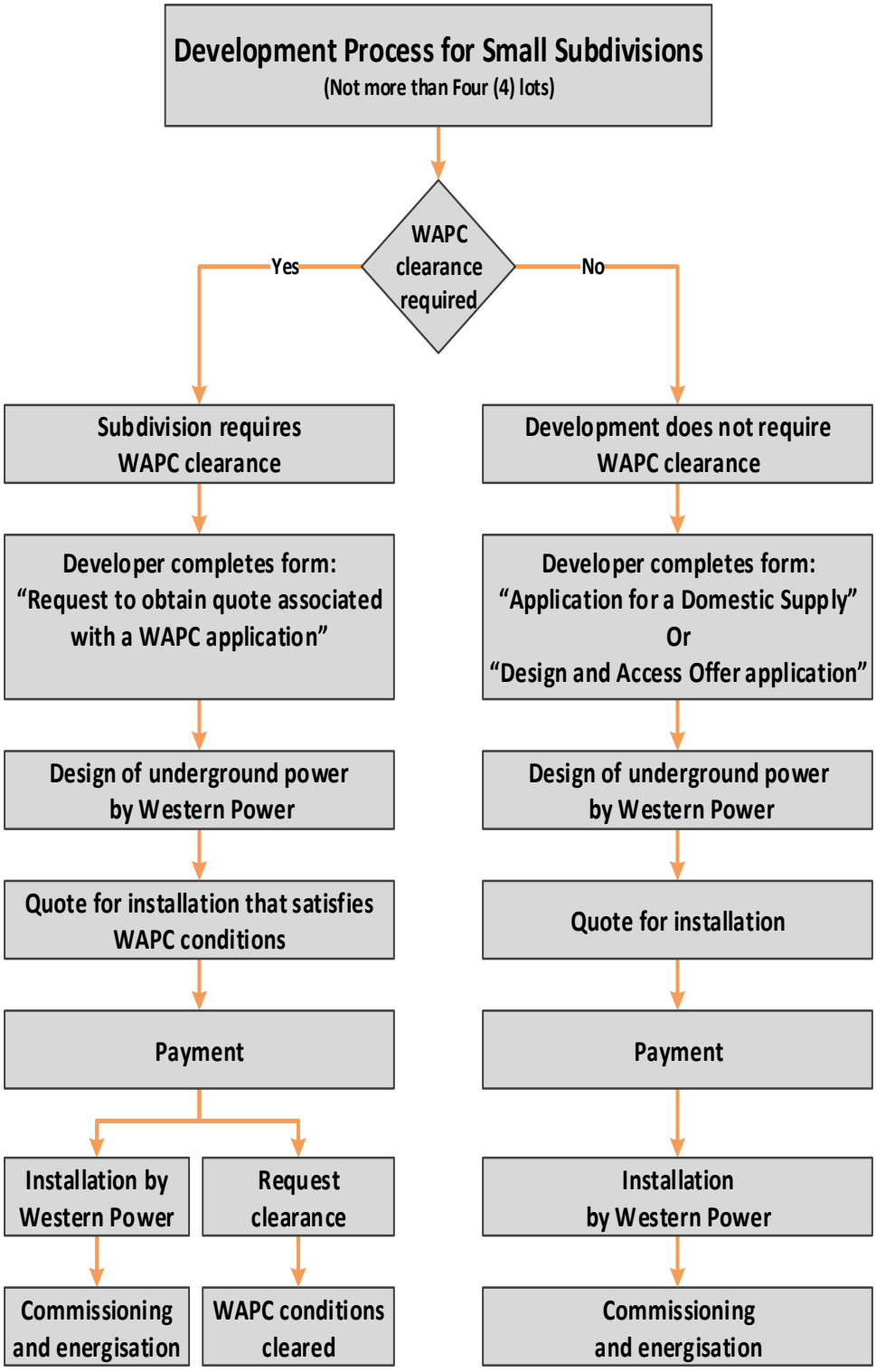

Figure 4: Development Process for Small Subdivisions

4.2.1 Process detail

A Developer, who intends to proceed with the development of a subdivision of not more than four lots, should follow the process in the following table:

WAPC Clearance Required (Freehold, vacant or survey strata subdivision)	WAPC Clearance not required (Previous cleared subdivision or built strata development)
The Developer must complete the appropriate application form which can be obtained from: the *Western Power website*	The Developer must complete the "Application For Domestic Underground Supply" form or "Design & Quotation Application for an Electrical Network Connection" form, which can be obtained from: the *Western Power website*
Return the completed form to Customer Network Connections, GPO Box L921, PERTH WA 6842) for processing. The application will not be processed unless the subdivision is approved by WAPC.	Return the completed form to Customer Network Connections, GPO Box L921, PERTH WA 6842) for processing.
Western Power will create a design project and advise the Developer of the reference project number.	Western Power will create a design project and advise the Developer of the reference project number.
Western Power will carry out the design of underground power and provide a Quote on the work required to meet the clearance conditions of WAPC approval.	Western Power will carry out the design of underground power to the Developer and provide a Quote for the installation work.

Table 2: Process Detail for Small Subdivisions

The Quote will be valid for 90 days and Western Power does not charge for the initial Quote. However, if requirements change or if the Quote expires, Western Power reserves the right to charge for any additional time spent in the preparation of a re-quote.

Western Power provides the Developer two options to pay for the work, if the Developer decides to proceed. The two payment options are as follows:

Either:

a) A full up-front payment of the quoted amount at the time of Acceptance of Quote;

Or:

b) Provided the total quotation is for more than $30,000, two staged payments of:
   I. 30% of the quoted amount, plus a $550 administrative charge at the time the quotation is accepted; followed by
   II. 70% of the quoted amount prior to commencement of site works.

4.2.2 Western Power's responsibility

The Quote provided by Western Power covers the following scope of work:

a) The Design of UDS for the subdivision, for a fee.
b) The supply and installation of all materials including cable and service pillars for the provision of underground power.
c) The supply and installation of street lights, if required.
d) The trenching and laying of cables.
e) Western Power will provide a service connection point in the form of a service pillar at property boundaries or where required a substation. Any electrical installation beyond service connection point is the responsibility of landowners or the Developer.

4.2.3 Developer's responsibility

The Developer/customer's scope of work and expenses include the following:

a) The accurate pegging of all subdivision and lot boundaries.

b) Providing land for the installation of a substation (transformers and switchgear) if required. The land must be incorporated as part of public road reserves, at no cost to Western Power.

c) Prior to the commencement of any work, the Developer must ensure the finished levels at each service pillar and substation site are set and all final survey boundaries pegs are in place.

d) Any verge reinstatement, the clearing or pruning of vegetation to Western Power's required safety profiles and relocation of other services, such as gas or water. Developers should liaise directly with the local council or service utility with regard to the cost of this work or repairs.

e) Obtain all necessary and relevant clearances required, including environmental clearance, native title, aboriginal heritage, etc.

f) Where an easement restrictive covenant or Notification is required by Western Power, the Developer must provide these at no cost to Western Power.

g) Advise potential land purchasers of all easement locations, restrictive covenants and Notifications and their use and restrictions.

h) Notify all affected parties, including other Western Power customers affected by the development. Where existing aerial mains are to be removed as part of the subdivision work, the Developer will also be responsible for the reconnection of existing Western Power connected customers to underground power and the cost to carry out the work.

i) Electrical installations beyond service pillars including consumers' main cables between service pillars and meter boards.

j) Coordination of all other services work.

k) Ensure the site is safe, in accordance with the Occupational Health Act 1984 and Occupational and Health Regulations 1996 and other Acts of Parliament, during the construction phase.

4.3 Development of large subdivision of more than four lots

Developers intending to proceed with the development of a subdivision of more than four lots shall engage a Designer organisation to produce designs in accordance with this manual.

4.3.1 Process

The following figure shows the development process for large subdivisions.

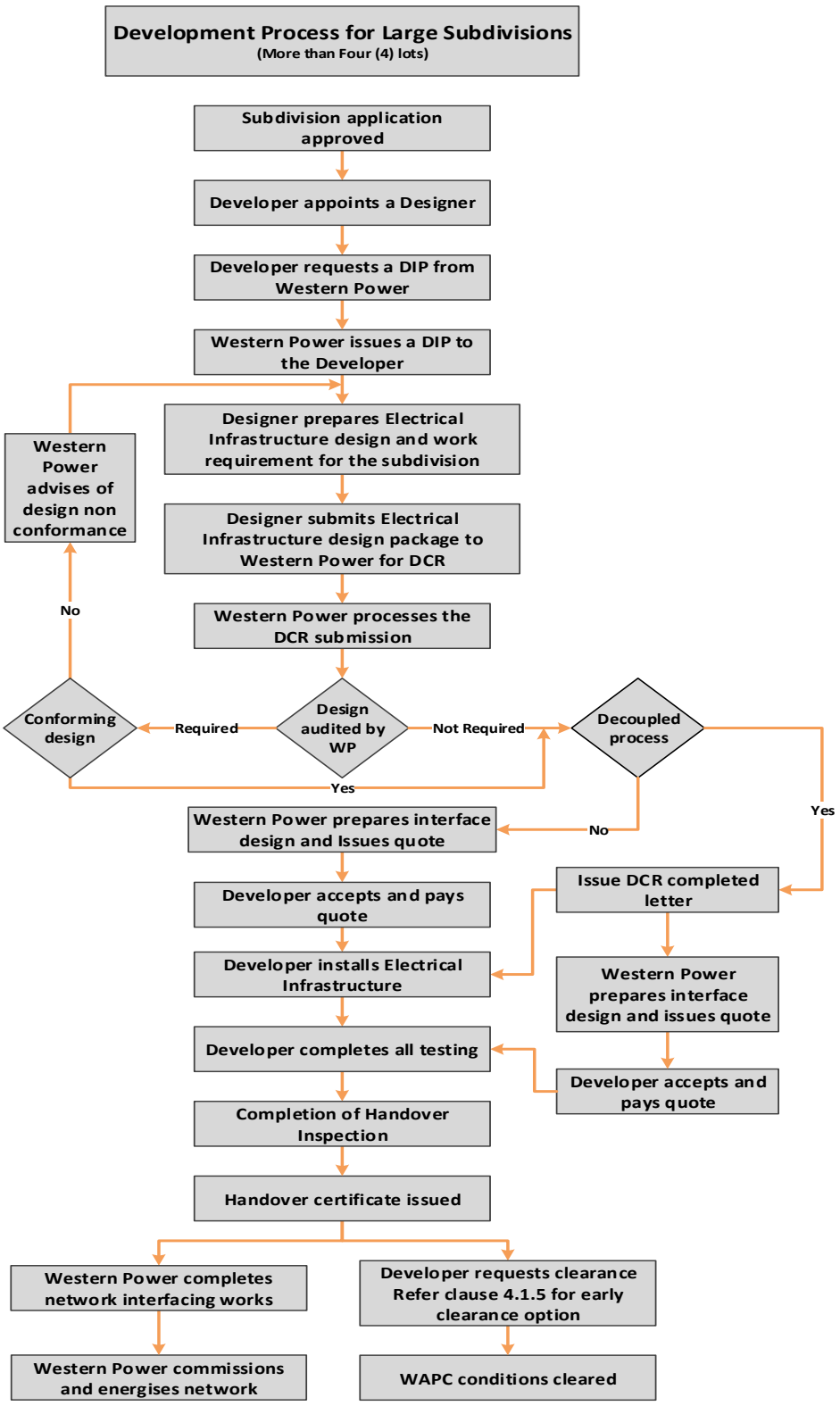

Figure 5: Development Process for Large Subdivisions

4.3.2 Process detail

4.3.2.1 Designs for underground distribution schemes

Developers are responsible for providing UDS designs by engaging Designers to develop them. The Developer must appoint an Engineer to check and certify that UDS designs meet the requirements of this Manual. Western Power will:

a) Provide the Designer Organisations with DIP appropriate to the developments and their locations.

b) Provide a site visit service, if required, to confirm the location of any Western Power equipment.

c) Audit the UDS designs certified by Engineers on random basis to ensure they conform to Western Power's design requirements, planning criteria and construction practices.

4.3.2.2 Developer requests a DIP from Western Power (DIP request)

The Developer is required to contact Western Power to register responsibility for the design of an UDS for a subdivision and request a DIP through Western Power's public electronic mailbox External Design and Construct, in accordance with the requirements in Clause 4.4.1. This contact may follow feasibility studies undertaken by the Developer based on information provided by Western Power.

The Developer must complete the "Subdivision Developer's Authorisation and DIP Request" form that provides details of the appointment of the Design Organisation, the Designer and the Engineer of the UDS design; and authorises Western Power to directly deal with them. This form is available for download from Western Power's website.

At this point, the Developer will provide information/documentation shown in Clause 4.4.1.

4.3.2.3 Western Power issues a DIP to Designer Organisation

Western Power will review the proposed subdivision, prepare the DIP, containing the information outlined in Clause 4.4.2, and issue it electronically to the Designer Organisation.

For any changes to the information contained in the DIP, written approval from Western Power must be obtained before they can be included in design.

The information contained in the DIP will be valid for a period of six months from date of issue.

4.3.2.4 Designer designs UDS

On receipt of the DIP, the Designer will proceed to prepare the UDS design. At this stage, it may be necessary for the Developer to negotiate with Western Power to specify which, if any, part of the work is to be undertaken by Western Power, e.g. headwork extensions. The Designer will then incorporate this into the design and capture it on the Bill of Materials. This work will be reflected in the final Quote from Western Power.

4.3.2.5 Engineer submits design for design conformance review (DCR)

When the UDS design is completed, the Engineer will check and certify that it meets the requirements of this Manual and all applicable written laws. The Engineer or Designer will then electronically submit the design to Western Power for a DCR in accordance with Clause 4.4.4 and Quote through Western Power's public electronic mailbox External Design and Construct.

4.3.2.6 Western Power processes DCR submission

Western Power perform a DCR to ensure design parameters have been incorporated into the design process and required design documents and certificates have been submitted.

Note that this review does not constitute approval of the design. Western Power takes no responsibility for the accuracy or correctness of the UDS design or associated Bill of Materials.

Western Power will carry out a conformance audit on the UDS designs at random. Western Power reserves the right to carry out a conformance audit on every UDS design by Western Power or Western Power appointed person.

When a UDS design is audited by Western Power, Western Power will advise the Designer whether the design is accepted or rejected due to non-conformance. If it is rejected, Western Power will give the reasons of non-conformance and advise the Designer of the re-conformance review fee. The Designer may then redesign and resubmit the scheme with the required re-conformance review fee.

4.3.2.7 Quote issue

Western Power will issue a Quote to the Developer of the UDS design except those which fail the conformance audit. The Quote will include standard charges, DIP and DCR fees, Reinforcement and Interface Work costs and quality assurance charges.

Generally Western Power will undertake Reinforcement and Interface Works however by agreement the Developer may undertake part of these works. Also refer to Clause 6.2.

4.3.2.8 Formal offer validity

The formal offer from Western Power in the form of a Quote is valid for a period of three months from the date of official correspondence. If payment has not been made within that three month validity period, the project file will be cancelled unless agreement in writing is received from Western Power to extend. Should the project be re-established at a later date, it will be treated as a new subdivision and subject to charges.

4.3.2.9 Developer accepts and pays Quote

If the Developer accepts and pays the Quote, the process will proceed in accordance with the agreed project criteria. Refer Clause 4.3.2.10 and section 6 for details of decoupled construction arrangements where developer is permitted to commence construction works prior to issue and payment of Western Power's quote.

The Developer is responsible for advising all other authorities or groups involved in the underground services e.g. Telstra, local councils, etc, and issuing drawings as necessary.

Installation will be coordinated through the nominated Western Power resource centre.

Western Power will order the materials that it is to provide after payment of the quotation. The order will be based on the Bill of Materials provided by the Designer. Western Power takes no responsibility for the accuracy or correctness of the Bill of Materials. A copy of materials to be ordered will be forwarded with the quotation letter for verification.

The Developer is responsible for purchasing materials and accepting those resources required for the work agreed to be undertaken by Western Power.

Errors in design or Bill of Quantities which result in under-ordering of materials and under-quoting for the installation of equipment will result in Western Power issuing an amended Quote or additional quotation to the Developer.

4.3.2.10 Payment of quote

For non decoupled large subdivision customers Western Power offers two payment options.

Either:

a) A full up-front payment of all charges applicable.

Or

b) Provided the total quotation is for more than $30,000, two staged payments of:

I. 30% of the quoted amount, plus a $550 administrative charge at the time the quotation is accepted; followed by

II. 70% of the quoted amount prior to commencement of site works, or clearance request, and to include per lot fee if applicable.

For decoupled large subdivision customers for which delayed quote payment is accepted all charges must be in one payment. Refer Clause 4.3.2.12 for additional decoupled project information.

Payment in full is required as a prerequisite for early clearance request. Refer to Clause 3.9 "Per-Lot Fee" System for early clearance requirements.

4.3.2.11 Delayed construction

For those projects for which quote payment is a prerequisite to UDS construction commencement the Developer is required to provide a construction administration package and commence their construction works on site within 6 months of quotation payment. Should this not occur Western Power reserves the right to provide a revised quotation (including re-conformance charges), should 12 months elapse Western Power reserves the right to cancel the project and provide a refund to the customer minus any costs incurred to date.

4.3.2.12 Decoupled construction agreement

Stages of some large subdivision may due to a critical timeframe be permitted to commence construction prior to interface works quote issue and payment following submission of DCR documents. For these decoupled projects Western Power will issue a letter acknowledging completion of the DCR and that the quote would be issued in due course following the completion of Western Power's interface works design.

The quote must be paid prior to a CM being appointed, issue of Handover certificate and Western Power undertaking interface works, commissioning and energisation.

4.3.3 Developer's responsibilities

Developers shall fulfil the following responsibilities in accordance with the requirements of Installation (refer Clause 6.2) which will include the following scope of work and expenses:

a) The Developer shall engage and appoint a Designer Organisation to design the Electrical Infrastructure of the subdivision and represent them in all matters relating to the design.

b) The Developer shall ensure that the Designer Organisation appoints an Engineer to oversee the design of the UDS and to certify the UDS design meets the requirements of this manual. The Developer shall also ensure that the Engineer appointed by the Design Organisation is covered by professional indemnity insurance of no less than $2 million, either personal or under the umbrella of the Designer Organisation.

c) The Developer shall appoint a Site Superintendent/Project Engineer.

d) The Developer shall engage contractors to carry out construction of the subdivision.

e) The Developer is fully responsible for ensuring that the Designer and Designer Organisation, the Site Superintendent/Project Engineer and installation contractors fulfil their responsibilities during the design and construction phases. The Developer has the ultimate responsibility for meeting Western Power's requirements.

f) Providing land for the installation of a substation (transformers and switchgear), if required. The land must be incorporated as part of public road reserves or public open space (POS) at no cost to Western Power.

g) Where any easement, restrictive covenant or Notification is required by Western Power, the Developer must provide these at no cost to Western Power.

h) All necessary and required civil works.

i) Advise potential land purchasers of all easement locations, restrictive covenants and Notifications and their proposed use and restrictions.

j) The Developer is responsible for notifying, negotiating with and obtaining agreement and approval from all parties, including other Western Power customers affected by the subdivision work. Where existing aerial mains are to be removed as part of the subdivision work, the Developer is responsible for reconnecting existing Western Power customers to underground power and associated costs. Where Electricity Infrastructure is to be installed in a road reserve, the Developer must obtain the approval of the relevant road authority.

k) The Developer must notify, negotiate with and obtain agreement of the parties affected on the removing of vegetation from neighbouring properties and/or road reserves arising from the work associated with a UDS in a subdivision.

l) Providing Western Power with "As Constructed" drawings and "As Constructed" records.

m) Supplying, installing and testing all cables and equipment and jointing cables in accordance with this manual. Projects where the Developer has agreed with Western Power to the undertaking interface works (refer Clause 6.2) Western Power shall undertake jointing and termination onto existing Western Power cables and equipment.

n) Providing equipment that meets Western Power's technical requirements.

o) Supplying and installing street lights.

p) Provide pre-commissioning sheets for all pillars, cable connections, transformers, RMUs and street lights.

q) Documented QA of cable alignments, cable depths, sand bedding, sand cover and danger tape.

r) Providing Western Power with a 12 month warranty for all equipment, installations and civil works.

The Developer is ultimately responsible to ensure that all design and construction works of a subdivision meet the requirements of this manual.

4.3.4 Western Power's responsibilities

Western Power is responsible for:

a) Providing a DIP (and if appropriate, information for preliminary feasibility studies) necessary to allow the Developer's Designer to design the UDS scheme.

b) Reviewing the Developer's DCR submission. This is not an approval or endorsement of the design. That is the responsibility of the Engineer.

c) Handling technical and construction matters with the Developer's representatives that cannot be resolved by the Developer's Designer. Refer site query process Clause 6.2.2.3.

d) Carrying out quality assurance audits at key stages of installation and testing.

e) Western Power may witness any tests performed by the Developer's installation contractor and/or perform its own tests prior to take over of the works.

4.3.5 Charges and refunds

4.3.5.1 Charges general

The charges contained in the formal offer are provided on the basis that all necessary information has been provided by the Developer and unless otherwise specified, the following assumptions have been made on work to be carried out by Western Power:

a) All Western Power work will be undertaken within normal working hours unless otherwise specifically stated in the Quote. The Developer may request Western Power to carry out quality assurance inspections and witness any tests after hours (additional costs will apply).

b) The site is readily accessible by a two wheel drive vehicle.

c) Site plans without contours marked shall be assumed to be level.

d) Site access is on a continuous basis. Site access and conditions are not detrimental to Western Power employees' or contractors' ability to work in an efficient, productive and safe manner.

e) The work-site is a greenfield site and clear access is available to trench on the allocated alignment without obstruction from other services, vegetation, etc.

f) All trenching is carried out in sandy soils free of rock.

g) All trenching is able to be carried out by machine.

h) Reinstatement is based on minimum greenfield reinstatement.

i) Trenches are level and accurately follow the allocated alignment resulting in minimum cable lengths.

j) All survey information, including boundaries, is accurate.

k) Lot boundaries as shown on the pre-calculated plan are correct.

l) Electrical demand allocations are as shown on the design drawings. These are calculated on the basis of either information provided by the Developer or Western Power standard values.

Any additional costs arising from deviations in these assumptions will be charged to the Developer. If any of the above assumptions are not applicable, Western Power must be informed to enable the calculation of new charges and avoid delays.

Changes to the subdivision layout, land use, zoning or the project staging may result in design changes and may incur additional charges.

4.3.5.2 Subdivision charges for individual installation schemes

The charges indicated on the Networks and Subdivision Page of the Western Power's website are minimum charges assuming Designers use Western Power's software and standard presentation of designs. Western Power reserves the right to charge additional sums for designs, drawings, and calculations and study results not presented in the format as given in Table 5. The Developer will be responsible for payment to Western Power of a recovery tax on capital contributions for commercial and industrial subdivisions. This amount will be included in Western Power's quote. Refer to Western Power's 'Recovering tax cost on capital contributions'.

4.3.5.3 Charges arising from redesign

The amount of additional expenses incurred by Western Power due to design revisions will vary. Hence the Developer should refer to the appropriate Western Power contact as soon as possible to determine any change to the total project cost. If installation has already commenced when a revision is requested, Western Power may also charge "stand-down" expenses.

Design changes which result in the need for Western Power to reissue DIPs or repeat conformance reviews will incur additional charges.

4.3.5.4 Refunds

If a project is cancelled at the Developer's request during construction, full payment made will be refunded less all non-recoverable costs (including material and/or labour) incurred by Western Power.

Once a project has been completed, refund is not available.

4.4 Western Power Designer information

4.4.1 Request for design information package

When requesting a DIP, the Developer must provide all of the information shown in the following table, in electronic form. Refer Clause 4.3.2.2

Project Name	Name of the subdivision, e.g. Thomson's Lake Stage 1
Developer's Name	Who is the Developer?
Location Plan	Showing nearby roads and map number and grid reference from the StreetSmart street directory.
WAPC Number	If the WAPC number is not available at the time of requesting a DIP, the Developer must provide it to Western Power prior to the submission for DCR. Survey diagrams are not essential at this stage.
Number and Type of Lots	Split into residential, commercial and industrials lots respectively.
Proposed Design Loading ADMD's	This will assist the network planning study required. Western Power will specify the preferred design ADMD in the DIP if it considers proposed design ADMD is not suitable.
Letter of Authorization	Letter from the Developer appointing the Designer and/or Designer Organisation and the Engineer of the subdivision/s and authorising Western Power to directly deal with them.
Payment guarantee for DIP & CR fees	This is the Letter of Acceptance of responsibility for payment for DIP and DCR fees if the project does not proceed.
Number of stages	For large subdivision development with more than one stage, usually in green field development.
Stage plan	A preliminary pre-calculated cadastral plan (electronic format preferred) showing stage boundaries, lot boundaries and sizes, lot numbers and contours (optional). Any other information to be on separate layer/s.
Time frame of development	Especially for subdivisions with a large number of stages. This will assist the network planning study required.
Concept plan (electronic format)	For greenfield subdivisions with a large number of stages. If a comprehensive concept plan is provided when the DIP for the first stage is requested, Western Power may be able to provide a DIP to cover all the stages. For any subsequent stage, the Designer is still required to send a request with an updated concept plan, which also shows the design of previous stages. Western Power will provide a project number and the SPIDA coordinates.

Table 3: Required DIP Request Information

4.4.2 Design information package (DIP)

Western Power will provide Designer Organisations with a DIP in electronic form.

This will contain information unique to a scheme or stage of development. The Designer will use this within the framework of this manual, to complete the scheme design.

The DIP, along with the design information within the UDS or other relevant manuals, is to be used as the basis of the design.

The DIP is valid for six months from date of issue. If the scheme does not proceed within this validity period, the Designer must re-apply for a DIP, together with a new application fee. A single 3 month extension to the DIP validity period can be sought (justification needs to be provided) at no cost by approaching the appropriate Western Power Project Manager.

The DIP will consist of the information given in the following table:

DIP Letter	Detailing conditions and design requirements that apply. It also includes a reference number for future correspondence and drawing numbering.
DIP Drawing (.dgn)	Provides the following: Details of HV system, e.g. cable size, entry and exit points at boundary of development. Transformer and switchgear locations, cable route, etc. Requirements for HV Y splits and possible location in the existing network for connection. Details of LV cables and interconnection points. Three-phase fault level. Any undergrounding or relocation of overhead systems required within the development and/or on surrounding boundary roads, if required. Any work Western Power requires to be done as part of the project. – Project funding arrangement.
SPIDA map LV (.pdf)	SPIDA map showing surrounding LV network.
SPIDA map HV (.pdf)	SPIDA map showing surrounding HV network.
LV Design files (.lvd)	LV Design files of existing network if required.
Surrounding subdivision Design Drawings (pdf) or relevant layers of dgn drawings to protect identity of third parties.	Design drawings of previous subdivision stages surrounding the development, if available and required.
WAPC.pdf	Subdivision approval letter with conditions from WAPC.
General	Any other relevant information.

Table 4: Design Information Package

For any changes to the information contained in the DIP, written approval from Western Power must be obtained before they can be included in the design.

4.4.3 Information for feasibility studies

Consultants or Designers may request information to allow them to carry out a preliminary feasibility study. A SPIDA map of the existing surrounding HV and LV networks may be sufficient for this rather than a DIP.

Western Power will provide a SPIDA map and charge the fee shown in Clause 4.3.5.2. If more information is required, the standard DIP will then be prepared and the appropriate fee charged.

Due to the nature of electricity distribution systems, the surrounding HV and LV network can change significantly with time. The change of the network may result in variation of the cost of providing supply extensions to subdivision developments. This variation may be significant. Accordingly, please note that Western Power will not accept any responsibility for variations between the Developer's budget estimate and firm quotations, nor for any direct or indirect consequent impact on the Developer's costs.

4.4.4 Submission requirements of design for design conformance review

When submitting a design drawing (including a revised drawing) for DCR the Designer is to provide the entire document in electronic form in the appropriate format, as shown in the following table:

Document Name	Format required & detail
UDS Design Drawing.	DGN format (Microstation - Bentley). The subdivision plan drawings shall be geospatially correct by incorporation of Map Grid of Australia MGA94 grid system. This geospatial information is required to enable incorporation into Western Power's GIS. Refer Note 2 below. All DGN drawings sent to Western Power must be saved in Default View, as opposed to Sheet View, prior to submittal.
LV Volt Drop Assessment Report.	LV Design File or other format approved by Western Power.
Voltage Fluctuation Assessment Report.	Motor Data and flick assessment in accordance with AS/NZS 61000 in a format approved by Western Power.
Bill of Materials (see Note 1 below).	TXT file based on the DDC Manual created from Microstation or DQM CU EXPORT FACILITY and generated by the DQM/CAD Interface – Urban Residential Design Software.
Designer Organisation's authorisation.	PDF format authorising Western Power and its contractor and agents to use the UDS design drawings as Western Power sees fit and authorising Western Power to provide drawings to the Developer and other parties, and as otherwise provided in Clauses 4.4.7, 6.2.2.6 and 6.2.2.7 of the UDS Manual.
NER Engineer Certification/Check Sheet	PDF format.
NER Engineer's certificate of $2M Professional Indemnity (PI) insurance.	PDF format (Note: The certificate of PI insurance can be submitted on annual basis.).
Letters of Approval including environmental approval from local government and other service providers as required	PDF format.
Other certificates as required, e.g. substation retaining wall certificate.	PDF format.
Street Light Authorisation letters, for the use of decorative or private street lighting from the local government.	PDF format.

Table 5: Submission Requirements of Design for DCR

Note 1:

The Bill of Materials must cover the materials which Western Power is to provide for the work agreed to be undertaken by Western Power. It is to be based on compatible units contained in Western Power's DDC. It shall be in a format suitable for direct loading into Western Power's DQM.

Note 2:

- The MGA94 file should only include the pre-calculated cadastral plan of the current subdivision stage where Western Power asset are to be installed.
- If the MGA94 file is not provided with the submission for DCR, it is to be provided to Western Power through the electronic mail box External Design and Construct at least five working days prior to Handover inspection.

The MGA94 file is required to be input into Western Power's GIS data base so that the necessary switching and commissioning program can be produced for the energisation of the subdivision.

4.4.5 Projects on hold for more than three (3) months Delays in DIP and DCR Western Power requested information of Designers

Projects on hold for more than three (3) months during DIP or DCR processes waiting subdivision designer information will be closed and invoiced.

4.4.6 Revision of design due to major and minor changes while under construction

During the construction of a subdivision, changes to the Electricity Infrastructure may be required which will necessitate changes in the electrical design.

4.4.6.1 Major changes in design

If a major change is made to a design after the design conformance and payment has been received from the Developer, the Designer must submit the revised design drawing to Western Power for a Design Conformance review (DCR) of Revision While Under Construction (RWUC).

The following changes are considered major and therefore a DCR of revision while under construction is required.

a) Encroachment on any easements.
b) Relocation of uni-pillars.
c) Addition or deletion of pillars
d) Installation of cables (HV or LV cables) to the 2.7m pole
e) Change of cable route.
f) Change of status of switching points.
g) Relocation of switchgear or transformer substation.
h) Addition or deletion of lots in the subdivision.
i) Addition or deletion of street lights.
j) Changes that will affect the interface scope of works and quotation.
k) Revised CAD drawings indicating boundary changes.

