NSP/004/105 (OHI 5) - Guidance on the Selection, Erection and Sagging of O/H line Conductors

1. Purpose

The purpose of this document is to provide guidance on the approved techniques associated with the erection of overhead line conductors for use on the Northern Powergrid Distribution System.

This document supersedes the following documents, all copies of which should be destroyed.

Reference	Version	Date	Title
NSP/004/105	4.0	Jan 2018	(OHI 5) Guidance on the selection, erection and sagging of O/H line conductors

2. Scope

This document includes details of the requirements for the preparation, running out, tensioning and sagging of overhead line conductors. It specifies the location of design and erection charts to be used for various construction types used on wood pole overhead lines.

2.1. Contents

1. Purpose 1
2. Scope 1
2.1. Contents 2
3. Technical Specification 3
3.1. Selection of Conductors 3
3.2. Preparing for Running of Conductors 3
3.3. Running Out and Stringing of Conductors 5
3.4. Tensioning and Sagging Of Conductors 7
3.4.1. HV Lines 8
3.4.1.1. Pre-Stress Tensions for Conductor Erection 8
3.4.2. LV Lines 9
3.4.3. House Services 9
3.4.4. General 9
3.4.5. Dismantling Conductors 10
3.5. Index to Drawings Detailing Approved Conductor Running Out Equipment 10
4. References 11
4.1. External Documentation 11
4.2. Internal Documentation 11
4.3. Amendments to Previous Version 11
5. Definitions 11
6. Authority for Issue 12
6.1. CDS Assurance 12
6.2. Author 12
6.3. Technical Assurance 12
6.4. Authorisation 12
Appendix 1- Index to Conductor Sag Charts 13
The documents detailed above can be located in NSP/004/041 13
Appendix 2 - Index to Conductor Sag Charts 14
Appendix 3 - Index to Conductor Sag Charts 15
Appendix 4 - Index to Conductor Sag Charts 16
Appendix 5 - Index to Conductor Sag Charts 17
Appendix 6 - Index to Historical Sag Curves and Erection Charts Used In Northern Powergrid (Northeast Ltd) 18
Appendix 7 - Index to Historical Sag Curves and Erection Charts Used In Northern Powergrid (Yorkshire PLC) 20
Appendix 8 - Table of historical conductor details 21

3. Technical Specification

This guidance note details the work undertaken on overhead line conductors and services under the following headings.

A. Selection of conductors

B. Preparation for running of conductors.

C. Running out and stringing of conductors.

D. Tensioning and sagging of conductors.

E. Dismantling or re-sagging of conductors.

3.1. Selection of Conductors

The range of conductors used on **new** overhead line constructions In Northern Powergrid shall be as specified in the following design specifications:

Voltage	Specification	Description
230/400V	NSP/004/041	Specification for LV ABC Overhead Lines
11 – 33kV	NSP/004/042	Specification HV Wood Pole lines up to 33kV
11 – 33kV	NSP/004/044	Specification for Compact Covered Conductor up to 33kV. To be used in high tree density or recreation area's
66 – 132kV	NSP/004/045	Specification for 66/132kV Wood Pole Lines

Details of the electrical ratings of new and existing conductors can be found in IMP/001/011 "Code of Practise for guidance on the selection of Overhead Line ratings".

3.2. Preparing for Running of Conductors

Conductors are available in standard drum lengths or in tailored lengths suitable for complete sections of overhead line. To minimise the need for full tension construction joints, overhead lines containing conductors with CSA >or = 100mm AAAC shall be ordered in section lengths.

The normal method of determining section lengths is to add 2% to the actual section length, plus sufficient to cater for jumpers.

For further details on the specification of overhead line conductors, see NPS/001/007

As the size of conductor in their respective types increase so proportionately do the weights and size of drum. The size and approximate weight of conductors currently used for lines up to 132kV are given in Appendix 8.

Conductor drums and maximum drum lengths have been specified to ensure that the overall drum weight and size can fit onto the company's standard type of "3 drum trailers" or "ABC drum trailers".

3 Drum Trailer Limitations

Maximum drum weight (including cond.)	670kg (each)
Max drum Diam	1200mm
Max drum Width	1000mm

ABC Trailer Limitation

Maximum Drum weight (including cond.)	1300kg
Max drum Diam	1800mm
Max drum Width	1100mm

The limitations for common standard conductor types are given below:

Conductor CSA	Cond Wt (kg/m)	Typical Drum Wt (kg)	Maximum allowable length of conductor based on weight	Company Standard Drum length
50mm AAAC	0.1666	90	3480m	1500m
100mm AAAC	0.3302	90	1750m	1500m
175mm AAAC	0.5930	90	1000m	1000m
200mm AAAC	0.690	90	840m	Not suitable for use on Standard 3 drum trailer – 1000m used on drum stands
4 X 70mm ABC	0.96	250	1093m	500m
4 X 120mm ABC	1.55	250	677m	500m
5 X 120mm ABC	1.7	250	617m	500m

Before moving drums of conductor to a position for running out, all ancillary preparatory work shall be completed so that the drums are only taken to site when required for conductor running.

Road, river, rail, power line and BT crossings etc must be adequately guarded to safeguard the conductor and the general public at all times. At least one person must be in attendance at all crossing points during the erection of the conductors. This person should have adequate means of communicating with the person in charge of the pull.

All road crossings must be signed and guarded in accordance with the Code of Practice for "Safety at Street Works and Road Works: a Code of Practise" and as further detailed in the drawings attached to the Code.

