Specification Number:	**18147**
Title:	**Functional Design Specification for MV Overhead Lines**
Revision Number:	**1**
Issue Date:	**August 2013**
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Approved for issue:	**Specifications Manager** **ESB Networks**

History of Revisions

Date	Revision Number	Author	Summary of Change
August 2010	Revision 0	Overhead Networks	First Issue
August 2013	Rev 1		Specification number added, front cover modified, Approval sheet added. Technical content unchanged

Note:
This specification will be reviewed at minimum before the Latest Review Date, but may also be reviewed in the interim. Consequently the “Latest Review Date” does not indicate that this particular version of the Specification is current. Accordingly, only the version of the specification issued by ESB to the user for the particular purpose/project should be used.

ESB Technical Specification Approval

Title	
Specification revision number & date	Doculive Spec. No. : 18147 Rev: 1 Date: August 2013 Consultant Reference No.: PG___-____-___-___ Rev: Date:
Produced by: NAP, Asset Management	Date: August 2013
Contract Conditions Reviewed:	

Eirgrid

Department:	**N/A**
Accepted::	
Date:	

ESB Networks:

Department:	Overhead Networks Section, Asset Management
Approved :	Approved
Date:	August 2013

1.0 Introduction

This specification outlines the design rules for constructing 20kV overhead network with:

- 100 mm^2 ACSR (Aluminium Conductor Steel Reinforced), known as "Racoon"
- 150 mm^2 AAAC (All Aluminium Alloy Conductor), known as "Mulberry"

2.0 100 mm^2 ACSR

2.1 Conductor Data

The table below lists the main characteristics of 100 mm^2 Aluminium Conductor Steel Reinforced (ACSR), which ESB specify for 3-phase 20kV networks. This conductor is also described as 92mm^2 ACSR in some ESB documentation because the actual cross-sectional area of the conductor is almost 92 mm^2.

Table 1 Conductor Data

Description	**Value**
Codename	Racoon
Overall Diameter	12.27 mm
Cross Sectional Area	91.98 mm^2
Stranding / Wire Diameter Aluminium	6 / 4.09 mm
Stranding / Wire Diameter Steel	1 / 4.09 mm
Weight/km	303 kg/km
Ultimate Tensile Strength	27.05 kN
Design tension	11.75kgf/mm^2
Target span	100m
AC resistance at 65^{o}C	0.447 Ω/km
Shunt susceptance, B	5.6 x 10^{-6} S/km
Series reactance, X	0.41 H/km
Maximum conductor temperature	65^{o}C
Thermal rating for maximum conductor temperature of 65^{o}C at ambient air temperature of 5^{o}C	385 A
Thermal rating for maximum conductor temperature of 65^{o}C at ambient air temperature of 25^{o}C	293 A
Short-circuit rating for initial conductor temperature of 65^{o}C and short-circuit duration of 0.1 seconds	17.7 kA
Short-circuit rating for initial conductor temperature of 65^{o}C and short-circuit duration of 1 seconds	5.6 kA
Short-circuit rating for initial conductor temperature of 65^{o}C and short-circuit duration of 2 seconds	4.0 kA

Technical requirements for this conductor can be found in the latest edition of ESB Specification 16374, titled: “Aluminium Conductor, Steel Reinforced (ACSR) for Overhead Lines”

2.2 Mechanical Design Details

See Appendix 1 for details on pole duties such as IMP (Intermediate Pole), LAP (Light Angle Pole), etc. Maximum span length is determined by a number of factors including:

- Pole strength
- Foundation strength
- Required ground clearance
- Avoidance of clashing between phases

Maximum span lengths have been calculated for design conditions such as maximum conductor temperature and ambient conditions such as air temperature and wind speed. The results are summarised in the table below. The overhead line must be designed so that span lengths are within limits set out in Tables 2, 3 and 4 and 5.

Table 2 Maximum wind span for unstayed poles based on pole strength and foundation strength

Pole Type			Foundation Depth (m)	Maximum wind span based on pole strength (m)	Maximum wind span for unstayed pole based on foundation strength	
Height (m)	Top Diameter (cm)	ESB Material Code			Poor Ground	Average Ground
10	18	1212219	2	109	50	86
11	18	1212260	2.2	119	66	113
11	20	1212262	2.2	153	70	121
11	22	1212263	2.2	190	75	129
12	20	1213315	2.3	165	72	135
13	20	1213363	2.3	166	67	126

The ESB material codes for wood poles are included in Table 2. Technical details for each pole size can be obtained from ESB specification 16196.

Loamy wet soil or loose sandy soil is considered to be poor ground for foundations. Ground consisting of clay or firm gravel provides average or better than average foundations. The wind span is the sum of half the span lengths the pole is supporting, as shown in Fig. 1. The Maximum wind span for poles planted in poor ground can be increased by installation of sleepers and/or side stays.

Table 3 shows the maximum span length to achieve a ground clearance of 7m for a conductor temperature of 15^{o}C. This clearance is achieved for foundation depths indicated in Table 2 and for conductor fixing arrangements as shown in ESB drawings.

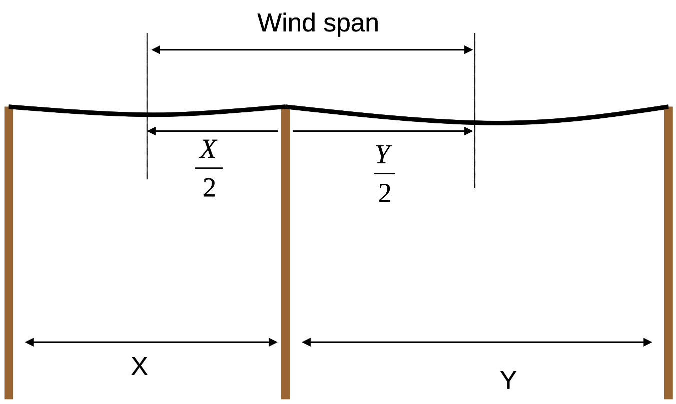


Fig. 1 Definition of Wind Span

Table 3		**Maximum span length to achieve 7m clearance for conductor temperature of 15^{o}C.**					
Pole Height (m)		**Pole duties for the 2 poles supporting the span**					
		Pole 1	**Pole 2**	**Pole 1**	**Pole 2**	**Pole 1**	**Pole 2**
Pole 1	**Pole 2**	**IMP or LAP**	**IMP or LAP**	**IMP or LAP**	**MAP, HAP or EP**	**MAP, HAP or EP**	**MAP, HAP or EP**
10	10	104		96		83	
10	11	113		105		98	
10	12	122		113		107	
11	11	122		115		108	
11	12	131		124		118	
12	12	139		133		127	

Data in Table 3 has been calculated for an equivalent span of 90m.

Clearance requirements are described in detail in section 4. 7m ground clearance for conductor temperature of 15^{o}C is required for overhead lines over fields and open ground. Higher clearance is required over roads and navigable waterways

Maximum span lengths to avoid clashing are included in Table 4.

Table 4 Maximum span lengths to avoid clashing for conductor temperature of 50°C.

	Pole duties for 2 poles supporting the span														
Pole Duty 1:	**IMP**					**LAP**				**MAP**			**HAP**		**EP**
Pole Duty 2:	**IMP**	**LAP**	**MAP**	**HAP**	**EP**	**LAP**	**MAP**	**HAP**	**EP**	**MAP**	**HAP**	**EP**	**HAP**	**EP**	**EP**
Maximum Span (m)	115	114	87	83	91	118	92	87	95	95	91	99	86	94	102

Minimum pole sizes are shown in Table 5.

Table 5 Minimum Pole Sizes categorised by Pole Duty

	Minimum pole top diameters (cm) for poles of height:			
Pole Duty	**10m**	**11m**	**12m**	**13m**
IMP, LAP or MAP	18cm	18cm	20cm	20cm
HAP, EP or BP	-	20cm	20cm	20cm
Pole with equipment	-	22cm	-	-

2.3 Erection Sag Charts

Conductors can be erected in accordance with design requirements by:

- Using a dynamometer to ensure the applied tension is in line with the requirements outlined in Table 6.

or

- Tensioning the conductor until the mid-span sag is in accordance with the erection sag table in Table 7. This data is also plotted in a chart in Fig. 2.