Note: Where a design conformance review of a Revision While Under Construction (RWUC) is deemed time critical, from a delivery perspective, the Designer may request to have the review processed in accordance with Western Power's decoupling procedures. For further information refer to Clause 4.3.12.

4.4.6.2 Minor changes in design

If a change is minor and deemed not significant enough to warrant a review of the design, the change shall be reviewed by the Developer's Designer. Details of minor changes need not be forwarded to Western Power but must be shown on the "As Constructed" drawing.

Any request for a minor design change conformance review will be treated in the same manner as a major design change conformance review. For details of changes considered to be minor, refer to Clause 6.2.8.29 "Minor Changes during construction".

4.4.7 Intellectual property license

By submitting a UDS design drawing (including a revised drawing) for DCR the Designer and Developer consent to Western Power and its contractors and agents:

a) using the UDS design drawings as Western Power sees fit including, without limitation, for Design Conformance Review purposes, to update Western Power's asset registers including SPIDA-web, for 'Dial Before You Dig' purposes, and to facilitate the design of other nearby, surrounding or adjacent subdivisions and distribution schemes; and

b) providing the UDS design drawings to the Developer and other parties including, without limitation, designers of nearby, surrounding or adjacent subdivisions and distribution schemes.

4.5 Submission for DCR with approved nonstandard equipment

Nonstandard equipment must be approved by Western Power. A Developer must notify Western Power when it intends to use approved nonstandard equipment in subdivisions, according to the following process.

To gain approval for nonstandard equipment or find out what nonstandard equipment has been approved see Clause 7.4

4.5.1 Prior to DCR and quote issued by Western Power

Where the Developer knows that they are going to use nonstandard equipment, prior to submission to Western Power:

a) The Designer shall show on the design drawing the detail of approved equipment to be installed when the design is submitted for DCR.

b) For approved nonstandard switchgear, the make and equipment part number must be shown on the drawing.

c) For approved nonstandard transformers, the make and Western Power dummy stock code must be shown on the drawing. The Developer must also stencil the dummy stock code on the external surface of the transformer tank.

d) For all other approved nonstandard equipment, details will be stated on the Letter of Approval.

e) Western Power will carry out the DCR.

f) When the design is submitted as conforming, Western Power will issue a quotation.

Note: The equipment part number or the dummy stock code of nonstandard equipment will be provided on the 'Certificate of Approval' of the equipment.

4.5.2 After DCR and quote issued by Western Power

Where the Developer decides to use nonstandard equipment after DCR:

a) The Designer shall revise the design drawing to include details of approved nonstandard equipment to be used.

b) For approved nonstandard switchgear, the make and equipment part number shall be shown on the drawing.

c) For approved nonstandard transformers, the make and Western Power dummy stock code must be shown on the drawing. The Developer must also stencil the dummy stock code on the external surface of the transformer tank.

d) For all other approved nonstandard equipment, details will be stated on the Letter of Approval.

e) The Designer must submit the revised design drawing as a revision for DCR.

f) The Developer shall also sign and return the Acceptance of Quote form, together with any payment required to Western Power within two working days of the submission of a revision for DCR to avoid any revision charges.

g) Western Power will review the revised design for conformance.

h) When the revised design is submitted as conforming, it will proceed to installation.

Note: The equipment part number or the dummy stock code of nonstandard equipment will be provided on the 'Certificate of Approval' of the equipment.

4.6 Dispute resolution process

A formal issue resolution path was established and announced in July 2005 through the Urban Power Bulletin. It provides a mechanism allowing Developers/Designers to raise issues about specific subdivision projects. It also provides a higher channel to raise the issue if Developers/Designers feel it has not been satisfactorily resolved. The process has been enhanced by appointing a Market Segment Manager who will act as the customer advocate and is shown in the following figure:

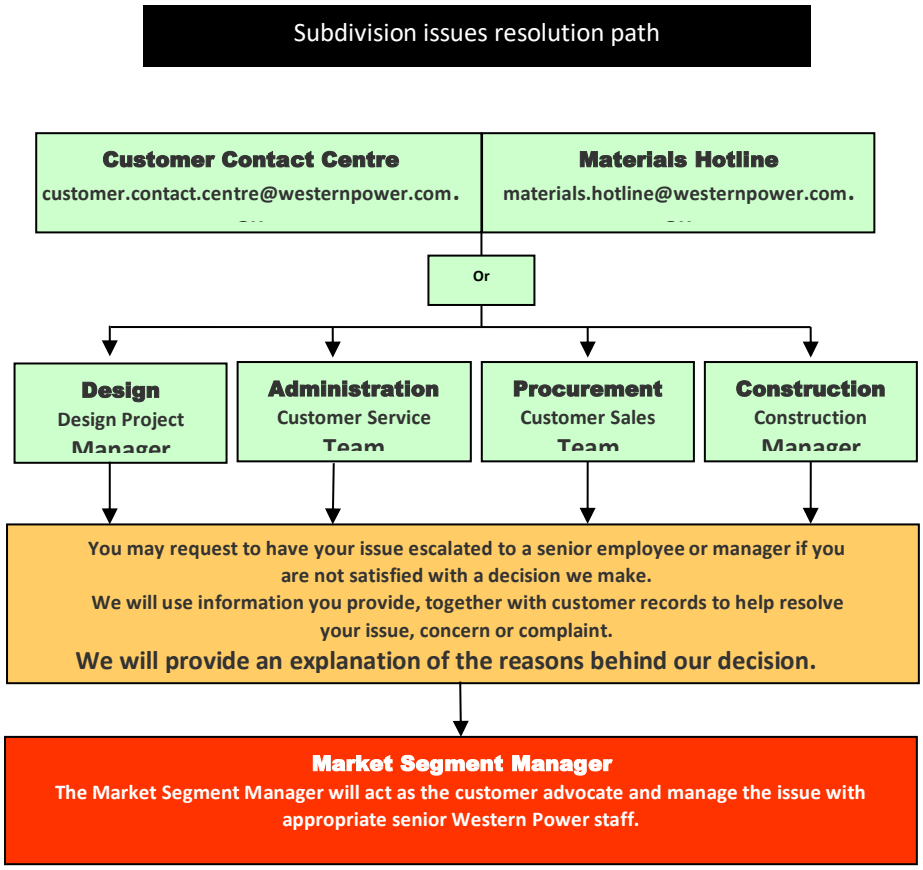

Figure 6: Development Process for Large Subdivisions

5. Design policy and requirements

This section informs Designers of Western Power's policies and requirements for the design of the Electricity Infrastructure in underground distribution network in subdivisional developments.

5.1 Designer qualification and experience

Designer organisations must employ or engage Engineers and Designers with the following minimum qualifications and experience:

5.1.1 Engineer

The Engineer

a) Must be in the discipline of Electrical Engineering with proven experience in subdivision electrical distribution design and must be registered as a professional engineer on the National Engineer Register (NER).
b) Must be appointed by and responsible to the Developer.
c) Must have Professional Indemnity (PI) insurance of no less than $2 million. Where the Engineer's PI insurance is already covered by the policies of professional liability insurance of the Designer Organisation a separate PI insurance is not required.

5.1.2 Designer

A Designer must have the following qualification and experience:

a) Formal training in electrical engineering with at least a certificate in Electrical Engineering from a nationally accredited institute in Australia or suitable electrical trade qualification.
b) Experienced in electrical distribution design.
c) Proficient in drafting skills, preferably Micro-station.
d) Must also be competent in the application of Western Power design software of LV Design and application of SA/NZS TS IEC 6100.3.5:

5.1.3 Designer Organisation

The Designer Organisation:

a) Must employ an Engineer and Designer/s to design the electrical reticulation of subdivisions.
b) Must be authorised in writing by the Developer to represent it in all matters relating to the design of Electricity Infrastructure for subdivisions.
c) Is responsible to the Developer.

5.2 Engineer's, Designer's and Designer Organisation's responsibilities

5.2.1 Engineer's responsibility

The Engineer is responsible for:

a) Overseeing the design of all Electricity Infrastructure in each UDS.
b) Approving the design of all Electricity Infrastructure in each UDS.
c) Certifying UDS designs comply with the requirements of this Manual and all applicable written laws, and
d) Ensuring that a UDS design is safe to construct and connect to Western Power's network.

5.2.2 Designer's responsibility

The Designer is responsible for:

a) Designing the UDS in accordance with all applicable written laws and the requirements of this manual.

b) Providing any information required by Western Power to process the DIP and DCR, including site formation and design information from the Developer's Civil Engineer and Surveyor.

c) Preferably attend pre-start meeting on site

d) Resolve any site issues arising from the construction of UDS in a subdivision development.

5.2.3 Designer's Organisation responsibilities

This section has been written so that either the Designer or Engineer can perform the design of Electricity Infrastructure of a UDS. This includes:

a) Representing the Developer of a subdivision development in all matters relating to the design and construction of UDS. This authorisation must be signed by the Developer.

b) Inspecting the site prior to designing the UDS to check any particular site requirements are included in the UDS design.

c) Communicating the requirements of the Developer to Western Power.

d) Communicating the requirements of Western Power to the Developer.

e) Notifying all concerned parties, including other Western Power customers affected by the development of a subdivision.

f) Obtaining all relevant clearances and approvals required for the UDS, including environmental, native title, Aboriginal heritage etc., and providing them to Western Power.

g) Obtaining approval from local government, other service providers (including but not limited to Main Roads WA, Telstra and Water Corporation) and other affected parties (such as other Western Power customers).

h) Providing Western Power with electronic "As Constructed" drawings of the UDS.

5.3 Design requirements

All UDS designs must comply with the Electricity (Network Safety) Regulations 2015, Western Power's requirements, this manual, any other relevant standards and information given in the DIP.

5.3.1 Environmental and aboriginal considerations

The Developer must investigate and manage all relevant environmental impacts and Aboriginal issues associated with its subdivision as is required by the relevant and applicable statutes as they apply at the time of the development process. The issues associated with a subdivision may include but not be limited to those given in Section 7 of Network Standard NS 14.2 Underground Cable Installation Manual Part 2 –Technical Requirements which is available on the Western Power website.

If Western Power is to undertake work within or for the subdivision, the Developer is to provide copies of its environmental approvals where those approvals may cover Western Power work.

If Developer is to undertake any works outside the subdivision or undertake interface works by agreement with Western Power the Developer must undertake necessary environmental and aboriginal considerations and provide a copy to Western Power upon request.

Information on Western Power's Environmental Policy is available on the Western Power Website.

5.3.2 Design load

The maximum demand on a transformer or a LV feeder, when divided by the number of loads supplied, provides a value which is in essence the "average contribution per customer", or simply the "average demand" for a typical customer.

The maximum demand on a transformer or a LV feeder is determined by using following the formula:

Maximum Demand = (N+1)/N x ADMD per lot x number of lots,

Where N = Number of lots and

ADMD = "After Diversity Maximum Demand"

For practical purposes, groups of 50 or more loads (i.e. N ⍰ 50) on a transformer or a LV feeder, N x ADMD are considered to produce a figure sufficiently close to the ultimate maximum demand. The effect of ADMD will diminish when N is reduced substantially below 50.

Hence, ADMD is the average load per customer determined by dividing the group maximum demand by the number of customers in the group when the group size is at least 50.

The Developer must use design loads for all UDS subdivision designs defined below.

To prevent incorrect diversity factor calculations, the number of nodes used in the LV design shall be the same as the number of loads that are shown on the design drawing plus known loads for future adjacent stages. Unloaded nodes shall not be included.

5.3.2.1 Residential, single phase, diversified loads – LV design A and B loads

For these loads, the load kVA is to be equal to the recommended After Diversity Maximum Demand (ADMD) value in the following table:

Residential Load Categories	ADMD
Single dwelling lots.	Determined by ADMD Calculator and specified in the DIP.
Duplex, triplex, or quadruplex lots.	Determined by ADMD Calculator and specified in the DIP.
Group housing/units up to 10 units.	Determined by ADMD Calculator and specified in per unit in the DIP.
Denser group housing exceeding 10 units, smaller units, retirement villages etc.	Determined by ADMD Calculator and specified in per unit in the DIP.

Table 6: Minimum ADMD Values (kVA)

The ADMD value of single, duplex, triplex or quadruplex lots and group housing units will be determined by the ADMD Calculator. The ADMD Calculator will calculate the ADMD of these lots based on size, land value and location (suburb). The value will be specified in the DIP. The ADMD values specified are minimum values.

The ADMD provided is based on the assumption that LV Design software is used to obtain the maximum load on a transformer or a LV feeder. When the number of loads is less than 50, the maximum load will be scaled up by the formula in Clause 5.3.2.

5.3.2.2 Rural residential, single or three phase, diversified loads LV design C loads

Rural residential development, including hobby farms, rural home sites and rural retreats, are generally on lots of 1ha to 10 ha in Rural or Special Rural Zones. These loads are usually higher than that in residential lots in urban areas. Therefore, the minimum ADMD value of 5kVA must be used.

If there is reason to believe that the actual design value should be greater than 5kVA, use an appropriate greater value.

If the number of loads on a transformer is substantially below 50, the ultimate load on the transformer shall be calculated using the formula,

Maximum Demand = (N+1)/N x ADMD per lot x number of lots.

5.3.2.3 Non-residential, three phase diversified loads – LV design C loads

For these loads, the Developer must use average load kVA values e.g. *commercial and light industrial estates*, unless otherwise known.

The current minimum design requirement for these loads is 200kVA/hectare

The above value is based on a horizontal development, e.g. single storey building. If the development is likely to be a multi-level development, the minimum design value will also depend on the total usable floor space and the type of usage. These multi-level development loads shall be considered discrete loads. Refer to Clause 5.3.2.5.

(To obtain the load kVA, multiply the kVA/hectare figure with the area of the lot, in hectares. Note: 1 hectare = 10,000m²)

5.3.2.4 Single phase, non-diversified, discrete loads - LV design D loads

For these loads, the Developer must use maximum load kVA values, e.g. from the name-plate rating, equipment specifications or by measurement.

(e.g. Street lights, pumps, and other significant single-phase loads).

To obtain the maximum kVA value for a single-phase load, use either:

$$\text{Single-phase kVA} = \frac{kW}{powerfactor} \quad ;$$

$$\text{Or Single-phase kVA} = VI = \frac{240}{1000} * I$$

5.3.2.5 Three phase, non-diversified, discrete loads – LV design E loads

For these loads, the Developer must only use maximum load kVA values calculated in accordance with the guidance given in AS/NZS 3000, and by agreement with Western Power. For example:

- High schools: as specified by designer or electrical consultant and a minimum of 600kVA.
- Primary schools: as specified by designer or electrical consultant and a minimum of 250kVA.
- Neighbourhood shopping centres: obtain the load kVA based on a minimum load density of 200 kVA/hectare; or as specified by designer or electrical consultant with a minimum of 200kVA/hectare.
- Large shops/business centres: as specified by designer or electrical consultant.
- Pumps and other large three-phase fixed equipment: obtain from equipment name-plate or specifications.

5.3.2.6 Single phase, non-diversified, discrete loads –LV design F loads

F loads can be used to model single-phase discrete loads on a three-phase network typically used for street light circuits.

5.3.3 Flood and water table level considerations for above ground assets

The Developer must ensure that all above ground assets are located above defined flood events and that the effect of water table level on transformer stability be addressed.

Detailed information can be obtained from the Department of Water via Landgate SLIP (shared land info platform) website.

5.3.3.1 Flood water consideration

From a subdivision perspective two flood events are considered; that related to river and river fringe flooding and; that related to localised peak storm events also referred to as inundation. For both flood event types State Planning requires residential habitable floor levels not be below the local 1:100 year Annual Recurrence Interval (ARI) reference flood level plus defined freeboard margins. Freeboard allows for such factors as wind and wave action and historical and modelling uncertainties.

The Developer must ensure ground mounted assets are installed above the following minimum flood level requirements and these localities not be subject to prolonged surface water pooling.

a) Distribution substation and HV switchgear sites:
   I. 1:100 year ARI event plus 500mm freeboard.
   II. May be greater at locations requiring increased flood security for example hospitals and essential services facilities. These to be determined on a case by case basis.
b) Mini and uni-pillars: 1:100 year ARI event plus 300mm.
c) Free standing low voltage (LV) frames, not forming part of a substation: 1:100 year ARI event plus 300mm.
d) Steel street light poles: 1:100 year ARI event.

5.3.3.2 Water table consideration

High water table level above the underside of transformer concrete support base is considered to result in unacceptable settlement over time possibly affecting the reliability of cable terminations.

Water table levels shall be addressed as follows:

a) Less than 0.5m below proposed substation level: Not a suitable substation location.
b) Between 0.5m and 1.0m: Install the equipment support culvert on a double concrete support base arrangement. Refer Distribution Substation Plant Manual.
c) Greater than 1.0m. Standard concrete base arrangement. Refer to Distribution Substation Plant Manual.

5.3.3.3 Compliance documentation

As part of the DCR submission the Developer will demonstrate compliance by provision of hydrology drawings indicating 1:100 year ARI and land contours and AHD values of substations. This information shall be in a suitable format to enable inclusion into Western Power's GIS for future project reference. Additionally water table levels are to be provided in those locations where substations are proposed to be installed.

Where hydrology drawings as referred above are not being prepared for the subdivision then flood levels shall be demonstrated in others ways that may include local government, land owner or previous Developer records.

5.3.4 Point of supply

Point of supply is where electricity is supplied and is the Western Power network and customer interface. It is also called point of connection.

Western Power will only provide one point of supply per freehold title lot and the point of supply will usually be in the form of a service pillar, a LV frame or a transformer at lot boundary.

Western Power will only provide one point of supply to service all the survey-strata lots that may include "common property lot" shown on a strata plan.

For residential lots, one mini-pillar will be installed to serve two lots, permitting a maximum of two (2) consumer mains cable connections per lot. If Developers intend to install one service pillar per lot due to special circumstances, such as parapet walls built to property boundary or retaining walls higher than 300mm, they must provide justification to Western Power and obtain the approval of Western Power. Refer Clause 2.2.3.4

A uni-pillar is to be provided for any group housing lot (building strata or survey strata) with more than four dwelling units or where loads exceed 63A. Each industrial or commercial lot must be provided with a supply, either from a direct transformer connection or a uni-pillar.

Where a uni-pillar is installed on a group housing, commercial or industrial lot, the top bar is not to be used for the purposes of network interconnection as it is designated as the customer's point of supply and consumer mains cable termination point.

5.3.5 Service pillars

5.3.5.1 Service pillar location

When lots face gazetted public road, service pillars must be located within the lot boundaries at the corner, as shown on:

- Figure 17: Pillar Location and Installation Requirements.
- Western Australian Distribution Connections Manual (Figure 49).
- Utility Providers Code of Practice Typical Lot Entry Arrangements.

The Utility Providers Code of Practice indicates several utility service lot entry arrangements, both front of lots and laneways, with the service pillar always located at the corner of the lot boundaries.

Also refer to Clause 6.2.8.19 Service pillar Installation.

Service pillars will only be permitted in gazetted laneways where there are no other roads in the vicinity, or it is necessary because of high retaining walls along front property boundary preventing safe access for operational and maintenance purposes. Refer to Clause 5.3.12 for additional laneway requirements.

In multiple battle-axe freehold lots with a shared driveway, pillars may be located to the side of the driveway. Where these result in a consumer's main being required to cross adjacent lots, this shall be covered by an easement across the front of the driveway. The easement may extend along the driveway, enabling all consumer mains to be installed within a common trench.

The easement shall be under Section 136C of the Transfer of Land Act 1893 in favour of Western Power.

Refer to UDS Manual Figure 16.

In residential freehold and strata title subdivisions:

a) Pillars for those lots created with non-gazetted rear laneway frontage and street access leg shall be located at the street frontage, not the laneway. Location shall be on the street boundary of the front lot with the principal street frontage adjacent to, but not within the access leg if it is 1.5 metres or less.

b) Where the pillar cannot reasonably be located adjacent to a common freehold boundary e.g. because of an existing driveway, then at Western Power discretion it may be located elsewhere on the street boundary of the front lot. In these instances an easement shall be provided from the common boundary to the pillar to protect neighbours future consumers mains. The easement shall be under Section 136C of the Transfer of Land Act 1893 in favour of Western Power.

5.3.5.2 Service pillar exclusion zone

An exclusion zone shall be maintained around network equipment to allow network staff, emergency personnel and electrical contractors sufficient room to gain access to or remove covers from network equipment, and to provide a safe working environment while operating switches, links, or fuses, completing or removing service connections or carrying out maintenance tasks.

The exclusion zone land shall be as flat as possible and that any adjacent land and batters or retaining walls appropriate to ensure cable cover depth not reduced by soil erosion. It is required that no communications or other utility services shall pass through or be located within the service pillar exclusion zone.

For both mini and uni-pillars, the service exclusion zone shall be the minimum separation required between the pillar low voltage earth electrode this being at the centre of the pillar and other services as defined in AS/NZS 3000 Table 3.7. This requires 500mm separation from water services, sanitary drainage and gas, and 600 for stormwater drainage.

The exclusion zone created around pillars and pits shall include a radial area extending 500mm in the horizontal plain from the centre of the pillar or pit including to the adjacent property boundaries and uninhibited in the vertical plain.

Refer to Clause 5.3.5.1 above for drawings indicating the exclusion zone and relation to lot boundaries and other utility services.

5.3.5.3 Service pillar identification

Service pillars bearing Western Power's present or former embossed logos and utilising triangular keyed cover locking bolts shall not be used for private non Western Power electricity distribution systems.

5.3.5.4 Service mini pillar network connections

Mini pillars installed both sides of a road connected to a single LV street feeder shall be connected:

a) from the LV feeder tee off to the adjacent mini pillar, then from that pillar to the pillar on the opposite side of the street, where the maximum demand of the whole arrangement does not exceed the rating of the 25mm^2 cable

Or

b) independently from the LV feeder tee off where the maximum demand is greater than the 25mm^2 cable rating. .(Preferred option)

For mini pillar street light fuse and cable terminations connection requirement refer to Distribution Construction Standards drawings U8, R32, R33, R35-2, R35-3, R 35-1-1 and R 35-1-2. Refer to Appendix 13.

5.3.6 LV kiosk installation

LV kiosks require the provision of an earth grading ring in accordance with the requirements of Distribution Design Catalogue Compatible Unit LU38 'LV Kiosk Type 1'. In situations where the earth ring will encroach onto adjacent lots an easement is requirement for an area from the kiosk to 250mm beyond the earth ring. Confirm project requirements with Western Power Land Development.

5.3.7 HV cables

The Developer must ensure that the following high voltage cables are used as a minimum for all UDS works, as indicated below unless otherwise specified in the DIP.

Where the use of termite treated cables is proposed, approval must be obtained from Western Power at the design stage as environmental issues must be addressed. Where termite treated cables are agreed to be installed ensure that the joint kits include termite protection.

Note: Western Power 33kV cables have termite treatment.

a) Cables used on 6 to 22kV three-phase systems between RMUs

- 400mm² aluminium (240mm² copper cable only permitted where 400mm² aluminium cable cannot be used due to installation or site constraints owing to its larger bending radius) XLPE insulated, PVC/HDPE sheathed cables used on 6.6kV, 11kV and 22kV systems before Y-split or the exit cable of not less than two km from zone substations.
- 3x1 core 185mm² aluminium XLPE insulated, PVC/HDPE sheathed cables after Y-split.

Note: Western Power will specify the size of HV cables to be used for specific situation in the DIP.

b) Cables used on 33kV three-phase systems between RMUs

- 3x1 core 185mm² aluminium XLPE insulated PVC/HDPE sheathed cables.

c) Cables used on 6kV, 11kV and 22kV three-phase between RMUs and Transformers or down stream of DOFs

- 3x1 core 35mm² aluminium XLPE insulated PVC/HDPE sheathed cables.

d) Cables 33kV three-phase between RMUs and transformers or down stream of DOFs

- 3x1 core 50mm² aluminium XLPE insulated PVC/HDPE sheathed cables.

e) SPUD Transformer Cables 12.7/22kV

- 1 core 35mm² aluminium XLPE insulated PVC/HDPE sheathed cables.

Working ends

HV cables that in the future are proposed to be extended beyond the subdivision project stage shall terminate into live end seals adjacent to the stage boundary as working ends.

These HV network extensions may include network feeders and interconnections to meet network planning requirements and to supply transformers in adjacent subdivision stages.

For details of working ends refer to Clause 6.2.8.20.

5.3.8 LV cables

The Developer must ensure that the following low voltage cables are used for all UDS works as a minimum, unless otherwise specified.

Feeder cables

240mm², 3 core, solid aluminium conductor, copper screen neutral (wave wound), 0.6/1kV, XLPE insulated, PVC sheathed cables.

120mm² cables can only be used for a spur feeder with not more than six residential lots connected or for rural lots connected to a 63kVA three-phase transformer where the feeder length is not exceeding 500m.

Mini-pillar connection cables

25mm², 3 core, stranded copper conductor, helical wound stranded copper neutral screen, 0.6/1kV, XPLE insulated Orange PVC sheath cables. Provide at least 300mm of slack in proximity to the pillar to provide flexibility in the final pillar positioning/repositioning.

Street lighting cables

Single core 10mm² or 16mm² stranded copper, XLPE insulated, helical copper wire neutral screen, PVC sheathed cables.

25mm², 3 core, stranded copper conductor, helical wound stranded copper neutral screen, 0.6/1kV, XPLE insulated Orange PVC sheath cables.

Working ends

LV feeder cables that in the future are to be extended beyond the subdivision project stage shall terminate into live end seals adjacent to the stage boundary as working ends.

These proposed extensions into future adjacent stages are to provide improved utilisation and flexibility of the LV network to suit stage boundary delineation.

For details of working ends refer to Clause 6.2.8.20.

5.3.9 Cable alignment

Western Power requires cables to be installed on proper alignment within gazetted public road reserves. Designers intending to install cables through private properties, Public Open Space (POS) and Public Access Way (PAW), must seek prior approval from Western Power and the Local Government Authority.

All cables, including street lighting cables, but excluding private street light cabling, shall be installed on the nominal alignment of 0 - 500mm from property boundary lines along gazetted public road reserve (Reference: Utility Providers Code of Practice for Western Australia)

Any variation to the cable alignment, i.e. outside the 0 - 500mm alignment to the 2.4 – 3.0m alignment, requires the prior approval of Western Power. If the variation of the cable alignment affects other utility services, it must also be approved by all the affected utility providers.

The following should be considered prior to seeking Western Power approval for a variation to the cable alignment:

a) Cable trench layouts – see drawings UDS-6-2 in Appendix 13
b) Access to the 0 -500mm alignment is obstructed (e.g. tress or other services)
c) Utilise the 0 – 500mm alignment on the other side of the road.
d) The 2.4 – 3.0m alignment should only be considered when no aerials are present and the 0 - 500mm alignment on both sides of the road are not feasible to utilise.

Where the cable is out of the nominal 0 - 500mm, heavy-duty ducts are to be used for mechanical protection (refer to Clause 5.3.11).

Where Western Power permits street lighting cables to be installed on the 2.4 - 3.0m alignment, the cables must be installed in heavy-duty ducts.

5.3.10 Permitted number of cables within nominal green field cable alignment

The Designer is to determine the number of cables that can be installed in the nominal cable alignment in accordance with the requirements on Drawing No. UDS-6-2 in 12: Cable Trench Layout (Sheets 1 of 7). The minimum depth of cover of cables and cable joints shall be 750mm below the expected finished ground level. When HV or LV cables are installed in ducts, the minimum clearance of 100mm between property boundary and ducts is to be maintained. For HV feeder and transformer cables in ducts on the bottom layer, the separation of the ducts at 100mm is acceptable.

Where the cable alignment on one side of the road is unable to accommodate the number of cables required, excess cables are to be installed on the cable alignment on the opposite side of the road.

5.3.11 Ducts

The Developer must ensure all cable ducts and pipes are non-metallic and comply with Australian Standard AS/NZS 2053. The size of ducts and pipes required for different type of cables are shown in the following table:

Description	Cable Size	HD Duct /Conduit Nominal Size (mm)	HD Polypipe Nominal Size. External/Internal Diameter (mm)
HV Feeder Cables	95 – 400mm²	150 mm	160/135
HV Transformer Cables	≥ 50mm²	150 mm	160/135
HV Transformer Cables	< 50mm²	100 mm	110/93
LV Cables	120 – 240mm²	100 mm	110/93
LV Service Cable	25mm²	50 mm	63/53
Street light Cables	10 – 25mm²	50 mm	63/53

Table 7: Cable Duct/Conduit and Pipe Sizes

All cable ducts, including spare cable ducts required, must be shown on the UDS design drawing.

5.3.12 Cables and electrical services in access lanes and laneways

In accordance with the WAPC Planning Bulletin Number 33 (Right of Way or Laneways in established areas guidelines) "Laneways" means a public road designed to provide access to the side or rear of lots, principally for vehicle parking. WAPC Policy No. DC 2.6 (Residential road planning) requires a minimum of six metres and a maximum of 13.5m for the width of reserve for laneway.

Western Power always requires cables and electrical services including transformers, switchgear, pillars and street lighting to be installed in gazetted road reserves not laneways. UDS Designs that require cables and electrical services to be in access lanes or laneways require a written submission explaining why this is necessary prior to submission for DCR.

Western Power will accept cables and electrical services in laneways on the following basis:

a) There is no alternative route for the installation of cables.
b) Access to electrical services from normal gazetted public road reserves is unsafe or not available.
c) Other WAPC conditions in the subdivision approval do not permit the installation of electrical services along normal gazetted public road reserves.

If Western Power approves to installation of cables in a laneway, the cable must:

Either

Be installed in the 0 - 500mm alignment from property boundary in cable ducts with a minimum of one spare duct,

Or;

Be direct buried in soil, provided 300mm of clean sand is installed below the cables and clean sand is installed above the cables all the way up to the road base with a minimum of one spare duct.

Note: Clean sand must meet the selection criteria of sand for bedding in Subdivision Design Guideline – No 4, Bedding sand and backfill sand around cables and general backfill for cable trench – material selection guidelines which is available at the Western Power website.

5.3.13 Cable near to retaining walls

Additional cables near to retaining walls must be installed in ducts. Existing cables are permitted to remain direct buried, and be suitably protected during construction works. Please refer to Clause 6.2.8.13 for construction requirements.

The location of all retaining walls and their civil design details must be shown on the UDS design drawing submitted for DCR.

5.3.14 Cable easement

If both Western Power and the local government authority approve the installation of cables in private properties, POS or PAW, they must be protected by an easement. Easements required for any overhead line shall be an easement in gross pursuant to the Energy Operators (Powers) Act. The Developer must arrange with Western Power Property Group for the creation of any required easement at no cost to Western Power and shall be responsible for advising all potential land purchasers of the easement locations and its use and restrictions.

Easements may be required in survey strata scheme subdivisions for customer owned services.

The minimum width of an easement for the installation of underground electrical cables shall be 1.0m.

“Easement in Gross” is an easement that is used for service authorities to protect their interests over Crown and freehold land. An easement in gross is an easement without a dominant tenement.

Western Power usually requires one of the following types of easement in gross.

a) Section 167 easement (previously section 27A easement)

This is an easement created automatically on new subdivision plans under Section 167 of the Planning and Development Act 2005 (previously Section 27A of the Town Planning and Development Act, 1928).