Consultation with and approval from the local authority, will be required for major roads. The normal alternatives are scaffolding and netting, the skycradle or sky sock, wagon mounted towers or closing the road following agreement with the local authority.

For less busy roads the above methods may still be appropriate but it may also be possible to use scaffold towers or mobile elevated working platforms (MEWP) set up at one side of the road only.

For farm tracks and very minor roads it will only be necessary to erect the appropriate signs and to have someone in attendance at all times when the conductor is or could be below statutory clearance.

It should be noted that the local highway authority require a minimum of 3 days' notice for traffic lights, although temporary stop go boards do not require notification provided that traffic flow can be maintained.

Where, after assessment by the supervising engineer, the crossing is unusual or presents special difficulties, he should seek advice from the Safety Section or the Policy and Standards Section.

Before the running out operation is commenced, all erection equipment shall be available on site and all conductor running blocks and working platforms erected at appropriate positions.

Various methods are available for supporting the conductor drums during running out operations; the preferred method is through the use of brake drum trailers as this allows a back tension to be applied to the drum thus allowing the conductor to be erected using tension stringing techniques.

When mounting drums for conductor running the following points must be observed;

a. The drum spindle shall allow for the drum to be securely supported in its stand and have smooth rotation.

b. The drum shall be kept under continuous observation, throughout the conductor running process. The attendant shall check the condition of the conductor as it leaves the drum and shall also be in constant control of the drum braking device to control the speed of the drum. The attendant shall stand at the rear of the drum when it is revolving.

c. The drum must be mounted so that the conductor runs from the top of the drum.

d. Tension stringing, using a drum trailer. The trailer shall be secured via its ball hitch to a vehicle or a ground anchor, ensuring the trailer cannot be up ended if the drum/conductor were to snag. The trailer legs shall be lowered for stability. The drum brake should be adjusted to give sufficient tension to maintain the conductor clear of the ground. The drum operator shall be in contact with the winch operator at all times.

e. The conductor brake drum shall be mounted on firm level ground approx. 16 to 20 metres away from the first pole, and in line with the span. The winch shall be set up in a similar way at least 20m away from the last pole

3.3. Running Out and Stringing of Conductors

Before commencing running out and stringing of conductors, an efficient code of signals for the stringing group shall be established. In the case of a short conductor run, hand signals, a whistle or by word of mouth will suffice, but in the case of long conductor runs or bad communicative conditions, loud hailers or portable communication shall be used.

All men engaged in the stringing work shall be fully acquainted with whatever procedure is to be adopted with special regard paid to procedures at crossings of roads, telecommunication circuits, railways, canals, rivers, HV or LV power line crossings etc.

Great care shall be taken that conductors are not damaged, kinked or scored when being pulled across walls, hedgerows, fences and other obstacles. The conductor should pass through a running block at each pole position, and must never be allowed to drag along the ground.

Access to fields shall only be made along officially agreed routes. These will be confirmed locally with the landowner or their representative before commencing work.

There are two basic methods for erecting new conductors, tension stringing and non-tension stringing. The method used being mainly dependent on size/type of conductor and length of run.

(a) Tension Stringing

This is the preferred method for the erection of conductors because during running out, all conductors are kept under reduced tension and clear of ground level, thus eliminating conductor damage. The conductor winch and brake drum trailers shall be set up at opposite ends of the section. Care shall be taken to ensure that both items of equipment are adequately secured via its ball hitch to a vehicle or temporary ground anchor. On new lines a rope bond should be 'walked' and passed through the running blocks in the section. The bond rope shall then be used to pull the conductor (three bond wires being used for three phase HV work) back onto the winch drum

whilst under tension from the brake drum assembly. A minimum of four personnel are required to safely carry out this routine, i.e. winchman, brake drum operator, conductor leading end man and overall job controller. Where road, river, rail, power line or telecommunication crossings are involved then at least one extra person will be required to be in attendance at each crossing point. The crossing attendants must be in verbal contact with the person in charge of the pull at all times.

With this method, it is possible to over fly obstructions such as roads, railways and overhead services. For restringing, it is permissible to use the existing conductors as pulling bonds.

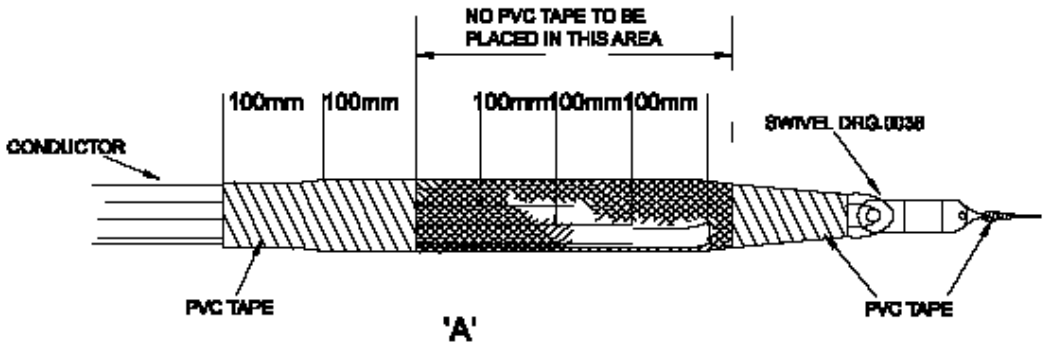
Normal running out tension is governed by vertical clearances required to ground level, but this is usually no more than one quarter of the conductor erection tension.

The winch bond wire shall be secured to the conductor via a suitable (approved) conductor stocking and swivel.