Table 6 Dynamometer Table for erection of 100 mm² ACSR

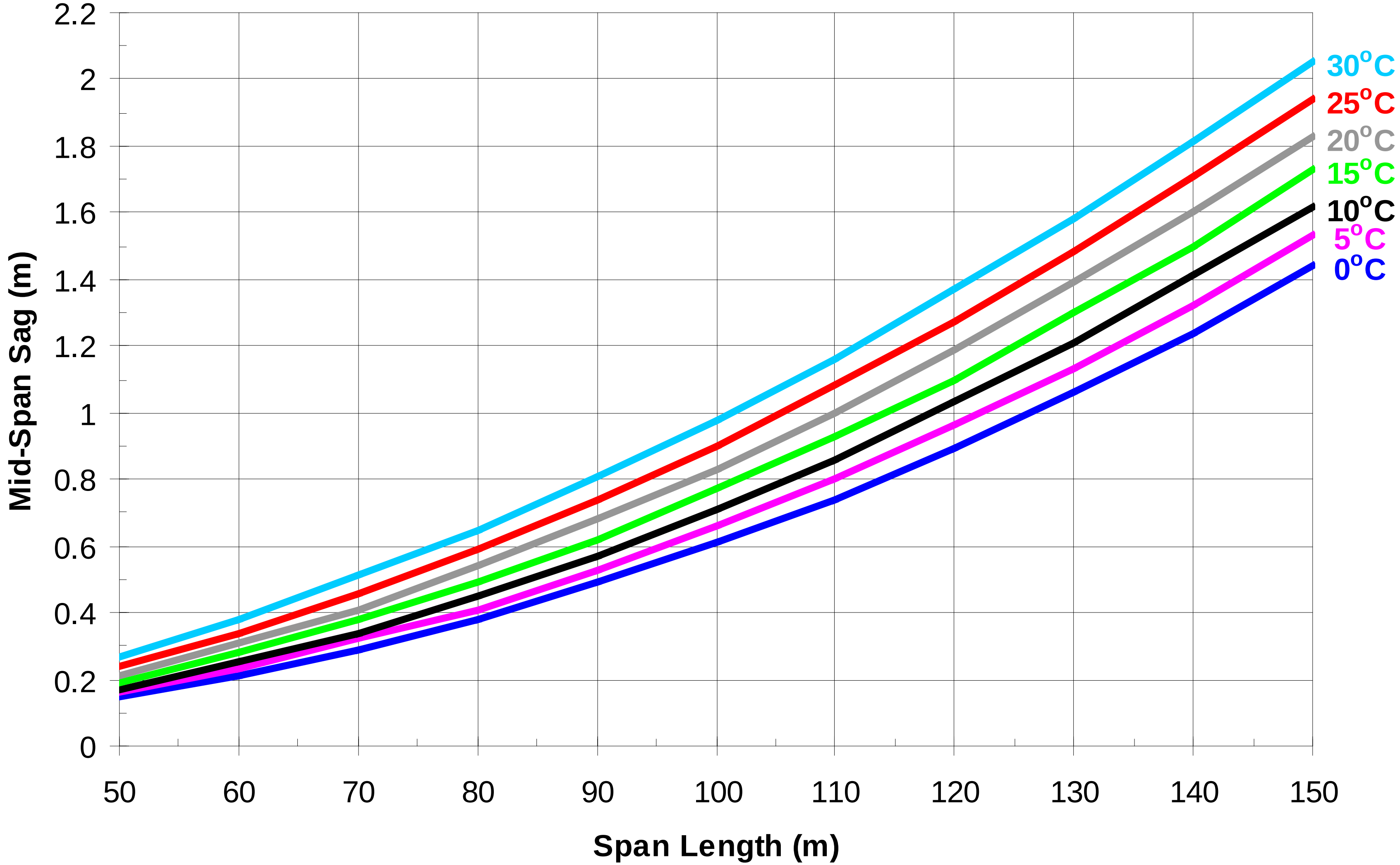
	Conductor temperature					
	0°C	**5°C**	**10°C**	**15°C**	**20°C**	**25°C**
Conductor tension at erection (kN)	6.4	6	5.5	5.1	4.7	4.3

Table 7 Erection Sag Table 100 mm^2 ACSR

	Mid-span sag (m) for conductor at temperature:						
Span Length (m)	**0^{o}C**	**5^{o}C**	**10^{o}C**	**15^{o}C**	**20^{o}C**	**25^{o}C**	**30^{o}C**
50	0.15	0.16	0.17	0.19	0.21	0.24	0.27
60	0.21	0.23	0.25	0.28	0.31	0.34	0.38
70	0.29	0.32	0.34	0.38	0.41	0.46	0.51
80	0.38	0.41	0.45	0.49	0.54	0.59	0.65
90	0.49	0.53	0.57	0.62	0.68	0.74	0.81
100	0.61	0.66	0.71	0.77	0.83	0.90	0.98
110	0.74	0.80	0.86	0.93	1.00	1.08	1.16
120	0.89	0.96	1.03	1.10	1.19	1.27	1.37
130	1.06	1.13	1.21	1.30	1.39	1.48	1.58
140	1.24	1.32	1.41	1.50	1.60	1.71	1.81
150	1.44	1.53	1.62	1.73	1.83	1.94	2.05

The Sag chart for 100 mm^2 ACSR is shown in Fig. 2.

Fig. 2 Erection Sag Chart for 100mm^2 ACSR



3.0 150 mm^2 AAAC

3.1 Conductor Data

The table below lists the main characteristics of 150 mm^2 All Aluminium Alloy Conductor (AAAC), which ESB specify for 3-phase 20kV networks.

Table 8 Conductor Data

Description	Value
Codename	Mulberry
Overall Diameter	15.9 mm
Cross Sectional Area	150.9 mm^2
Stranding / Wire Diameter Aluminium	19 / 3.18 mm
Weight/km	426 kg/km
Ultimate Tensile Strength	42.291 kN
Design tension	12.81 kgf/mm^2
Target span	90m
AC resistance at 65^{o}C	0.245 Ω/km
Shunt susceptance, B	5.9 x 10^{-6} S/km
Series reactance, X	0.33 H/km
Maximum conductor temperature	65^{o}C
Thermal rating for maximum conductor temperature of 65^{o}C at ambient air temperature of 5^{o}C	544 A
Thermal rating for maximum conductor temperature of 65^{o}C at ambient air temperature of 25^{o}C	435 A
Short-circuit rating for initial conductor temperature of 65^{o}C and short-circuit duration of 0.1 seconds	36.0 kA
Short-circuit rating for initial conductor temperature of 65^{o}C and short-circuit duration of 1 seconds	11.4 kA
Short-circuit rating for initial conductor temperature of 65^{o}C and short-circuit duration of 2 seconds	8.0 kA

Technical requirements for this conductor can be found in the latest edition of ESB Specification 16144, titled: “All Aluminium Alloy Overhead Conductor (AAAC) and associated connectors”

3.2 Mechanical Design Details

See Appendix 1 for details on pole duties such as IMP (Intermediate Pole), LAP (Light Angle Pole), etc. Maximum span length is determined by a number of factors including:

- Pole strength
- Foundation strength
- Required ground clearance
- Avoidance of clashing between phases

Maximum span lengths have been calculated for design conditions such as maximum conductor temperature and ambient conditions such as air temperature and wind speed. The results are summarised in the table below. The overhead line must be deigned so that span lengths are within limits set out in Tables 9, 10, 11 and 12.

Table 9 Maximum wind span for unstayed poles based on pole strength and foundation strength

Pole Type			Foundation Depth (m)	Maximum wind span based on pole strength	Maximum wind span for unstayed pole based on foundation strength	
Height (m)	Top Diameter (cm)	ESB Material Code			Poor Ground	Average Ground
10	18	1212219	2	75	76	123
11	18	1212260	2.2	73	93	150
11	20	1212262	2.2	94	102	163
11	22	1212263	2.2	120	109	175
12	20	1213315	2.3	130	122	196
13	20	1213363	2.3	128	112	182
14	20	1213414	2.3	129	102	169

The ESB material codes for wood poles are included in Table 11. These codes can be used to obtain technical details for each pole size can be obtained from ESB specification 16196.

Loamy wet soil or loose sandy soil is considered to be poor ground for foundations. Ground consisting of clay or firm gravel provides average or better than average foundations. The wind span is the sum of half the span lengths the pole is supporting, as shown in Fig. 3. The Maximum wind span for poles planted in poor ground can be increased by installation of sleepers and/or side stays.

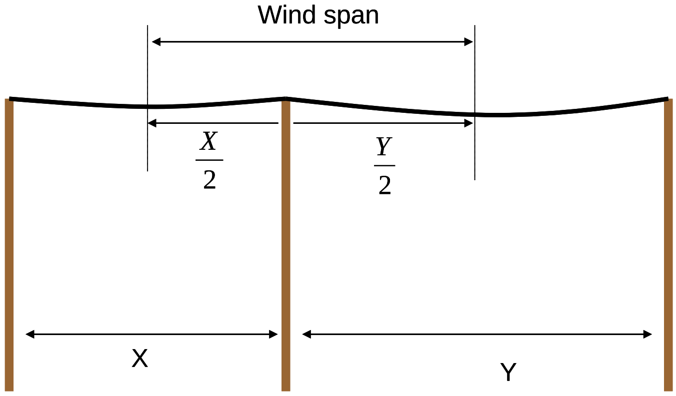


Fig. 3 Definition of Wind Span

Table 10 shows the maximum span length to achieve a ground clearance of 7m for a conductor temperature of 15°C. This clearance is achieved for foundation depths indicated in Table 9 and for conductor fixing arrangements as shown in ESB drawings.