It is created when new Titles of lots within the subdivision are created, to facilitate the installation of and ongoing access for roads and utility services including Western Power distribution systems. The easement must be shown on the deposited plans submitted to the DLI for the issuing of land titles.

b) Section 136C easement

An easement created on freehold titles including survey strata lots and plans under Section 136C of the Transfer of Land Act 1893 to provide for consumer owned services such as electrical and plumbing connections to the requisite utility network.

c) Section 144 crown easement

Crown easements are required to protect cables in existing POS. They can be granted by the Minister under the Land Administration Act 1997. Crown easements require the approval of the DLI.

d) Energy Operators (Powers) Act 1979

Easements for transmission and distribution overhead assets on freehold land within new subdivisions. Can be created with an easement in gross under the Energy Operators (Powers) Act 1979.

5.3.15 Water course drains and navigable canals.

5.3.15.1 Water courses and drains

The Developer shall ensure all water course drains are shown on the UDS design drawings.

Substations shall not be installed near water course drains, or sumps where a minimum of one metre above the 100 year flood level cannot be achieved. Detailed requirements for substation sites are shown in Clause 5.3.18.

The design drawing must show the design for the installation of cables that cross a water course, open drain. Cables must be installed in concrete-encased heavy-duty ducts not deeper than 1500mm and have a minimum cover of 500mm below the bottom of the water course drain.

Where the water course drain is non-navigable and does not meet the requirements above, cables shall be installed in heavy-duty ducts with an extra steel conduit for additional support and cross the open course drain in open air. The steel conduit and heavy-duty duct must be extended at least 2 metres into soil from either side of the open course drain to provide support so that the cable does not suffer damage by its own weight.

5.3.15.2 Navigable canals

Cabling under man made canals is not permitted. Alternative provisions in road reserves or suitable access provisions within bridge structures must be provided to address maintenance requirements and safety associated with boat anchor or dredging damage.

5.3.16 Transformers and size

Transformer types and sizes to be installed in different types of subdivisions must meet the design criteria in the following table:

Residential Subdivision.	MPS transformers. 630kVA & 1000kVA Non-MPS transformers may only be used with the approval of Western Power where there is a significant local load to warrant the increased transformer size. Piggy backing of transformers is not permitted.
Rural Residential Subdivision with three-phase power.	63kVA, ground mounted transformers with up to a maximum of five transformers in a string. MPS transformers. Piggy backing of transformers of above 63kVA is not permitted. Piggy backing of three-phase transformers with single-phase transformers is not permitted.
Rural Residential Subdivision with single-phase power.	25kVA or 50 kVA SPUD transformers. 10kVA or 25kVA SPURS transformers.
Commercial and Industrial subdivision.	Non-MPS transformers up to maximum of 1000kVA and piggy backing of transformers are not permitted.

Table 8: Transformers and Sizes

5.3.17 HV breech joints

A high voltage ring main unit (RMU) must be used where a HV feeder splits into two or more branches and/or feeds transformers. Standard RMUs available are of size 2+1, 2+2, 2+3, 3+0, 3+1, 3+2 and 4+0.

HV breech joints may only be used in the following situation:

a) The currently available range of switchgear is not adequate, e.g. a 4+2 is required; and
b) The breech joint must have a switch on each of the three sides so that isolation can occur if there is a joint problem; and
c) None of the three sides of the breech joint must form part of a major interconnection between adjacent HV feeders.

Note: The maximum size cable that can be breeched from a 400mm^2 HV cable is 95mm^2.

5.3.18 Substations

5.3.18.1 Substation sites

When the installation of a substation (including package substations, transformers and switchgear) is required, the relevant clauses contained in the Western Power document Western Australian Distribution Connections Manual shall apply (See Western Power's website). Refer Clause 5.3.3 for substation flood water mitigation requirements.

The Developer is responsible for advising potential land purchasers of all substation sites the proposed use and restrictions on the use of adjacent lots. As a minimum, substation sites must be shown on the Developer's sales brochures.

Substation sites are to be located on public owned land (e.g. road reserve extension or public open space) or in the case of substations dedicated to a single lot they may be located within the lot adjacent to the road reserve. The Developer is responsible for providing all substation sites. Substation sites to be located within the road reserve must also be located in the indent of the road reserve and as close as possible to the road boundary line extension along normal gazetted public road reserve and shall include any retaining walls and batters.

Retaining walls are preferred to batters. Refer substation site drawing example Appendix 13 Figure 16. Extended Substation Site. Where the Developer chooses to locate substation sites on POS, it shall take the following into consideration:

a) Suitable location of sites within POS.
b) Size, shape, contour and dimensions of POS.
c) Community standards of health, safety and amenity.

Note transfer of land for a substation site may not be appropriate in some situations, Refer Clause 4.1.6.2 for consideration of these alternative arrangements.

Civil consultant's drawings detailing site levels, retaining wall and battered slope designs shall be submitted for DCR. A signed certificate of verification is required by a professional Civil Engineer registered on the Engineers Register (NER) verifying that the substation retaining walls are structural sound and/or battered slopes are suitable for their purpose.

Substation sites cannot be located on a transmission easement or distribution cable easement.

The substation site civil and land requirements are shown on drawings in the Distribution Substation Plant Manual which can be found on Western Power Website.

Western Power may specify the location of substation sites of a subdivision based on strategic operational requirements in the DIP.

The following restrictions will apply to the use of lots immediately adjacent to substation sites,

Fire separation:

Distribution Substation Plant Manual and Western Australian Distribution Connections Manual define spatial separation between buildings and substation equipment. These requirements can be mitigated by provisions of suitable fire rated walls or buildings.

Where the above fire clearance requirements of commercial, industrial or lots that are vested in the Crown are not mitigated to be contained within the substation site as part of the subdivision works the Developer shall place a restrictive covenant in the form of a section 129BA under the Transfer of Land Act 1893 to burden the affected lot/s and define substation to building clearance requirements or to discuss other options with Western Power.

Lots that are vested in the Crown require consent from the Department of Lands or any management body or any utility or public authority that will be granted a management authority to enable the restrictive covenant to be placed. Design drawings for distribution transformer sites adjacent to or within commercial or industrial lots shall indicate dimensioned fire clearance area limit around the site and be submitted as part of the Design Conformance Review. For preparation of Restrictive Covenant documents Developers may use prescribed wording provided by Western Power or prepare their own document that would require Western Power's review. Contact Western Power's Property Specialist for document preparation options and applicable fees.

Noise compliance for Distribution Transformers:

Noise emitted from distribution transformers located adjacent to lots where noise sensitive premises exist or are proposed shall be evaluated to ensure compliance with state government environmental protection requirements.

Compliance shall be achieved by the following individual or combination procedure considerations:

a) Adequate distance separation.

b) Compliance due to local environmental noise influencing factors, for example adjacent major roadways.

c) Substation walls or fences to attenuate sound pressure levels entering the adjacent properties. NER Engineer sign off if wall is an integral part of substation retaining.

d) Notifications on property titles or notes on development plans to identify the noise affected portion of the lot that may require building design features to address noise compliance.

Transformer noise assessment where required shall be undertaken to ensure compliance with Environmental Protection (Noise) Regulations 1997 and particularly the Environmental Protection (Western Power Electrical Distribution Transformer Noise Emissions).

Western Power have developed in conjunction with the Department of Environment Regulation and the UDIA a work instruction 'Noise Compliance Requirements for Distribution Transformers' for use by developers to assess noise compliance, assisting in the determination of distribution transformer siting and any attenuation or notification measures required to ensure compliance. This document can be found on Western Power's web site.

Design drawings for distribution transformer sites adjacent to existing or proposed noise sensitive premises shall indicate dimensioned noise affected area limit around the site and be submitted as part of the Design Conformance Review. Where necessary provide evidence of any notifications (**In the form of 70A Notification under the Transfer of Land Act (1893))** or clauses in the Detailed Area Plan when requesting subdivision clearance and note their requirement on the design drawing. Any 70A Notification shall be submitted to WP for agreement and signing.

5.3.18.2 Substation equipment termination requirements

HV cables shall be correctly terminated into HV switchgear. Incorrect terminated cables will create electrical hazards that will jeopardise the safety of Western Power's employee and persons engaged in the operation and maintenance of the equipment and the safety of the general public.

The configuration of switches, switchfuses and the layout of terminating HV cables shall be clearly shown on the design drawing submitted for Design Conformance Review. Refer Appendix 4 item 5 'Cable terminating and circuit naming'.

Terminating Cables Layout Requirements:

The layout of terminating cables must be designed according to the following practice:

a) The 35mm^2 HV cable of the local transformer must be connected to the nearest switchfuse.

b) Crossing of HV cables must be avoided as far as practicable.

c) All 35mm^2 HV cables must not be connected to switches as they are not fault rated unless protected by fuses.

d) The destination of every HV cable must be clearly shown on the switchgear configuration and cable layout diagram.

5.3.19 HV earths near to telecommunications equipment

No HV earths (e.g., substation and HV cable pole terminations) shall be located within 15m of any existing or proposed telecommunications provider equipment pits.

Where this is not possible, undertake an assessment in accordance with AS/NZS 3835, obtain the telecommunication provider's (e.g. Telstra) written approval to allow HV earths to be installed within 15m of their equipment and provide this approval to Western Power together with calculations as part of the DCR submission

Deep earths at pillars to assist in achieving substation earthing requirements are not considered HV earths for the purposes of this section. Refer to Western Power's FAQ on Earthing Standards and Telecommunication equipment located in the vicinity of proposed distribution HV earths.

5.3.20 Distribution HV power lines, cables and earths in proximity of metallic pipes

During an earth fault on the HV power network a potential difference, or voltage, can develop between a HV earth and metallic pipeline due to Earth Potential Rise (EPR). If the HV power line or cable is in parallel to a metallic pipeline, a power frequency voltage can be induced onto the metallic pipeline called Low Frequency Induction (LFI). These electrical effects can be on both buried and above ground metallic pipes.

Where HV power lines, cables and earths are to be installed in proximity of metallic pipeline(s), the Designer must assess EPR/LFI on the pipeline in accordance with Australian Standard AS/NZS 4853: as set out below and must ensure the total site risk is As Low As Reasonably Practicable (ALARP).

The design shall follow the process steps below:

1. The first pass (Level 1) EPR/LFI assessment shall be done in accordance with the process in AS/NZS 4853: Figure 4.1 using appropriate values from Tables 4.2 and 4.3 of the standard as a zone of interest to identify possible metallic pipeline assets (pipeline or appurtenances) of concern from DBYD.

   a) If no metallic pipeline assets are identified within the zone of interest: Document the assessment for submission with the DCR. No further action is required.

   b) If any part of a metallic pipeline is found within the zone of interest or Tables 4.2 and 4.3 of the standard do not cover the project's design parameters: Continue to step 2.

2. For metallic pipeline assets identified in the Level 1 assessment, a detailed (Level 2) EPR/LFI assessment shall be done as per AS/NZS 4853: using site specific parameters to calculate a refined zone of interest.

Note: Western Power may request a Water Corporation pipeline assessment to be carried out for Water Corporation assets

a) If the Level 2 zone of interest contains no metallic pipeline assets: Document the assessment and parameters for submission with the DCR. No further action is required.

b) If only an inaccessible asset or buried pipeline(s) is still within the refined zone of interest but no above ground metallic pipeline assets:

   Calculate the touch voltage at the pipeline, compare to allowable touch voltage limit document the assessment for submission with the DCR and notify the pipeline asset owner of the extent of pipeline within the hazard contour.

c) If there are still accessible or above ground metallic pipeline assets within the Level 2 zone of interest that cannot be avoided by design improvements / changes, continue to Step 3.

3. For metallic pipeline assets that remain within the zone of interest after the Level 2 assessment, the design shall be completed so as to ensure the total risk posed by the installation is As Low As Reasonably Practicable (ALARP) as per Level 3 assessment in AS/NZS 4853:. The assessment demonstrating ALARP shall be documented in full to produce a detailed report. The pipeline asset owner shall be notified and supplied with a copy of the report. Where mitigation options require works on or around the pipeline asset, approval from the pipeline owner for such works shall be obtained. Projects assessed to Level 3 ALARP risk shall be tested after construction before energisation to verify the design.

All assessment reports must be signed off by a NER. The Designer must provide the signed assessment report to Western Power as part of the DCR submission. Where the pipeline owner is required to be contacted, this shall be prior to the DCR submission and the assessment report, the notification letter to the pipeline owner and any required approvals from them shall be provided as part of the DCR submission.

5.3.21 Low voltage feeder design criteria

The Developer must ensure its Designer uses the following design parameters to design each LV feeder in a UDS design:

a) Voltage variations upstream of the customer's point of attachment (i.e. service pillar) must be within the allowable limit of plus or minus 6% of the nominal voltage of 240V single-phase or 415V three-phase under normal conditions.

b) Conductor current carrying capacity to be adequate under normal operating conditions.

c) The sum of current of all outgoing feeders of a transformer does not exceed the name plate continuous rated current of the transformer.

d) LV feeders must be protected by LV fuses installed immediately after the transformer, e.g. transformer fuseboard or contiguous panel with the transformer. The fuse rating for residential street circuits cannot exceed 315 amps at any substation. Downstream fusing must not be used to extend the length of a feeder backbone.

e) Blocking in of LV feeders must be done when feeders are separated by not more than two lots that are outside the subdivision but will be developed in the future. They must be interconnected by underground cables running in proper cable alignment along the road boundary of the undeveloped lots via suitable open points.

Designers are to use the LVDESIGN software package to ensure the voltage drop, line currents and fuse protection are adequate for each circuit and must include the LVDESIGN file in the submission for DCR. Designers may choose to use other methods or software to carry out the evaluation and assessment, provided they are approved by Western Power.

5.3.22 Uni-pillars in low voltage feeder

In order to provide operational flexibility in residential subdivisions, uni-pillars must be installed as follows along the complete length of every LV feeder:

a) Less than 6 lots: No uni-pillar required.

b) Between 6 and 16 lots (inclusive): One uni-pillar required.

c) Between 17 and 32 lots (inclusive): 2 uni-pillars required.

Exemptions may be granted by Western Power in particular situations e.g. laneways and retaining walls.

Switching points shall be created at each uni-pillar in both residential, and commercial and industrial subdivisions. For commercial and industrial subdivisions provide one uni-pillar per lot. Refer Distribution Construction Standards drawing U9 for cable termination arrangements.

5.3.23 Load and network connection on a LV spur

In the design of LV feeder network, spur LV feeders are unavoidable in the following situations and Designers must give specific consideration to ensure power reliability and qualities are maintained in the future.

Short LV spur feeder

For a short LV feeder that will not be extended because there is no possibility of further subdivisions at the end of the feeder Western Power requires a uni-pillar to be installed on the last lot where the total of more than six lots is connected to the spur feeder. This uni-pillar will be used for interconnection in the future.

LV feeder in cul-de-sac

The cul-de-sac exists in a short street and canal block layout. For LV feeder stops at the end of a cul-de-sac where there is no possibility of any future interconnection at the end of the LV feeder, the following design principle should be followed.

a) If the number of lots in the cul-de-sac does not exceed 16, a uni-pillar must be installed at the entrance.

b) If the number of lots is more than 16, then a uni-pillar must be installed for every 16 lots of the Cul-de-sac.

c) A second LV feeder shall be made available at the entrance of the cul-de-sac. The second feeder shall be a feeder with either no load connected or spare capacity which can pick up not less than 25% of the design load of the cul de-sac feeder.

5.3.24 Electrical requirements for motor/pump starting

Dependent upon the size and location of the electrical motor, starting restrictions may apply and the installation must comply with Clause 3.5 of Office of EnergySafety's "WA Electrical Requirements" that is available from the office of Energy Safety's web site and clauses below.

The Developer's Designer/Consultant must ensure the proposed motor starting requirements are acceptable, prior to the connection of the motor.

Where the subdivision affects the existing and/or proposed pumps of Water Corporation, the Designer must obtain actual pump starting and full load operating details from Water Corporation. The Designer is to provide this data to Western Power for verification.

Designers are to work out the voltage fluctuations of the network in the subdivision and are to include the result in the submission for DCR. Refer to Clause 2.1.3 Power Quality.

5.3.25 Street lighting

5.3.25.1 General

Street lighting forming part of a WAPC subdivision application shall be undertaken in accordance with the UDS Manual requirements.

Street lighting not associated with a WAPC subdivision application shall be undertaken through Western Power's Customer Network Connections Branch processes.

Street lighting must be designed to comply with the requirements of the local government authority. The street lights will either be Western Power's standard street lights or non-Western Power street lights (private street lights).

Western Power-standard street lights include non-decorative steel standard and decorative street lights.

The method of supplying the street lights will be dependent on the local government's policies. Where "dusk-to-dawn" lighting is approved, each street light must be supplied from the nearest pillar with a fuse at the pillar and a link at the street light column.

Only one fuse is permitted at each pillar. Where multiple street lights loop and connect to a single pillar or individually connected to other pillars. Where "dusk-to-dawn" lighting is not approved, street lights must be supplied from separate street lighting cables run from substations.

The Developer shall ensure its Designer liaises with the LGA to establish the street lighting requirements and designs an appropriate lighting design.

If a style of Western Power Supplied decorative street lighting range is selected, the Developer must provide the written approval from the LGA, as this range carries a premium tariff.

Choose powder coat colours carefully. Should powder coat colours be changed, the cost may be similar to purchasing a new pole, as the poles are required to have the existing powder coat finish stripped and a new powder coat finish applied to the same standard.

5.3.25.2 Street lights near to existing overhead power lines

The Developer shall ensure its UDS design meets all safe clearances in accordance with AS/NZS 7000 'Overhead line design – Detailed procedures' and are maintained between existing power lines and street lights in the subdivision. The Designer must show the clearances of street lights from any existing overhead power lines on the UDS design drawing to be submitted for DCR.

Street light standards must not be installed on the same side of a road where existing overhead transmission and/or distribution (HV and LV) mains will remain.

5.3.25.3 Street lights location

All street lights, not mounted on wood poles, are to be installed along extension of common property boundary line on the 2.7m alignment unless prior written approval is obtained from Western Power.

Where the road reserve has a verge wider than 3.7m street lights must be installed with a minimum set back from the kerb line in accordance with the following Western Power Policy Statements, however, the Developer is required to obtain the approval of the LGA, road authority and other utility providers.

a) Placing of power poles within road reserves in built up areas.
b) Placing of poles along roads with speed limits not exceeding 70 km/h.
c) Placing of rigid poles along roads with speed limits exceeding 70 km/h.

The above policy statements can be found at the Western Power's Website under the heading 'Roadside Power poles'.

The Designer must show the setback on the scheme design drawing for DCR where it is not on the 2.7m alignment.

Where a road terminates at a tee junction, at end of a terminating road street lights must be installed close to the centre or along the property boundary extension.

Street lights preferred at the end of cul-de-sac, however locations by agreement with local council.

Street lights must not be installed in water course or drains.

Developers shall ensure that the street light poles are a minimum of 400mm from the property boundary. In laneways, the street light terminal cover (cut-out box) must face into the laneway.

Street lights in laneways shall be positioned in a 1m deep x 1m wide road reserve extension at lot boundaries. Locate the pole centrally.

5.3.25.4 Western Power's standard street lights

Western Power has two types of standard street lights as follow:

a) Western Power Non-decorative street lights.
b) Western Power Decorative street lights.

If one of Western Power's standard street lights is installed, the same arrangements will apply as for all other equipment supply/installation work.

Western Power will own, operate and maintain the street light system in this case.

Non-decorative street lights are not suitable for laneway locations due to potential glare and light spill issues. Unless otherwise approved in writing by the LGA, street lights in laneways shall be at a height of 4.5m and details to be agreed with Western Power and the LGA.

5.3.25.5 Approval of Western Power supplied decorative street lights in subdivision

Developers will generally install either Western Power non-decorative street lights or Western Power decorative street lights.

Energy consumption on Western Power non-decorative street lights will be charged to LGAs as per gazetted street lighting tariffs.

Energy consumption on Western Power decorative street lights will be charged to LGAs at a rate usually higher than the gazetted tariff. Developers can only install decorative street lights in subdivisions where the LGA is on an appropriate contract, e.g. Street Vision of Synergy or similar. Therefore, Developers are required to seek the approval of LGAs if they intend to install Western Power decorative street lights in subdivision developments.

Subdivisions will usually be developed progressively in multiple stages and it will reduce process time for all parties involved if LGA can provide blanket approval for decorative street lights for the complete development instead of individual stages. LGAs may also consider providing blanket approval for all the subdivision developments within a suburb or the whole city/town to Western Power directly. LGA should specify the street light standard colour and the type of luminaries.

A decorative street lights approval form is available at the Western Power's website.

5.3.25.6 Non-Western Power supplied street lights (Private street lighting)

The Developer is responsible for all work associated with the installation of a special non-Western Power street lighting system. The LGA is responsible for the ongoing operation and maintenance of the system and payment of the applicable tariff charges.

In this case, the LGA may choose an un-metered or metered supply. All UMS connections shall be in accordance with Western Power's "Un-metered Supply Network Standard".

Notes:

Un-metered supplies are only available to statutory authorities. The total load connected to each point of supply is limited to 4.8kW single-phase. Western Power's Un-Metered Supply Network Standard can be found at the Western Power website.

The following additional conditions apply:

a) The Designer must provide Western Power with a letter from the applicable LGA accepting:

   I. that it will own, operate and maintain the street light system and pay the applicable tariff charge; and

   II. that, in addition to any advice through an electrical contractor's submission of statutory forms, it will advise Western Power of any increases or reductions in the loads connected to the supply.

b) The installation must comply with AS/NZS 3000 including earthing and protection.

c) The installation must not be connected to Western Power's street lighting system.

d) The Developer is responsible for all installation work, including cabling.

e) Cabling shall not be installed in Western Power's 0 - 500mm alignment. The preferred location is in the 2.4 - 3.0m alignment as indicated in the Utility Providers Code of Practice.

f) Where a metered supply is required the installation must also be provided with a main switchboard incorporating metering to Western Power requirements.

g) Where an un-metered supply is required, street light standards can be supplied from a fuse from the nearest pillar with appropriate label, without the need for a switchboard.

h) Where a switchboard is required, a weatherproof durable label will be installed by the Developer adjacent to the main switch, reading "Main Switch – Un-metered Supply - Installation Maintained by City/Shire of <Insert City/Shire Name> - Isolate supply at all times before commencing work".

i) Each light standard must be equipped with a means of isolation located in the base.

j) Each light standard shall be identified as belonging to the City/Shire of <Insert City/Shire Name>, and include instructions for maintenance and repairs to be referred to the City and not Western Power.

k) Preliminary Notice and Notice of Completion will be submitted to Western Power to initiate the issue of a service ruling and final inspection of the installation as appropriate. In addition to normal information, your electrical contractor is required to endorse the Preliminary Notice and the Notice of Completion in the following terms if it is an un-metered supply: "Un-metered Supply. Total Load kW "

5.3.25.7 Street lighting outside gazetted public road reserve

Western Power's street lights, including decorative street lights under a Synergy scheme, can only be installed in gazetted public road reserve.

If a LGA or other authority require lights on POS, PAW and Crown Reserve, private street lighting must be installed.

5.3.26 Underground transmission protection pilot cables

Where existing transmission protection aerial pilot cables are to be relocated underground, the underground pilot cables must be shown on the UDS design drawing.

The underground pilot cables must be designed to meet the requirements in the DIP.

Underground pilot cables shall not be installed with high voltage cables, and an alternative cable route for pilot cables must be planned unless as otherwise specified in the DIP.

In situation where it is not possible to provide an alternative route, the Designer must seek the approval of Western Power.

Where more than one underground pilot cable is to be installed they shall be installed in separate routes. Shared trench arrangements for multiple underground pilot cables shall not be used unless prior approval is obtained from Western Power.

5.3.27 Existing customers and affected parties

Where existing aerial mains are to be removed as part of the subdivision work, the Developer is responsible for the reconnection of existing Western Power aerial-connected customers to the underground system at their cost.

The reconnection services to existing customers can be one of the following:

a) A normal service pillar at the front boundary.
b) A wall mounted pillar; or
c) Retaining the existing overhead service via a service pole.

The Designer is to include the appropriate design on the UDS design drawing to be submitted for DCR.

5.3.28 Subdivision design drawing requirements

The Developer must ensure that the design drawing submitted for DCR shall comply with the “Subdivision Design Drawing Minimum Requirements” in Appendix 4.

Failure to meet the above minimum requirements will result in non-conformance.

5.3.29 Variations to Western Power designs or standards

Western Power will consider requests for variations in design or standard practice. These must be made by the Developer or his representative in writing on a Request for Variation to Western Power Design or standard form shown in Appendix 2 or similar. The request must include a marked up plan showing proposed changes and the Developer must include sufficient documentation to justify the changes.

5.4 Design for 63KVA, three phase, ground mounted transformer application

In broadacre subdivisions it is often more cost effective to install multiple small (63kVA) transformers rather than bigger 315kVA transformers.

5.4.1 Design aspects and philosophy

The basic design philosophy is given in the following table:

Design Aspect	Philosophy
ADMD	An ADMD of 5kVA per rural lot should be used unless demands for discrete loads are known. ADMD for other areas will be as per instruction from Western Power.
Cable installation	HV cables will be 35mm² three-phase for 6/11kV and 22kV, and 50mm² for 33kV. LV cables should be 4-core, sized to ensure volt drop is within limits.
Earthing	Same earthing as the 315kVA MPS transformer site (Distribution Substation Plant Manual Section)
Foundations	A standard concrete pipe culvert is to be used (same as SPUDS).
HV Connections	The transformer is designed to be loop in /loop out of up to five transformers in a single string.
Installation lot size	In subdivisions the same site size and layout as the 315kVA MPS will apply (Distribution Substation Plant Manual), so that the transformer can be upgraded easily in the future.
LV fusing	The transformer is fitted with 100A red spot fuses and distribution busbar.
Number of load connections	At 5kVA per rural lot, one 63kVA transformer can supply up to 11 lots subject to volt drop within limit.
Voltage drop	To facilitate minimum volt drop, the transformer must be close to the centre of the load.

Table 9: Design Aspects and Philosophy of 63kVA Transformer

5.4.2 HV connection

63kVA transformers can be piggy-backed up to a maximum of five transformers in a string.

Western Power requires Developers to install ground mounted 2+1 RMU switchgear to supply transformers.

In large subdivisions where two strings of transformers are required, it is preferable that a 2+2 RMU switchgear is installed to supply each string. The Designer must ensure that equal numbers of transformers are on each string. By using one 2+2 RMU instead of two 2+1 RMUs, the amount of HV assets to be installed may be reduced.

In existing residential areas with an overhead network where there is no potential for further network extension the transformers may be supplied via pole top drop out fuses.

5.4.3 LV connection

The transformer low voltage side is fitted with three-phase 100A fuses and distribution bar. A maximum of two LV feeder cables can be connected back-to-back to the distribution bar and a maximum of 4 x 25mm² service cable can also be connected to the distribution bar.

Western Power prefers the connection of one 240mm² LV feeder cable from the distribution bar to a nearby uni-pillar and then splitting into 2 x 120mm² LV feeder cables for reticulation where LV feeder length is not exceeding 500m (refer Clause 5.3.8). The cabling cost will be greatly reduced by using 120mm² cables.

The Developer will not be permitted to connect consumer's main cables directly to the distribution bar. They must always be connected via service pillars at the property boundaries.

5.5 Single phase underground distribution system (SPUDS)

The Single Phase Underground Distribution System (SPUDS) is designed for rural subdivision in areas zoned "Rural" or "Special Rural" with lots sizes of between 1 and 4 hectares. It is cost competitive with the overhead systems traditionally offered for those subdivisions.

The HV reticulation in this system is designed as a single-phase Screen Wire Earth Return (SWER) system, operated at 12.7kV. This HV voltage level is adopted for both the 22kV and 33kV systems to allow standard equipment to be used throughout Western Power.

The system is based on servicing the residential lots using several 25kVA single-phase padmounted transformers, each serving up to four customers (refer Clause 5.3.2). Each transformer is internally fused to protect the system from internal transformer faults.

The single-phase SWER supply is provided by a single core 35mm² HV underground cable with a heavy-duty copper screen to provide the earth return path. The single core cable loops in and out of a string of 25kVA transformers using separable, non-load break connectors.

The SPUDS will be supplied from one of the following system:

a) Metropolitan 22kV 3-wire system with no running earth.
b) Country 22kV 4-wire system with running earth.
c) Country 33kV 4-wire system with running earth.

The structure of the SPUDS to be used depends on the size of the subdivision, the configuration and the voltage level of the HV overhead system and can be broadly categorised into four systems as follows:

d) Metro 22kV or Country 33kV, two-phase with pole top or ground mounted isolating transformer and a string of 25kVA, single-phase, 12.7kV, 2- bushing or 3- bushing tee off transformers.
e) Country 22kV, single-phase (with running earth) HV direct connected via DOF and up to a maximum of 8 x 25kVA, single-phase, 12.7kV, 2- bushing or 3- bushing tee off transformers.
f) Metro 22kV or Country 33kV, 3 x two-phase padmounted isolating transformers (loop in & loop out) and each with a string of 25kVA single-phase, 12.7kV, 2- bushing or 3- bushing Tee off transformers.
g) Metro 22kV, two-phase HV direct connected via DOF and a string of 25kVA, single-phase, 22kV, 4-bushing transformers.

Each SPUD transformer reticulates the LV supply to service pillars through a three core 25mm² XLPE cable. Customers' main cables are not permitted to connect directly to the transformer. They must always be connected via services pillars at property boundary.

The details of the SPUDS arrangement and design are in Western Power's SPUDS Manual.

Ensure that a surge arrester is provided on the unused bushing of the last padmounted transformer in the 'string'.

5.6 Design documents

5.6.1 Western Power design manual/policy (available online. Refer section 1.3)

Distribution Design Catalogue.
Distribution Substation Plant Manual.
Distribution Subdivision Policy.
FAQ on earthing standards
Locating Ground Mounted Equipment Policy.
Network Standard NS 14.2 Underground Cable Installation Manual Part 2- Technical Requirements.
Placing of power poles within road reserves in built up areas.
Placing of poles along roads with speed limits not exceeding 70 kMH.
Placing of rigid poles along roads with speed limits exceeding 70 kMH.
Subdivision Design Drawing Minimum Requirements (Appendix 4).
Un-metered Supply Network Standard.
Western Australian Distribution Connections Manual

Table 10: List of Western Power Policies and Manuals Available

The above documents are available on the Western Power's website:

5.6.2 Western Power design manual/policy

- Distribution Overhead Line Design Manual
- Single Phase Underground Distribution System – Design and Operations Manual (SPUDS).
- LVDESIGN User Guide.
- DQM/CAD Interface Urban Residential Design User Guide.
- Project Designs Using CAD for Microstation Manual.

5.6.3 Western Power design software

- LVDESIGN.
- DQM/CAD Interface software (includes DQM/CAD Interface for Underground Distribution Designs and Project Designs Using CAD for Microstation - Bentley).

For enquiries about purchasing the above design software, please contact the Land Development Team Leader on: 13 10 87

6. Installation policy and requirements

This section outlines the installation options available to a Developer and defines the processes, policies and requirements governing the construction of the underground distribution network in subdivision developments.

The installation process cannot commence until the Developer's UDS design conforms to Western Power's requirements and the Developer has accepted the Western Power quotation. Where a decoupled project process is agreed then the construction works can commence prior to quote issue and payment. Refer Clauses 1.2, 4.3 and 6.2.