Details of approved swivels can be found on drawing 1091450038.

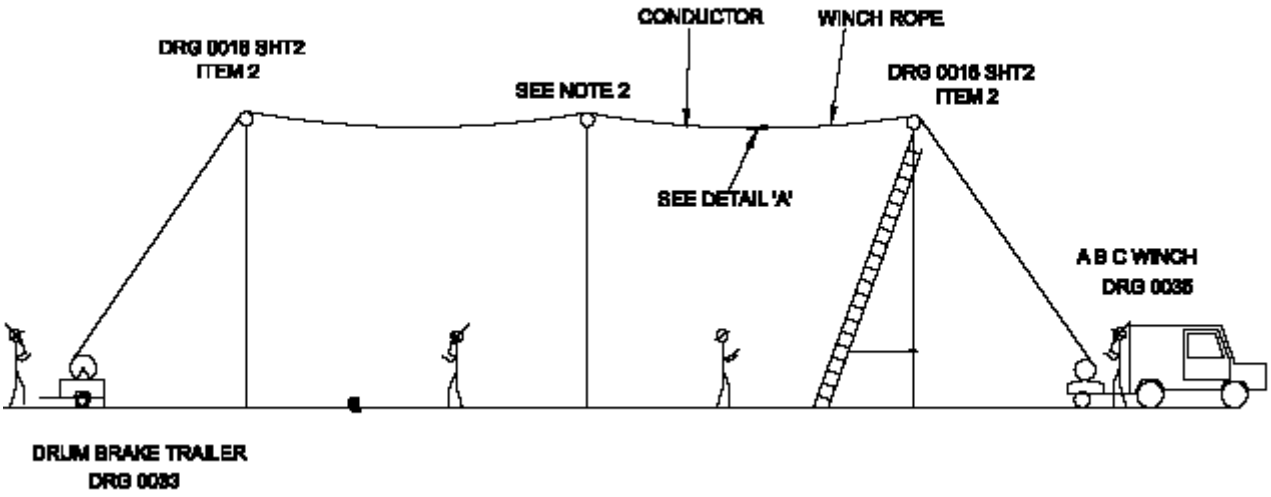
Due to numerous issues associated with the tension stringing of ABC conductors, further detailed information specific to the erection of ABC has been provided.

Where ABC is used with stockings, the ABC shall be cut and taped in a staggered manner to provide the optimum profile for passing through the conductor running blocks.



In all cases of stocking usage, the open end of the stocking shall be securely taped to the conductor to eliminate the premature release of the conductor stocking. Details of approved ABC and bare wire stockings can be found on drawing 1091450015 sheets 1 & 2.

Further guidance for ABC conductor stringing can be found in drawing 1.09.145.0021, sheet 2



Details of the approved intermediate pole roller suspension clamps are included in drawing 1.00.043.1406, sheet 2. During conductor stringing the additional rollers detailed on drawing 1.09.145.0021 shall be fitted to avoid conductor snag. Additionally to reduce the risk of snagging of the ABC the first and last poles shall always be fitted with large diameter running blocks.

The portion of the conductor which has been in contact with the stocking or preform shall be cut out due to possible conductor damage.

Note: conductor preforms may be used for pulling in bare conductors.

b. Non Tension Stringing

This alternative method may be more suitable for short sections consisting of up to four spans. Using this procedure, it is necessary to pull conductors out by hand without tension, but precautions are required over obstacles and at ground level to prevent conductor soiling/damage during running out. This system is not recommended for use with PVC or XLPE covered conductors as it is very difficult to prevent damage to the insulation.

On reaching the section or terminal pole the conductor shall be made off on the appropriate terminal fitting as specified in NSP/004/106.

3.4. Tensioning and Sagging Of Conductors

The procedure to be adopted until final tension is applied will vary according to conditions encountered, generally dependent upon the availability and efficiency of temporary stays coupled with what it is possible to achieve within a one day period. Where final tension is not possible in sections of line, the conductors shall be erected to approximate sag and temporarily made off, ensuring that where statutory clearances are concerned these are strictly adhered to. In addition, pole and crossarm alignment shall be sufficiently near final position.

Final tensioning and sagging shall be carried out as detailed in section 3.4.1 and 3.4.2 fs, using the sag tables specified in the appendix to this document.

3.4.1. HV Lines

As much of the preliminary sagging procedure as possible shall be carried out at ground level using the winches and brake drums ensuring that equipment involved has sufficient loading capacity for the conductor being tensioned.

Each conductor, beginning with the centre one, shall be pulled up at the tensioning position either by winch, mechanically operated or anchored to the ground, or by hand (particularly where light conductors are involved). The winch shall be anchored as far from the tensioning pole as practical, ideally not less than 30 m. It is essential that when erecting the two outer conductors, correct crossarm alignment is maintained, therefore both shall be tensioned simultaneously.

To cater for this when using the winch a flexible wire rope passed through a snatch block attached to the winch will enable equal tension to be applied to the conductors. The conductor load is then transferred to the line tensioning mechanical equipment (e.g. Roto-lifts and clamps) at the tensioning pole. The ground tensioning equipment is removed, jumper length requirement ascertained and the conductor cut, lowered to the ground and rewound on to the drum.