Table 10	**Maximum span length to achieve 7m clearance for conductor temperature of 15°C.**						
Pole Height (m)		**Pole duties for the 2 poles supporting the span**					
		Pole 1	**Pole 2**	**Pole 1**	**Pole 2**	**Pole 1**	**Pole 2**
Pole 1	**Pole 2**	**IMP or LAP**	**IMP or LAP**	**IMP or LAP**	**MAP, HAP or EP**	**MAP, HAP or EP**	**MAP, HAP or EP**
10	10	107		100		94	
10	11	116		113		107	
11	11	124		119		114	
11	12	133		128		123	
12	12	142		137		132	
12	13	150		146		141	
13	13	159		154		150	
13	14	167		163		158	
14	14	174		170		166	

Data in Table 10 has been calculated for an equivalent span of 90m.

Clearance requirements are described in detail in section 4. 7m ground clearance for conductor temperature of 15°C is required for overhead lines over fields and open ground. Higher clearance is required over roads and navigable waterways

Maximum span lengths to avoid clashing are included in Table 11.

Table 11 Maximum span lengths to avoid clashing for conductor temperature of 40°C.

	Pole duties for 2 poles supporting the span														
Pole Duty 1:	**IMP**					**LAP**				**MAP**			**HAP**		**EP**
Pole Duty 2:	**IMP**	**LAP**	**MAP**	**HAP**	**EP**	**LAP**	**MAP**	**HAP**	**EP**	**MAP**	**HAP**	**EP**	**HAP**	**EP**	**EP**
Maximum Span (m)	128	127	99	94	102	126	98	93	102	101	97	105	92	100	109

Minimum pole sizes are shown in Table 12.

Table 12 Minimum Pole Sizes categorised by Pole Duty

	Minimum pole top diameters (cm) for poles of height:			
Pole Duty	**10m**	**11m**	**12m**	**13m**
IMP	18cm	18cm	20cm	20cm
LAP	-	20cm	20cm	20cm
HAP, EP, DEP or pole with equipment	-	22cm	-	-

3.3 Erection Sag Charts

Conductors can be erected in accordance with design requirements by:

- Using a dynamometer to ensure the applied tension is in line with the requirements outlined in Table 13.

or

- Tensioning the conductor until the mid-span sag is in accordance with the erection sag table in Table 14. This data is also plotted in a chart in Fig. 4.

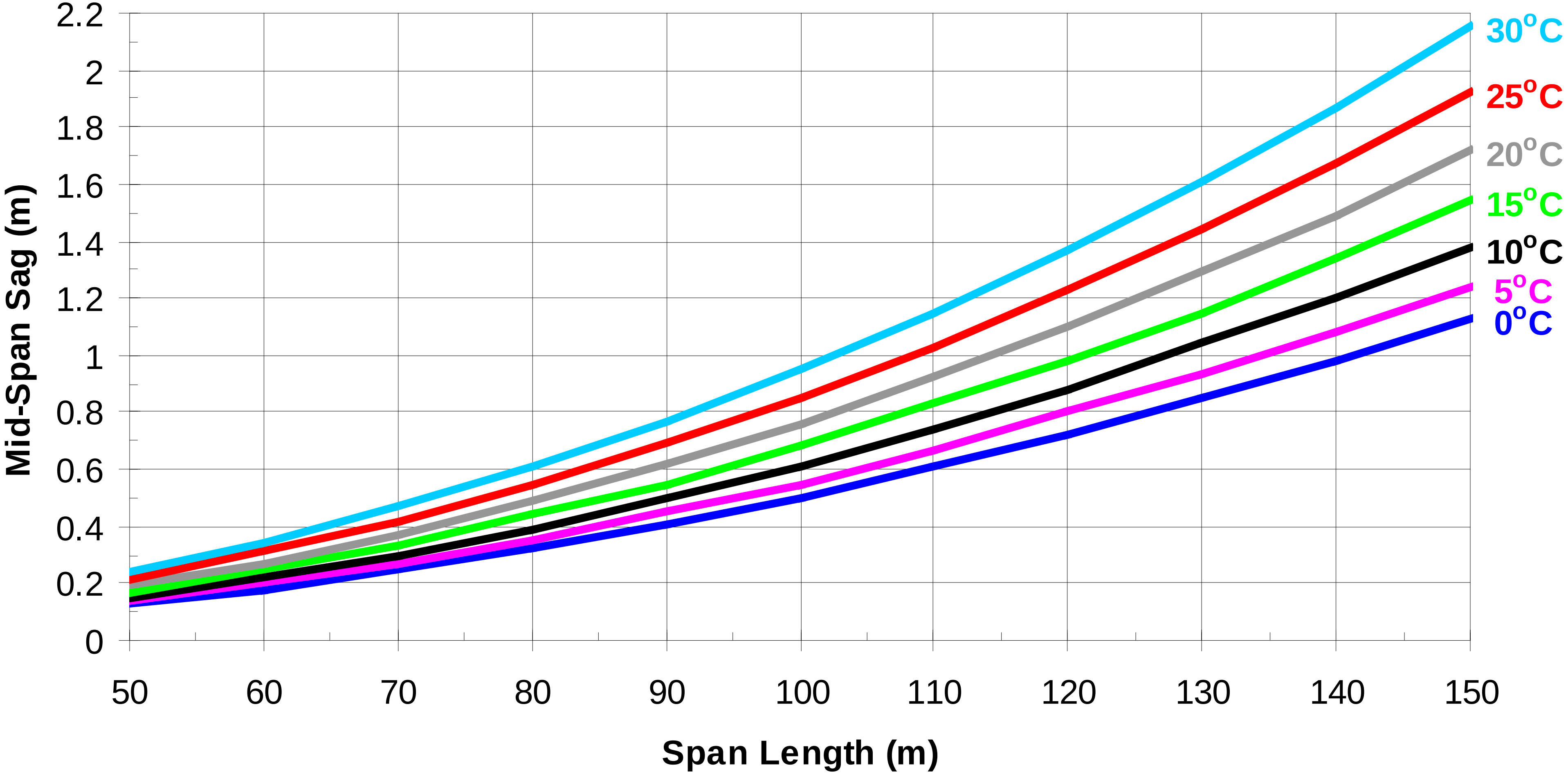
Table 13	Dynamometer Table for erection of 150 mm^2 AAAC					
	Conductor temperature					
	0°C	5°C	10°C	15°C	20°C	25°C
Conductor tension at erection (kN)	10.3	9.4	8.5	7.6	6.8	6.1

The erection sag chart for 150 mm2 AAAC is shown in Table 14.

Table 14	Erection Sag Table 150 mm^2 AAAC						
	Mid-span sag (m) for conductor at temperature:						
Span Length (m)	**0°C**	**5°C**	**10°C**	**15°C**	**20°C**	**25°C**	**30°C**
50	0.13	0.14	0.15	0.17	0.19	0.21	0.24
60	0.18	0.20	0.22	0.25	0.27	0.31	0.34
70	0.25	0.27	0.30	0.33	0.37	0.42	0.47
80	0.32	0.35	0.39	0.44	0.49	0.55	0.61
90	0.41	0.45	0.50	0.55	0.62	0.69	0.77
100	0.50	0.55	0.61	0.68	0.76	0.85	0.95
110	0.61	0.67	0.74	0.83	0.92	1.03	1.15
120	0.72	0.80	0.88	0.98	1.10	1.23	1.37
130	0.85	0.93	1.04	1.15	1.29	1.44	1.61
140	0.98	1.08	1.20	1.34	1.49	1.67	1.87
150	1.13	1.24	1.38	1.54	1.72	1.92	2.15

The Sag chart for 150 mm^2 AAAC is shown in Fig. 4.

Fig.4 Erection Sag Chart for 150mm^2 AAAC



4.0 Clearances

4.1 Clearances Within the Span

Phase spacing at IMP and LAP cross-arms shall be at least 0.807m.

Phase spacing at cross-arms supporting tension insulators shall be at least 1.02m on 3-phase network.

All unearthed pole-top steelwork shall be at least 5.2m above ground.

Phase to earth clearance shall be at least 0.22m at cross-arm fixings.

4.2 Vertical Ground Clearance

Table 15 shows minimum vertical ground clearance to be achieved at erection with a conductor temperature or 15°C.