Refer Utility Providers Code of Practice requirements. Specific clauses are referenced in this document.

Note: Partial energisations may contribute to significant safety issues therefore any work required at the front end of a subdivision to facilitate onsite building programs, including the removal and relocation of existing assets, must be processed as a separate project.

6.1 Small subdivision (i.e. not more than four lots)

6.1.1 Installation policy

Where the proposed subdivision is for four lots or less, or if it is an amalgamation of lots into four lots or less Western Power will design and construct the UDS. Refer to Clause 1.1 'Purpose' for information on flexibility in defining small subdivisions.

The Developer can elect to carry out trenching and laying of cable in accordance with the requirements in Clause 6.2.8. The Developer should advise Western Power of its intention to carry out trenching and laying of cable when requesting a Quote.

6.1.2 Process and responsibility

Western Power generally requires:

- 12 weeks from receipt of payment to the commencement of the UDS work.
- Once payment is received, Western Power will issue payment acknowledgment and appoint a CM to schedule and oversee the construction work.

The Developer must:

- contact the CM within 12 working days of receipt of payment about the construction program.

The Developer is required to complete its work in accordance with Clause 4.2.3

If the Developer is to carry out trenching and laying of cable, they must:

- complete the handover certificate for the cable and forward it to the CM before Western Power begins its work.

6.2 Large subdivision (i.e. more than four lots)

For large subdivisions of more than four lots the Developer is responsible for the design, material supply, electrical infrastructure installation, inspection, testing and administration of the subdivision. Refer to Clause 1.1 for information on flexibility in defining small subdivisions.

Western Power will carry out all of the interfacing work required to connect the electricity infrastructure of a subdivision to the SWIS network unless there is agreement on an individual case basis for the Developer to undertake some of these works. Also refer to Clause 4.3.2.7.

The Developer pays Western Power the quoted price plus GST to carry out construction works on the Developer's subdivision site that is the Developer's workplace to create serviced lots that the Developer can sell to prospective land purchasers.

The following table summarises the process and the responsibilities of the Developer and Western Power for large subdivisions.

Event No.	Activity Description (Activities may not necessarily be carried out in event No order.)	Responsibility of
1	Scheme DCR submitted and Quote issued by Western Power.	Western Power
2	Accepts and pays Installation Quote. This may by agreement be deferred if the process is decoupled. Refer Figure 5.	Developer
3	Clears WAPC conditions when Deposited Plan submitted and accepted and either early clearance payments received, **or** Handover Inspection has been completed from the Developer. In both cases, the compliance of any easement or any other special conditions must be met by the Developer.	Western Power & Developer
4	Provides all project and safety management associated with the construction of the electrical network on site for the proposed subdivision and its interface with the Western Power's network.	Developer
5	Appoint the Site Superintendent/Project Engineer.	Developer
6	Provide construction administration package to Western Power	Developer
7	The Developer's contractor purchases materials and equipment.	Developer
8	Provides all the materials necessary to complete the electrical construction work in accordance with the conformed design.	Developer
9	Security of all Western Power materials released to the Developer's contractor and/or installed on site.	Developer
10	The Developer's contractor carries out installation construction work as per conformed design drawing. Carries out the installation, jointing and termination of all equipment in accordance with the conformed design, Western Power specifications and standards and relevant Australian codes and standards.	Developer
11	Provides documented QA. Refer to Clause 4.3.3.	Developer
12	Carries out all inspection and testing requirements including pre commissioning.	Developer
13	Provides test results and schedules as required to Western Power.	Developer
14	Western Power's QA Officer conducts inspection during progress of the construction work and testing. Developer's contractor to assist with provision of evidence information e.g. photographs. Refer Clause 6.2.2.4.	Western Power & Developer
15	Provides "As Constructed" drawings.	Developer
16	Provides "As Constructed" records.	Developer
17	Handover inspection (Pre-handover meeting) conducted by Western Power CM and the Site Superintendent/Project Engineer when practical completion is achieved.	Developer & Western Power
18	Rectifies defects.	Developer
19	Handover Inspection (Handover meeting) completed and accepted by Western Power CM.	Developer & Western Power
20	Issues handover certificate. Can be issued with exceptions for example: Completion of street light installation and conversion of overhead to underground customer supplies.	Developer & Western Power
21	Completes interfacing work.	Western Power or Developer by agreement
22	Commissions and energises network.	Western Power
23	Provides an unconditional 12-month warranty for all installed equipment commencing from the date of the hand-over certificate.	Developer

Table 11: Large Subdivision Process & Responsibilities

6.2.1 UDS workplace

6.2.1.1 Developer's site

The Developer is responsible for the workplace created by all work undertaken on or in connection with a development and the UDS for that development.

Refer Clause 1.2 for a definition of 'site'.

6.2.1.2 Site Safety

Before any works are undertaken on the development site in connection with a UDS, the Developer must:-

a) Prepare and approve a Site Safety Management Plan for its Development. This Plan must incorporate Western Power's Contractor Safety Guidelines; and

b) Provide a copy of its Site Safety Management Plan to Western Power prior to construction of works on site. (Refer Clause 6.2.2.2)

c) Western Power's representative will liaise with the Developer's Site Superintendent to ensure all Western Power's personnel who will come onto the Developer's site are inducted according to the Developer's Site Safety Management Plan.

d) Western Power's personnel and contractors shall follow the Developer's Site Safety Management Plan and all lawful directions given by the Site Superintendent in connection with site safety.

To the extent that Western Power's own work safety practices and procedures are:

e) more specific to the UDS works to be undertaken; or

f) more exhaustive than those of the Developer's Site Safety Management Plan;

Western Power's personnel and contractors shall follow those practices and procedures.

6.2.1.3 Liaison and cooperation for site safety

The Developer must ensure that Western Power's personnel have uninterrupted access to that part of the development site reasonably required for the UDS works to be undertaken by Western Power.

The Developer's Site Superintendent and Western Power's representatives will liaise and cooperate to:

a) Identify the extent of Western Power's site for UDS works;

b) Fix the date and times for access to the Western Power site; and

c) Ensure that as far as reasonably practicable, Western Power will have continuous, uninterrupted and exclusive access to that site at all times while it completes the inspection and interface works.

6.2.2 Construction administration

6.2.2.1 Commencement of construction

The construction phase of the UDS will commence upon either:

a) Receipt of the completed Acceptance of Quote form, accompanied by payment in full of the quoted price and GST, or

b) Issue of a DCR completion letter for projects agreed to be decoupled.

Delay in commencement of work on site may result in reissue or cancellation of the issued Quote. Refer to Clause 4.3.2.11

6.2.2.2 Information to be provided prior to commencement of construction

The Developer shall provide the following information as a package to Western Power's subdivision administration (Email: subdivisionsadmin@westernpower.com.au) to include all information as a zip file at least two working days prior to commencement of construction:

a) Copy of the Site Safety Management Plan. Refer Clause 6.2.1.2.
b) The name of the Site Superintendent/Project Engineer.
c) The name of Civil Engineer.
d) The name of the cable laying contractor.
e) The name of electrical contractors/workers assigned to the Electrical Infrastructure installation and a copy of their qualifications.to demonstrate compliance with Clause 6.2.7.
f) A letter authorising the above people to carry out the subdivision work and to hand over their work to Western Power.
g) Confirmation of the latest design revision.
h) Commencement date of the construction works.
i) Scheduling information sheet; and
j) An up-to-date construction project programme and schedule of site meetings. Refer Clause 6.2.2.2 - Figure 7. This shall include installation events detailed in Clause 6.2.2.6 - Inspection.

Western Power to be advised of any change of personnel.

Submission of these documents does not constitute Western Power's endorsement or approval of the contents therein.

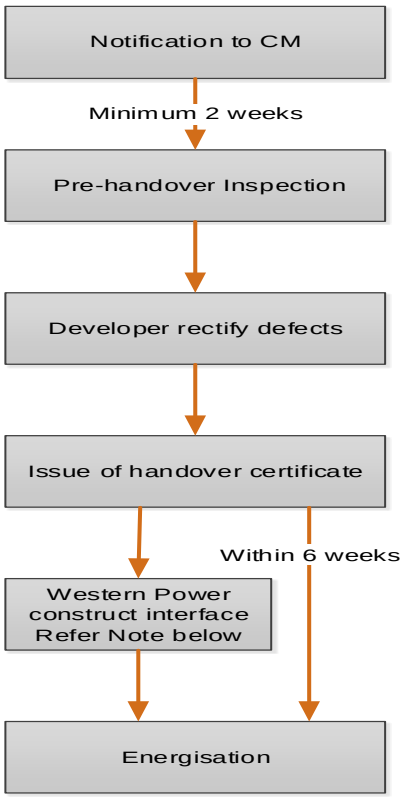

Figure 7: Construction timeline for large subdivisions

Note: Western Power may construct the interface works at any stage following receiving the project depending upon the site situation.

6.2.2.3 Site queries

Any site queries related to the electrical installation shall be directed to the Developer's electrical designer as per the process diagram below.

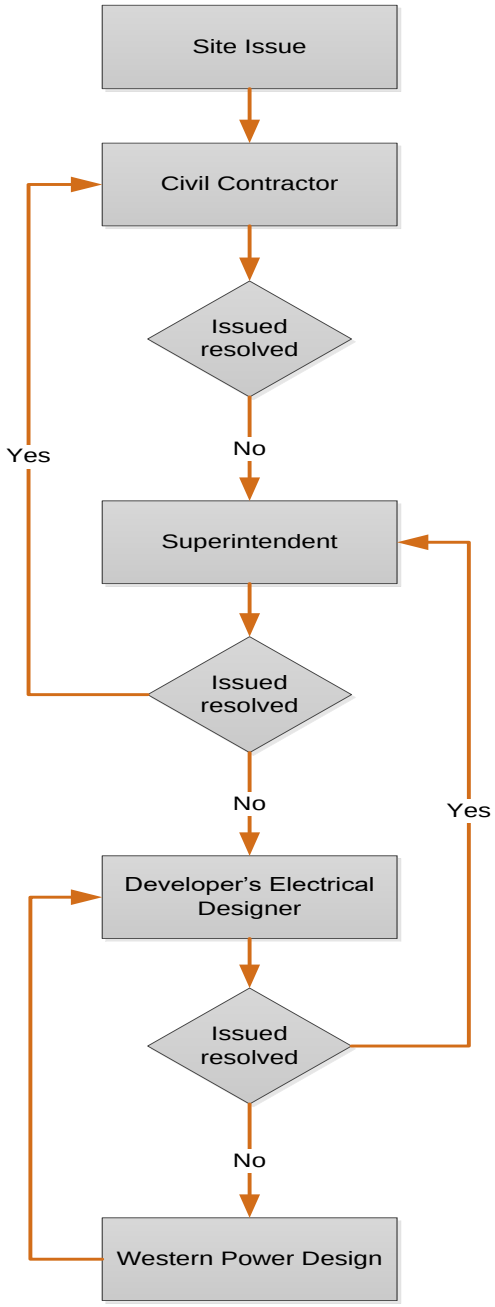

Figure 8: Site query process

6.2.2.4 Key project personnel

Site Superintendent/Project Engineer

Western Power requires the Developer to appoint a Site Superintendent/Project Engineer as the site representative for the installation of electrical services. In addition to the functions given by the Developer, the Site Superintendent is the Developer's representative for the following purposes in connection with a UDS namely:

a) Provide Western Power with a copy of the site safety management plan.
b) Arranging site meetings.
c) Communications regarding the works programme and advising resource and material availability.
d) Ensuring Western Power receives the signed-off electrical cable test schedules and HV cable joint schedule.
e) Ensuring Western Power receives the signed-off Material & Equipment Schedule for subdivisions.
f) Ensuring Western Power receives the signed-off "As Constructed" drawings.
g) Preparation and sign-off for handover inspection.
h) Accepting warranty commitments on behalf of the Developer.
i) Handover inspection and Handover, and
j) Referring all technical matters to their Designer representative. Refer Clause 5.2.2.
k) None of the Developer's personnel or contractors who undertake UDS works is eligible to be the Site Superintendent.

Construction Manager (CM)

The CM appointed by Western Power to be responsible for pre-handover inspection, testing and commissioning, interface works and energisation.

Quality Assurance Officer

The Quality Assurance (QA) Officer is appointed by Western Power as its inspector to monitor electrical equipment installation standards on subdivision developments.

The QA Officer will conduct random and periodic inspections during the progress of the installation construction work. The QA officer may assist the CM at the Handover inspection stage of the subdivision Developer's representatives may contact the QA officer by email to quality.wpdt@westernpower.com.au including Western Power project reference.

The QA Officer can be a person or organisation independent of the construction contractors and/or Western Power.

6.2.2.5 Inspection

A QA Officer will conduct random and periodic inspections during the progress of the Electricity Infrastructure installation. The Developer must give the QA Officer, site and equipment access to conduct all inspections required.

The QA Officer will accordingly inform the Site Superintendent/Project Engineer of any defect.

The Developers project program must provide the QA Officer dates (and any progressive updates) for the following key milestones:

a) The commencements of any cable pull to enable inspection of equipment and methodology.
b) Trenches being backfilled to enable inspection of duct/cable alignment and separation and check the suitability of backfill.
c) Cable jointing, termination and testing of high voltage cables, switchgear, transformers and substation earthing.

The Site Superintendent/Project Engineer must allow one working day for the QA Officer to inspect trenches prior to being backfilled. In case trenches are backfilled before the expiry of inspection duration, the Developer is responsible for providing inspection pot holes, and associated costs, as required by the QA Officer for inspection.

To assist the QA officer in confirming installation compliance and reducing the requirement for potholing and other invasive procedures it is required that the contractor progressively record evidence photographs. These shall be of underground cable installations prior to and after backfilling to indicate cable arrangements and depth below finished ground level at least one per cable run. This photographic evidence shall be of good quality and include some adjacent features to help identify the relevant subdivision. Photographs shall be submitted with test sheets.

For any Western Power requested potholing the Developer's contractor will be responsible for DBYD and any services associated damage.

6.2.2.6 Testing

The Developer must conduct tests to prove the integrity of Electricity Infrastructure installed and to ensure all technical requirements are met at least four weeks prior to handover of the asset and equipment to Western Power. The tests to be carried out are listed in Clause 6.2.6.

The Developer must provide Western Power a schedule of proposed tests at least three working days in advance of the tests being carried out and Western Power reserves the right to witness any test or to require tests to be repeated or equipment to be opened up or trenches pot holed for inspection.

The Developer must give Western Power access to the site and equipment necessary to undertake any tests Western Power deems necessary to test the integrity of any part of the network installed by the Developer. The Developer is responsible to clear the site, provide access to equipment, provide pot holes, remove and replace any panels etc as required by Western Power.

The Developer is responsible to repair or correct any equipment or workmanship issues which are found by test to be unsatisfactory.

6.2.2.7 As constructed drawings

Upon completion of UDS work for a subdivision, the Developer must provide Western Power with "As Constructed" drawings of the UDS.

The Developer must ensure that the "As Constructed" drawings:

a) Are certified "As Constructed", signed and dated by a surveyor who is eligible for membership of the Institution of Engineering and Mining Surveyor Australia (IEMSA) or the Institute of Surveyor, Australia (ISA) or by the Developer's contractor. A certificate from the surveyor is acceptable. The surveyor or Developer's contractor is required to certify that all Electrical Infrastructure assets including but not limited to cables, transformers, switchgear, pillars, street lights, are physically installed as shown on the "As Constructed" drawings.

b) "As Constructed" drawings may be submitted in electronic form only, in which case include on the drawing a note certifying it being "As Constructed" and cable contractor company name and contact details. The drawing shall be revised to "As Constructed".

c) Is in DGN (Micro-station - Bentley) format incorporating the MGA94 grid system. Refer Clause 4.4.4 - Table 5.

d) Includes revision number, revision date and "As Constructed" details, including any changes in design or W P standard requirements.

e) Includes dimensioned locations of all underground in-line, breech joints, working ends and all off-alignment cables are detailed using standard symbols.

f) Nominate cable depths that are greater than 1500 below finished ground level.

g) Is submitted electronically to Western Power with the certificates of the Site Superintendent and the surveyor via Western Power's public electronic mailbox External Design and Construct, at least five working days prior to the scheduled date of the pre-handover inspection.

Refer Utility Providers Code of Practice Clause 6.4 regarding DBYD drawing information that proves to be inaccurate.

The "As Constructed" drawing will be processed by Western Power and forwarded to the CM prior to Handover inspection. The CM will not accept any "As Constructed" drawing on site from the construction contractor.

By submitting an "As Constructed" drawing (including a revised drawing) the Designer and Developer consent to Western Power and its contractors and agents:

h) using the "As Constructed" drawing as Western Power sees fit including, without limitation, to update Western Power's asset registers including SPIDAWeb, for 'Dial Before You Dig' purposes, and to facilitate the design of other nearby, surrounding or adjacent subdivisions and distribution schemes; and providing the "As Constructed" drawing to other parties including, without limitation, designers of nearby, surrounding or adjacent subdivisions and distribution schemes

6.2.2.8 As constructed records

Upon completion of all the UDS work of a subdivision, the Developer must provide Western Power with the following "As Constructed" records:

a) The records shall include locations of pillars, road crossings, cable pits, cable joints, working ends, substations, street lights, cables through a nonstandard alignment or a POS, PAW, ROW or private property and cables in the allocated alignment at minimum 100m intervals and at changes of direction. All shall be dimensioned from the nearest property boundary. The cable installation records must be signed off by either a surveyor who is eligible for membership of IEMSA or ISA or the Developer's contractor.

b) Electrical cable test schedules signed off by the licensed Electrical Worker who has carried out the tests or by an accredited cable jointer if tests have been carried out by such person.

c) A HV cable joint schedule signed off by an accredited cable jointer who has carried out the work.

d) A material and equipment schedule must be completed and signed off by the Cable Laying Contractor.

e) Photographs to assist QA review. Refer Clause 6.2.2.5

The Developer must ensure that the "As Constructed" records are provided to the Western Power at least five working days prior to the scheduled date of the pre-handover inspection.

Standard forms for Electrical Test Schedules, HV cable Joint Schedule and Material and Equipment Schedule are available for download from Western Power's website.

By submitting an "As Constructed" records (including revised drawings) the Designer and Developer consent to Western Power and its contractors and agents:

f) using the "As Constructed" records as Western Power sees fit including, without limitation, to update Western Power's asset registers including SPIDA-web for 'Dial Before You Dig' purposes, and to facilitate the design of other nearby, surrounding or adjacent subdivisions and distribution schemes; and

g) providing the "As Constructed" records to other parties including, without limitation, designers of nearby, surrounding or adjacent subdivisions and distribution schemes.

6.2.2.9 Pre Handover inspection

The Developer shall provide a notice (See example Appendix 10) for the pre-handover inspection as shown in Figure 7 'Construction Timeline for Large Subdivisions'.

Pre-handover inspection occurs when, in the CM's opinion, all Electricity Infrastructure in the UDS is substantially completed (i.e. practical completion is achieved).

During the pre-handover inspection, the CM will indicate to the Site Superintendent/Project Engineer any defects or outstanding items to be rectified. The Site Superintendent/Project Engineer is responsible for recording any defects or outstanding items.

6.2.2.10 Handover inspection

The handover inspection is deemed to be completed only when all electrical connections including working ends have been completed and tested, all covers and safety equipment and signs are in place and any remaining minor works can be carried out without removing safety covers or access to electrical connections. An example of such further works would be the repair of paint damage on pad-mounted equipment or the replacing of a temporary label with a permanent one.

The CM will endorse the Completion Check List in Appendix 11 – Completion Check List and will certify completion of handover inspection when the Developer has satisfied the following conditions:

a) All works associated with the UDS subdivision or stage that was undertaken by the Developer has been completed, except Reinforcement and Interface works and commissioning to be undertaken by Western Power.

b) All inspection certificates are completed satisfactorily by the Developer and endorsed by Western Power.

c) All tests have been carried out by the Developer and endorsed by Western Power.

d) Western Power has received all "As Constructed" drawings in electronic format and all the "AS Constructed" records. (Where applicable include drawing and record reference/version numbers to be recorded on the Handover Certificate).

e) All high voltage switches have been locked in the open position. All high voltage fuse switches are fitted with the correct size fuse and are locked in an open position, and high voltage earth switches are locked in the closed position.

f) All links and fused links of the low voltage network have been handed over to the CM and all LV switches are in the open position.

g) All equipment or partial equipment included in the handover inspection is clearly marked with a label signifying that the equipment is operational and is/can be energised. (See sample label Figure 11); and

h) The Site Superintendent /Project Engineer must be aware of that upon completion of handover inspection all equipment in the subdivision is part of Western Power's operational network and no site contractor can access it unless authorised by the CM.

6.2.2.11 Handover

The handover is a key milestone for large subdivisions to enable the:

a) provision of WAPC clearance; and

b) transfer of ownership and operational control of the equipment to Western Power to enable connection to its network and live commissioning checks to be conducted.

The handover of the subdivision occurs when all works associated with the UDS subdivision or stage electrical works have been completed.

The handover certificate in Appendix 12 – Handover Certificate is the official acknowledgement by the Developer that the ownership of all Electricity Infrastructure for which they undertook associated with the subdivision has passed to Western Power and has been constructed in accordance with this UDS manual.

The handover certificate is also an acknowledgement by the Developer that they and any other parties under its control, no longer have access to the Electricity Infrastructure.

Upon handover Western Power owns the network and access can be obtained only through Western Power's Networks Operational Control Centre (NOCC).

The Developer unconditionally warrants the design and installation and all Electricity Infrastructure for which they undertook in the UDS for a period of 12 months from the date of the handover certificate. Refer to Clause 6.2.4.

6.2.2.12 Commissioning

Western Power commissioning requires the energisation of equipment therefore can only commence after handover and completion of interface works by Western Power.

The Developer is responsible for all pre-commissioning of equipment which may be witnessed by the CM.

6.2.2.13 Early clearance

In accordance with Clause 4.1.5, the Developer can request early clearance of large subdivisions from Western Power. The quote payment is a requirement for decoupled and non decoupled projects where early clearance is requested.

6.2.3 Early clearance completion

The Developer is required to complete all Electricity Infrastructure installation work in a UDS up to the handover inspection stage within 20 weeks of the date of early clearance given by Western Power. This is to ensure there are no delays to home builders in getting electricity supply for building work.

6.2.4 Warranty

The Developer must provide an unconditional 12-month warranty for the design and installation of all equipment Electricity Infrastructure associated with the provision of electrical services to the subdivision undertaken by, or on behalf of the Developer. The warranty commences from the date of the hand-over.

Defects in the Electricity Infrastructure which arise during the warranty period and are solely caused by Western Power supplied equipment will be rectified by Western Power at Western Power's cost.

All other defects and omissions in the Electricity Infrastructure which arise during the warranty period will be rectified by Western Power at the Developer's cost. Prior to carrying out any rectification work Western Power may, in its sole discretion, require full or part payment of Western Power's estimate of the costs of rectification.

6.2.5 Ownership and responsibilities for equipment

When the Developer supplies and installs all the Electricity Infrastructure associated with the UDS, the Developer owns all equipment and is responsible for its security up until the following at which time ownership transfers to Western Power at issue of the handover certificate.

When Western Power supplies equipment to the Developer for the Developer's subcontractor to install, the equipment remains the property of Western Power but its control and security is the responsibility of the Developer until it is installed and formally handed over to Western Power. Any loss due to damage or theft is the responsibility of the Developer until handover.

When Western Power supplies and installs equipment, ownership of all materials remains the property of Western Power, both during and at the completion of the project.

6.2.6 Tests

The Developer must carry out tests on all installed equipment that forms part of the subdivision including those specified below and complete and submit the relevant test work instructions to the CM.

Applicable tests, inspections, checks inclusive of recording of results, shall be undertaken on all equipment forming part of the subdivision including as appropriate those elements listed below to demonstrate compliance with test requirements.

- Low voltage XLPE cable.
- High voltage XLPE cable.
- Earthing system resistance testing. (All equipment).
- Low voltage kiosk.
- MPS distribution transformer.
- Non-MPS distribution transformer.
- HV ring-main switchgear.
- Single-phase transformer (Ground mount).
- Steel standard street light.

Testing shall be undertaken in accordance with the requirements of Table 12.

Test work instructions are provided in "Network Standard NS 11, Testing & Commissioning". When completing the test work instructions include the Western Power project reference e.g. MS/SS number in the 'Work Package No.' location.

All electrical testing of Electricity Infrastructure shall be carried out by an electrical worker licensed under the Electricity (Licensing) Regulations 1991 and/or an accredited cable jointer as permitted under Clause 6.2.7.6.

The electrical worker or the accredited cable jointer who carries out the tests is to complete and sign off the testing work instructions and forward them to the QA Officer to be received at least five working days prior to the hand-over inspection.

Equipment to be tested	Network Standard NS11 Work Instruction Reference	Work Instruction Items to be Completed
LV cables	2.6 - Low Voltage Cables With / Without Pillars	Complete items 1 – 8 only.
HV cables	2.1 – High Voltage XLPE Cables	Complete items 1 – 7 only.
HV cables	2.2 – High Voltage Mixed Cables	Complete items 1 – 8 only.
Earthing	4.1 - Earthing System Resistance Testing (All Equipment)	Complete all items
LV switchgear	4.10 – Low Voltage Kiosk	Complete items 1 –3 only
HV switchgear	4.9 – High Voltage Ring-Main Switchgear	Complete items 1 – 7 only
Transformers	3.1 - MPS Distribution Transformer	Complete items 1, 2 and 3 only
Transformers	3.2 - NON-MPS Distribution Transformer	Complete items 1, 2 and 3 only
Transformers	3.3 – Single-phase Transformer (Pole Mount, Pad Mount)	Complete items 1, 2 and 3 only
Transformers	3.6 - SWER Isolation Transformer Ground Mount	Complete items 1, 2 and 3 only
Street lights	2.7 - Steel Standards Street Lights	Complete items 1 – 5 only

Table 12: Test Work Instruction Schedule

Refer Network Standard NS 11 Testing and Commissioning.

Commissioning and energisation of equipment and the completed installation does not form part of the Developer's requirements and shall be undertaken by Western Power following handover.

Where energisation does not follow immediately after commissioning then prior to energisation (assuming that sufficient time has lapsed between the handover and the energisation period), that part of the network to be energised shall be retested in accordance with the requirements of Network Standard NS 11, Testing & Commissioning.

Energisation delays requested by the Developer/customer may be subject to time limitations and or network reinspection fees.

6.2.7 Installer requirements, qualifications and responsibilities

All persons who undertake work associated with a UDS in subdivisions must hold all necessary licences and authorisations. The Developer must ensure that all work associated with a UDS is carried out by qualified persons as required by the applicable written laws and as a minimum are qualified as below.

6.2.7.1 Cable Laying Contractor

The cable laying contractor must employ suitably qualified cable layers for the installation of underground cables.

6.2.7.2 Cable Layer

A person undertaking cable laying must have Statement of Attainment for the nationally accredited unit of competence AQF training 'UETTDRCJ21A (or current update) –Lay ESI electrical cables'. Refer Table 13.

Note: A person who has previously completed 'PTS 287 Lay underground electrical cables' at PTSWA can continue to undertaking cable laying.

6.2.7.3 Cable Jointer

A person engaged in carrying out cable jointing work must hold qualifications suitable for the work they are to undertake, these being:

AQF UET30812 (or current update) Certificate lll in ESI – Power Systems – Distribution Cable Jointing. This applies to all jointing and termination work on low and high voltage cables up to 33KV where cables are completely disconnected from the source of electricity supply.

Or,

Statement of Attainment from a Recognised Training Organisation in UETTDRCJ27A (or current update) 'Install and maintain de-energised high voltage underground polymeric cables' (for HV) and/or UETTDRCJ26A(or current update) 'Install and maintain de-energised low voltage underground polymeric cables' (for LV) undertaken by recognised current trade or industry qualified electrical or electricity workers

Or,

Holders of the following Western Power accreditation can continue to joint underground cables.

- Category D – Cable jointer underground HV up to 33kV (XLPE). This category applies to all jointing and termination work on low and high voltage cables in underground where cables are completely disconnected from the source of electricity supply.
- Category E – Cable jointer underground LV to 600Volts (XLPE). This category applies to all jointing and termination work carried out on low voltage cables underground where cables are completely disconnected from the source of electricity supply.

Western Power qualified cable jointers may perform cable insulation testing, continuity and core-to-core testing of underground cables, provided they have previously completed the necessary training as required by Power Training Services (PTS) 289 Low Voltage Cable Jointing and PTS 290 High Voltage Cable Jointing.

6.2.7.4 Electrical Worker

The following work must be carried out by electrical workers licensed under the Electricity (Licensing) Regulations 1991:

- The final connection of all underground cables and circuits, including switchgear, transformers, earthing and street lights.
- The wiring of circuits, including street light circuits.
- The testing of cables and circuits, except where the testing of cables is permitted under Clause 6.2.7.6.
- The installation of substation equipment, including transformers and switchgear, excluding the unloading and positioning of substation equipment onto their supporting bases.

6.2.7.5 UDS subdivision installer qualification matrix

The following table summarises the UDS installer qualification requirements.

Qualifications	Lay Cable	Joint Cables (up to 33KV)	Joint Cables (up to 600V)	Test excluding Earth & Very Low Frequency (VLF) Tests	Earth & VLF Tests	Cable Termination	Cable & Circuit Connection (Note 1)
Accredited Cable Layer (Completed AQF training 'UETTDRCJ21A –Lay ESI electrical cables', or Lay Underground Electrical Supply Cables conducted by PTS). Refer clause 6.2.7	P	N	N	N	N	N	N
AQF UET30812 Certificate lll in ESI – Power Systems – Distribution Cable Jointing or Statement of Attainment that includes units demonstrating competency. Refer clause 6.2.7	N	P	P	N	N	P	N
Category D Cable Jointer	N	P	P	P (Note 2)	N	P (Up 33KV Cable)	N
Category E Cable Jointer	N	N	P	P (Note 2)	N	P (Up to 600V Cable)	N
Electrical Worker [licensed under the *Electricity (Licensing) Regulations 1991*]	N	N	N	P (Note 3)	P (Note 3)	N	P (Note 3)

Table 13: UDS Installer Qualification Requirement

P = Permitted N = Not permitted

Note 1: Cable & circuit connection includes the connection of cables and circuit on switchgear, transformers, earthing and street lights.

Note 2: Accredited cable jointers may perform cable insulation testing, continuity and core-to core testing of underground cables, provided they have completed the necessary training as required (PTS 290 Low Voltage Cable Jointing or PTS 289 High Voltage Cable Jointing). The tester shall have completed the relevant training course for the cable voltage they are testing. That is, LV can test up to 1000V and HV test 1000V – 33kV.

Note 3: As defined in the existing Electricity (Licensing) Regulations 1991. However this may change from time to time and the Developer must ensure that the requirements in the Regulation are complied with.

6.2.7.6 Enquires on accreditation and training

The Developer can find out whether a contractor is a Western Power preferred contractor (vendor), or whether a person is accredited or authorised to carry out work in subdivisions, by contacting Power Training Services:

For any enquiries about gaining accreditation, please contact Power Training Services. Power Training Services can be contacted at:

Power Training Services WA
Training Place, Jandakot WA 6164
Phone (08) 9411 7888
Fax (08) 9411 7887
Email: pts@westernpower.com.au

6.2.8 Construction requirements and standards

6.2.8.1 General requirements

The Developer shall ensure that the UDS in the subdivision is constructed in a safe and efficient manner with minimal disruption to the public and in accordance with:

a) The construction requirements and standards described in this manual;
b) Western Power's Network Standard NS 14.2– Underground Cable Installation Manual, Part 2;
c) All regulatory standards and the requirements shown in Clause 6.2.9;
d) All statutory requirements; and
e) Satisfies Western Power's Environmental Policy.