Conductors on wood pole lines are set to the correct sag by means of a suitably calibrated dynamometer, applied in a known span length and a known temperature at the time of sagging. When stranded conductors are tensioned, the strands bed down and the conductor stretches which causes an increase in sag. This is catered for by pre-stressing the conductor to a stipulated tension for a given period of time, or erecting it over tension so as to give a sag less (i.e.. conductor tension tighter) than design tension, or both. For copper and copper cadmium the pre-stress method alone shall be used; aluminium (alloy and ACSR) shall be pre-stressed and then erected at a 5 or 10% over tension dependent on conductor erection chart (excluding 50 mm^2 AAAC which is pre-stressed only). Design charts shall not be used for erecting new conductors.

3.4.1.1. Pre-Stress Tensions for Conductor Erection

Conductor Type	Pre-stress Erection Tension
4 x 70mm^2 ABC	4513N (450kgf)
4/5 x 120mm^2 ABC	5884N (600kgf)
50mm^2 AAAC / 50 mm^2 XLPE	5884N (600kgf)
100mm^2 AAAC /120 mm^2 XLPE	12258N (1250kgf)
175mm^2 AAAC /185 mm^2 XLPE	14,710N (1500kgf)
200mm^2 AAAC	14,710N (1500kgf)

The pre-stress tension shall be maintained for a period of one hour. During the first ten minutes, most of the strand bedding down and conductor stretch will occur and continuous tension correction will be necessary. Further corrective checks and adjustments are then made at 15 minute intervals. Coincident with the pre-stressing operation, observations must be kept on stay positions, terminal, angle and section poles for plumb, balance and crossarm alignment. On completion of pre-stressing, the temperature of the day is obtained, specified sag chart consulted and the documented final erection tension applied to the conductors. A final check is made to ensure angle, section and terminal poles are plumb, crossarms correctly aligned and stays balanced. Once the tension has been finally checked, the conductors shall be made off with the appropriate terminating medium as specified in NSP/004/106. On completion of the final make-off, intermediate poles are ready for binding-in. Each straight line pole shall be checked for plumb and crossarm alignment and the binders applied as specified in NSP/004/106 and appropriate task instruction. On completion of binding-in, running blocks shall be lowered to the ground by sash line and insulator pins checked for security.

Note: In order to pre-stress conductors on lines comprising three or more sections, it is imperative that the section poles be stayed temporarily in both directions to avoid distortion of an adjoining section which has already been erected. This proviso also applies to two span sections where it is not possible to 'hang' at both terminations and balance out on the section pole.

3.4.2. LV Lines

The span(s) selected for sagging shall be as near as possible to the centre of the section of conductor under construction. Where aluminium conductors are used with short span lengths, the selected span should ideally include a straight line pole to facilitate sagging on the basis of two adjacent spans (not exceeding 60 m) with the conductors hanging free at the centre support.

Conductors shall be pre-stressed for as long a period as practicable through not less than 20 minutes as quoted on appropriate sag table. Aluminium conductors shall be pre-stressed on the adjacent spans principle (over tensioning is not required for ABC conductor).

Dynamometers shall always be used for the erection of conductors.

Where a public lighting wire forms part of the overhead line network, this wire is to be sagged to hang parallel to the network conductors.

3.4.3. House Services

Erection of house services is also governed by statutory compliance with the clearances required in NSP/004/011, due account being taken of the maximum operating temperature stipulation and of cold temperature tensions. Also, it is necessary to ensure that the strength of the building material at the point of the attachment and the available loading capacity of the pole are not exceeded.

There are practical limitations to providing sag and tension tables to cater for all service situations which may be encountered in the field. Table 2 is a simplified sag chart for design and erection purposes.

The transverse load due to services provides a significant contribution to the total load on the network pole and is a major factor in determining the maximum allowable wind spans on the network. Account should be taken of services of similar tensions erected on opposite sides of a pole which will balance each other out.

When extra services are added to an existing pole, consideration must be given to re-sagging existing services (whilst maintaining ground clearance), upgrading poles or back-staying the services.

3.4.4. General

Where bridging through of jumpers is involved, care shall be taken to ensure that jumpers are neatly shaped and that adequate clearance is provided between the jumper and tension set assembly before binding-in the jumper to the pilot insulator. In the case of the underslung jumper, it shall be checked for swing and stability under adverse weather conditions. Conductor connections shall be as specified in NSP/004/107.

On completion of work at section or terminal positions, all pole and conductor fittings shall be finally checked for security, all nuts properly tightened, split pins opened etc. Erection equipment can then be lowered to the ground.

On completion of the line work, a careful inspection shall be made of the ground at each pole and all scrap lengths of binding wire, staples or scrap material removed. All pole positions shall be checked at the base and any voids suitably filled and reinstated.

3.4.5. Dismantling Conductors

Although this instruction details the methods of erection of conductors, when conductors are to be dismantled, the preparatory work, safety and operational procedures will be similar.

When conductors are to be dismantled the conductor should be caught and held, the tension released slowly and the conductor lowered to the ground. If the conductor is to be cut then all tension must have been released before cutting commences. ON NO ACCOUNT should conductors be cut while under tension. This applies to all conductors including service concentric cable.