Table 15 Vertical Ground Clearance Required for new Construction with conductor temperature of 15°C

Item	Terrain	Clearance - metres	Comments
1	Fields	7	
2	Roads	7.5	Position pole close to road so that road crossing occurs within the first 15m of the span.
3	Canals	7.5	Position pole close to canal bank so that canal crossing occurs in the first 15m of the span. Avoid subsidence zone.
4	Railways – not electrified	7.5	Position pole so that: • At least 1.5 times its installed height separates it from the railway line • Railway crossing occurs within first 15m of the span

Table 15 (contd.) Vertical Ground Clearance Required for new Construction with conductor temperature of 15°C

Item	Terrain	Clearance - metres	Comments
5	River Shannon	Varies	See ESB standard titled: "Waterway crossing standard for LV & 10\20\38kV overhead lines". This standard specifies clearance required and outlines other requirements such as fixing of warning signs and game-guards, obtaining a foreshore license, recording the crossing and notifying users of the waterway. See Appendix 4 for further details.
6	Other navigable rivers and designated water ways	Varies	
7	Waterways not designated as navigable	7.5	This clearance applies to highest water level. Contact Waterways Ireland to find out designation of a specific waterway.
8	Bord Na Móna Railways	≥ 8.5	There must be 2m clearance above the highest load carried on the railway.
9	Bord Na Móna Machinery Routes	Height of machine + 2m	Ground clearance is 2m higher than tallest machine using the route. Ground clearance must be at least 6.5m.

See Appendix 3 for design details on crossings and conflicts

An overhead line shall not be erected over sportsfields for rugby, GAA or other sports where tall goalposts and screens may be installed.

5.0 Electrical Design

5.1 Earths

Earths are only required where pole-mounted equipment such as reclosers, triple-pole switches, voltage regulators, auto-sectionalisers or surge arresters have been installed. Earths installed for such equipment shall have a resistance to earth not exceeding 20Ω. $25mm^2$ bare copper conductor shall be used as the earth conductor.

5.2 Switching Points

ESB Networks will specify switching points and switching duties required on the network being built.

5.3 Surge Arresters

Surge arresters shall be installed to provide lightning protection for any reclosers, triple-pole switches, voltage regulators, auto-sectionalisers, or pole-top cable terminations installed on the network being built.

5.4 Voltage Regulator

ESB Networks will specify if a voltage regulator installation is required. A voltage regulator installation consists of two 1-phase regulators installed open delta, or three 1-phase regulators installed close delta. The installation requires by-pass switches to be installed on a pole on the backbone line. The by-pass switches feed the voltage regulators, which are installed on a wood pole portal structure close to the backbone line. A suite of construction drawings (ESB Reference: PG567-D021-312-012) are available

5.5 Auto-Sectionaliser

ESB will specify if any sectionalsiers are required. The sectionaliser is a remotely controlled 3-phase load-break fault-make switch that can be installed on a pole on the backbone line. Construction drawing (ESB Reference: PG567-D021-207-001-000) is available.

5.6 Triple-Pole Switch

ESB will specify if any triple-pole switches are required. The triple-pole switch is a manually operated 3-phase load-break fault-make switch that can be installed on a pole on the backbone line. Construction drawing (ESB Reference: PG567-D021-206-001-000) is available.

5.7 Recloser

ESB will specify is any reclosers are required. The recloser is a 3-phase fault-make fault-break circuit-breaker that can provide fault protection and can also be remotely controlled. The recloser is mounted on a pole on the back-bone line. Construction drawing (ESB Reference: PG567-D021-104-002-000) is available.

6.0 Pole numbering, Danger Notices, Bird Diverters and Network Records

6.1 Pole Numbering

Poles shall be numbered sequentially. The pole closest to the ESB HV station shall have the lowest number. Check with ESB for number to be applied to the first pole. Pole numbers shall be stamped onto an aluminium plate and fixed to each pole.

6.2 Danger Notices

Danger notices shall be fixed to every pole. See Appendix 6 for details of danger notices.

6.3 Bird Diverters

Bird diverters shall be installed on overhead lines at waterway crossings and where overhead network crosses recognised bird flight corridors. Bird diverters must be in accordance with ESB Specification16979.

6.4 Network Records

As-built record of the line must be returned to the ESB Networks Project Liaison at the time of commissioning. A line may not be switched in if the as-built records are not in order. The record should include the following:

* Detailed OSI (Ordnance Survey Ireland) map showing structure locations. Pole numbers on the map must correspond with numbers physically attached to each pole.

* Map must be of scale 1:1000, 1:2500 or 1:5000.

* The map shall include the following detail:

    - Conductor type
    - Pole numbers and pole type installed
    - Details on any switching points
    - Arrester installations
    - Fuse installations, if any
    - Earths installed
    - Any other electrical equipment installed on the overhead line
    - Network passing through forests where easements have been purchased
    - Waterway crossings where license has been obtained from Waterways Ireland

Appendix 1: Pole Duties

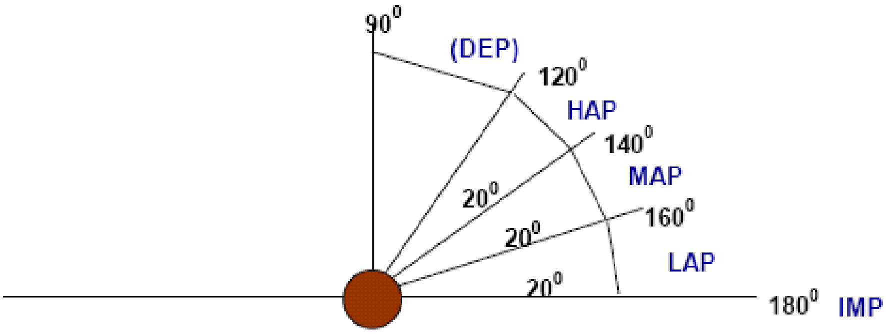


Fig. 5 Pole duties – determined by the enclosed angle

Pole duties are determined by angle of deviation as shown in Fig. 5. Details are included in Table 16.

Table 16 Information of Pole Duties

<table>
<tr><th colspan="2">Pole Duty</th><th>Enclosed Angle</th><th>Cross-arm</th><th>Insulators</th><th>Conductor</th></tr>
<tr><td>DEP</td><td>Double-End Pole</td><td>90^{o} to 120^{o}</td><td>2 EP cross-arms required</td><td rowspan="4">Tension Insulators</td><td rowspan="3">Conductors must be terminated</td></tr>
<tr><td>HAP</td><td>Heavy Angle Pole</td><td>120^{o} to 140^{o}</td><td rowspan="2">Single cross-arm bisecting the angle</td></tr>
<tr><td>MAP</td><td>Medium Angle Pole</td><td>140^{o} to 160^{o}</td></tr>
<tr><td>EP</td><td>End Pole</td><td>-</td><td>Single cross-arm</td><td>1 overhead span terminated at this pole</td></tr>
<tr><td>LAP</td><td>Light Angle Pole</td><td>160^{o} to 180^{o}</td><td>Single IMP cross-arm bisecting the angle</td><td rowspan="2">Pin insulators</td><td rowspan="2">Conductors run through</td></tr>
<tr><td>IMP</td><td>Intermediate Pole</td><td>180^{o}</td><td>Single cross-arm</td></tr>
</table>