6.2.8.2 Site safety

The Developer is responsible to ensure that the site is safe in accordance to the Occupational Safety and Health Act 1984 and the Occupational Safety and Health Regulations 1996.

The Developer must also comply with all lawful decisions from the CM relating to the safety of Western Power's personnel or assets.

6.2.8.3 Installation drawings

The Developer shall ensure all Electricity Infrastructure, including substation, earthing and street lights, is installed in accordance with:

a) Drawings and diagrams shown in Appendix 13 – Equipment and Installation Drawings and the following:
b) Distribution Substation Plant Manual (DSPM);
c) Distribution Design Catalogue (DDC).

6.2.8.4 Finished ground level

The Developer must ensure:

a) Prior to the commencement of any electrical work, including cable laying, the finished ground levels are established by the Site Superintendent/ Project Engineer.
b) Where the road reserves have not been constructed or formed, the Site Superintendent/Project Engineer will ascertain and agree with the CM the required depth of cover of cables before excavation upon such road reserves.
c) Pillars and pad-mount transformers and switchgear are not be installed unless the sites are completed with finished ground level.

6.2.8.5 Survey pegs

The Developer shall ensure:

a) The Site Superintendent/Project Engineer has accurately pegged all subdivision and lot boundaries. Any additional costs incurred by Western Power as a result of boundaries being pegged incorrectly will be charged to the Developer.

b) Prior to the commencement of trenching and cable laying work, all final survey pegs are in place and maintained in-situ throughout trenching and cable laying until the CM has completed inspections.

c) The Site Superintend/Project Engineer replaces any moved or missing pegs.

d) Where there are large curves or long lot frontages, sufficient peg positions are in place to enable accurate placement of cables in the allocated alignment.

e) An offset peg at an agreed distance from the property boundary prior to trench excavation is acceptable. However, final boundary pegs must be installed by the Developer upon completion of ground work and prior to the installation of pillars.

6.2.8.6 Trenching

The Developer shall ensure that excavation of trenches is carried out as shown on the conformed scheme design drawing and complies with:

a) Western Power's Network Standard NS 14.2– Underground Cable Installation Manual, Part 2; and

b) Drawing No. UDS-6-2 shown in Appendix 13 – Equipment and Installation Drawings

Particular care shall be taken to ensure that there is sufficient cover over the cables.

When crossing a road reserve, the trenching must be such that a minimum of 750mm of cover is maintained over cable conduits at all points to ensure present and future joints have minimum of 750mm cover. Maximum depth, if required, of 1100mm at the crown of the road. The trenching must be such that the final contour of the road reserve is followed.

Where the presence of structures, existing services or plant in the road reserve will not allow the installation of cables with these minimum specified covers, the Site Superintendent/Project Engineer must bring the matter to Western Power's attention and seek direction prior to proceeding further.

Machine excavation of trenches shall not be used where there are existing cables within required minimum approach distances. Refer Clause 6.2.8.27.

Where there are existing cables in the cable alignment, hand digging must be used to excavate for the installation of new cables.

The Site Superintendent/Project Engineer must coordinate joint trenching requirements and the Developer must make all necessary arrangement with other utilities to achieve this.

Trenching works must also comply with the recommendations of WorkSafe Western Australia, Code of Practice: Excavations, which can be found on the WorkSafe Western Australia website.

6.2.8.7 Cable ducts

The Developer shall ensure that all ducts are installed in accordance with:

a) the conformed design drawings as indicated in Appendix 6 – Cable Duct Specification; and

b) Appendix 13 – Equipment and Installation Drawings

6.2.8.8 Cable laying

The Developer shall ensure that all cable laying works comply with Western Power's Network Standard NS 14.2– Underground Cable Installation Manual, Part 2 and the recommendations of the Electricity Supply Association of Australia Publication Number "ESAA C(b)2 –Guide to the Installation of Cables Underground".

Cables must be installed in Western Power's standard alignment and in accordance with the "Utility Providers Code of Practice for Western Australia" and Drawing No. UDS-6-2 described in. Other services are not permitted in the power cable alignment without written permission from Western Power.

During the installation, underground straight joints in HV or LV cables must be kept to a minimum. The number of HV or LV cable joints permitted is to be calculated by the following formula:

N = 1 + L1/L2 for L1 ⍰ 150m

N = 0 for L1 ⍰ 150m

Where,

N = Number of joints permitted

L1 = Total Cable route length between terminals (metres)

L2 = 250m (Standard cable drum length)

Joints at existing working end locations are additional to these requirements. All cables shall be marked or tagged as they are laid, to individually identify them, prior to jointing.

The ends of cut cable must be capped with water sealing cable end caps immediately after cutting to prevent water ingress. Refer Network Standard NS 14.2– Underground Cable Installation Manual, Part 2 - Technical Requirements clause 16.11 and UDS Manual Appendix 13 for end cap requirements.

These cables shall include:

a) Cables, both HV and LV laid in the ground for future use (working ends).
b) LV cables including 25mm^2 service cables to be terminated into pillars or pole termination.
c) LV cables to be terminated into the transformer or pole termination.
d) HV cables to be terminated into switchgear or pole termination.

Refer Clause 6.2.8.20 for working end live end seal requirements.

The preferred method of installing cable is to mount the cable drum on jacks, cable trailer or cable stand and unroll the cable from the drum into the trench. If it is necessary to pull in the cable, then cables must be fully supported by suitable proprietary cable rollers during cable laying.

At no stage may the cable be permitted to drag on the ground or be subjected to treatment which could damage the outer sheath.

Any damage to the cable will lead to Western Power rejecting the affected part of the installation and new cable will need to be laid.

6.2.8.9 Crossings: Railway, utility services, road and vehicle crossovers

The Developer shall ensure that all cables crossing roads and vehicle cross-overs are installed to meet the requirements of Western Power's Network Standard NS 14.2– Underground Cable Installation Manual, Part 2 - Technical Requirements.

6.2.8.10 Backfilling

The Developer shall ensure:

a) Bedding and backfilling meets the requirements of Western Power's Network Standard NS 14.2– Underground Cable Installation Manual, Part 2 Clause 16.12 'Exposed Underground Cables'. This refers to backfilling and trench protection. Developers are encouraged to adapt these requirements.

b) Backfilling complies with the published "Subdivision Design Guideline – Number 4, Bedding Sand and Backfill Sand around Cables and General Backfill for Cable Trenches – Material Selection Guidelines".

c) Where cable joints or terminations are performed by Western Power, the appropriate portions of the trench are not backfilled until the Western Power work is completed. Additional charges will be incurred for any extra work required by Western Power.

d) All backfill and reinstatement is completed so that water run-off, or collection, will not cause soil erosion.

6.2.8.11 Reinstatement

The Developer shall ensure:

a) Reinstatement is based on minimum greenfield reinstatement.

b) The reinstatement meets the LGA's requirements.

6.2.8.12 Cable and duct placement at road truncations

The Developer shall ensure all cables and ducts crossing roads at truncations are installed in accordance with:

a) Drawing No. UDS-6-3;

b) Appendix 13 – Equipment and Installation Drawings

c) and are installed from edge to edge of the cable alignment.

6.2.8.13 Cable installed near to retaining walls

Where cable is to be installed near to retaining walls, the Developer shall ensure that the cable is installed in and protected by cable ducts. Cable ducts must be installed prior to the construction of retaining walls.

Retaining walls and footings must not encroach on the nominal cable alignment of 0 - 500mm.

6.2.8.14 Cable installed in laneway

In accordance with Clause 5.3.12 the Developer must obtain Western Power's prior approval for the installation of underground cables in a laneway. Where approval is given by Western Power the cable must be:

Either:

Installed in the 0 - 500mm alignment from property boundary in cable ducts with a minimum of one spare duct,

Or:

Direct buried in soil, provided 300mm of clean sand is installed below the cables and clean sand is installed above the cables all the way up to the road base with a minimum of one spare duct.

Note: Clean sand must meet the selection criteria of sand for bedding in Subdivision Design Guideline – Number 4, Bedding Sand and Backfill Sand around Cables and General Backfill for Cable Trench – Material Selection Guidelines,

6.2.8.15 Cable installed in easement

Where cable is to be installed in an easement, the Developer must supply and install the cable ducts as detailed in the conformed design drawing with the cross-section details of cable easement in Figure 15.

6.2.8.16 Cable installed off nominal alignment

If Western Power approves installation of cables outside the 0 - 500mm alignment, the Developer must ensure each cable is installed in duct with PVC marker tape.

Where approval is given by Western Power to install cables in the 2.4 - 3.0m alignment, it must be installed in cable duct with PVC marker tape.

The Developer must comply with Clause 5.3.9 in regard to the approval of cable off nominal alignment of 0 - 500mm.

6.2.8.17 LV cable joints and terminations

The Developer shall ensure that low voltage cables are jointed and/or terminated only by suitably qualified cable jointers using techniques and work practices as detailed from time-to-time by the manufacturer or by Western Power.

When terminating low voltage three-phase cables the core numbers and colours must always match each other and cores one, two and three must be terminated red, white, blue respectively. All LV cable terminations should be undertaken prior to termination at equipment of origin.

The Developer works shall include:

a) Labelling of all cable ends with 'cattle tags' as detailed in Western Power's "Distribution Equipment Labelling Standard NS 05."
b) Clear and legible labelling of all equipment to which cables will be terminated.

Western Power work shall include:

a) Permanent labelling of all equipment after handover and prior to commissioning in accordance with Western Power's Distribution Equipment Labelling Standard NS 05.

6.2.8.18 HV cable joints and terminations

The Developer shall ensure that HV cables are jointed and/or terminated only by suitably qualified cable jointers using techniques and work practices as detailed from time-to-time by the manufacturer or by Western Power. All cable joints must be installed in accordance with the manufacturer's instructions supplied with the cable joint kit.

Cables should be terminated and connected at both ends on the same day and if terminating into a working end this shall be undertaken prior to terminating onto equipment of origin. Particular care should be taken to ensure correct phase connection occurs. Sufficient slack

The cable jointer must also complete the "HV Cable Joint Schedule" as shown in Appendix 8 – HV Cable Joint Schedule and provide the schedule to the QA Officer prior to handover inspection.

Labelling shall be undertaken as detailed in Clause 6.2.8.17 LV Cable Joints and Terminations.

6.2.8.19 Service pillars installation

The Developer shall ensure that services pillars are installed and located within lot boundaries along public road reserves in accordance with this section and Clause 5.3.5.1 Service Pillar Location.

Where retaining or boundary walls exist along the boundary, the service pillar shall be installed as per the details in Appendix 13 – Equipment and Installation Drawings.

Mini and Uni-pillars have embossed marking to indicate at what depth below finished ground level the base shall be buried. For subdivision pillar locations where gardens have not been established ensure this mark is approximately 100mm above the ground level to allow for future landscaping that typically raises the finished ground level. Pillars shall preferably be installed on flat ground. In situations where sloping ground is unavoidable the 100mm shall be the average height of the embossed mark above ground. To assist with minor pillar height adjustment additional length of service cable is recommended.

Uni-pillars shall not be installed behind retaining walls. Western Power may provide exceptions where the retaining wall is low and does not interfere with Western Power cable ducts and 24/7 access is provided.

Western Power cables installed under or through retaining walls shall be enclosed in conduit.

6.2.8.20 Working ends terminations

Cables for both HV and LV may be extended beyond the subdivision scheme boundary for future extension into the next stage. The Developer shall ensure these working end cables are terminated into live end seals (LES) as detailed below:

Previous working ends comprised cable ends brought out of the ground into pillars with white painted lids labelled 'Working end only – not for connection'. These white pillars are not permitted to indicate existing working ends in the future.

Live end seal terminations:

Terminate the cables into HV and LV live end seals, install underground to beyond the last lot boundary, provide a protective cable cover and identify the location with a marker post.

Termination into live end seals should be undertaken prior to termination of the cable at its origin irrespective of whether this equipment is live.

For detailed instruction on the equipment design and construction refer to the following documents:

- Distribution Construction Standards Handbook: R34-2 (HV) and R34-1 (LV).
- Distribution Design Catalogue: HU3 (HV) and LU62 (LV)

Ensure working end locations are detailed on the As Constructed drawings including dimension beyond subdivision.

Also refer to Western Power's Work Practices Manual Clause 7.4 for additional information on future connection of LV and HV cables in greenfield subdivisions.

6.2.8.21 Western Power street lights

The Developer is responsible for all work associated with the installation of street lights.

Western Power street lights are to be installed in the positions nominated on the conformed scheme design drawing on the 2.7m alignment and to the depth shown on the drawings in the relevant section of the Distribution Design Catalogue.

Where the road reserve has a verge wider than 3700mm, street lights can be installed at a minimum set back from the kerb line shown on the conformed scheme design drawing (also see Clause 5.3.25.3). The Developer is required to obtain the approval of LGA and other Utility Providers.

After installation of the column the hole is to be back-filled and well tamped to provide a secure foundation.

6.2.8.22 Substation

The Developer must ensure that each substation site is prepared and constructed in accordance with:

a) Clause 5.3.18.
b) The requirements shown on the conformed design drawing.
c) Distribution Substation Plant Manual
d) Western Australian Distribution Connections Manual.

The Developer must ensure that all substation equipment, including transformer and switchgear, is installed by a licensed electrical contractor or a licensed electrical worker, in accordance with the following:

e) The manufacturer's information.
f) Western Power's requirements as illustrated in drawings of the Distribution Substation Plant Manual and the Distribution Design Catalogue.

6.2.8.23 Substation ducts

The Developer shall install all substation ducts in accordance with the drawings in the Distribution Substation Manual.

6.2.8.24 Substation earthing

The Developer shall install substation earthing in accordance with substation earthing arrangements shown on the relevant compatible unit drawings in the DDC. Appendix 13 – Equipment and Installation Drawings shows a list of examples of drawings.

The substation earthing grid must be buried 150mm below finished ground level of the substation.

The substation earthing must also be constructed to comply with the requirement of "Combined Earthing Connections Concept Diagram" of AS 2067 Appendix B and Western Power FAQ on Earthing Standards

All earthing cables must be tagged and labelled at the earth bar end to clearly indicate where they are connected.

6.2.8.25 Substation screening and fencing

If screening or boundary fencing is required, the Developer is responsible for installation. All screening and boundary fencing installations must meet the requirements of Western Australian Distribution Connections Manual.

Metallic screening or boundary fencing adjacent to substations is not recommended and is to be avoided in subdivision development. However, if a Developer insists on metallic screening or boundary fencing and to create safety awareness to future land owners the following minimum requirements shall be undertaken.

Based on the network connection point for each project Western Power shall state in the DIP whether metallic fences will pose a step-touch voltage risk or not.

Unless exempted through the DIP step-touch voltages on metallic fences on the substation site boundary shall be considered in an EPR (Earth Potential Rise) study for every substation. The step-touch voltages shall be assessed assuming that a metallic fence will be erected on the substation site boundary unless the site is located inside a building.

If exemption is granted in the DIP, the Developer shall record this exemption in the project records as the outcome of the metallic fence step-touch voltage assessment by Western Power.

Note: EPR studies may still be required for other metallic structures/services around the substation site such as metallic pipelines, telecommunication services, etc.

If no exemption is granted for metallic fences, an EPR study shall be carried out to assess step-touch voltages on metallic fences for the substation(s) in that subdivision stage/project. It shall be assumed that a metallic fence is installed on the Western Power site boundary but not connected to the substation earthing.

For such fences the subdivision/substation(s) earthing shall be designed to meet tolerable step-touch voltage limits of AS2067. The EPR study shall be undertaken using the fault levels and protection settings provided by Western Power in the DIP. An EPR report detailing any mitigation needed to meet tolerable voltage limits on the fence is to be submitted to Western Power for conformance. The EPR study will have one of two outcomes:

The substation earthing has been designed such that step-touch voltages on the fence are within tolerable voltage limits and metallic fences will not pose a step-touch voltage risk.

The step-touch voltages limits on the metallic fence cannot be met, then one of the following options can be used:

a) The substation site boundary can be increased such that the step-touch limits on the metallic fence are met at the new substation site boundary; or
b) The Developer shall install a masonry property boundary fence at the same time as the installation of the substation. This masonry fence is required on all sides of the substation adjoining private property and extending along the private property boundaries to the point where step-touch voltages on the property boundary fence are within limits.

Note: These options shall not be used to mitigate step-touch voltages for the power system earthing design of the Western Power substation site.

Western Power may consider a Developer's alternative solution.

6.2.8.26 Access to electrical equipment

The Developer must ensure that all contractors and personnel working on or near Western Power's network comply with Western Power's work in vicinity requirements – 'Work near electricity'.

If the contractor requires access to any equipment that has been commissioned and handed over to Western Power or equipment bearing an operational label (see Figure 11), then the contractor must first obtain the appropriate electrical permit from Western Power.

6.2.8.27 Excavation near to existing asset

The Developer must ensure that when excavation work is to be carried out near Western Power underground and overhead electrical networks, the contractor complies with the following:

a) Working near electricity - Safe distance and network assets published by Western Power, and can be found on the Western Power website.
b) WorkSafe Western Australia, Code of Practice: Excavations. Information on the Code of Practice: Excavation, which can be found at the WorkSafe Western Australia website.
c) Utility Providers Code of Practice

6.2.8.28 Working in the vicinity of overhead power lines

The Developer must ensure that when work is to be carried out in the vicinity of Western Power's overhead power network, the contractor complies with the requirement of:

a) The Occupational Safety and Health Regulations 1996, and
b) WorkSafe Western Australia, 'Guidelines to Work in the Vicinity of Overhead Power Lines' which can be found at the WorkSafe Western Australia website.

c) When planning above ground work near a power line, the contractor is advised to refer to Western Power website for information on 'Working near electricity'.

6.2.8.29 Minor changes during construction

During construction of underground Electricity Infrastructure, the contractor may need to make minor changes to the UDS design to address a site specific requirement. The following changes are considered minor. All changes must be forwarded to the Developer's Designer or Design Organisation for approval and management.

a) Minor adjustment of cable truncation.

b) Minor relocation of street lighting being not more that the distance of a standard lot frontage within the current subdivision to a maximum of not more than 20m within the street lighting alignment (outside transmission line easement) but still meeting other requirements.

c) Relocation of pillar for reticulation pump along the same LV feeder towards the district substation.

d) Relocation of mini pillars across side lot boundary from the corner of a lot to the corner of the adjacent lot.

e) A change that in the opinion of all affected parties and Western Power does not affect the agreed design/scope of works, functionality or integrity of the Electricity Infrastructure.

All minor changes must be shown on the "As Constructed" drawings to be submitted to Western Power prior to commencement of the pre-handover inspection. Refer to Clause 4.4.6.1 for those requirements defined as major changes during construction.

6.2.8.30 Existing customers and affected parties

The Developer is responsible for notifying all concerned parties, including other Western Power customers affected by the work associated with a UDS.

Where existing aerial mains are to be removed as part of UDS, the Developer is also responsible for the reconnection of existing Western Power aerial connected customers to the underground system. The Developer must engage the services of an electrical contractor to undertake these reconnections. All such reconnection work must be completed before the aerial mains in the street can be removed.

There are three options for reconnection of services to existing customers affected, viz:

a) Where there is sufficient space at the front boundary of the affected lot for a normal pillar to be installed, as shown in drawing UDS-6-1P in Network Standard NS 14.2– Underground Cable Installation Manual, Part 2, the existing overhead services will be replaced with underground services. Western Power will provide a pillar at the Developer's cost. The Developer is responsible for installing the underground service from the pillar to the existing customer.

b) In the case where there is insufficient space for a normal pillar to be installed, a wall mounted pillar will be required. Western Power's CM will supply the wall mounted pillar to the Developer, who is responsible for having it installed on the facade of the affected building. A minimum of four weeks' notice is required to enable Western Power to order the pillar. Western Power will supply and install the underground service cable up to the facade of the building, allowing sufficient length to reach the wall mounted pillar itself. The Developer must have the cable fixed to the facade of the building, up to the wall mounted pillar. Western Power will undertake the final connection of the underground service to the wall mounted pillar, in conjunction with the Developer's electrician.

c) Retain the existing overhead service. In this case, a service pole must be installed by the Developer. The service pole must be located so that the existing aerial service cable can be terminated on the pole. A meter enclosure must be mounted on the pole and able to accommodate a standard meter panel (450mm x 225mm) and a customer's panel (225mm x 225mm).

This enclosure will become the new main switchboard for the premises. The service pole must be wired with sufficient lead length to reach the pillar as indicated on the Western Power drawing.

In all of the above options, the Developer is to inform existing customers affected that all wiring downstream of the Western Power pillar is their responsibility. That is, if the wiring is damaged (e.g. by storms) they will be responsible for repairs.

6.2.9 Installation document

- AS/NZS Standard 3000 Australian/New Zealand Wiring Rules
- Distribution Design Catalogue (Western Power)
- Distribution Substation Plant Manual (Western Power)
- Electricity (Network Safety) Regulations 2015
- Electrical Safety Rules (ESSR) (Western Power)
- Occupational Safety and Health Act and Regulations
- Guidelines for work in the vicinity of overhead power lines (WorkSafe)
- Utility Providers Code of Practice for Western Australia (Dial Before You Dig)
- Network Standard NS 11 , Testing & Commissioning (Western Power)
- Network Standard NS 14.2 – Underground Cable Installation Manual, Part 2 (Western Power)
- Western Australian Electricity Requirements (WAER) (Office of Energy)
- Western Australian Distribution Connections Manual (Western Power)
- Code of Practice: Excavations (WorkSafe)

7. Materials and equipment

In a UDS the Developer can only use materials and equipment approved by Western Power. All the materials and equipment listed in the Distribution Design Catalogue (DDC) with a corresponding Western Power stock number are Western Power standard materials and equipment and may be used without further approval from Western Power.

Nonstandard equipment must first be approved by Western Power for use. The process to seek approval to use nonstandard equipment is shown in Clause 7.4.

Materials and equipment in the DDC may be revised from time-to-time.

7.1 Materials & equipment for large subdivisions

7.1.1 Direct purchase from Western Power logistic

Western Power holds stock of approved materials and equipment (listed in DDC) for UDS developments at Jandakot Stores. Developers may purchase this material for large subdivision schemes.

7.1.2 Process for ordering from Western Power logistic

The process of ordering material from Western Power's Logistics is described below:

a) Contractors must request a Quote by sending in a Bill of Quantity with the list of stock items and the UDS subdivision project number. Usually more than one contractor will request a Quote as they will tender for work from Developers.

b) Western Power Logistic provides a Quote with price and delivery availability subject to 'Terms and Conditions of sale of material'. Refer to the Western Power's website.

c) One of the contractors will accept the Quote and will provide Western Power Logistics with a purchase order.

d) Once the order is accepted Western Power Logistics will provide the contractor with weekly updates of availability.

e) Western Power will request collection of the ordered materials when the order is complete. The order shall be collected within a timeframe advised by Western Power logistics, or be subject to an automatic return to inventory, which may incur a restocking fee.

7.1.3 Material collection process

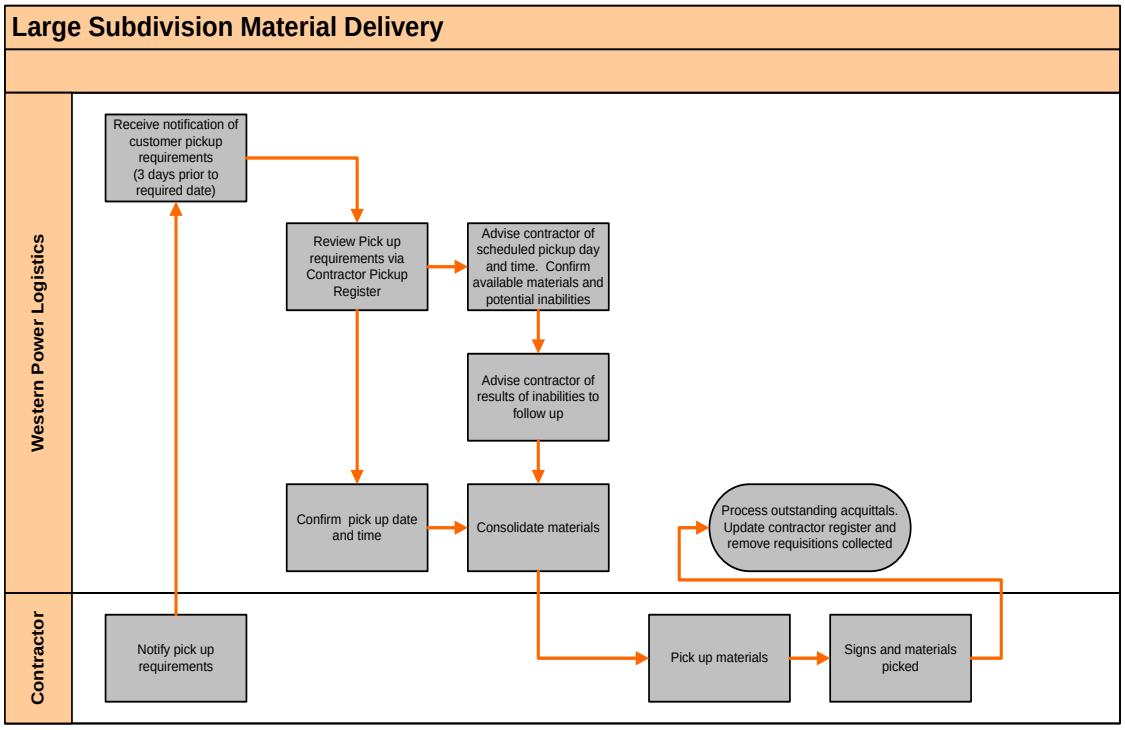

Figure 9: Materials Delivery

Note: Procurement Services require a minimum of three (3) working days' notice before material can be collected. Refer to Clause 7.2 Materials Hotline.

7.1.4 Responsibility for security and damage

The Developer supplies all materials and equipment, including cables, switchgear and pad-mount transformers required. Until handover of a UDS is accepted by Western Power, those materials and equipment supplied by the Developer remain the property of the Developer who is fully responsible for security. Refer to Clause 6.2.2.8 for handover arrangements.

Damage to other materials and equipment supplied by Western Power on-site by other contractors, utilities etc will be paid for by the Developer.

7.2 Materials hotline

Procurement Services at Jandakot Distribution Centre has a dedicated materials hotline telephone number and email address to manage customer enquires relating to materials and logistics matters.

Contractors should contact Procurement Services three working days prior to pick up via the materials hotline on (08) 9411 7795 or e-mail materials.hotline@westernpower.com.au to book an agreed collection time.

Contractors can also contact the materials hotline to check delivery status and/or negotiate an early delivery.

Details of the material hotline can be found at Western Power's website.

7.3 Standard street light materials list

Steel standards and some decorative street lights are normally available within two to three weeks of ordering. However, other non-decorative street lights, may take up to 16 weeks to procure.

Developers and Designers can check the availability of street lights from the Standard Street light Materials List that designates the street light items held in stock for land development work on Western Power's website.

7.4 Alternative materials and equipment

7.4.1 Process overview

A Developer may be permitted to use nonstandard equipment provided it complies with Western Power's technical requirements and is approved by Western Power before installation.

The process requires the submission of a formal application (feasibility study) for each piece of nonstandard equipment prior to the installation and use of that equipment. Application review periods will vary dependant on the number and type of equipment approvals being sought.

For approval, the applicant must show how the proposed equipment and where applicable quality assurance program meets or exceeds all of Western Power's requirements.

An upfront application fee paid upon application, will be required for each item of nonstandard equipment. This allows for a preliminary review of the application and an estimate of the time required to undertake the evaluation. All evaluations will be charged at the nominated hourly rate inclusive of GST.

Where approval to use the equipment is granted an implementation charge may also be applied to cover network administration and training expenses including but not limited to items such as creating new drawings, updating systems, training for Designers and constructors, etc.

7.4.2 Approval review process

Table 14 shows the process whereby approval is provided for equipment.

Steps	Action	Responsibility
1	Send feasibility study request with application fee.	Applicant.
2	Confirmation letter sent to applicant advising receipt of application.	Western Power.
3	Preliminary review undertaken for completeness of application and estimate of evaluation cost.	Western Power.
4	Pay evaluation costs.	Applicant.
5	Advise of projected review completion date.	Western Power.
6	Undertake evaluation and conformance review of equipment.	Western Power.
7	Advise applicant of recommendations and conditions of approval if required.	Western Power.
8	Prepare agreement between Western Power and applicant for conditions and terms of approval, including costs associated with implementation of new equipment.	Western Power.
9	Accept terms and conditions approved.	Western Power & Applicant.
10	Process complete.	

Table 14: Approval Review Process for Nonstandard Equipment

7.4.3 Application for equipment approval

Application form must be completed and forwarded together with the application fee and supporting information via: Western Powers Feasibility study Website

7.4.4 Certificate of approval of equipment

Western Power will provide the applicant with a certificate of approval for each item of nonstandard equipment, if the request is approved. The certificate of approval will state the approval conditions and validity.

7.4.5 Notification of use of approved alternative equipment for subdivision

The Developer must give Western Power prior written notice each time the approved nonstandard equipment is used in a UDS. The details of the equipment must be shown on the electrical design drawings for DCR and on the “As Constructed” electrical drawing for handover inspection.

Where a Developer chooses to use an approved nonstandard item, it will be responsible for its use for a period of 12 months from handover.

Developers and Designers should refer to Clause 4.5 for details of the process for providing notification to Western Power.

7.4.6 Spares for alternative materials and equipment in subdivision

Approved alternative equipment is nonstandard for Western Power and spares are not held within Western Power stores. The Developer should make appropriate arrangements to provide spares for replacement to Western Power's satisfaction.

A guarantee of availability of spares by the equipment manufacturer or providing spare equipment to Western Power at the Developer's own cost is an arrangement acceptable to Western Power.