3.5. Index to Drawings Detailing Approved Conductor Running Out Equipment

Insulator mounted running blocks	1091450019
ABC Terminal Pole Running Blocks	1091450020
ABC Combined running block/rollers	1000431406
ABC Combined running block/rollers extension roller	1091450021
Conductor Clamps	1091450054
ABC Cum Along Clamp	1091450016
ABC Pull Stockings	1091450015

4. References

4.1. External Documentation

Reference	Title
	Safety at Street Works and Road Works : a Code of Practise

4.2. Internal Documentation

Reference	Title
IMP/001/011	Code of practise for guidance on the selection of Overhead Line ratings
NSP/004/011	Overhead Line Clearances
NSP/004/041	Specification for Aerial Bundled Conductors (ABC) installed on LV Lines
NSP/004/042	Specification for HV Single Circuit Overhead Lines on Wood Poles for voltages up to 33kV
NSP/004/044	Specification for Single Circuit Lines of Compact Construction on wood poles for use at voltages up to and including 33kV
NSP/004/045	Specification for EHV Single Circuit Wood Pole Lines operating up to 132kV with span lengths up to 220m
NSP/004/106	Guidance on the selection and application of conductor joints, Terminations & Binders
NSP/004/107	Guidance on the selection of conductor Jumpers and Non-tension connections on wood pole lines

4.3. Amendments to Previous Version

Reference	Description
Whole Document	Document reviewed no changes required – Paul McAdoo 03/10/2023 Doc approved by email Paul Black 05/10/2023 Doc republished to grid and externally - LB 17/10/2023

5. Definitions

Reference	Definition
n/a	n/a

6. Authority for Issue

6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		Date
Liz Beat	Governance Administrator	17/10/2023

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

Review Period - This document should be reviewed within the following time period.

Standard CDS review of 3 years	Non Standard Review Period and Reason	
Yes	Period: n/a	Reason: n/a
Should this document be displayed on the Northern Powergrid external website?		Yes

		Date
Steven Salkeld	Policy and Standards Engineer	15/01/2018

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		Date
Ged Hammel	Senior Policy and Standards Engineer	18/01/2018

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Paul Black	Head of System Engineering	17/10/2023

Appendix 1- Index to Conductor Sag Charts

LV ABC Construction – Lines constructed to NSP/004/041 and using standard conductors

Chart Title	Basic Span	Appendix No.
Extended Service Spans		
Design Sag & Tension Data for 2 & 4 Core 35mm^2	50m	3
Reduced tension for ABC Attached to Buildings		
Common erection table for 35 – 120mm ABC	20	8
Main Lines		
Design Sag & Tension Data for 4 Core 70mm^2	50	5
Design Sag & Tension Data for 4 Core 120mm^2	50	7
Historical Sizes Of ABC for Guidance Only		
Design Sag & Tension Data for 4 Core 50mm^2	50	4
Design Sag & Tension Data for 4 Core 95mm^2	50	6

The documents detailed above can be located in NSP/004/041

LV Open Wire Renovation – Lines renovated to NSP/004/041/001

Chart Title	Basic Span	Appendix No.
32mm2 (3/3.75mm) HDBC – Table 1 (Normal tension)	40	2
32mm2 (3/3.75mm) HDBC – Table 2 (Reduced tension)	40	2
32mm2 (3/3.75mm) HD PVC (type 8) - Table 1 (Normal tension)	40	3
32mm2 (3/3.75mm) HD PVC (type 8) - Table 2 (Reduced tension)	40	3
70mm2 (7/3.55mm) HDBC – Table 1 (Normal tension)	40	4
70mm2 (7/3.55mm) HDBC – Table 2 (Reduced tension)	40	4
70mm2 (7/3.55mm) HD PVC (type 8) - Table 1 (Normal tension)	40	5
70mm2 (7/3.55mm) HD PVC (type 8) - Table 2 (Reduced tension)	40	5
50mm2 (7/3.10mm) HDBC – Table 1 (Normal tension)	40	6
50mm2 (7/3.10mm) HDBC – Table 2 (Reduced tension)	40	6
50mm2 (7/3.10mm) HD PVC (type 8) - Table 1 (Normal tension)	40	7
50mm2 (7/3.10mm) HD PVC (type 8) - Table 2 (Reduced tension)	40	7
100mm2 (7/4.39mm) HDBC – Table 1 (Normal tension)	40	8
100mm2 (7/4.39mm) HDBC – Table 2 (Reduced tension)	40	8
100mm2 (7/4.39mm) HD PVC (type 8) - Table 1 (Normal tension)	40	9
100mm2 (7/4.39mm) HD PVC (type 8) - Table 2 (Reduced tension)	40	9

The documents detailed above can be located in NSP/004/041

Appendix 2 - Index to Conductor Sag Charts

HV Construction – 11/20 & 33kV lines constructed to NSP/004/042 and using standard conductors

Conductor Type	Basic Span	Altitude or Loading	Appendix No.
50mm^2 AAAC	80m	Normal	2
	90m		3
	100m		4
	120m		5
100mm^2 AAAC	80m		6
	90m		7
	100m		8
175mm^2 AAAC	80m		9
	90m		10
	100m		11
200mm^2 AAAC	80m		12
	90m		13
	100m		14
50mm^2 AAAC	75m	High	15
	80m		16
	90m		17
	100m		18
100mm^2 AAAC	80m		19
	90m		20
175m^2 AAAC	80m		21
	90m		22
200m^2 AAAC	80m		23
	90m		24

The documents detailed above can be located in NSP/004/042/001

Appendix 3 - Index to Conductor Sag Charts

HV Covered Conductor Construction – 11/20 & 33kV lines constructed to NSP/004/044

Conductor Type	Basic Span	Altitude or Loading	Appendix No.
50mm2 XLPE covered AAAC	100m	Normal	9
120mm2 XLPE Covered AAAC	100m		10
185mm2 XLPE Covered AAAC	100m		11
50mm2 XLPE covered AAAC	90m	High	12
120mm2 XLPE Covered AAAC	90m		13
185mm2 XLPE Covered AAAC	90m		14