Appendix 2: Staying Requirements

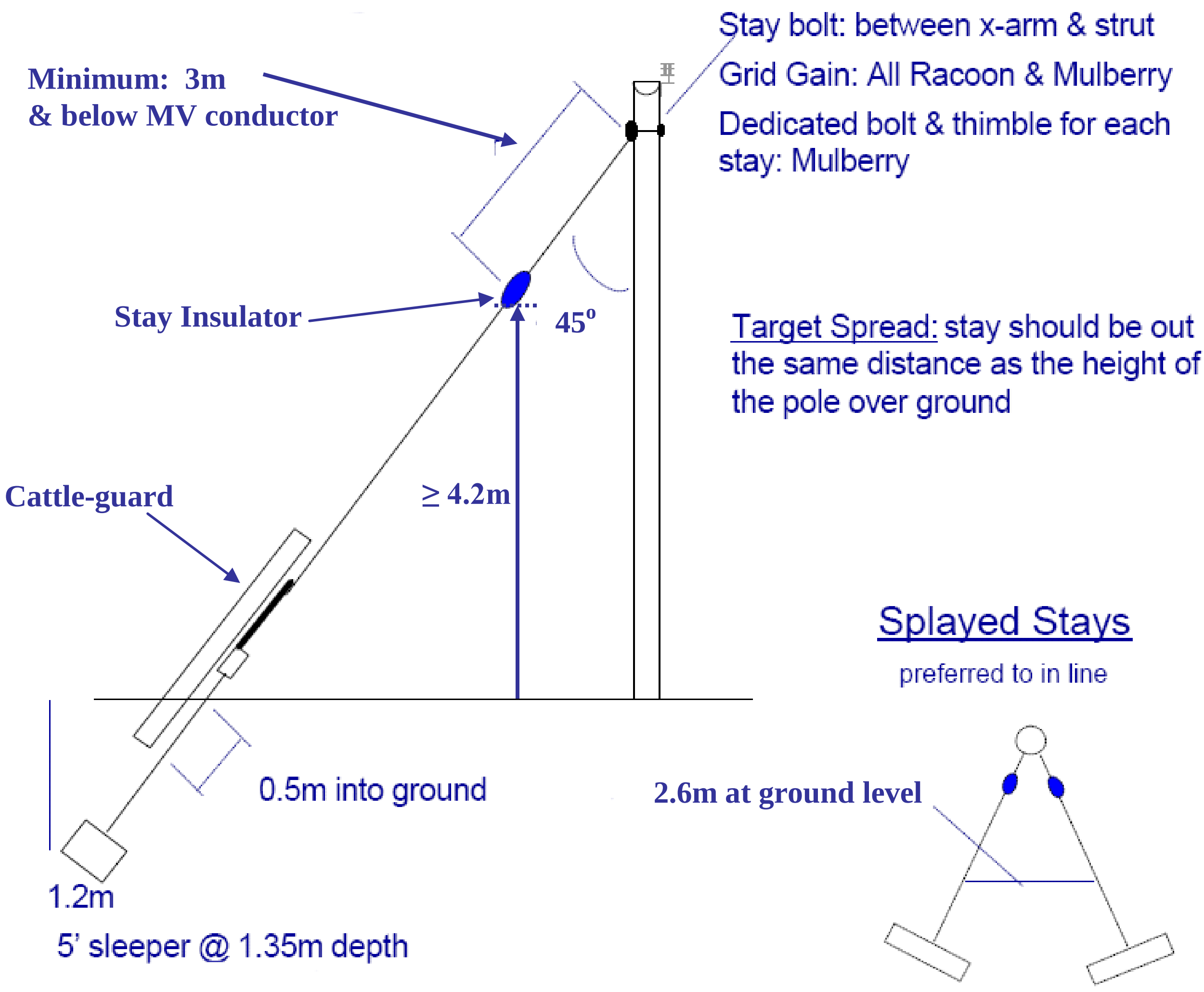


Fig. 6 Design Standards for stays

Stays are required for supporting:

- Angle poles
- Poles where the conductor has changed
- Poles with significant pole-top equipment
- Poles in poor foundations

Number of stays required depends on the pole duty and the conductor installed. See Table 17 for details.

Table 17 **Stay requirements for Racoon and Mulberry 20kV Overhead Lines**		
Pole Duty	**Stays Required for Conductor Type:**	
	Racoon	**Mulberry**
LAP	1	1
MAP	1	2
HAP	2	2
EP	2	2
DEP	3	3

The standard stay is designed for loading of up to 6.5 tonnes. Table 17 lists stay requirements for standard stays. There is a design available for a 13 tonne stay which can replace 2 standard stays.

Appendix 3: Crossings and Conflicts

There are design rules for a 20kV line crossing:

- Another overhead power line
- An overhead phone line
- An electrified railway

There are also design rules for conflicts with:

- Buildings
- Wind turbines
- Public lighting columns
- Footbridges
- Vegetation

A3.1 Crossings

Table 18 Crossings for erection of conductor at 15°C

Crossing	Vertical Separation (m)	Comments
Phone line	3	Phone line: • Must be insulated • Must pass underneath the 20kV line See section A3.3 for further details
LV line	2	
MV Line	2	
38kV line	> 3m	Request advice from ESB for each crossing
110kV line or higher voltage	Individually assessed	Complete BX254 form and send to ESBI Conflicts section (HVConflictSolutions@esb.ie)
Electrified railway	3.2	
Wall	3	

A3.2 Conflicts

Table 19 Horizontal clearances for crossings

Crossing	Horizontal Clearance (m)	Comments
Wind turbine	Height of installed turbine + 20m	Turbine height includes blade at highest point of its arc
Building	1m + height of pole	Network should be designed to meet this clearance. However, if this clearance is not possible to achieve, absolute minimum horizontal clearance is 6m. See section A3.5
Public lighting columns	1m + height of public lighting column or the 20kV pole – whichever if the taller	Network should be designed to meet this clearance. However, if this clearance is not possible to achieve, clearance can be reduced if the line is constructed in accordance with the special requirements outlined in section A3.6
Footbridges	1m + height of pole	Green PVC conductor must be installed on span in close proximity to the footbridge
Vegetation	4m radius	See section A3.7 for further details

A3.3 Phone Lines

A3.3.1 Crossings

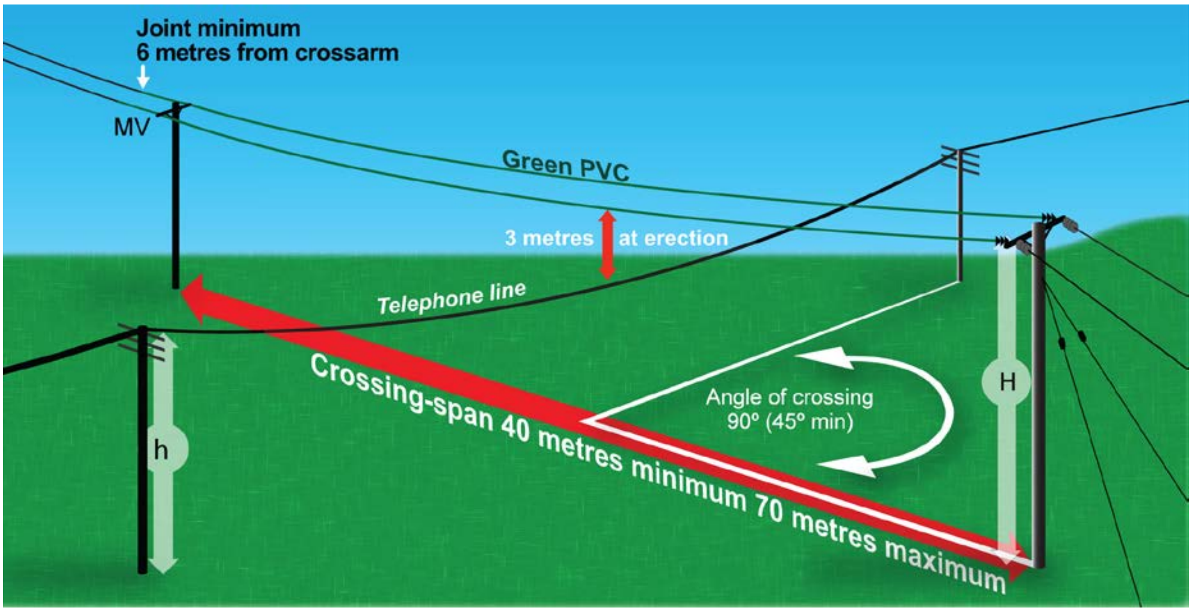


Fig. 7 20kV line crossing a phone line

Basic requirements for a 20kV line crossing a phone line are:

- Span length must be in the range 40m to 70m
- Poles can be any duty, but must be one size heavier than required for standard design
- Vertical separation between the phone line and the 20kV line must be at least 3m
- The 20kV line must be above the phone line
- Phone line must be insulated
- Use green PVC conductor for the crossing span in the 20kV line
- Crossing angle must be at least 45^{o}, and preferably 90^{o}.
- There must be no joints in the crossing span
- Bare 20kV conductors must be at least falling distance from the phone line, which is defined as greater of:
    - H+1, where H = height of 20kV pole
    - 1.5*h, where h = height of pole on phone line
- Stays must be installed on 20kV poles within falling distance of the phone line. There must be at least 3m horizontal clearance between 20kV poles and poles on the phone line. Regard 20kV pole stay above the insulator as part of the live network when calculating this clearance.

A3.3.2 Approaches

There are also restrictions for 20kV lines approaching (but not crossing) within 25m of a phone line. These restrictions are:

- 20kV network cannot be within 5m of a phone line. Regard 20kV pole stay above the insulator as part of the live network when calculating this clearance. The stay insulator must be at least 4.2m above ground
- For 20kV network within the falling distance but more than 5m from the phone line:
    - Stay all poles away from the phone line
- For 20kV network within 25m of the phone line but outside the falling distance:
    - Green PVC conductor must be used and terminations insulated if the phone line is uninsulated. This requirement does not apply if the phone line is insulated.

A3.3.3 Parallel Runs

Under fault conditions, 20kV overhead lines may induce over-voltages in phone lines running parallel to the overhead network. Calculation below shows limits for 20kV network with earth fault currents of up to 500A.