Appendix 1 - Map of the South West Interconnected System

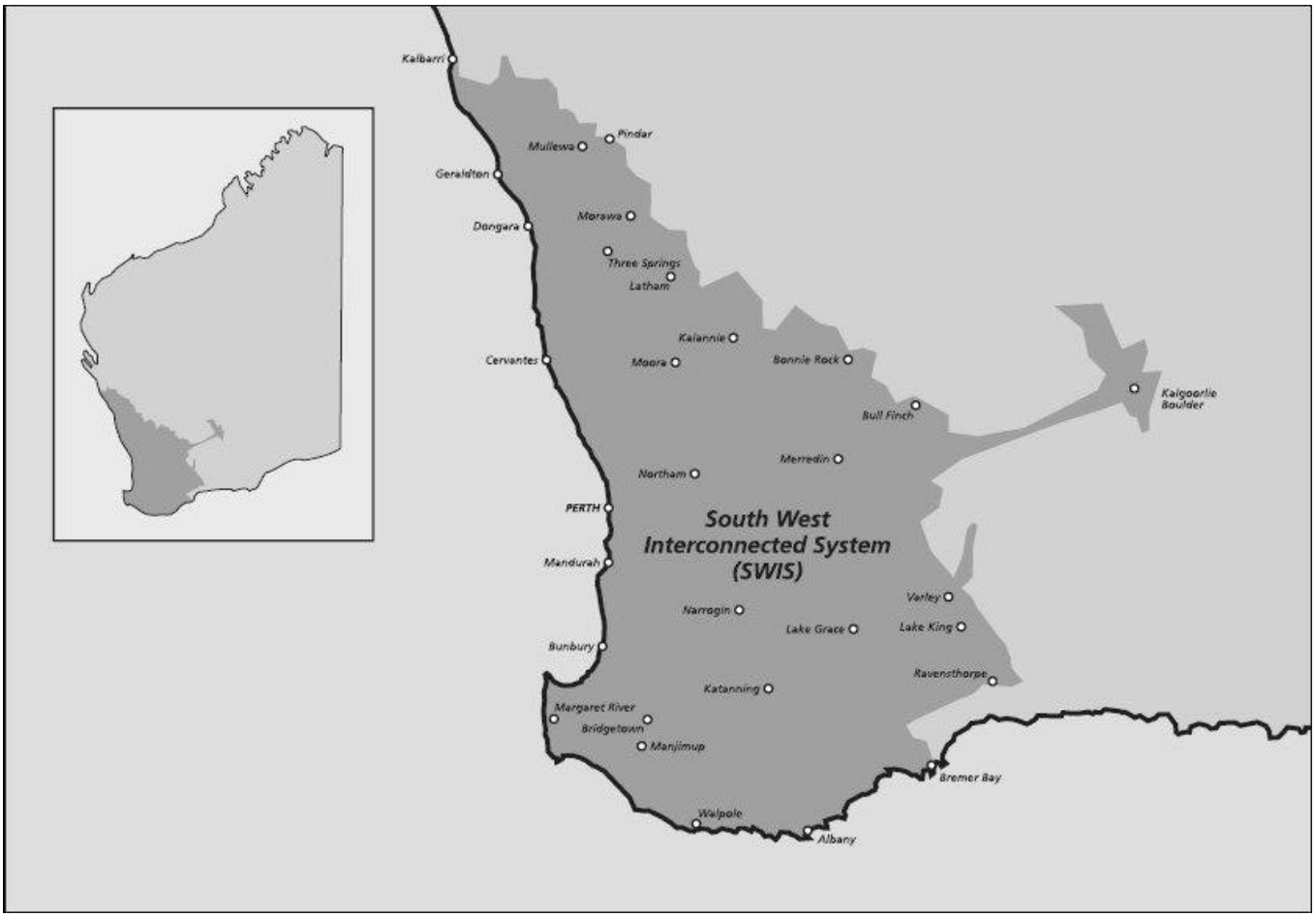

Figure 10: Map of the South West Interconnected System

A detailed colour map is available from the Western Power Website.

Appendix 2 – Request for Variation to Western Power Design or Standard

UDS NUMBER:	
STAGE:	
DEVELOPER:	
CONSULTANT:	
VARIATION REQUEST:	
SUPPORTING DOCUMENTS:	
REQUESTED BY:	
Signed	Date
REQUEST APPROVED/NOT APPROVED	
Signed Western Power Engineer	Date

Appendix 3 – Subdivision Design Submission NER Engineer Certification

Subdivision Design Submission NER Engineer Certification (Page 1 of 3)

(Revised 24/11/15) (Must form part of design conformance review submission)

Western Power ref: MS/SS/NS_____ Designer/Consultant ref: _____

Designer's Drawing No. _____/____/ Sheet 1 Rev. ___ Date: _____
Designer's Drawing No. _____/____/ Sheet 2 Rev. ___ Date: _____
Designer's Drawing No. _____/____/ Sheet 3 Rev. ___ Date: _____

The above submitted drawings meet Western Power's requirements. This includes (but is not limited to) the following:

HV Network

ITEM	Description	Y	N/A
1.1	HV entry and exit points are as per DIP or as agreed.		
1.2	Correct size HV cable has been used as per DIP or as agreed.		
1.3	HV design is optimum with minimum number of switchgear.		
1.4	Correct land size has been allocated for transformers and RMU's.		
1.5	Substation HV cable layout and connections are correct.		
1.6	No HV earths located within 15m of Telstra pits unless approved by Telstra in accordance with AS/NZS 3835.		
1.7	Effect of EPR and LFI on metallic pipelines assessed in accordance with AS/NZS 4853 and pipeline owner approval received (where applicable).		
1.8	Effect of EPR on metallic substation fencing assessed in accordance with AS 2067 and suitable mitigation applied (where applicable).		
1.9	129BA restrictive covenant for fire protection applied around substations on commercial/industrial lots.		
1.10	Substation site civil works (i.e. battered slopes or retaining walls) are structurally sound and suitable for their purpose (certified by civil NPER engineer).		
1.11	Substation sites mitigated from water inundation.		
1.12	Transformers sites compliant with noise requirements.		
1.13	All equipment sites shall comply with flood level requirements.		
1.14	Substation sites compliance with ground water level requirements.		

LV Network

ITEM	Description	Y	N/A
2.1	Correct data are used in LV Design calculations.		
2.2	LV Design calculations (including cable capacity & current) are within Western Power's limits.		
2.3	All motor Flicker are within acceptable limits defined in AS/NZS 61000.3.5.		
2.4	Transformer capacity is enough for this subdivision stage.		
2.5	LV feeders are as evenly loaded as practical.		
2.6	Transformer and feeder load details are correct and are clearly shown on the submitted drawings.		
2.7	Street lighting design complies with local government authority requirements, AS/NZS 7000 safe clearances from existing power lines, pole setbacks calculator and AS/NZS 1158.		

DM#: 1965955

Subdivision Design Submission NER Engineer Certification

Subdivision Design Submission NER Engineer Certification (Page 2 of 3)

Other

ITEM	Description	Y	N/A
3.1	Appropriate design loads for each lot as per DIP or as agreed.		
3.2	Design satisfies WAPC conditions.		
3.3	Distribution easements applied over cables to be installed as required		
3.4	Transmission easements applied to existing transmission power lines.		
3.5	Proposed work in vicinity (WIV) of existing energised Western Power assets can be constructed in accordance with Occupational Safety and Health (OSH) and Worksafe requirements.		
3.6	Bill of materials is correct.		
3.7	Design drawing minimum requirements satisfied.		
3.8	Appropriate 3rd party approvals received (e.g. Local Government Authority, Main Roads, Public Transport Authority).		
3.9	All non-standard equipment clearly identified and agreement by Western Power for its use.		

(Note 1 Y = YES, N/A = NOT APPLICABLE)
(Note 2 DIP stands for Design Information Package.)

Comments: _____
_____

To the best of my knowledge and by virtue of my NER registration, training, qualifications and experience I certify that the design submission on the above drawings meet all the Electricity (Supply Standards and System Safety) Regulations 2001, Western Power's requirements in the Design Information Package, the *Underground Distribution Schemes Manual*, published Subdivision Design Requirements, and any other relevant standards.

Signed: _____ Date: ____/_____/_____

Name : _____

Qualifications : _____

Engineer Australia membership number : _____

DM#: 1965955

Subdivision Design Submission NER Engineer Certification

Subdivision Design Submission NER Engineer Certification (Page 3 of 3)

Authorisation of NER Certification of Subdivision Design Revision for Minor Changes

Western Power Ref: MS/SS/NS_____ Designer/Consultant Ref: _____

To Western Power,

I hereby authorise the following persons to certify design revision submissions for minor changes* for the above subdivision on behalf of myself.

1.
2.
3.

I accept full liability and responsibility of any such certification executed under this authorisation subsequent to any minor changes required on the original design submission with my certification. This authorisation will remain in force unless withdrawn by me in writing.

Signed : _____ Date: _____

Name : _____

Qualifications : _____

Engineer Australia Membership Number : _____

* Minor changes are defined as follows:

- Minor adjustment of cable truncation.
- Minor relocation of streetlighting of not more than 20 metres within the streetlighting alignment (outside transmission line easement).
- Relocation of pillar for reticulation pump along the same LV feeder towards the district substation.
- Relocation of mini pillars across side lot boundary from the corner of a lot to the corner of the adjacent lot.
- Installation of cables (HV or LV cables) to the 2.7m pole alignment to avoid trees and rocks only.

(Note: Any minor change revision submission must include a copy of this authorisation.)

DM#: 1965955

Appendix 4 – Subdivision Design Drawing Minimum Requirements

Page 1 of 4

1A. Title block that must include the following information:

1. Name of Project and Staging
2. Drawing Title
3. Contact Details of Developer/Project Manager (Optional)
4. Electrical Consultant Contact Detail
5. Lot Details
6. Geographic Location provided in DIP drawing
7. Street Smart (Optional)
8. WAPC Ref No.
9. Western Power Ref No.
10. Drawing Scale
11. Electrical Consultant Drawing Number
12. Sheet Number
13. Revision Number
14. Sheet Size
15. North Point
16. Date Drawing Created or revision.
17. Western Power logos must not be shown on Electrical Designer's drawings

1B. Revision box (Must be updated every time a change is made to a drawing once a copy has been received by Western Power)

1. Revisions Number/Letter
2. Checked by
3. Drawn by
4. Designed by
5. NER Engineer
6. Date of Revision
7. Provide clear/unambiguous description of changes to all drawing sheets

1C. Drawing Revisions

1. Drawing revisions shall be highlighted by clouding and revision identification reference. Previous revision highlighting shall be removed.

2. Western Power's legend as per the CAD Interface Package.

1. All drawing symbology as per Western Power's legend including colour and line weights.
2. All cable sizes to be identified and matched with legend.

3. Safety Issues / Warnings

1. 'Dial before you dig' logo.
2. Working in the vicinity of overhead lines to comply with "WORKSAFE" clearances during construction logo.
3. Telecommunication trunk services.
4. High pressure Gas.
5. High pressure Water.

Subdivision Design Drawing Minimum Requirements (Page 2 of 4)

4. Feeder loading, naming and volt drop table

1. Must be updated in every stage.
2. Must be included for every transformer utilised (even if there is only one lot added or it is situated outside the subdivision boundary).
3. Include any Tx whose load is altered by other subdivision.

All subdivisions must show:

1. Tx name, and location, including type of land use if known e.g. primary school or POS etc.
2. Transformer voltages, kVA and rated current.
3. Fuse and Circuit No.
4. Amp rating of fuses
5. Cable size in mm^2
6. Accurate Circuit Description
7. Maximum volt drop on each feeder
8. Maximum current on each LV feeder
9. Total current on Tx
10. ADMD specified

Note: Max current is to be calculated by the LV Design package and not determined arithmetically by adding individual customer loads.

5 Cable termination and circuit naming:

Substation configuration diagram requirements:

1. Switches and switchfuses must be labelled on the configuration diagram.
2. Switches and switchfuses must be shown in the same order of the physical arrangement of the switchgear.
3. If the substation contains a transformer, the transformer must be shown on the left of the switchgear as viewed from the front.

Circuits should be named as follows:

4. If the load is contiguous with transformer substation site, it must be named “CONTIGUOUS SUPPLY” with the nature of land use, e.g. “EXISTING SCHOOL”. See circuit No. 1 of the above table.
5. If the feeder supplies only a pump via a pillar, it must be named “PUMP SUPPLY” with pump size in kVA, the nature of land use and Lot number, e.g. “PUMP SUPPLY 3.5kVA (POS LOT 400)”.
6. Use Lot numbers of the first pillar fed by that feeder or the Lot number where the feeder ends as a working end along the longest route.
7. For existing circuit, name the feeder “EXISTING CIRCUIT “with street name or the lot number at the end of the LV feeder, such as “POS LOT 400”. Circuits which are not used should be marked ‘SPARE’ or ‘FUTURE’.

Circuits should be numbered from left to right when viewed from the front of the LV frame.

6 Street Lighting must show:

1. Type of lighting
2. Location and orientation.
3. If Decorative Lighting is installed, indicate colour and CU unit
4. Indicate if lighting is Private or Western Power. If private street lighting is installed, a separate drawing must be submitted to Western Power prior to handover.

Subdivision Design Drawing Minimum Requirements (Page 3 of 4)

7 Substation and Switchgear land requirements drawing

1. Show substation detail with dimensions of land including allowance for proposed batters and retaining walls.
2. Location from lot boundaries and adjacent lot numbers must be shown
3. Civil requirements (0.5m above the 100 year flood level, retaining walls)
4. Duct requirements (if set back in POS or private property)
5. If nonstandard equipment is to be used, all equipment shall be evaluated to the current technical requirements as determined by Asset Management. The process requires a formal submission of application for equipment approval.
6. This approval from Asset Management is required prior to submitting the design for conformance review. Submission of nonstandard equipment must comply with Design Requirement #1 and #2.
7. Note requirement for additional support base in high water table areas.

1.

8 Pole numbers and location

1. Pole numbers or pick ID for all poles as part of the subdivision must be shown on the design drawing.
2. All pole locations need to be surveyed

9 HV and LV open points

1. Uni-pillar (LU11) must be shown as 'on' or 'off' with arrow point indicating cable terminated on the top bar of the uni-pillar.
2. LV Blades (LU9) or LV Cable termination to LV ABC switch (LU37) must be shown as 'on' or 'off'.
3. Switch point status on the HV of the RMU must be shown on drawing.

10 Stage boundary

1. Must cover scope of all works, including working ends.
2. Must include all lots that are provided with a LV supply in this stage and exclude those lots that do not have a supply for this stage.
3. Must include all cables, substations, pillars, street lights and any other assets being installed or having their ON/OFF status changed in this stage.
4. Must include removal, relocation or modification to any existing Western Power assets. This information will be provided in the DIP.

Note:

Boundaries can be discontinuous, i.e. there can be a boundary around the entire subdivision and then a small separate boxed boundary around a uni-pillar a distance away that requires its status changed from OFF to ON.

11 Easements and Restrictive Covenants

1. Any existing or future transmission easements and assets must be shown.
2. Any existing or future distribution easements and assets must be shown.
3. Any existing or future easements for other utilities must be shown.
4. For underground cable easement, a cross section detail must be shown.
5. Type of easement must be shown (refer Clause 5.3.14 – Cable easement).
6. Any substation fire clearance Restrictive Covenant must be shown.

Subdivision Design Drawing Minimum Requirements (Page 4 of 4)

12 Design drawing must include:

1. All relevant sections and dependent equipment from previous stages must be included if the same transformer is being utilised.
2. Previous stages adjacent to the subdivision must be shown having the equipment and cables at a line weight of 0 and using the same styles and colours.
3. HV and LV interconnection points and sources of all feeders.
4. Any existing transformer which was installed in the previous stage if its capacity is being utilised for the proposed subdivision.
5. Location of RMU / drop out fuses if transformer is being installed or upgraded.
6. A detail of location and clearances of all equipment to be installed in the vicinity of aerial lines, easements and structures, only where applicable.
7. HV and LV working ends.
8. Retaining wall detail showing minimum distance of pillar to wall.
9. All pre-negotiated and pre-approved work partially or fully funded by Western Power as a note, including all material that Western Power is subsidising.
10. Multiple cable trench details. Locate and identify each cable.
11. CAD Design drawings shall have different engineering disciplines saved onto separate layers.
12. Pillars shown on the drawing for future installation and use shall be labelled as such to assist in ensuring cabling is not inadvertently installed to these locations
13. Transformer capacity allocation for future stages to be identified for adjacent stage availability.
14. Identification of dedicated pillars 'DEDICATED PILLAR TO LOT (NUMBER)'.

13 Commercial, industrial and mixed use sites

1. Lot size in m.
2. ADMD listed on each lot.
3. For group housing, the number of units and total load must be shown.

14 When submitting the drawing for conformance review (as per Electronic Submission Procedure)

1. All files should be placed into a zip file for every submission.
2. Regardless if any of the file(s) have had their content changed or not, they should all be included into one zip file for a complete submission each time.
3. Western Power's standard NER certification letter and check sheet must also be included for every submission, unless a 'minor change notification' has previously been received in which case designer certification is required.

Appendix 5 – Decorative Street Lights Approval Forms

Decorative Street Lights Approval Forms (Page 1 of 2)

Use of Decorative Street Lights In Subdivisions Approval Form

Why is approval of Local Government Authority required?

Street lighting within subdivision developments is provided for the local Government Authority. Developers will generally install either Western Power Standard street lights or Western Power's decorative street lights.

Energy consumption on Western Power standard street lights will be charged to LGAs as per gazetted street lighting tariffs.

Energy consumption Western Power's decorative street lights will be charged to LGAs according to the contract price agreed in the StreetVision Scheme and will usually be higher than the gazetted tariff. Therefore, developers are required to seek the approval of LGAs if they intend to install decorative street lights in subdivision developments.

Decorative Street Lights Approval

All subdivision electrical designs with decorative street lights submitted to WPC for Conformance Review by developers' electrical consultants/designers need to be accompanied with this form approved by the relevant Local Government Authorities (City/Shire).

Subdivisions will usually be developed progressively in multiple stages and it will reduce process time for all parties involved if Local Government Authorities can provide blanket approval for decorative street lights for the complete development instead of individual stages. Local Government Authorities may also consider providing blanket approval for all the subdivision developments within a suburb or the whole City/Town to Western Power directly.

Local Government Authorities should specify the street light standard colour, type of standard, type of outreach and/or the type of luminaries. The acceptable combinations for decorative streetlights are available on the Synergy Website by clicking on the following link:

http://www.synergyenergy.com.au/Business_Segment/Products_and_Services/Streetlight_Designer.html

How can this form be submitted?

This form can be submitted in two ways:

1. Submit via the developer's electrical consultant/designer

   - Fill out an electronic copy of this form.
   - Send to the Electrical Consultant/Designer of the subdivision from the individual work email address of an **authorised officer** of the Local Government Authority (City/Shire). This form of email verification is of paramount importance as the submission to Western Power will not be accepted without it.

   (Note: The Electrical Consultant/Designer will save the received email as an electronic transcript and include it in their Conformance Review ZIP file for submission to Western Power.)

   OR

2. Submit to Western Power directly

   The Local Government Authority (City/Shire) can send the electronic copy of the completed form via email directly to Western Power's subdivisional inbox at the following address.

   Subdivisional Inbox: subdivisions@westernpower.com.au

   Alternatively a paper copy signed by an authorised officer from the Local Government Authority (City/Shire) may be faxed to the WPC Subdivision Administration.

   Subdivisional Fax: (08) 9225 2073

IMPORTANT NOTE:
The approval given by LGA will continue to apply until Western Power is advised in writing otherwise.

The approval is purely for the acceptance of the type of decorative street lights installed and the associated charges of decorative street lights. All street lighting designs will still need to be submitted by the developer's electrical consultant/designer to the Local Government Authority (City/Shire) for design approval.

Decorative Street Lights Approval Forms (Page 2 of 2)

To Manager
Distribution Design
Western Power Corporation
85 Prinsep Road
Jandakot

Date:	

Subject: Decorative Street Lights Approval

The City/Town/Shire approves the installation of Western Power decorative street lights and accepts the running costs of the decorative street lights in accordance with the StreetVision Scheme

(Please cross one box only)

☐	in all new subdivisions in our area.
☐	in all stages of the subdivision/s listed below only.
☐	in the stage/s of the subdivision listed below only.

Subdivision Name/s	
WPC subdivision ref. No.	MS/SS/NS No.

The decorative street lights must be of the following specification:

(Please cross one box only)

☐	No specific requirements	
☐	COLOUR:	
	POLE:	
	OUTREACH:	
	LUMINAIRE:	
	LAMP(HPS/MH/MV):	

City/Town/Shire of :	
Authorised by (Name):	
Signature (only if faxed):	
Position:	
Contact Number:	

Appendix 6 – Cable Duct Specification

Introduction

This specification applies to the supply and installation of ducts for electric cables. Unless otherwise specified, the Developer shall be responsible for the supply and installation of all cable ducts and concrete encasement (where required) as shown on the subdivision design drawings.

Materials

All cable ducts must comply with AS 2053.1. – Conduits and Fittings for electrical installations – general requirements.

They shall be heavy-duty (HD) category and light orange in colour. In addition, all ducts must be non-metallic and comply with AS2053.

Size of Conductors

There are numerous sizes available and they are 40mm, 50mm, 80mm, 100mm and 125mm, for rigid ducts and 50mm, 90mm, 110mm and 140mm for flexible duct, e.g. polypipe. The appropriate size determined in Clause 5.3.11 of UDS Manual must be selected. However, for 33kV subdivisions, 150mm duct must be used for the high voltage cable.

Installation of Ducts

All ducts shall be installed in accordance with the requirements of Network Standards NS 14.2– Underground Cable Installation Manual, Part 2.

Supervision of Installation

The Developer shall be fully responsible for the supervision of the duct installation. Any remedial works required by Western Power's Construction Manager shall be carried out promptly. Actual extra costs incurred by Western Power, as a result of such remedial works causing a delay to the Western Power contractor's work, may be charged to the Developer.

Appendix 7 – Sample Operational Label

Figure 11: Sample Operational Label

Label Specification

- Aluminium, Weatherproof and Self-adhesive. Ensure adhesive is effective for all weather conditions, durable and applied to the complete label area
- Dimensions: 100mm (Width) by 80mm (Depth)
- Black print with the word “DANGER” to appear in **Red**
- Mounted in prominent position on equipment e.g. side of mini and universal pillar or front door of substation

Appendix 8 – HV Cable Joint Schedule

LOCATION (Lot Number)	Type of Joint (Straight or Breech)	Manufacturer	Manufacturer's Cat. No.	Date of Installation
Cable Jointer: **Signature:**		**Western Power Rep :** **Pay No.:**		

Appendix 9 – Site Inspection Schedule

westernpower

FIELD SERVICES

Quality Endorsed Company

Sub-Division Development - Site Inspection Schedule

Notice to Developer/Cable Layer/Cable Jointer

The Quality Assurance Officer is to be advised of the completion of each stage shown below and prior to the commencement of each subsequent stage

Stage 1 Trenching Requirements

Alignment:-	Greenfield site	0-500mm	Bedding:-	150mm of clean sand
Cable:-	Minimum Cover	750mm	Conduits:-	Min cover 750mm from finished ground level. Must also extend min. 1 metre beyond kerb/road edge.
Depth:-	Maximum	1500mm		

Note1 The cable depth must be consistent over whole site at nominated depth +/- 50mm

Note2 A finished ground level peg must be in place to determine cable depth

Stage 2 Cable Installation

- One L.V. cable – 100mm from property boundary line.
- One H.V. cable – 500mm from property boundary line

Note 1 Where more than one cable is laid in the trench, the full trench width shall be utilised with the maximum possible spacing between H.V. and L.V. cables maintained.

Note 2 Cables must have a minimum clearance of 150mm from other services (eg. Gas, water). If this cannot be achieved contact Western Power's representative.

Stage 3 Cable Jointing

- The Quality Assurance Officer must be notified one working day prior to the commencement of cable jointing.
- Jointing techniques will be verified by the QA Officer by random inspection.

Stage 4 Backfill

- Material shall be of clean sand free of rock or other hard formation.
- Clean sand to a depth of 300mm shall be placed over the cable prior to the placement of danger tape
- Danger tape shall be positioned directly over the cable.
- Where two or more cables are installed danger tape or cover must be wide enough to cover cables.
- Other utilities shall not be allowed to encroach into Western Power's alignment.

Stage 5 Installation of Pillars, Switchgear L.V. & H.V.

- Switchgear can only be installed by a Western Power approved electrical contractor.
- All jointing can only be performed by a Western Power approved cable jointer.

Stage 6 Testing

- All electrical cables and equipment shall be tested prior to pre-handover and results recorded.

Stage 7 Pre- Handover

Pre-handover means:

- All stages 1 through 6 are complete
- The only outstanding work to be performed is any interface work eg. Connection (OH/UG) from existing to new.

Note 1 All pillars, transformers, switchgear and streetlight inspection panels must be open prior to the QC Officer's arrival on site to conduct the pre-handover checks.

Stage 8 Confirming Handover

- Handover must be confirmed with the Construction Project Manager (CPM) one week prior to the planned date.

Contact Personnel

Quality Assurance Officer		Construction Project Manager	
Name		Name	
Phone	Fax	Phone	Fax
Mobile		Mobile	

DMS#: 3047188

Appendix 10 – Site Inspection Reports

Site Inspection Reports (Page 1 of 8)

Site Inspection Report

Stage: **Trenching**			
Work Order #:	*DQM No.:*	*Pre-start Meeting (Y/N):*	*Option (A/B):*
Date:	*Time On Site:*	*Time Off Site:*	

Inspection Item	*Inspection Result*	*Person Responsible*

1. Boundary Pegs In Place

- ☐ 1 Yes
- ☐ 2 No Pegs In Place
- ☐ 3 Finished Ground Level
- ☐ 9 Other (See Comments)

2. Trench Alignment

- ☐ 1 Yes
- ☐ 2 No (Trench NOT Aligned)
- ☐ 9 Other (See Comments)

3. Trench Depth

- ☐ 1 Yes
- ☐ 2 Not to Start Up Agreement
- ☐ 3 Too Shallow
- ☐ 4 Too Deep
- ☐ 9 Other (See Comments)

4. Bedding

- ☐ 1 Yes
- ☐ 2 Rocks In Bedding
- ☐ 3 Rubbish In Bedding
- ☐ 4 Install Suitable Bedding
- ☐ 9 Other (See Comments)

5. Conduits

- ☐ 1 Yes
- ☐ 2 Wrong Alignment
- ☐ 3 Wrong Size
- ☐ 4 Wrong Class
- ☐ 5 Wrong Depth
- ☐ 9 Other (See Comments)

Action Taken/Comments:

Inspected By: _____ ***Signature:*** _____ ***Pay No:***_____

Contractor/Project Manager: _____ ***Signature:*** _____

DMS3045600V3 Page 2 of 8

Site Inspection Reports (Page 2 of 8)

Site Inspection Report

Stage: **Cable Installation**			
Work Order #:	*DQM No.:*	*Pre-start Meeting (Y/N):*	*Option (A/B):*
Date:	*Time On Site:*	*Time Off Site:*	

Inspection Item ***Inspection Result*** ***Person Responsible***

1. Boundary Pegs In Place

- ☐ 1 Yes
- ☐ 2 No Pegs In Place
- ☐ 3 No Finished Ground Level
- ☐ 4 No Finished Ground Level In Trench
- ☐ 9 Other (See Comments)

2. Correct Installation Method Used

- ☐ 1 Yes
- ☐ 2 No Rollers Installed
- ☐ 3 No Bells Installed On Ducts
- ☐ 4 No Stocking
- ☐ 5 No Break Load Device
- ☐ 9 Other (See Comments)

3. LV Cable Correct Alignment

- ☐ 1 Yes
- ☐ 2 Inside Private Property
- ☐ 3 Special Agreement with Asset Management
- ☐ 4 Diverted to Avoid Other Services
- ☐ 5 Cables NOT Capped
- ☐ 9 Other (See Comments)

4. HV Cable Correct Alignment

- ☐ 1 Yes
- ☐ 2 Inside Private Property
- ☐ 3 Special Agreement with Asset Management
- ☐ 4 Diverted to Avoid Other Services
- ☐ 5 Cables NOT Capped
- ☐ 9 Other (See Comments)

5. All Cables 150mm Clear of Other Services

- ☐ 1 Yes
- ☐ 2 Special Agreement with Asset Management
- ☐ 9 Other (See Comments)

6. Changes to 'As Constructed' Drawings

- ☐ 1 Yes
- ☐ 2 No (NOT 'As Constructed')
- ☐ 9 Other (See Comments)

Action Taken/Comments:

Inspected By: _____ ***Signature:*** _____ ***Pay No:***_____

Contractor/Project Manager: _____ ***Signature:*** _____

Site Inspection Reports (Page 3 of 8)

Site Inspection Report

Stage: **Jointing**			
Work Order #:	*DQM No.:*	*Pre-start Meeting (Y/N):*	*Option (A/B):*
Date:	*Time On Site:*	*Time Off Site:*	

Inspection Item ***Inspection Result*** ***Person Responsible***

1. Boundary Pegs In Place

- [ ] 1 Yes
- [ ] 2 No Pegs In Place
- [ ] 3 No Finished Ground Level
- [ ] 4 No Finished Ground Level In Trench
- [ ] 9 Other (See Comments)

2. Correct Installation Method

- [ ] 1 Yes
- [ ] 2 Not to Design Drawing
- [ ] 9 Other (See Comments)

3. Pillars in Correct Lot

- [ ] 1 Yes
- [ ] 2 Changed from Plan to Suit Other Services
- [ ] 9 Other (See Comments)

4. Correct Phasing on Joints and Terminations

- [ ] 1 Yes
- [ ] 2 Tee Joint NOT Made Off
- [ ] 3 Uni Pillars NOT to Standard
- [ ] 4 Working End NOT to Standard
- [ ] 5 Pole Term NOT to Length
- [ ] 6 Street Lights NOT to Standard
- [ ] 7 Mini Pillars NOT to Standard
- [ ] 9 Other (See Comments)

5. Quality of Joint

- [ ] 1 Yes
- [ ] 2 Not to Manufacturers Specs
- [ ] 3 Site Untidy
- [ ] 9 Other (See Comments)

Action Taken/Comments:

Inspected By: _____ ***Signature:*** _____ ***Pay No:***_____

Contractor/Project Manager: _____ ***Signature:*** _____

DMS3045600V3 Page 4 of 8

Site Inspection Reports (Page 4 of 8)

Site Inspection Report

Stage: **Backfill**			
Work Order #:	*DQM No.:*	*Pre-start Meeting (Y/N):*	*Option (A/B):*
Date:	*Time On Site:*	*Time Off Site:*	

Inspection Item ***Inspection Result*** ***Person Responsible***

1. Backfill Free of Rocks and Sharp Surfaces

- ☐ 1 Yes
- ☐ 2 Coffee Rock
- ☐ 3 Limestone
- ☐ 4 Granite
- ☐ 5 Other Contaminations
- ☐ 9 Other (See Comments)

2. 300mm Clean Sand Placed Over Cable

- ☐ 1 Yes
- ☐ 2 Insufficient
- ☐ 3 Too Much
- ☐ 4 Contaminated
- ☐ 9 Other (See Comments)

3. DANGER Tape Installed Over Top of Cable

- ☐ 1 Yes
- ☐ 2 Vindex off Alignment
- ☐ 3 Conduit off Alignment
- ☐ 4 Tape Missing Over Joint Area
- ☐ 9 Other (See Comments)

4. Correct Amount of DANGER Tape Installed

- ☐ 1 Yes
- ☐ 2 Only One Tape Installed Where Multiple Cables are Installed in Trench
- ☐ 9 Other (See Comments)

5. Other Utilities inside Western Power Alignment

- ☐ 1 Yes
- ☐ 2 Special Agreement with Asset Management
- ☐ 9 Other (See Comments)

Action Taken/Comments:

Inspected By: _____ ***Signature:*** _____ ***Pay No:*** _____

Contractor/Project Manager: _____ ***Signature:*** _____

Site Inspection Reports (Page 5 of 8)

Site Inspection Report

Stage:	**Installation of Pillars, Switchgear LV & H/V**		
Work Order #:	*DQM No.:*	*Pre-start Meeting (Y/N):*	*Option (A/B):*
Date:	*Time On Site:*	*Time Off Site:*	

Inspection Item	*Inspection Result*	*Person Responsible*

1. Switchgear Installed Correctly

	1	Yes
	2	Too High
	3	Too Low
	4	Not Level
	5	No Pegs
	6	Erosion Problem
	7	Earthing NOT Installed
	9	Other (See Comments)

2. Uni and Mini Pillars Installed Correctly

	1	Yes
	2	Erosion Problem
	3	Too High
	4	Too Low
	5	Incorrect Alignment
	6	Other Services
	9	Other (See Comments)

3. Transformer Installed Correctly

	1	Yes
	2	Too High
	3	Too Low
	4	Not Level
	5	No Pegs
	6	Erosion Problem
	7	Earthing NOT Installed
	8	Cables NOT Labelled
	9	Other (See Comments)

Action Taken/Comments:

Inspected By: _____ ***Signature:*** _____ ***Pay No:*** _____

Contractor/Project Manager: _____ ***Signature:*** _____

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Refer to DM for current version

Site Inspection Reports (Page 6 of 8)

Site Inspection Report

Stage:	**Testing**		
Work Order #:	*DQM No.:*	*Pre-start Meeting (Y/N):*	*Option (A/B):*
Date:	*Time On Site:*	*Time Off Site:*	

Inspection Item ***Inspection Result*** ***Person Responsible***

1. H/V Testing Successful

- ☐ 1 Yes
- ☐ 2 Yes (NOT Witnessed)
- ☐ 3 Received Test Results
- ☐ 4 No (NOT Successful)
- ☐ 9 Other (See Comments)

2. L/V Testing Successful

- ☐ 1 Yes
- ☐ 2 Yes (NOT Witnessed)
- ☐ 3 Numerous Tests to Achieve Required Results
- ☐ 4 Sheath Fault
- ☐ 5 Phase Fault
- ☐ 6 Neutral Fault
- ☐ 9 Other (See Comments)

Action Taken/Comments:

Inspected By: _____ ***Signature:*** _____ ***Pay No:*** _____

Contractor/Project Manager: _____ ***Signature:*** _____

DMS3045600V3 Page 7 of 8

Site Inspection Reports (Page 7 of 8)

Site Inspection Report

Stage:	**Pre Handover Inspection**	
Work Order #:	*DQM No.:*	*Pre-start Meeting (Y/N):*
Date:	*Time On Site:*	*Time Off Site:*

Inspection Item	***Inspection Result***	***Person Responsible***

1. Handover Inspection Achieved

	1	**Yes**
	2	**No**
	3	**Numerous Visits to Complete Outstanding Defects**
	9	**Other (See Comments)**

2. Outstanding Items:

All the following outstanding items or defects must be rectified by the developer by the required by date.