The documents detailed above can be located in NSP/004/044

Appendix 4 - Index to Conductor Sag Charts

HV Construction – 11/20 & 33kV lines constructed to NSP/004/042 and using historical conductors re-sagged to comply with the specification

Conductor Type	Basic Span	Altitude or Loading	Appendix No.
.017" / 13mm CACU	80	All Altitudes Wind = 760(N/m²), Ice = 0mm	26
	90		27
	100		28
	120		29
.05" / 32mm HDBC	80		30
	90		31
	100		32
	120		33
.05" / 50mm AAAC	80		34
	90		35
	100		36
	120		37
.25" / 16mm HDBC	90		38
	100		39
3 swg HDBC	90		40
	100		41
5 swg HDBC	90		42
	100		43
6 swg HDBC	90		44
	100		45
7swg HDBC	90		46
	100		47
.175" / 175mm ACSR (CE/C/36)	76.2 (250ft)	Normal Altitude Wind = 380(N/m²), Ice = 19mm (Dia.)	48
.1" / 100mm ACSR	90		49
.1" / 100mm ACSR	100		50
.1" / 70mm HDBC	90		51
.15" / 100mm HDBC	90		52
.2" / 125mm HDBC	100		53
.1" / 100mm ACSR	90	High Altitude Wind = 570(N/m²), Ice = 25mm (Dia.)	54
.1" / 70mm HDBC	90		55
.15" / 100mm HDBC	90		56
.2" / 125mm HDBC	100		57

The documents detailed above can be located in NSP/004/042/001

Appendix 5 - Index to Conductor Sag Charts

EHV Construction – 66kV lines constructed to OHL4

Conductor Type	BASIC SPAN	DRAWING NO	ERECTION CHARTS SHT/MOD	SAG CURVES SHT/MOD
100 mm2 (7/4.65 mm) Aluminium Alloy ("OAK")	120 m	1.09.140.0301	2B	3A
100 mm2 (7/4.65 mm) Aluminium Alloy ("OAK")	150 m	1.09.140.0303	2A	3A
175 mm2 (37/2.79 mm) ACSR ("LYNX")	100 m	1.09.140.0600	2A	3A
175 mm2 (37/2.79 mm) ACSR ("LYNX")	120 m	1.09.140.0601	2A	3A

EHV Construction – 66/132kV lines constructed to NSP/004/044

Conductor Type	BASIC SPAN	DRAWING NO	Conductor sag & tension chart
175 mm2 (7/4.65 mm) Aluminium Alloy ("Elm")	130 m	-	Within Design Spec

Appendix 6 - Index to Historical Sag Curves and Erection Charts Used In Northern Powergrid (Northeast Ltd)

– For Reference Only, Not to be used for erecting new lines

	BASIC SPAN	DRAWING NO	ERECTION CHARTS SHT/MOD	SAG CURVES SHT/MOD
SERVICE CONDUCTORS (OHL 3)				
Service Spans - Service Spans - (16 mm2 (7/1.70 mm) PVC Copper (25, 35 mm2 Hybrid Single Core Concentric)	20 m	1.09.140.1101	1A	
Service Lines - 16 mm2 (7/1.70 mm) PVC Covered Copper	50 m	1.09.140.1100	1A	-
ABC Attached to Buildings				
LV CONDUCTORS ERECTED TO OHL 3				
32 mm2 (3/3.75 mm) HD Copper - Bare and PVC	40 m	1.09.140.3404	1A/2A	-
70 mm2 (7/3.55 mm) HD Copper - Bare and PVC	40 m	1.09.140.3405	1A/2A	-
50 mm2 (7/3.10 mm) Aluminium - Bare and PVC	40 m	1.09.140.3406	1A/2A	-
100 mm2 (7/4.39 mm) Aluminium - Bare and PVC	40 m	1.09.140.3407	1A/2A	-
50 mm2 (19/1.78 mm) ABC	50 m	1.09.140.0061	1B	-
95 mm2 (19/2.52 mm) ABC	50 m	1.09.140.0060	1B	-
120 mm2 (37 Comp) ABC	50 m	1.09.140.0062	1	-
For other conductor sizes, refer to Overhead Mains Section, Board Headquarters				
CONDUCTORS ERECTED TO OHL 5/89				
32 mm2 (3/3.75 mm) HDBC	80 m	1.09.140.1204	2A	3C
32 mm2 (3/3.75 mm) HDBC	100 m	1.09.140.1205	2A	3C
32 mm2 (3/3.75 mm) HDBC	120 m	1.09.140.1206	2A	3C
32 mm2 (3/3.75 mm) HDBC	90 m	1.09.140.1207	2	3A
70 mm2 (7/3.55 mm) HDBC	80 m	1.09.140.1360	2A	3B
70 mm2 (7/3.55 mm) HDBC	100 m	1.09.140.1361	2A	3B
70 mm2 (7/3.55 mm) HDBC	120 m	1.09.140.1362	2A	3B
70 mm2 (7/3.55 mm) HDBC	90 m	1.09.140.1363	2	3A
50 mm2 (7/3.30 mm) Aluminium Alloy ("HAZEL")	80 m	1.09.140.0284	2A	3B
50 mm2 (7/3.30 mm) Aluminium Alloy ("HAZEL")	90 m	1.09.140.0287	2	3
50 mm2 (7/3.30 mm) Aluminium Alloy ("HAZEL")	100 m	1,09.140.0285	2A	3B
50 mm2 (7/3.30 mm) Aluminium Alloy ("HAZEL")	120 m	1.09.140.0286	2A	3B
100 mm2 (7/4.65 mm) Aluminium Alloy ("OAK")	80 m	1.09.140.0304	2A	3A
100 mm2 (7/4.65 mm) Aluminium Alloy ("OAK")	90 m	1.09.140.0307	2	3
100 mm2 (7/4.65 mm) Aluminium Alloy ("OAK")	100 m	1.09.140.0305	2A	3A
100 mm2 (7/4.65 mm) Aluminium Alloy ("OAK")	120 m	1.09.140.0306	2A	3
175 mm2 (19/3.76 mm) Aluminium Alloy ("ELM")	80 m	1.09.140.0340	2A	3A
175 mm2 (19/3.76 mm) Aluminium Alloy ("ELM")	90 m	1.09.140.0343	2	3
175 mm2 (19/3.76 mm) Aluminium Alloy ("ELM")	100 m	1.09.140.0341	2A	3A
175 mm2 (19/3.76 mm) Aluminium Alloy ("ELM")	120 m	1.09.140.0342	2A	3A