Table 20 Maximum Parallel run between 20kV overhead line and phone line

Separation (m)	15m	30m	60m	100m	200m
Length of Run (m)	2,200m	3,100m	3,400m	4,000m	4,800m

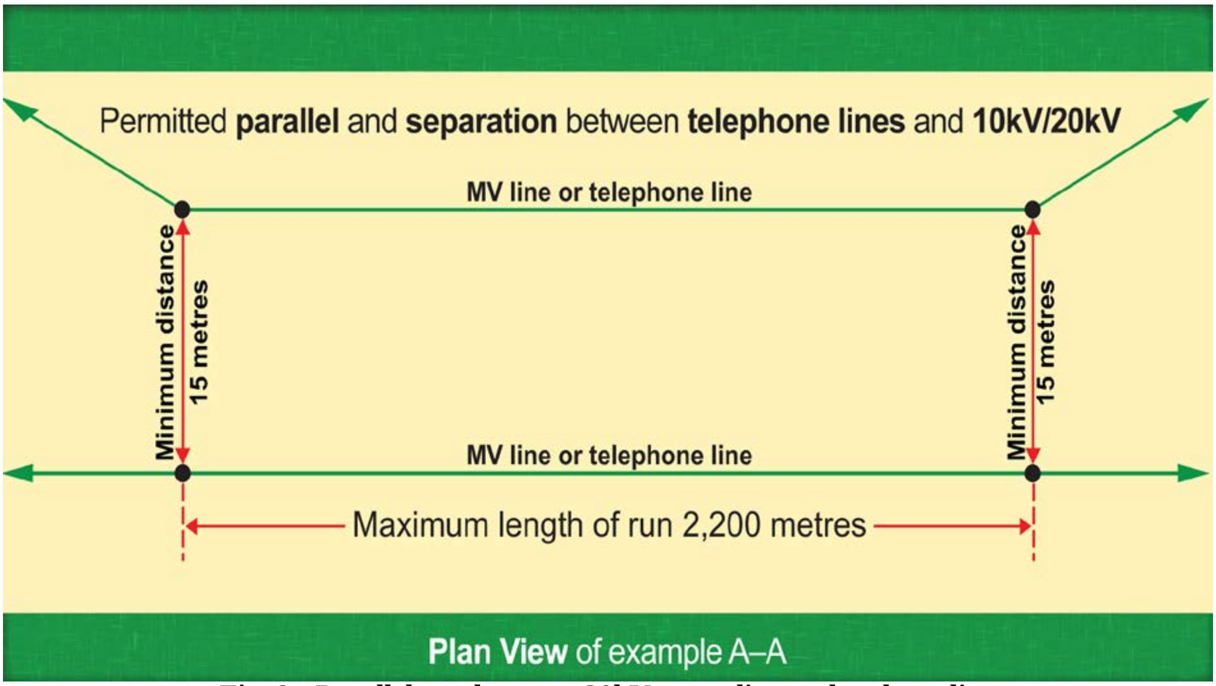


Fig. 8 Parallel run between 20kVpower line and a phone line

A3.3.4 Earth Separation

Earthing on the phone line must be separated from power earths installed for equipment on the 20kV network. Separation distance in Table 21 applies to point nearest approach between the two earthing systems.

Table 21 Minimum separation between 20kV earths and phone line earths

	Separation from phone line earths	
20kV earth	**Normal Soil**	**Rocky Soil**
0 – 20Ω	10m	15m

A3.4 Overhead Power Line

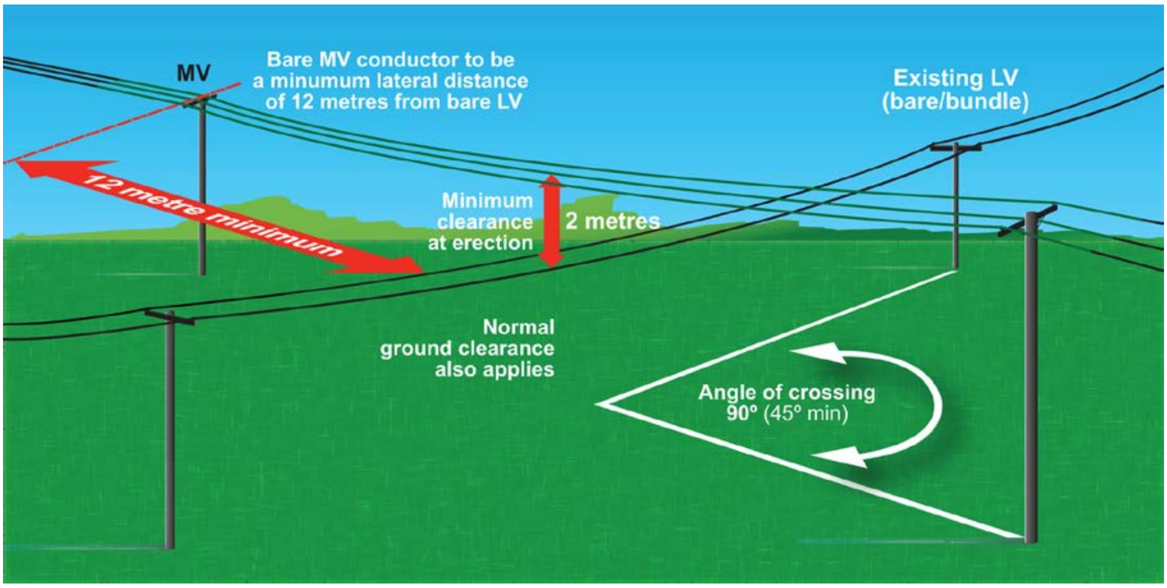


Fig. 9 MV power line crossing an LV power line

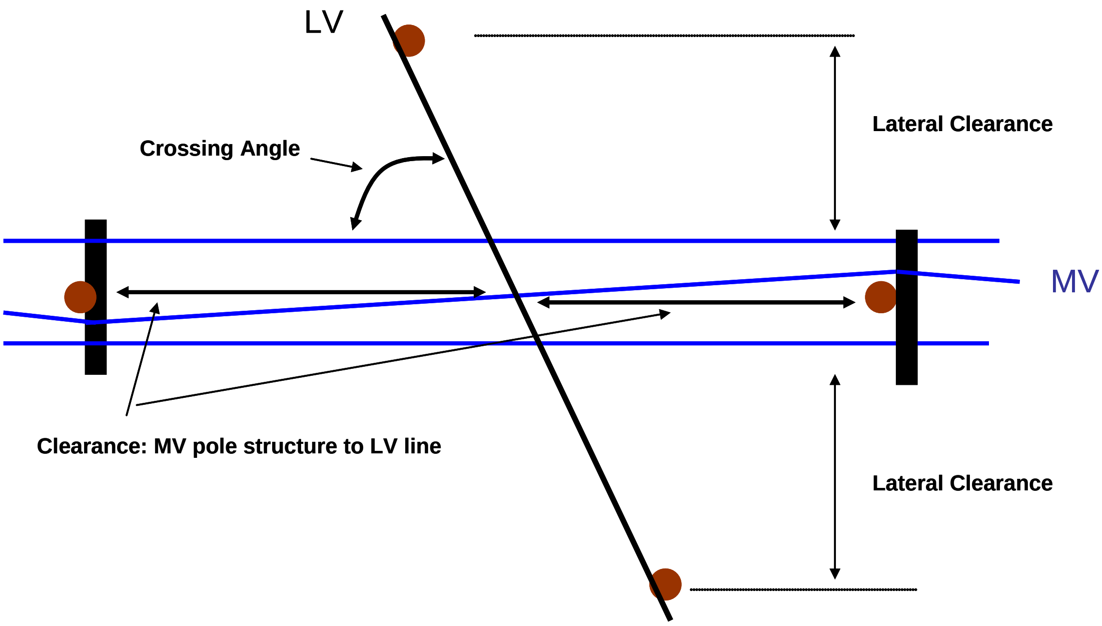


Fig. 10 Plan view of 20kV line crossing an LV line

Fig. 9 shows sketch of 20kV line crossing an LV line. This crossing is shown in plan view in Fig. 10 where terminology describing is defined, including crossing angle, lateral clearance and clearance of the 20kV pole to the LV line. This terminology also applies for a 20kV line crossing a second line operating at 20kV or above.

Requirements for a 20kV line crossing an LV line include:

- 20kV line must be above the LV line and must have vertical separation of at least 2m when erected with a conductor temperature of 15^{o}C.
- Crossing should take place within in the first 20% of both spans
- Bare MV conductors must be at least 12m from bare LV conductors
- If the LV conductor is bare, then green PVC conductor must be installed in the crossing 20kV span. Green PVC conductor is not essential if the LV conductor is insulated. However, it is preferred.

Table 22 New Construction requirements for 20kV line crossing a second power line operating at LV, MV, 38kV, 110kV, 220kV or 400kV

20kV Line Crossing:	Minimum Crossing Angle	Minimum Lateral Clearance	Minimum Horizontal Clearance between 20kV line & Structures of second line	Minimum Vertical Separation between 20kV conductors and conductors of second line	Fill out BX254 Form?	Send BX254 form to
LV	45^{o}	3m	5m	2m	No	
MV		3m	5m		No	-
38kV	30^{o}	5m	9m	Individually assessed	Yes	38kV Design, Network Projects
110kV		15m	10m	Individually assessed	Yes	Conflicts & Arbitrations Section, ESBI
220kV or 400kV	Individually assessed				Yes	Conflicts & Arbitrations Section, ESBI

For 20kV network crossing a 10kV or 20kV line:

- Circuits must not share the same pole
- Crossing must occur with first 20% of both spans
- The second line must be below the 20kV network if it is operating at 10kV

If the 20kV network is crossing a power line operating at 38kV or above, the 20kV line must be below the higher voltage line.

Crossings of 38kV networks and above must be individually assessed. It is necessary to enter details of the crossing into form and send it to:

- 38kV Design, ESB Networks for 38kV crossings. (Your local ESB contact shall be able to advise you)
- Conflicts & Arbitrations Section in ESBI for crossings of 110kV and above. Details can be emailed to: HVConflictSolutions@esb.ie.