No.	**Outstanding Item/Defect**	**Required by Date**

Action Taken/Comments:

Inspected By: _____ ***Signature:*** _____ ***Pay No:*** _____

Contractor/Project Manager: _____ ***Signature:*** _____

Developer's Site Superintendent/Project Engineer :_____***Signature:***_____

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Site Inspection Reports (Page 8 of 8)

Electrical Assets Infrastructure
Pre-handover Site Inspection

Project Name and Stage:

Date:

Project No:

WAPC No:

Key Parties

Developer:

Developer's Consulting Engineer:

Representative:

Main Contractor (MC):

Representative:

Electrical Consultant:

Representative:

Sub-Contractor (SC):

Representative:

Parts	Inspection Items – inspected and verified by Subcontractor (SC) and Main Contractor (MC) to meet the Specification, Drawings & UDS Manual	Ready for Pre-Handover
Trenching & bedding	*1. Trench alignments/excavation conform to network & UPCoP requirements* *2. Trench depths validated to subdivision finished levels* *3. Bedding in accordance with network requirements, free of obstructions*	Verified (SC) ☐ Verified (MC) ☐
Cable & access installation	*1. Cable installation completed in accordance with the UDS Manual* *2. LV cables installed to the correct depth and alignment* *3. HV cables installed to the correct depth and alignment* *4. Conduits, ducts, pulling pits, draw wires installed* *5. Cables and access ways clear of other services and obstructions*	Verified (SC) ☐ Verified (MC) ☐
Cable jointing, terminations & seals	*1. Jointing, terminations, and seals in accordance with the UDS Manual* *2. Joints and seals correctly located within and to identified boundaries* *3. Joints, terminations, and seals complete, compliant and documented* *4. Phasing of joints and terminations correct and validate*	Verified (SC) ☐ Verified (MC) ☐
Backfill & surface coverings	*1. Boundary pegs in place and visible* *2. Clean fill in place around cables and equipment* *3. Danger/marker tape correctly installed* *4. Backfill and surface coverings in place and complete* *5. Reinstatement (where applicable) complete* *6. Above ground markers correctly installed and secure*	Verified (SC) ☐ Verified (MC) ☐
LV & HV equipment installation	*1. Network equipment correctly located within and to identified boundaries* *2. Pillars and cable pits correctly installed and terminated* *3. Transformers correctly installed and terminated* *4. Switchgear correctly installed and terminated* *5. Street lighting correctly installed and terminated* *6. Supplementary infrastructure and supports installed and complete*	Verified (SC) ☐ Verified (MC) ☐

SAMPLE

Developer Pre-Handover Site Inspection Template – April 2019 EDM

Testing	*1. Testing completed in accordance with the UDS Manual* *2. LV testing complete, compliant & documented* *3. HV testing complete, compliant & documented* *4. Test reports documented (note qualifications and experience of jointer(s)*	Verified (SC) ☐ Verified (MC) ☐
As constructed drawings and documents	*1. Finished ground levels documented* *2. Agreed non-conforming cable depths confirmed and documented* *3. Conduits, ducts, pits, and cables documented* *4. Cable joints, terminations and seals locations confirmed and documented* *5. Agreed non-electrical utilities located within power alignments documented* *6. LV/HV equipment/infrastructure locations confirmed and documented*	Verified (SC) ☐ Verified (MC) ☐

Main Contractor's statement

We the Contractor certify that the assets constructed comply with Western Power's applicable design and construction manuals including the Distribution Substation Plant Manual, the Distribution Construction Standards Handbook, and the Underground Cable Installation Manual for these works.

Name of Contractor:

Name and position:

Signed:

Date:

Site Superintendent or Electrical Consultant's statement

Based on the visual inspection of electrical services installation, to the extent that can be reasonably expected during the periodic site visits, viewing of contractor's test results, and the as-constructed documentation, we consider that the works are practically complete and ready for handover to Western Power in accordance with the current issue of the Western Power Underground Distribution Schemes (UDS) Manual.

Name of Company:

Name and position:

Signed:

Date:

Please submit the completed document together with all relevant data sheets through *Western Power's online application portal*, two days prior to the pre-handover inspection.

SAMPLE

Appendix 11 – Completion Check List

COMPLETION CHECK LIST

UDS NUMBER: _____
STAGE: _____
LOT NUMBERS: _____
DEVELOPER: _____
CONSULTANT: _____

INSPECTION & TESTING SCHEDULES:	SUBMITTED	PASSED
LV CABLE TESTING SCHEDULE	☐	☐
HV CABLE TESTING SCHEDULE	☐	☐
INSPECTION SCHEDULE	☐	☐
HV SWITCHGEAR TESTING SCHEDULE	☐	☐
LV CONTINUITY & PHASING SCHEDULE	☐	☐
EARTH TEST SCHEDULE	☐	☐
AS CONSTRUCTED DRAWINGS	☐	☐
EQUIPMENT SUBJECT TO THIS HANDOVER IS CLEARLY MARKED BY A LABEL	☐	☐
ALL OUTSTANDING PERMITS CANCELLED	☐	☐

ITEMS REQUIRING FURTHER WORK:

_____
_____
_____
_____
_____
_____
_____
_____

SIGNED **WESTERN POWER CPM**

DATE:

DMS#3065277

Appendix 12 – Handover Certificate

Handover certificate

Original to be returned to works administration on completion
Western Power, 363 Wellington Street Perth WA 6000

1990

Please note that from the date and timed stated, the apparatus detailed below which has previously controlled

By _____
(Name)

Of _____

Is now handed over to _____
(Name)

Of _____

Date _____ Time _____

Project number _____

Location _____

Apparatus being handed over _____

With the following exceptions and comments _____

Any further work on the apparatus can only be carried out with the permission of the appropriate authority and subject to the issues of an appropriate permit to work authorisation. (Refer to clause 3.9 of the safety instructions).

Handed over by _____ Accepted by _____
(Sign) (Sign)

Please sign in the space provided below that you understand and acknowledge the changed conditions which now apply to the apparatus.

Name	Signature	Name	Signature

NOTE: In the case of Contractors the above should be signed by the Contractor and forwarded to the Western Power Project Manager stating that all relevant Contractor Employees have been advised.

Distribution: Green copy – Accepting Officer; Yellow copy- Project Officer; Pink copy – Handing Over Officer; White copy – Spare 06/11

SAMPLE

Appendix 13 – Equipment and Installation Drawings

Equipment and Installation Drawings (Page 1 of 16)

This appendix contains additional drawings for key equipment used by Western Power in the construction of Underground Distribution Schemes (UDS)

The drawings are separated as follows:

- Low Voltage Equipment
- Substation Earthing Arrangement
- Substation Ducts Arrangement
- Street lights
- Cable Trench Arrangement.

Low voltage Equipment Drawings

Listed below are examples of the drawings. All drawings can be found in the Distribution Construction Standards Handbook. Drawings prefixed R in Part 2 and prefixed U in Part 5. These drawings are not reproduced in the UDS Manual and can be accessed via Western Power's Public website.

Index of Drawings

Drawing Number	Drawing Title
R 32	Wavecon Mimi pillar Terminal Block Termination Details
R 33	Mini Pillar Wavecon Working End
R 35 series	Mini pillar supply arrangements (Various)
U8	URD Mini Pillar Installation Guide
U9	UDS Universal Pillar Installation Details

Equipment and Installation Drawings (Page 2 of 16)

Substation Earthing Arrangement Drawings

All substation earthing shall be installed in accordance with the relevant compatible unit (CU) drawings under 'HU – High Voltage Underground' in the Distribution Design Catalogue (DDC).

Listed below are examples of the drawings. These drawings are not reproduced in the UDS Manual and can be accessed via the above link.

Index of Drawings

Drawing Number	Drawing Title
HU 5	Switchgear kiosk 3+0
HU 6	Switchgear kiosk 2+1
HU 7	Switchgear kiosk 2+2
HU 8	Switchgear kiosk 3+1
HU 9	Switchgear kiosk 4+0
HU 27	SPUD isolation transformer
HU 63	SPURS transformer 1 phase 10kVA
HU 64	SPURS transformer 1 phase 25kVA
HU 31	SPUD transformer 1 phase 2 bush
HU 34	SPUD transformer 1 phase 3 bush
HU 35	SPUD transformer 1 phase 4 bush
HU 59A	Non-MPS transformer district outside installation
HU 61	MPS district transformer
HU81	Switchgear kiosk 3+2
HU82	63kVA 3 phase transformer

Equipment and Installation Drawings (Page 3 of 16)

Substation Ducts Arrangement Drawings

Listed below are examples of the drawing. These drawing are not reproduced in the UDS Manual and be accessed in the Distribution Substation Plant Manual

Index of Drawings

Drawing Number	Drawing Title
DSPM Section 3	Substation Ducting Cross Section – Civil Requirements

Street Lights Drawings

Listed below are examples of the drawing. These drawing are not reproduced in the UDS Manual and can be accessed in the Distribution Construction Standards Handbook – Section 2.

Index of Drawings

Drawing Number	Drawing Title
R 26/1	Street Light Cutout, Single-phase Supply
R 26/2	Street Light Cutout, Single-phase Supply for Class II Luminaires
R 26/3	Street Light Cutout Connection Arrangement for Electrical Attachment
R 27	Fusing Arrangement for Street Light Columns
R32	Mini Pillar Terminal Block Termination Details (Street Light)

All Western Power standard street lighting (non-decorative) equipment drawings are available in the Distribution Design Catalogue – SL – Street lights

All Western Power standard decorative street lighting equipment is available in the Distribution Design Catalogue – DM – Decorative Materials

Equipment and Installation Drawings (Page 4 of 16)
Cable Trench Arrangements
Index of Drawings

Drawing Number	Drawing Title
UDS-6-2	Cable Trench Layout (Sheets 1 to 7)
UDS-6-3	Cable and Duct Placements on Truncations

Working end drawings

Listed below are drawings references for HV and LV live end seals.

The following standard equipment drawings are available in the Distribution Design Catalogue:

Drawing Number	Drawing Title
HU3	HV CABLE END SEAL
LU62	LV LIVE END SEALS

The following standard installation drawings are available in the Distribution Construction Standards Handbook.

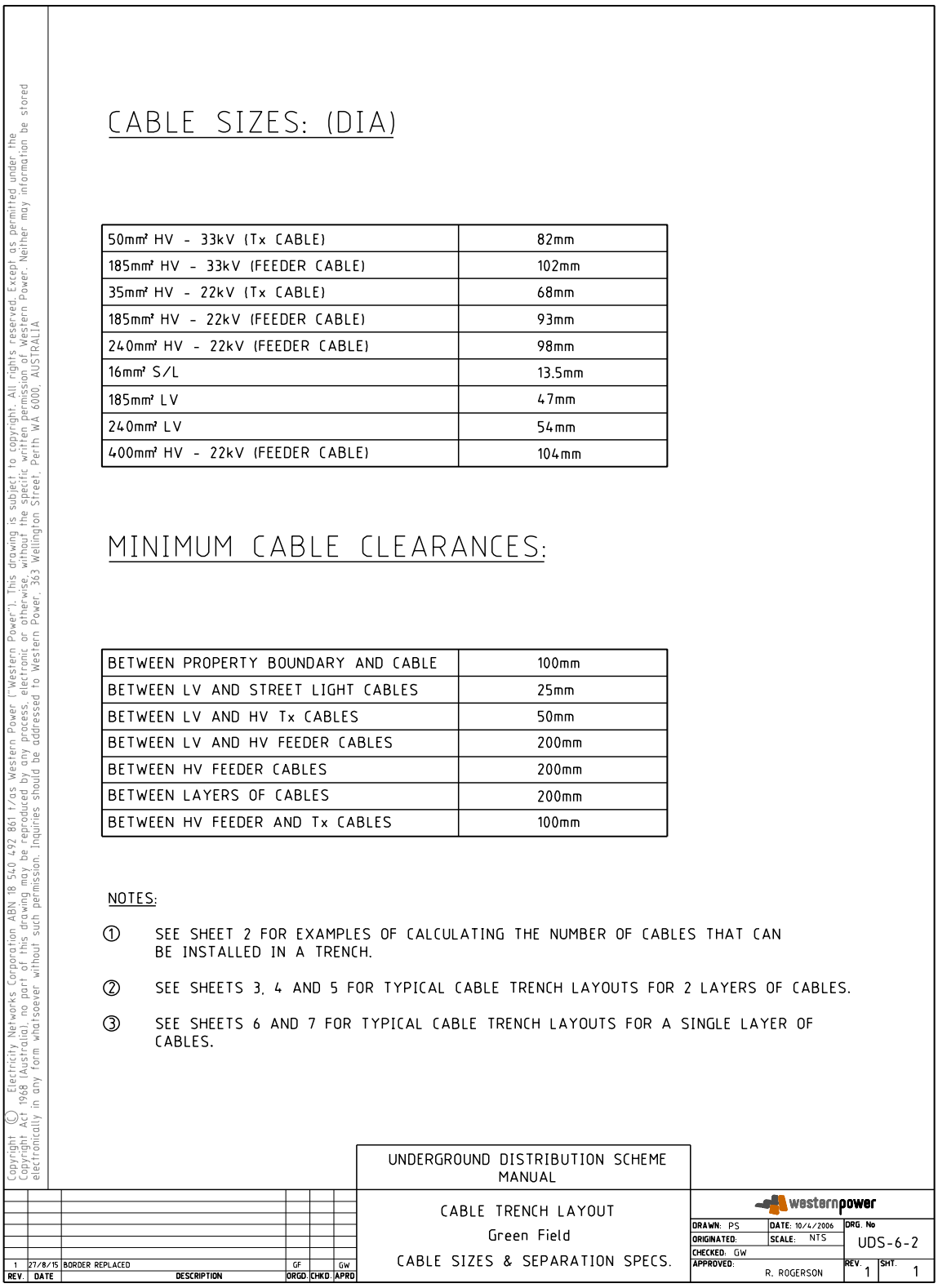
Drawing Number	Drawing Title
R34 - 1	LV CABLE LIVE END SEAL
R34 - 2	HV CABLE END SEAL

Cable end cap drawing

The following standard equipment drawing is available in the Distribution Design Catalogue:

Drawing Number	Drawing Title
CN73	CABLE END CAP

Equipment and Installation Drawings (Page 5 of 16)



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CABLE SIZES: (DIA)

50mm² HV - 33kV (Tx CABLE)	82mm
185mm² HV - 33kV (FEEDER CABLE)	102mm
35mm² HV - 22kV (Tx CABLE)	68mm
185mm² HV - 22kV (FEEDER CABLE)	93mm
240mm² HV - 22kV (FEEDER CABLE)	98mm
16mm² S/L	13.5mm
185mm² LV	47mm
240mm² LV	54mm
400mm² HV - 22kV (FEEDER CABLE)	104mm

MINIMUM CABLE CLEARANCES:

BETWEEN PROPERTY BOUNDARY AND CABLE	100mm
BETWEEN LV AND STREET LIGHT CABLES	25mm
BETWEEN LV AND HV Tx CABLES	50mm
BETWEEN LV AND HV FEEDER CABLES	200mm
BETWEEN HV FEEDER CABLES	200mm
BETWEEN LAYERS OF CABLES	200mm
BETWEEN HV FEEDER AND Tx CABLES	100mm

NOTES:

① SEE SHEET 2 FOR EXAMPLES OF CALCULATING THE NUMBER OF CABLES THAT CAN BE INSTALLED IN A TRENCH.

② SEE SHEETS 3, 4 AND 5 FOR TYPICAL CABLE TRENCH LAYOUTS FOR 2 LAYERS OF CABLES.

③ SEE SHEETS 6 AND 7 FOR TYPICAL CABLE TRENCH LAYOUTS FOR A SINGLE LAYER OF CABLES.

REV.	DATE	DESCRIPTION	ORGD.	CHKD.	APRD
1	27/8/15	BORDER REPLACED	GF		GW

UNDERGROUND DISTRIBUTION SCHEME MANUAL

CABLE TRENCH LAYOUT
Green Field
CABLE SIZES & SEPARATION SPECS.

westernpower

DRAWN: PS	DATE: 10/4/2006	DRG. No UDS-6-2
ORIGINATED:	SCALE: NTS	
CHECKED: GW		
APPROVED: R. ROGERSON	REV. 1	SHT. 1

Figure 12: Cable Trench Layout (Sheets 1 of 7)

Equipment and Installation Drawings (Page 6 of 16)

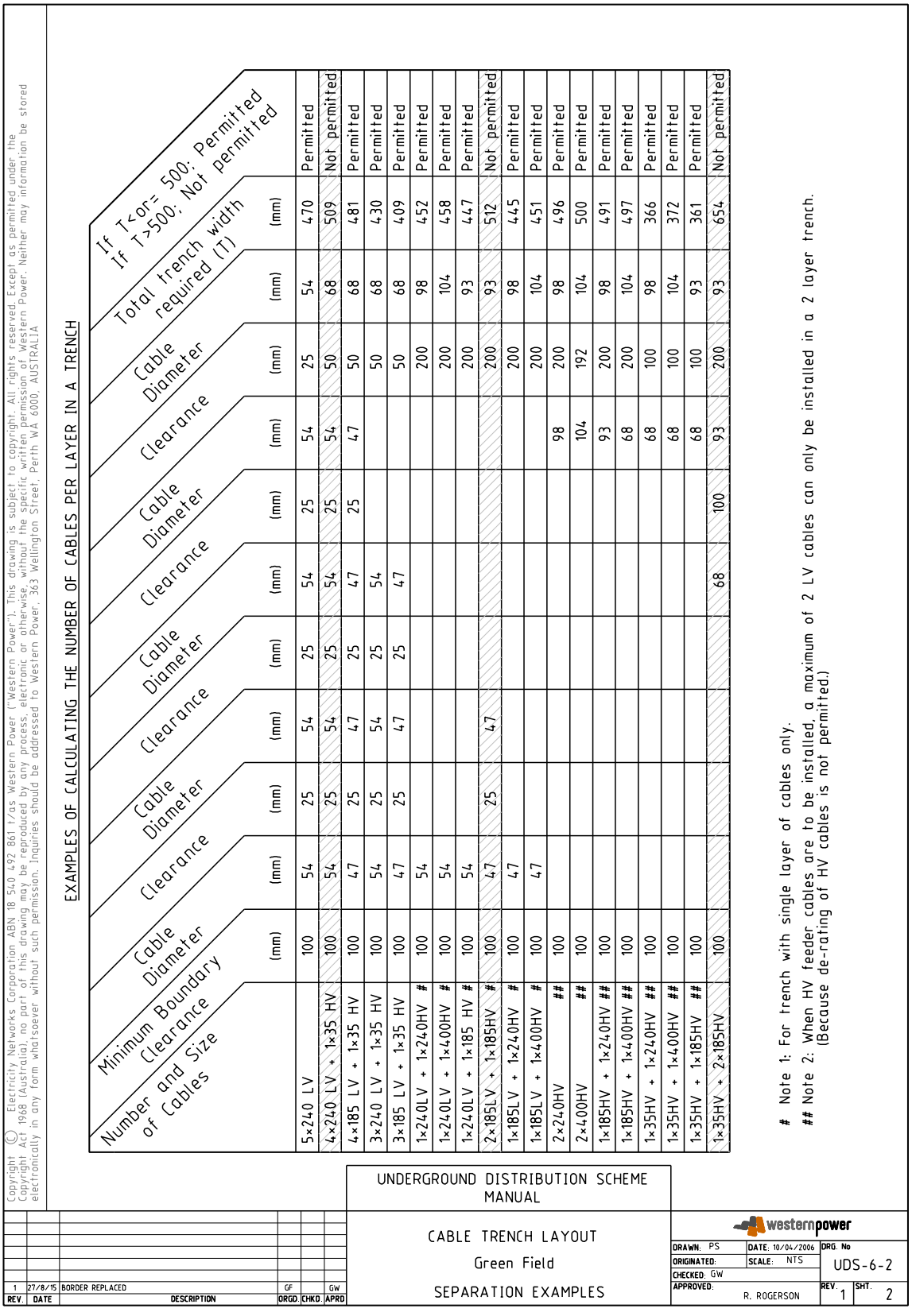

Figure 12: Cable Trench Layout (Sheet 2 of 7)

Equipment and Installation Drawings (Page 7 of 16)

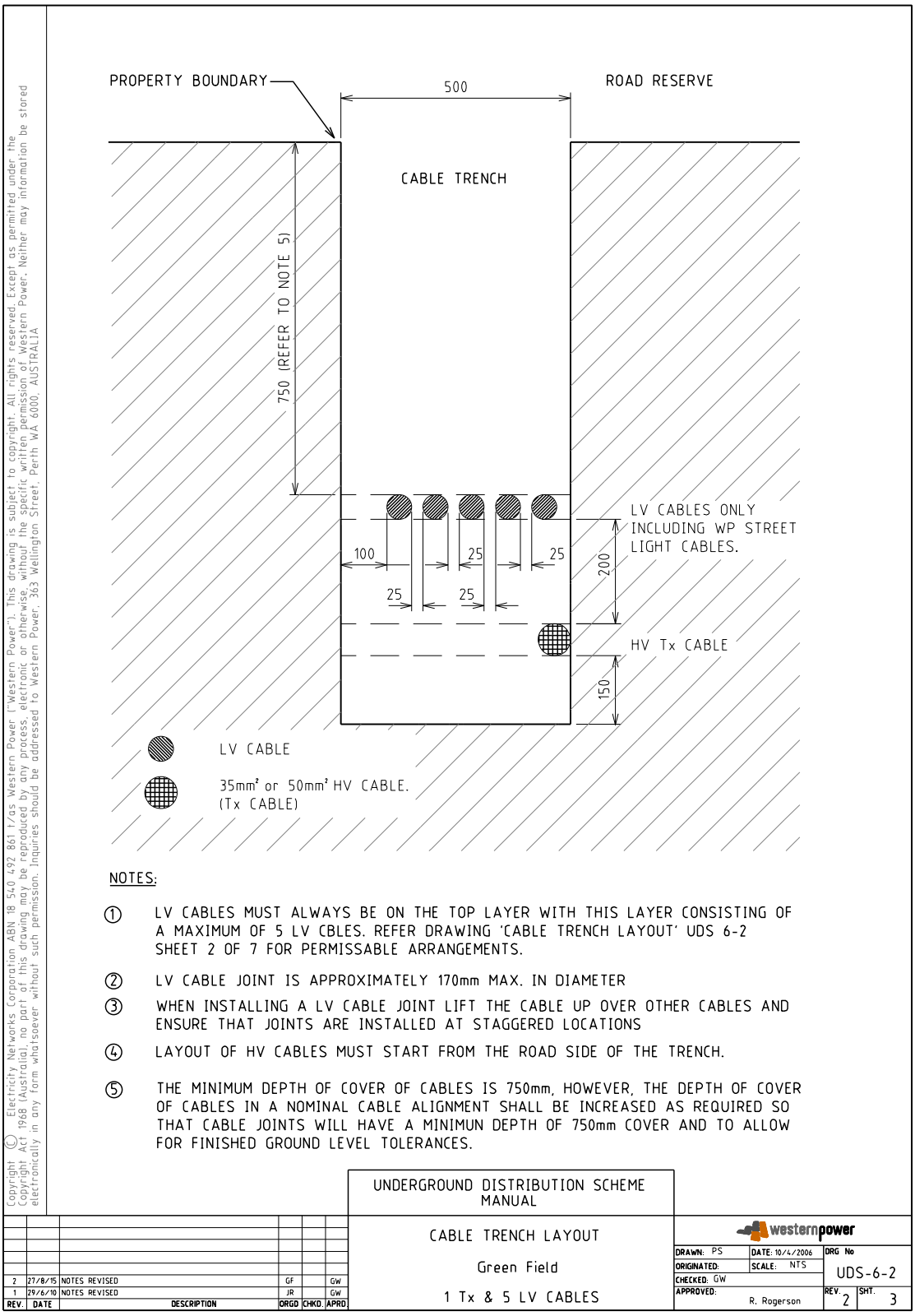

Figure 12: Cable Trench Layout (Sheet 3 of 7)

Equipment and Installation Drawings (Page 8 of 16)

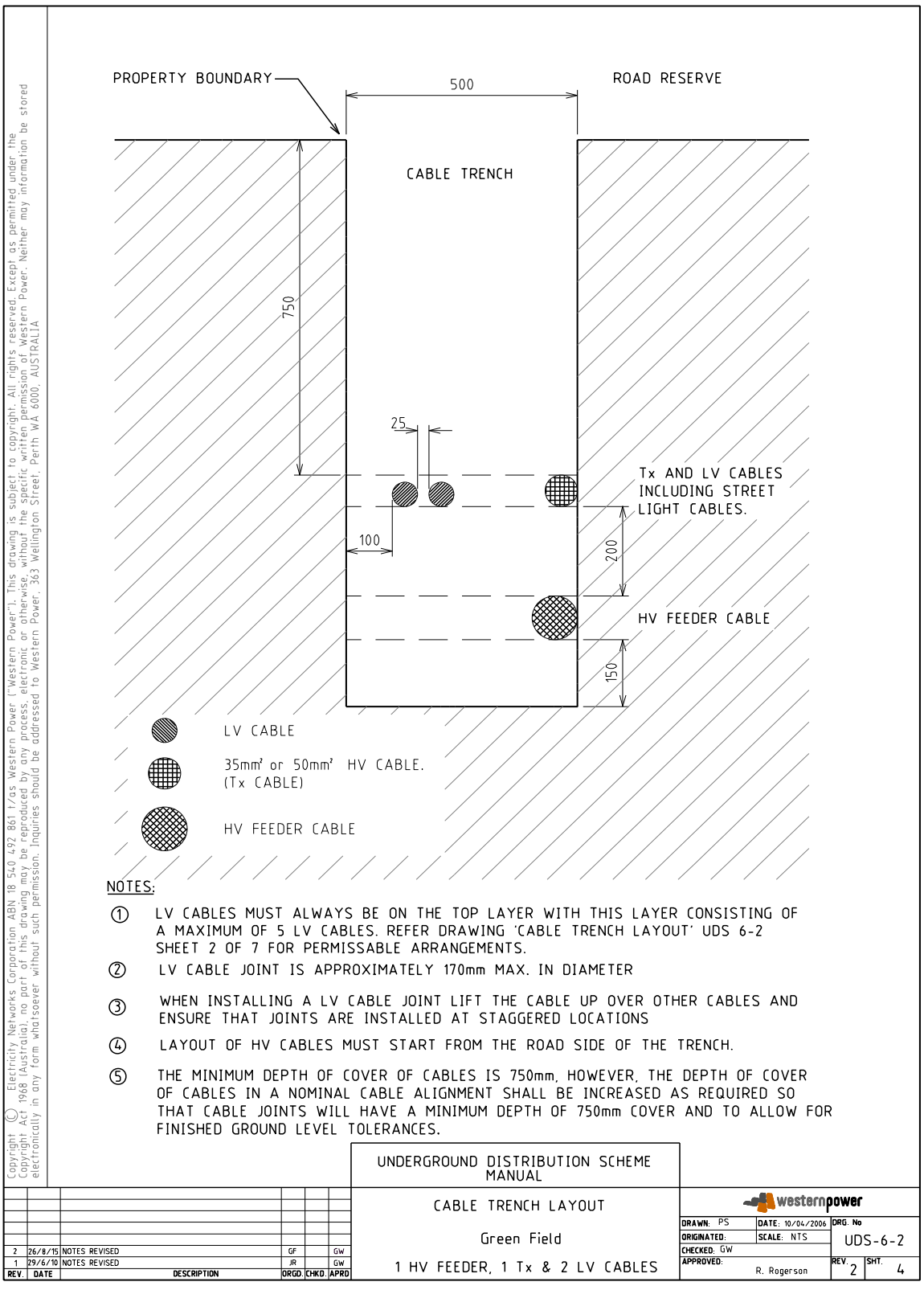

Figure 12: Cable Trench Layout (Sheet 4 of 7)

Equipment and Installation Drawings (Page 9 of 16)