175 mm2 (18/1/3.61 mm) ACSR ("CARACAL")	80 m	1.09.140.0620	2A	3A
175 mm2 (18/1/3.61 mm) ACSR ("CARACAL")	100 m	1.09.140.0622	2A	3A
175 mm2 (18/1/3.61 mm) ACSR ("CARACAL")	120 m	1.09.140.0623	2A	3A
50 mm² Aluminium Alloy Covered Cond	80m	1.09.140.0657	1	-
50 mm² Aluminium Alloy Covered Cond	90m	1.09.140.06.56	1	-
50 mm² Aluminium Alloy Covered Cond	100m	1.09.140.06.55	1	-
50 mm² Aluminium Alloy Covered Cond	120m	1.09.140.06.54	1	-
120 mm² Aluminium Alloy Covered Cond	80m	1.09.140.0653	1	-
120 mm² Aluminium Alloy Covered Cond	90m	1.09.140.0652	1	-
120 mm² Aluminium Alloy Covered Cond	100m	1.09.140.0651	1	-
120 mm² Aluminium Alloy Covered Cond	120m	1.09.140.0650	1	-
0.15 sq in (18/1/.132 in) ACSR	400 ft	66.5/14.165	2A	-
0.15 sq in (18/1/.132 in) ACSR	340 ft	66.5/14.181	2A	-
0.175 sq in (18/1/.142 in) compacted ACSR	340 ft	66.5/14.182	2A	-
0.15 sq in (37/.102 in) ACSR	420 ft	1.09.140.0560	4A	-
13.15 mm2 (3/2.36 mm) Cad Cu	105 m	1.09.140.1001	2A	3
13.15 mm2 (3/2.36 mm) Cad Cu	120 m	1.09.140.1002	2A	3
13.15 mm2 (3/2.36 mm) Cad Cu	90 m	1.09.140.1003	2	3
0.15 sq in (19/.01 in) HDBC	90 m	1.09.140.1400	4A	3
0.2 sq in (19/.116 in) HDBC	300 ft	1.09.140.1450 *	4A	-
0.2 sq in (19/.116 in) HDBC	325 ft	1.09.140.1451 *	4A	-
0.2 sq in (19/.116 in) HDBC	350 ft	1.09.140.1452 *	4A	-
0.2 sq in (19/.116 in) HDBC	350 ft	1.09.140.1453 *	4A	-
0.2 sq in (19/.116 in) HDBC	350 ft	1.09.140.1454 *	4A	-
.025 sq in (7/073 in) Cad Cu	40 m	1.09.140.1150	Sht 1	
.025 sq in (7/073 in) Cad Cu	100 m	1.09.140.1151	Sht 1	
.025 sq in (7/073 in) Cad Cu	120 m	1.09.140.1152	Sht 1	
.04 sq in (7/093 in) Cad Cu	90 m	1.09.140.1153	Sht 1	
.04 sq in (7/093 in) Cad Cu	100 m	1.09.140.1154	Sht 1	
.04 sq in (7/093 in) Cad Cu	120 m	1.09.140.1155	Sht 1	
.058 sq in (7/104 in) HDBC	90 m	1.09.140.1208	Sht 1	
.058 sq in (7/104 in) HDBC	100 m	1.09.140.1209	Sht 1	
.058 sq in (7/104 in) HDBC	120 m	1.09.140.1210	Sht 1	

* Conductor sagged parallel to catenary cable design curves only - not for erection purposes.

Appendix 7 - Index to Historical Sag Curves and Erection Charts Used In Northern Powergrid (Yorkshire PLC)