Copies of the BX254 form can be obtained from ESB Networks.

A3.5 Building Conflict

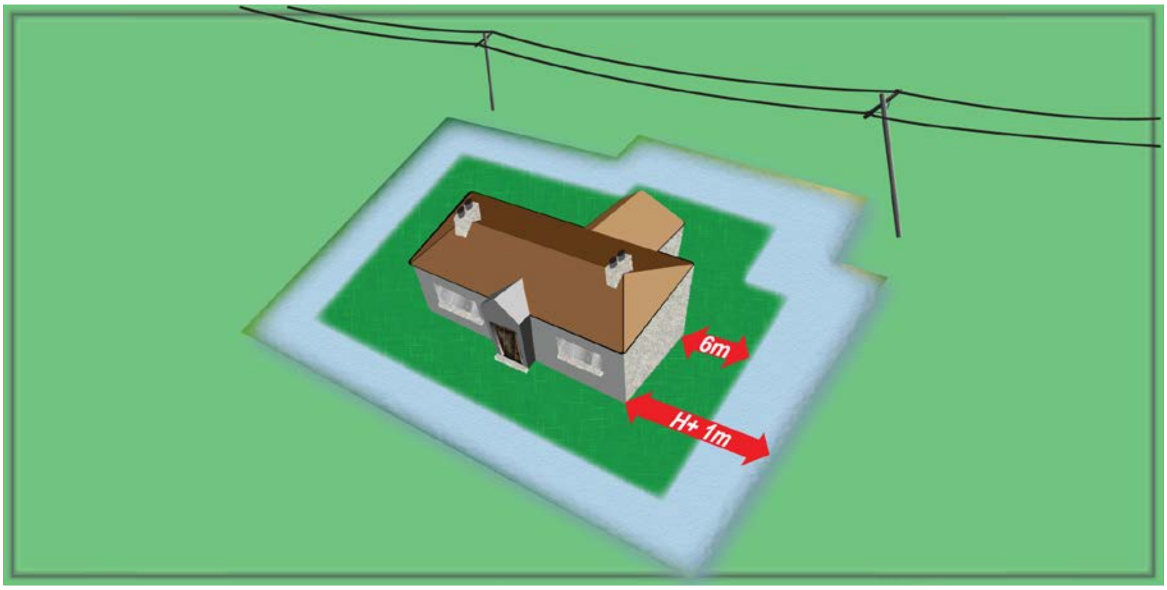


Fig. 11 Clearance of 20kV from buildings

If at all possible, horizontal clearance between a 20kV line and building must be at least height of pole + 1m. However, in exceptional circumstances, where this clearance cannot be achieved, the absolute minimum horizontal clearance is 6m.

Definition of buildings for this standard includes:

- Dwellings, offices and institutions
- Warehouses, factories, churches and public buildings
- Farmyard buildings, oil tanks and silos
- Fixed caravans, mobile homes and site offices
- Scaffolding during construction
- TV aerials antennae and advertising signs
- Metal roofed hay barns

A3.6 Public Lighting Conflicts

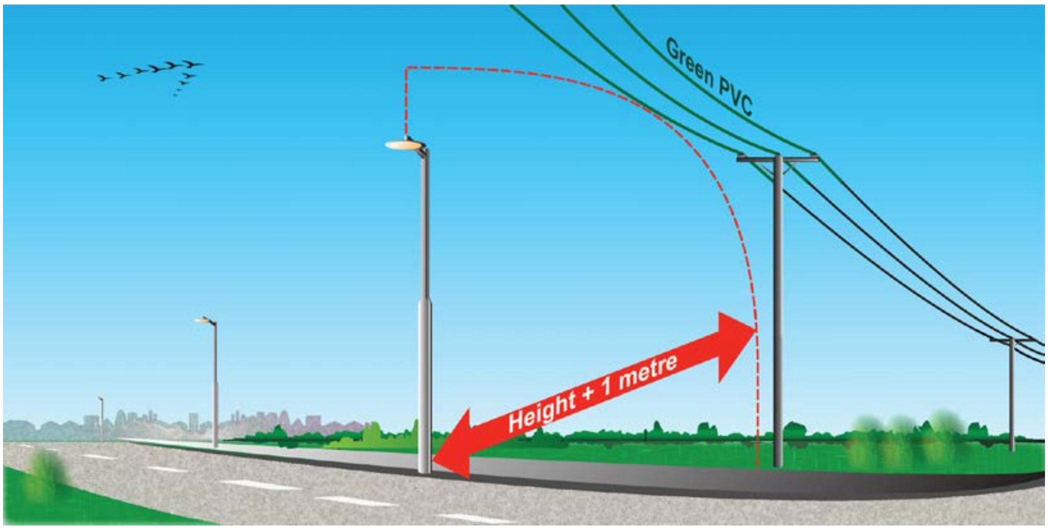


Fig. 12 Clearance between 20kV lines and public lighting columns

If at all possible, 20kV lines should be erected outside of the falling zone of public lighting columns.

Falling zone is defined as the greater of:

- Height of 20kV pole + 1m
- Height of public lighting column + 1m

If this clearance cannot be achieved, absolute minimum horizontal clearance between the 20kV line and the public lighting column is 5m.

If the 20kV line is within the falling zone, green PVC conductor must be installed for the 20kV span in close proximity to the public lighting column.

A3.7 Vegetation

The following clearances must be achieved from trees and hedges:

- There must be no overhanging branches over the 20kV line
- There must be a radial clearance of at least 4m from trees and hedges
- Remove trees in poor condition that are within falling distance of the 20kV line
- Clear vegetation at switching points to allow safe access and operation
- 20kV line crossing through a forest requires a 20m tree-exclusion corridor.

Appendix 4 Waterway Crossings

Line crossings of waterways are not confined to lines that actually cross over from one side to the other of a waterway. They also include lines that exist above a waterway but do not actually cross over. Such lines may pass over a bend or a bulge in an irregular shaped shore-line.

Designated Waterways include:

- All of the tidal shoreline of Ireland up to the high water mark.
- Rivers and inlets as set out in the Dept of Communications, Marine and Natural Resources list of 1995.

Specified inland waterways are those waterways managed by Waterways Ireland:

- The river Shannon and its Maigue, Fergus, Owenogarney tributaries.
- The Erne Waterway
- The Barrow Waterway
- The Grand and Royal canals
- The Corrib river and lake (separate trustees).

See website www.waterwaysireland.org. Crossing of a specified inland waterway manged by Waterways Ireland requires a license issued by Waterways Ireland.

Waterway crossing should be avoided if at all possible. If waterway crossing of a designated or specified waterway is essential, procedure is as follows:

- Minimum vertical clearance as shown in Table 23
- Installation of covered conductor – such as green PVC conductor - for the crossing span
- Provision of warning notices visible 100m from the 20kV line for sailors in mid-channel; of the waterway. This may sometimes require the signs to be erected on supports independent of the crossing poles themselves
- Installation of bird diverters on the crossing span, which will also improve line visibility for sailors
- Report waterway crossing to the UK Hydro-graphic Office. They will update the Admiralty charts/maps. In this way, the charts used by navigators will give them advance notice of line crossing locations.
- Report the location and vertical clearance of each crossing to all interested parties, such as the Department of the Marine, Port Authorities, sailing clubs, etc.

See ESB document titled: “Waterway Crossing Standard for LV & 10/20/38kVOverhead Lines” (ESB reference: DTIS-280705-BQD) for further