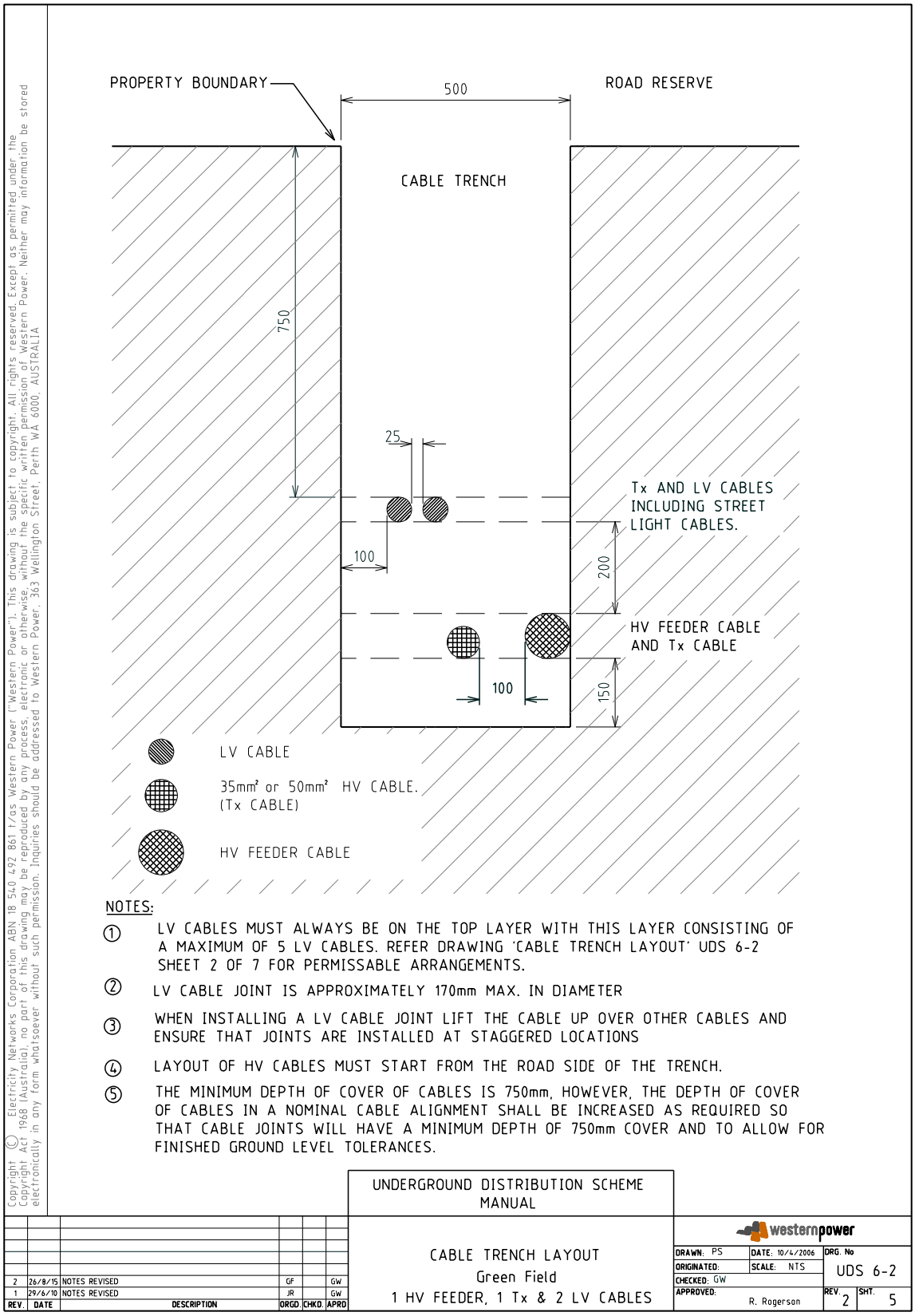

Figure 12: Cable Trench Layout (Sheet 5 of 7)

Equipment and Installation Drawings (Page 10 of 16)

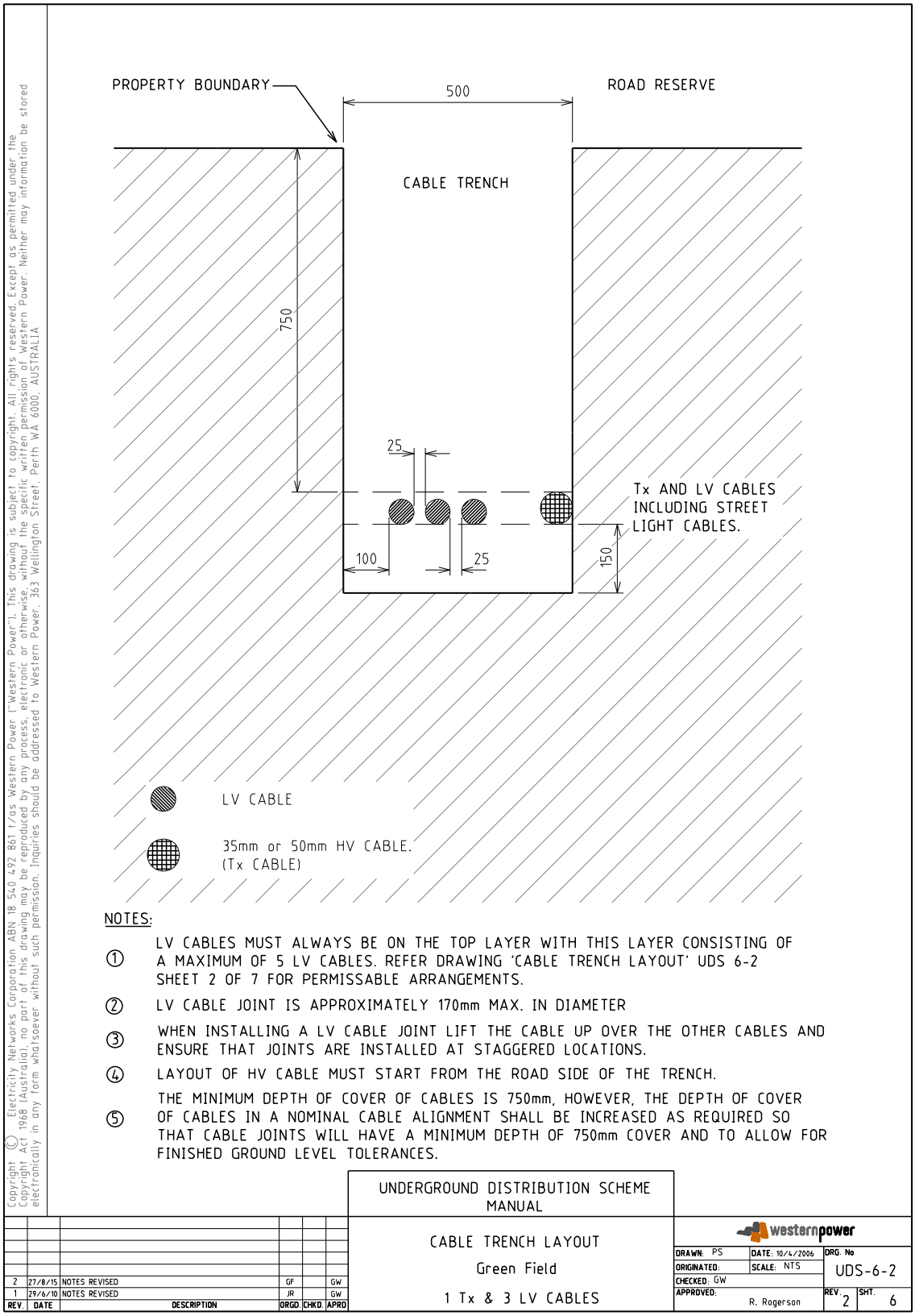

Figure 12: Cable Trench Layout (Sheet 6 of 7)

Equipment and Installation Drawings (Page 11 of 16)

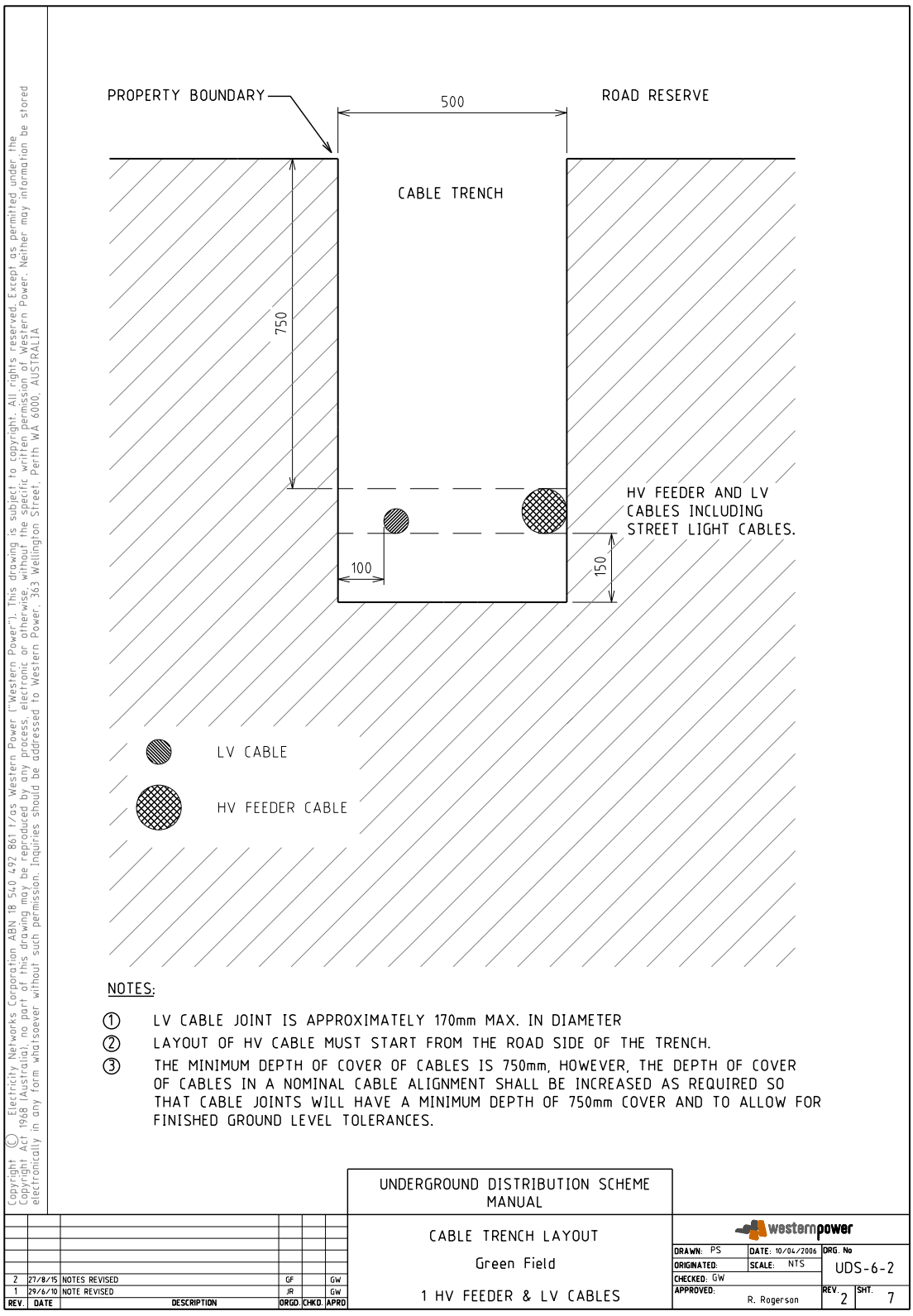

Figure 12: Cable Trench Layout (Sheet 7 of 7)

Equipment and Installation Drawings (Page 12 of 16)

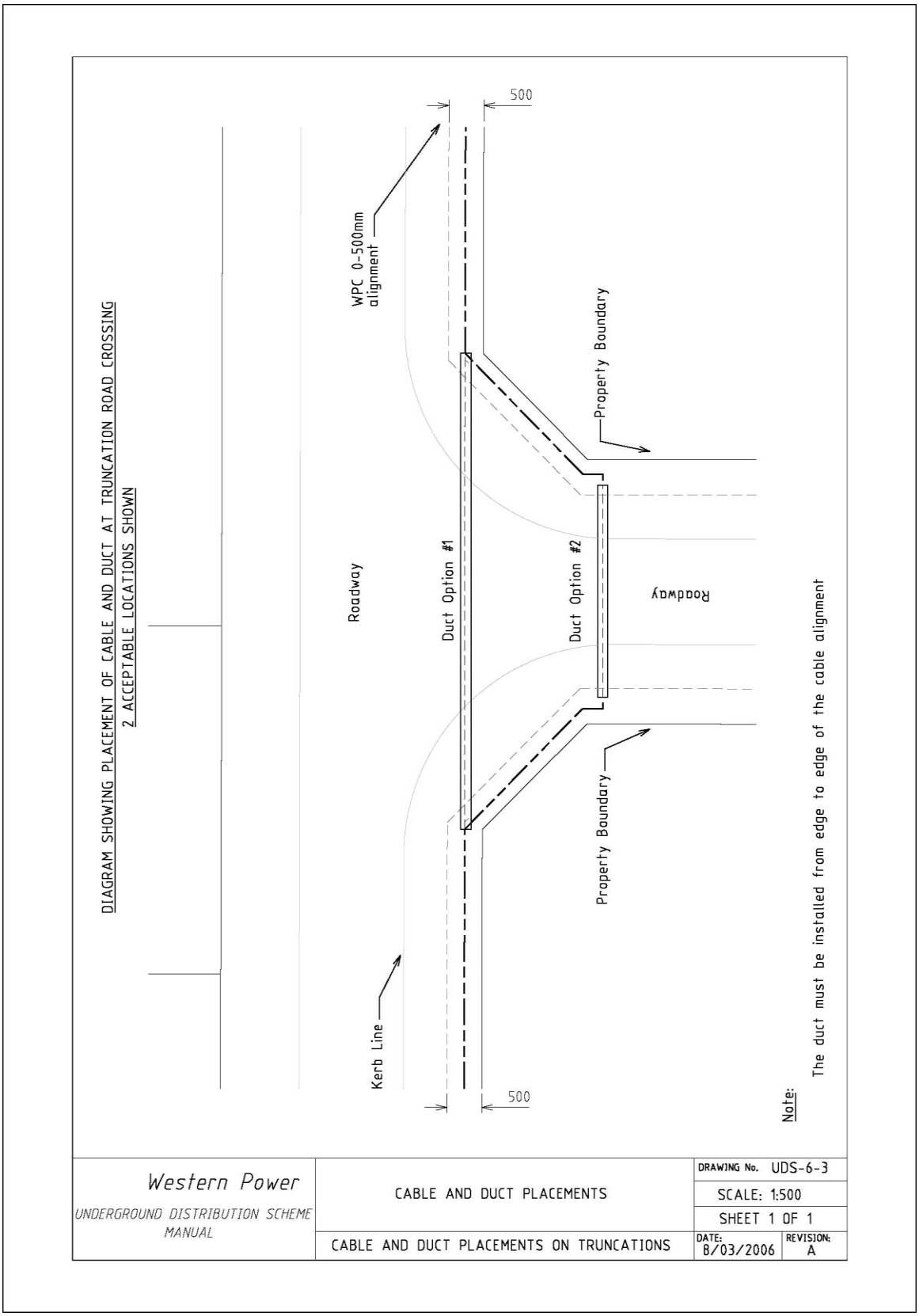

Figure 13: Cable and Duct Placements on Truncations

Equipment and Installation Drawings (Page 13 of 16)

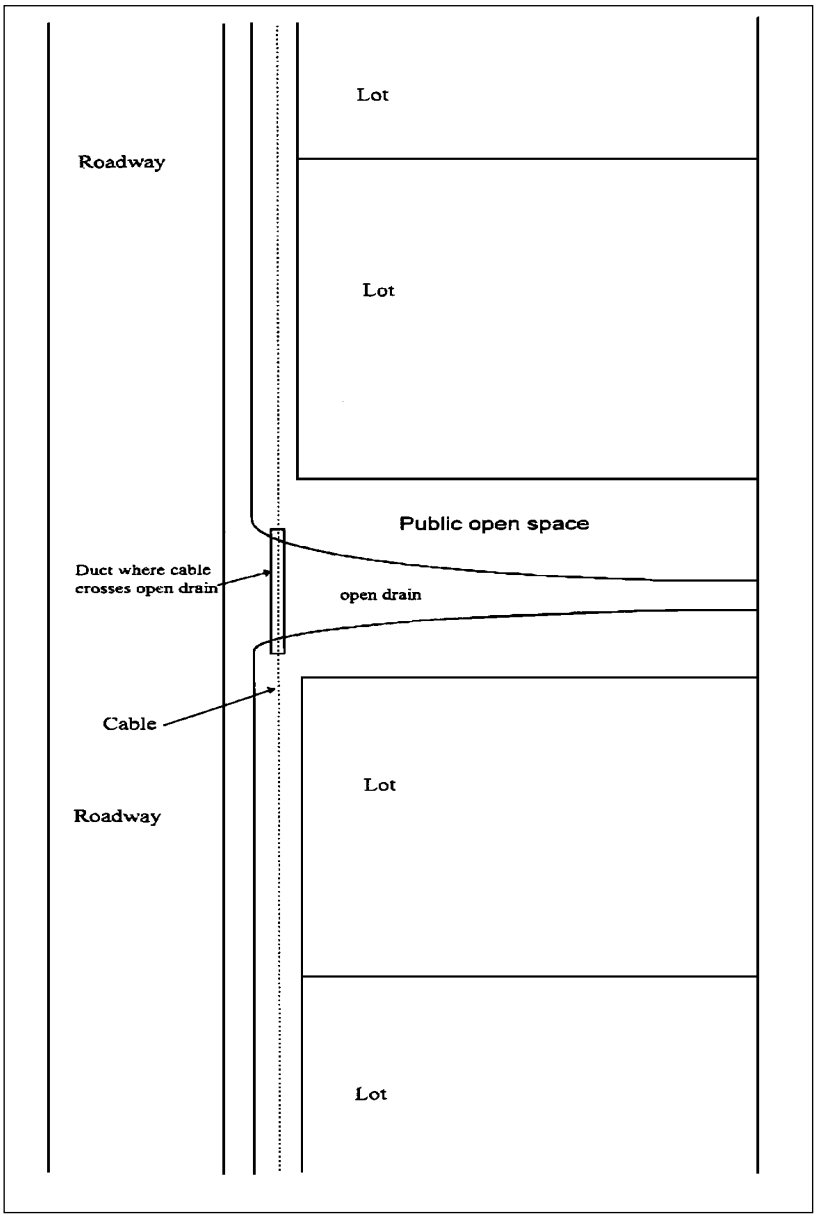

Figure 14: Placement of Duct where Cable crosses Water Course or Open Drain

Note: Ducts must have a minimum cover of 500mm below the bottom of water course or open drain.

Equipment and Installation Drawings (Page 14 of 16)

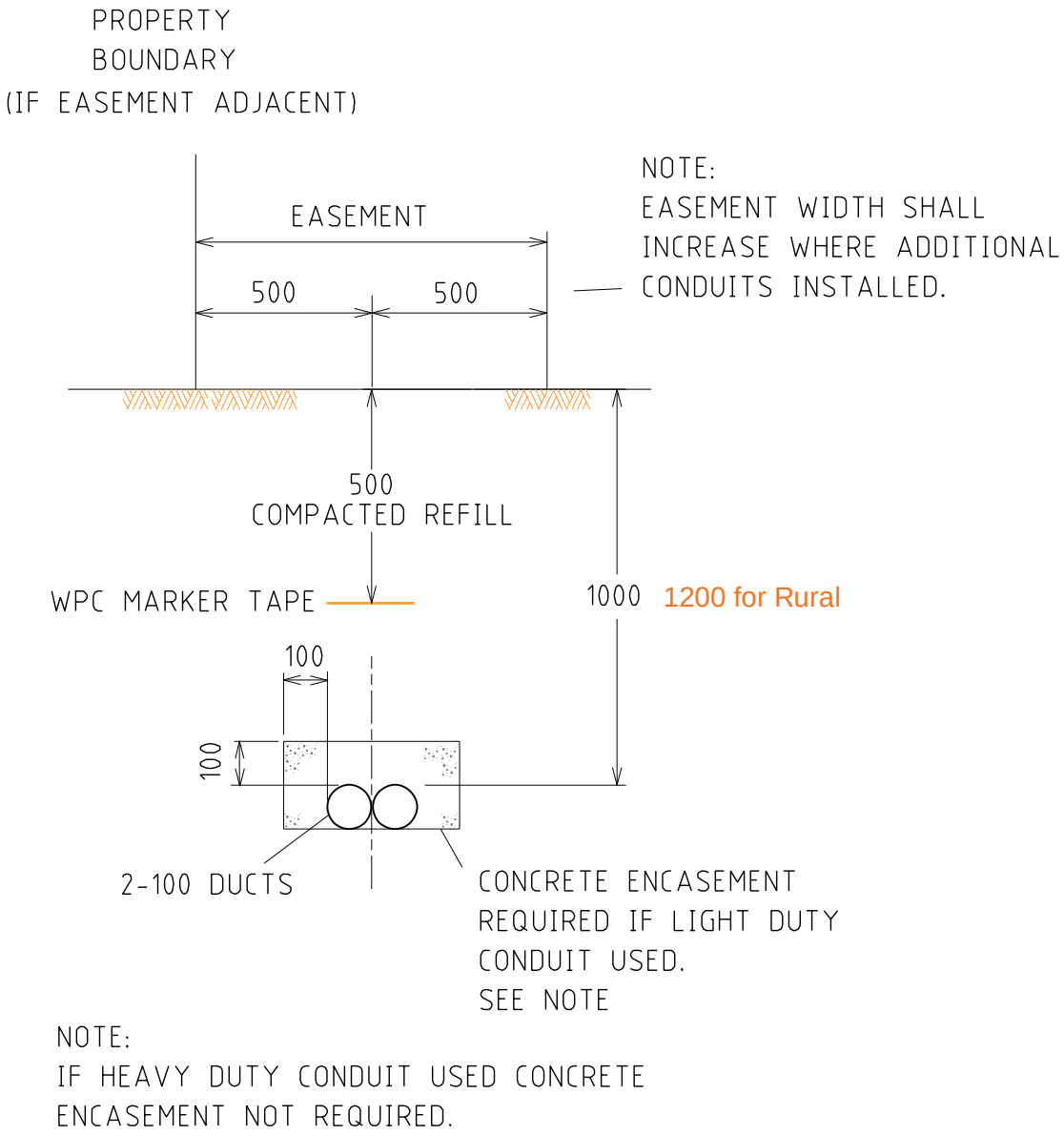

Figure 15: Cross Section Details of Cable Encasement

Equipment and Installation Drawings (Page 15 of 16)

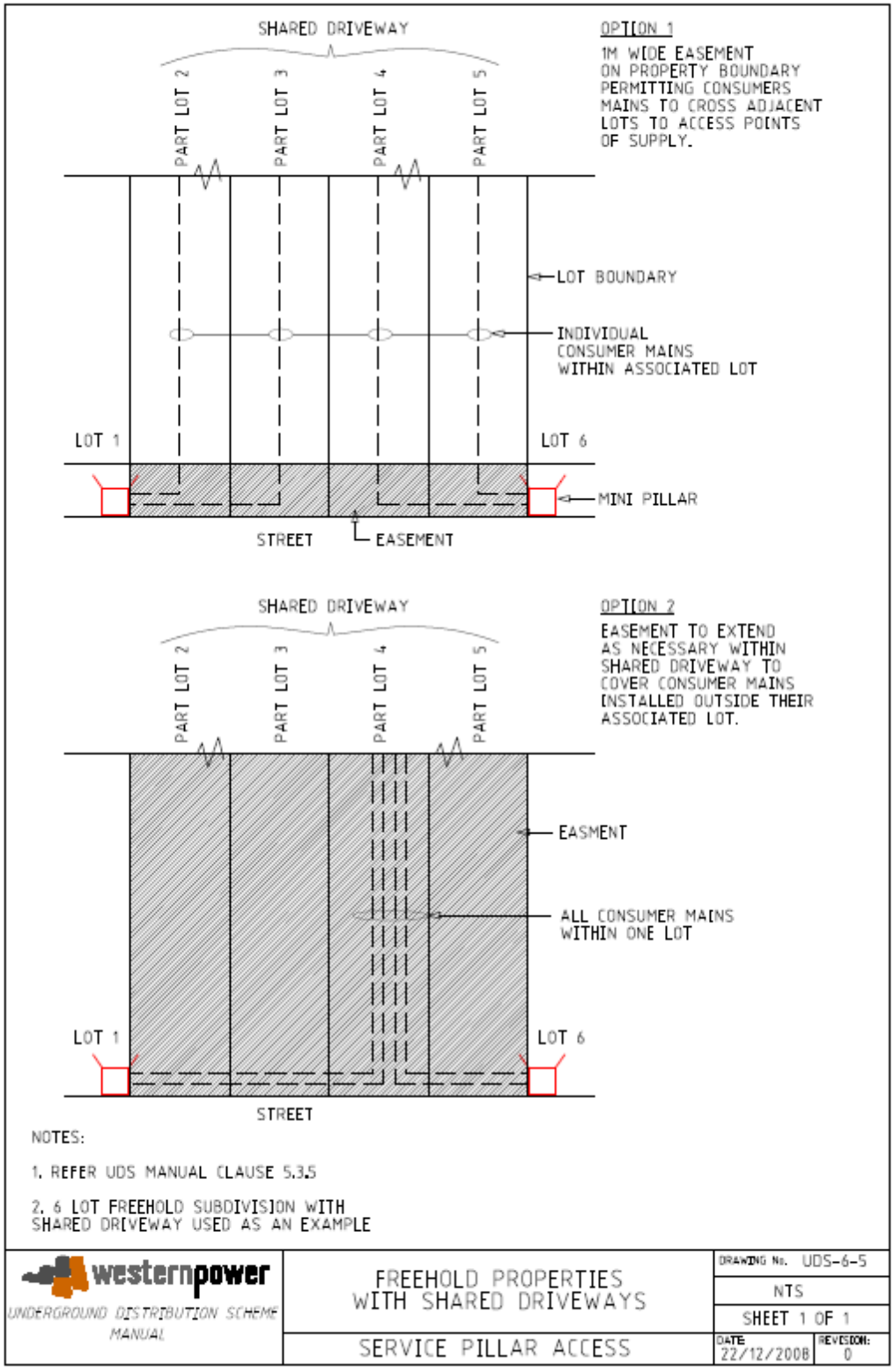

Figure 16: Shared Driveway Service Pillar Access

Equipment and Installation Drawings (Page 16 of 16)

Service pillars shall be installed in accordance with Clause 5.3.5. The drawings below indicate pillar locations for lots with and without retaining walls and conduit provisions to mini pillars for Western Power and customer's cables for lots with retaining walls.

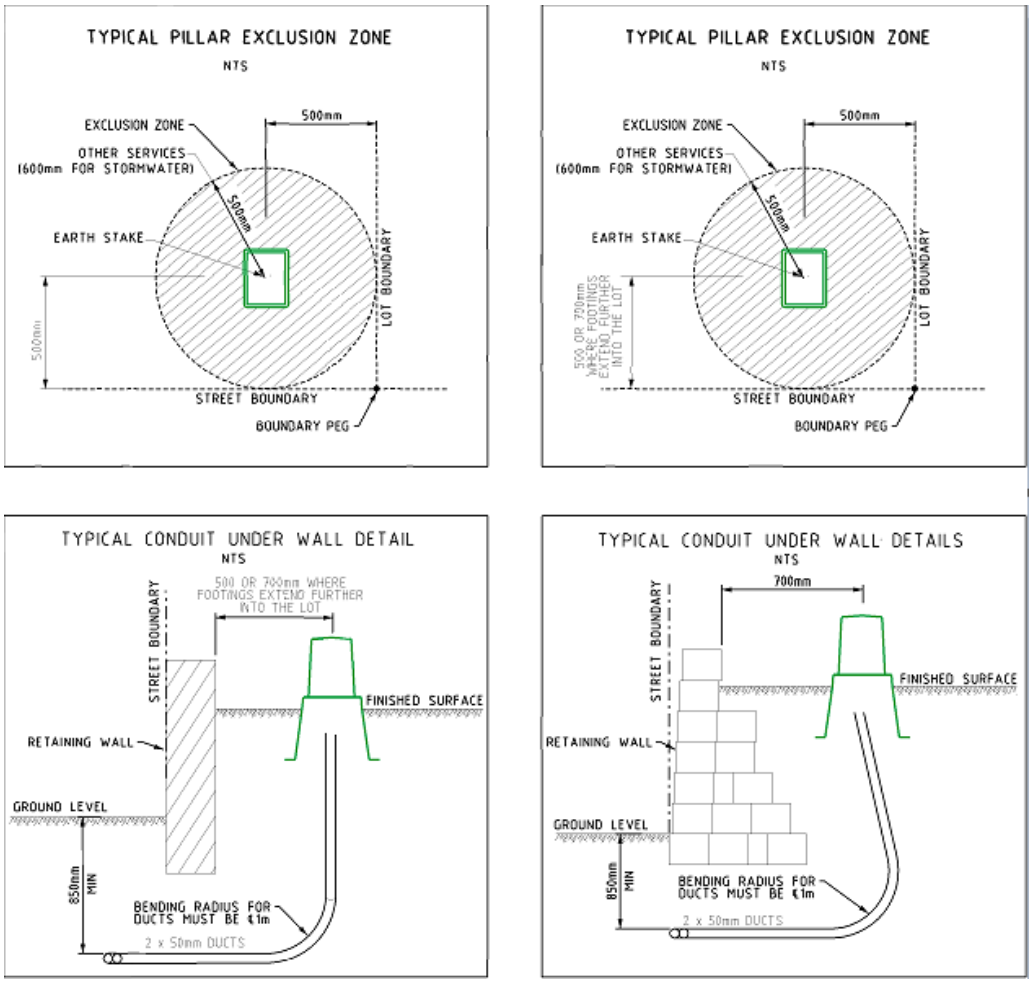

Figure 17: Pillar location and Installation requirements

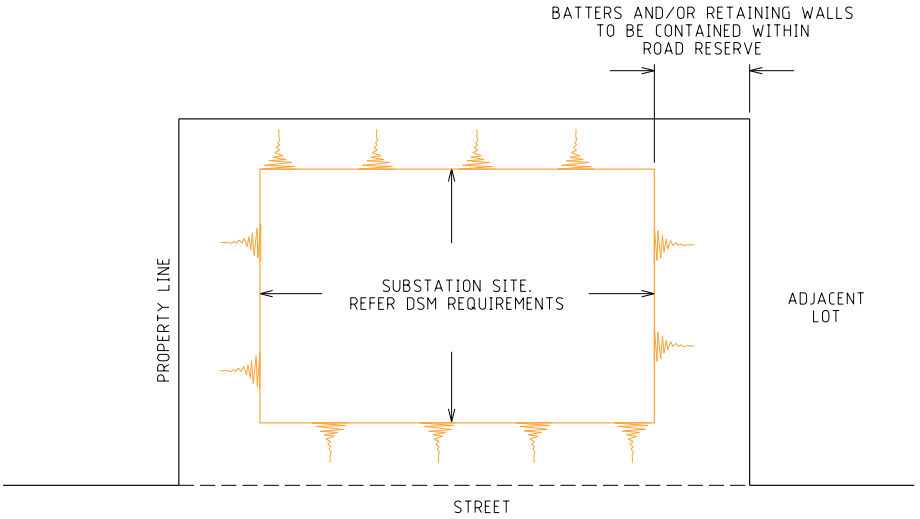

Figure 18: Extended Substation Site

Appendix 14 - UDS Manual Amendments Register

INITIAL PUBLICATION	
Date of Publication:	November 1995
11th Edition	
Date of Amendment:	December 2015
11th Edition Revision One	October 2017
11th Edition Revision Two	May 2019
11th Edition Revision Three Text shown in **blue** (additions) Text shown in **red** (Deletions) Amendments below do not include minor text corrections	
Date of 3rd Amendment:	November **2019**

P#	Clause	Reference	Amendment
49	3.8.12	2nd para	® Replace the word "three" with the phase "five years or as otherwise agreed by the Committee"
169	Fig 17	All	® Dimension reference points clarified.

Document End