– For Reference Only, Not to be used for erecting new lines

Conductor Type	Basic Span	Altitude or Loading	Appendix No.
LV Lines designed to 43-12			
4x95mm^2 ABC Design Chart	50m	n/a	4
2 or 4x35mm^2 ABC Design Chart	50m	n/a	5
All appendix refer to DSS/004/041 ver 1.0			
HV Lines at 11or 33kV designed to 43-40			
Conductor Type	**Basic Span**	**Altitude or Loading**	**Appendix No.**
32mm^2 HDBC Design Chart	100m	Low	19
32mm^2 HDBC Erection Chart	100m		20
32mm^2 HDBC Design Chart	80m	High	21
32mm^2 HDBC Erection Chart	80m		22
70mm^2 HDBC Design Chart	120m	Low	23
70mm^2 HDBC Erection Chart	120m		24
70mm^2 HDBC Design Chart	100m	High	25
70mm^2 HDBC Erection Chart	100m		26
50mm^2 AAAC Design Chart	**100m**	**Low**	**27**
50mm^2 AAAC Erection Chart	**100m**		**28**
50mm^2 AAAC Design Chart	**80m**	**High**	**29**
50mm^2 AAAC Erection Chart	**80m**		**30**
100mm^2 AAAC Design Chart	**100m**	**Low**	**31**
100mm^2 AAAC Erection Chart	**100m**		**32**
100mm^2 AAAC Design Chart	**100m**	**High**	**33**
100mm^2 AAAC Erection Chart	**100m**		**34**
175mm^2 ACSR Design Chart	**100m**	**Low**	**35**
175mm^2 ACSR Erection Chart	**100m**		**36**
175mm^2 ACSR Design Chart	**100m**	**High**	**37**
175mm^2 ACSR Erection Chart	**100m**		**38**
All appendix refer to DSS/004/042 ver 1.0			
EHV Lines 33 or 66kV designed to CE/C/37			
Conductor Type	**Basic Span**	**Altitude or Loading**	**Appendix No.**
175mm^2 ACSR Design Chart	**150m**	**ALL**	**1**
175mm^2 ACSR Erection Chart	**150m**	**ALL**	**2**
All appendix refer to DSS/004/040 V1.0			

Appendix 8 - Table of historical conductor details

METRIC CONDUCTORS								PREVIOUS IMPERIAL CONDUCTORS (WITH EQUIVALENT METRIC DIMENSIONS)									
MATERIAL	NOMINAL AREA		STRANDING & WIRE DIAMETER	Dia.	Weight	CALCULATED BREAKING LOAD		NOMINAL EQUIVALENT COPPER AREA	STRANDING & WIRE DIAMETER		APPROX OVERALL DIAMETER		WEIGHT	NOMINAL BREAKING LOAD		ACTUAL AREA	
	mm²		mm	mm	kg/km	kgf	kN	in²	in	mm	in	mm	kg/km	lbf	kN	in²	mm²
ACSR (BS215 Part 2)	+ 50	("Rabbit"	6 + 1/3.35	10.05	216.7	1871	18.35	.05	6/1/.132	6/1/3.35	.396	10.1	214	4110	18.28	.09579	61.8
	* 60	("Skunk"	12 + 7/2.59	12.95	463	5290	51.88	.06	12/7/.102	12/7/2.59	.51	13	463	11620	51.68	.1553	100.2
	**70	("Horse")	12 + 7/2.79	13.95	538	6370	61.2	-	-	-	-	-	-	-	-	-	-
	+100	("Dog")	6/4.72 + 7/1.57	14.15	402	3334	32.70	.1	6/.186+7/.06	6/4.72+7/1.	.558	14.2	395	7300	32.47	.1842	118.8
	+150	("Wolf")	30 + 7/2.59	18.13	744.2	7056	69.20	.15	30/7/.102	30/7/2.59	.714	18.1	727	15170	67.48	.3023	195.1
	+150	("Dingo")	18 + 1/3.35	16.75	516.4	3640	35.70	.15	18/1/.132	18/1/3.35	.660	16.7	506	7895	35.12	.26	167.5
	+175	("Lynx")	30 + 7/2.79	19.53	878	8137	79.80	.175	30/7/.110	30/7/2.79	.777	19.6	846	17530	77.98	.3516	226.9
	175	("Bures")	18/A1 + 1/3.61	16.4	587	4191	41.10	.175	18/1/.142	18/1/3.61	.646	16.4	586	9070	40.34	.3009	194.3
	(Compacted)							(compacted									
	+175	("Caracal"	18 + 1/3.61	18.05	598.7	4191	41.1										
Plain Aluminium (BS215 Part 1)	+50	("Ant")	7/3.10	9.30	145	844.	8.28	.05	7/.122	7/3.10	.366	9.3	144	1960	8.72	.08183	52.79
	+100	("Wasp")	7/4.39	13.17	290	1631	16.00	.1	7/.173	7/4.39	.519	13.2	290	3700	16.46	.1646	106.2
	+150	("Hornet")	19/3.25	16.25	434	2620	25.7	.15	19/.128	19/3.25	.64	16.3	433	5680	25.27	.2445	157.7
Alum Alloy (BS3242)	+50	("Hazel")	7/3.30	9.90	166.6	1713	16.8	.05	7/.130	7/3.3	.39	9.91	163.7	3880	17.26	.09289	59.93
	+100	("Oak")	7/4.65	13.95	330.2	3395	33.3										
	+175	("Elm")	19/3.76	18.8	593	6026	59.10	-	-	-	-	-	-	-	-	-	-
Hard Drawn Copper (BS125)	16		3/2.65	5.69	148.3	672.	6.59	.025	3/.104		.224	5.67	147.3	1520	6.76	.02548	16.44
	32		3/3.75	8.05	296.9	1296	12.71	.05	3/.147	3/3.73	.317	8.05	294.4	2920	12.99	.05092	32.85
	70		7/3.55	10.65	621	2741	26.88	.1	7/.136	7/3.45	.408	10.4	588.1	5870	26.11	.1017	65.6
	100		7/4.30	12.9	911.2	3838	37.64	.15	7/.166	7/4.22	.498	12.6	876.1	8530	37.94	.1515	97.74
	125		19/2.90	14.5	1130	4929	48.34	.2	19/.116	19/2.95	.58	14.7	1166	11600	51.60	.2008	129.5
Copper Cadmium (BS125) Ø	13		3/2.36	5.08	118.5	807.6	7.92	0.17	3/.093	3/2.36	.2	5.08	118.5	1780	7.92	.02038	13.15