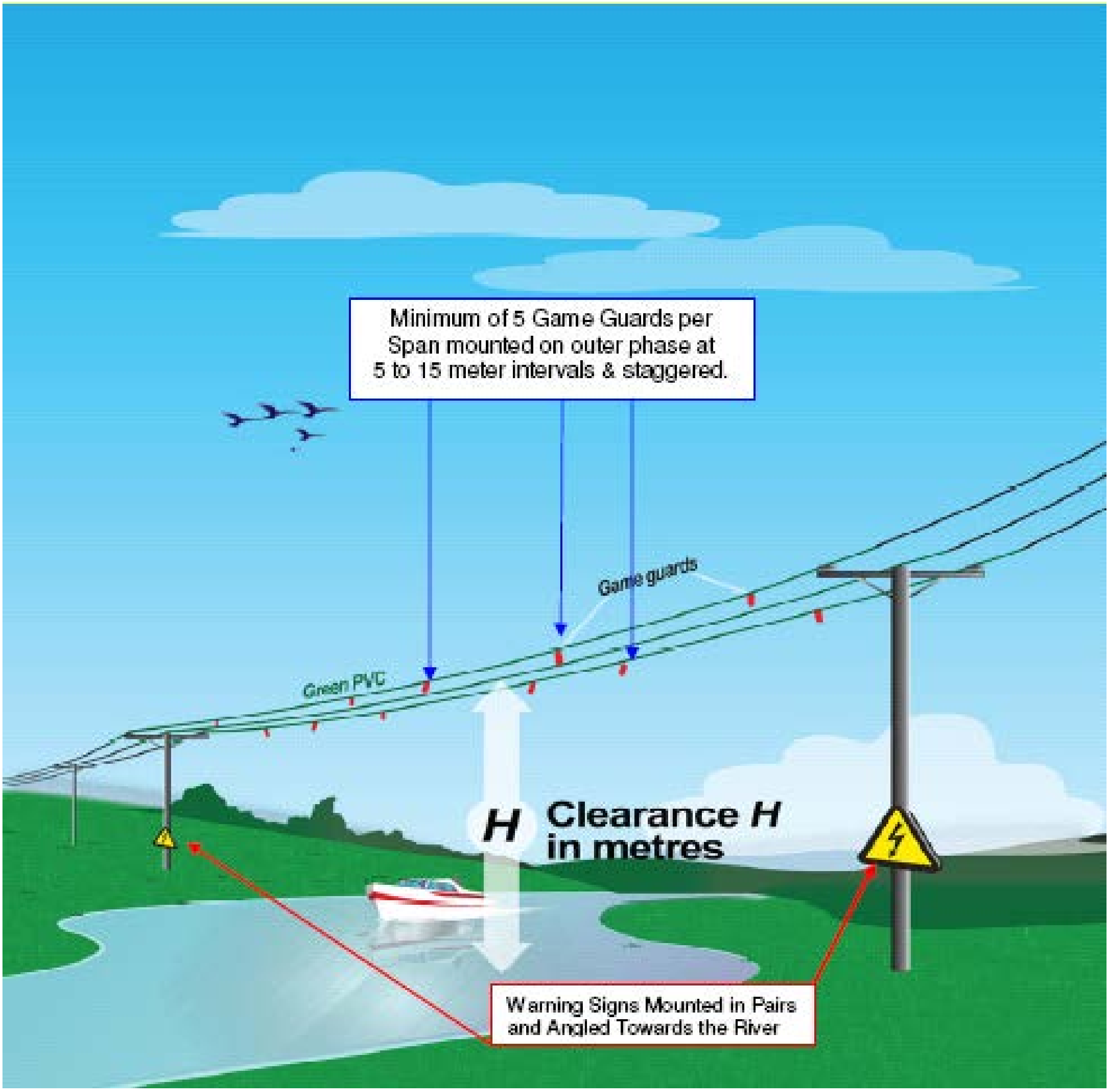


Fig. 13 Waterway crossing

details.

Table 23 Vertical clearance above high water level for conductor erected at 15°C

Risk Category	Description	Vertical Clearance (m)
High	Crossings assessed to be at risk of inadvertent contact due to leisure sailing activities, etc.	11.6
	Crossings over the river Shannon are as agreed with the appropriate authorities	13.1
	Crossings of individually specified known navigable routes or seaways with higher risk of contact where the clearance required "G" has been advised by the Minister or other appropriate authority	G+1.5
Medium	Crossings assessed to have low risk of contact due to navigation.	7.5
Low	Crossings assessed to have no risk of contact due to navigation.	7

Appendix 5 Danger Notices

There are new mandatory requirements for the shape and designed of danger notices used on ESB networks since 1st November 2007 when the Safety Health and Welfare at Work regulations (2007) came into force.

These regulations stipulate that danger notices must comply with EU standards. Safety signs must use a combination of shape, colour and symbol or pictogram to maiximise likelihood of person understanding its meaning regardless of their literacy or language ability. Text must not be included in the sign, but can be included in a supplementray sign which can be displayed in a addition to the safety sign. In Gaeltacht areas, text in acompanying signs must be in Irish.

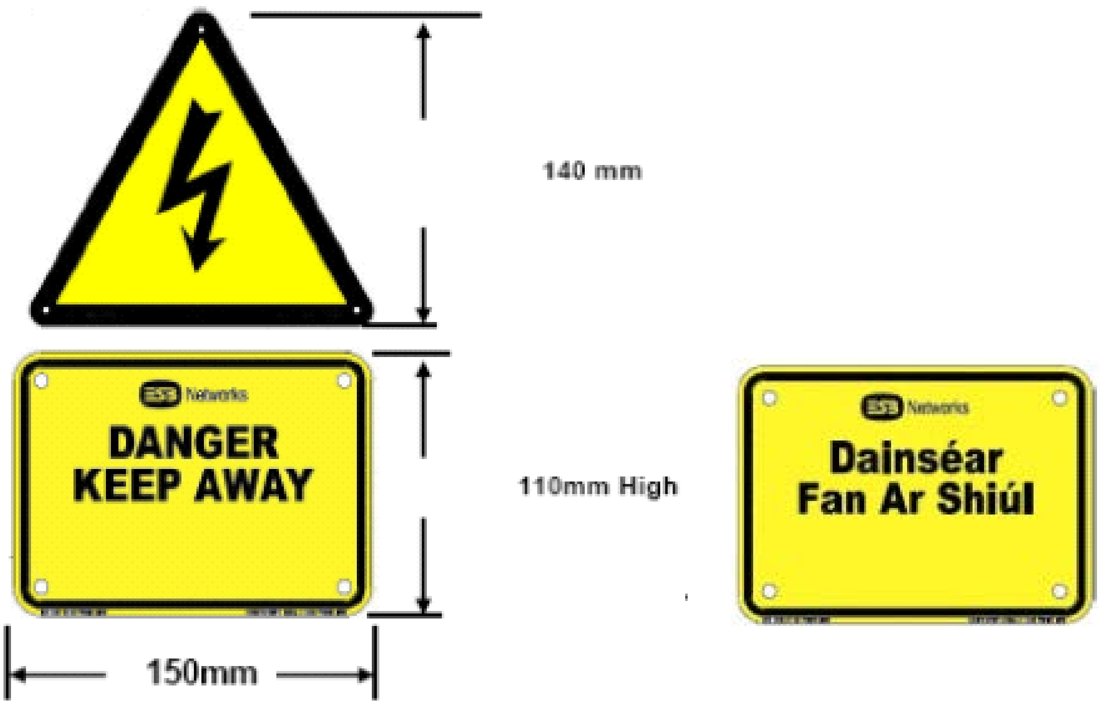


Fig. 14 ESB Danger signs complying with new regulations

ESB specification 16163 outlines requirements for ESB danger notices.

Appendix 6 List of Material Specifications

All materials used by builders of contestably built lines must be in accordance with the relevant ESB Specification. In many cases a single specification will reference numerous other ESB specifications and international standards. It is the responsibility of the builder to ensure that the materials sourced by them are in compliance with all these specifications / standards.

ESB Networks ensures that the materials procured are of a high quality and are in full compliance with our specifications. A similar standard of quality will be expected from builders of contestably built lines. Builders will be required to keep records of type testing, sample testing, quality assurance, health & safety and environmental data as set out in ESB specifications.

ESB Networks can not supply materials to builders of contestably built lines. The builder must source these materials directly.

In the event of materials being sourced from another supplier, ESB inspectors will wish to satisfy themselves of the suitability of the alternative sources and materials including material type testing and assessment of the quality assurance regime in operation at the manufacturing plant. This will involve visits to manufacturing/testing locations and conducting inspection/tests on delivered consignments.

A list of materials specifications associated with 20kV lines is set out in the following page.

Item	Material Description	ESB Specification
1	Stranded Galvanised Steel Stay Wire	16129
2	Aluminium Tension Connectors	16141
3	Galvanised Insulator Pins	05117
4	38kV and MV Insulator fittings	16370
5	Hot Dip Galvanising of Iron and Steel articles other than wire	05030
6	Creosoted Wood Poles	16196
7	Small-woods	16111
8	38kV & MV Conductors	16144 & 16374
9	MV Triple Pole Switches	16354
10	Aluminium Tap-off Connectors	16143
11	Straight Through Non-Tension Connectors	16130
12	Tension/String Insulator units for lines up to 42kV.	16348

Item	Material Description	ESB Specification
13	Copper Connectors Tension & Tap-off for 38kV, MV & LV Lines	16148
14	Preformed Helical Ties for Dist OH Lines	16195
15	Helical Stay Grip Dead-ends	16170
16	Helical Distribution Dead-ends & Accessories	16145
17	Remotely Operated Pole Switches MV & 38kV	16360
18	Yellow Plastic Stay Markers	17019
19	Aerial Warning Spheres	16979
20	Galvanised Steel Twisted Links	05116
21	Compression fittings and dies for ACSR/AAAC conductors	16501
22	General Specification for Galvanised Steelwork	05115
23	20kV Inland Pin Insulators	16121
24	20kV Coastal Pin Insulators	16133
25	20kV Tension Insulators	16349
26	20kV Surge Arresters	16347
27	20kV Stay Insulators	16339
28	20kV pole-mounted fuse isolators & disconnects	16367
29	20kV Recloser	16355
30	Signs, Labels & flags for danger, warnings plus asset numbering.	16163