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NSP/004/107 - (OHI 7) Guidance on the selection of conductor jumpers and non-tension connections

1. Purpose

The purpose of this document is to provide guidance on the application and use of jumpers and non-tension connectors on overhead lines for use on the Northern Powergrid distribution network.

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

Document Reference	Document Title	Version	Published Date
NSP/004/107	(OHI 7) Guidance on the selection of conductor Jumpers and non-tension connections	3.1	Feb 2019

2. Scope

This document includes details on the types of jumper and non-tension connectors that should be applied in various tabulated circumstances shown in Appendix 1. This guidance given in this document is limited to equipment for use on overhead lines up to and including 33kV.

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3. Technical Specification

3.1. General

Conductor connections are required when lines terminate, section lengths are connected together or a line is interconnected with ancillary equipment.

3.2. Jumpers

Jumpers are used to continue the main line at section poles or bridge the gap between the main line and pole connected plant.

Where bridging through of jumpers is involved, care shall be taken to ensure that jumpers are neatly shaped, are limited in length and statutory electrical clearances are provided at all points throughout the length of the jumper.

Jumpers connected to plant shall be moderately taut but should not exert any undue force on the main line of the connections. The maximum length of unsupported jumper length shall be no greater than 3.0m

The minimum vertical clearance for bare jumpers to metalwork, specified below, allows for a swing clearance of 30°:

LV Lines	230 mm (9 in)
11 kV and 20 kV lines	450 mm (18 in)
33 kV lines	500 mm (20 in)

Flexible jumpers shall not be utilised without the corresponding pin connectors and stress relieving heat shrink tubes.

On HV lines the jumper arrangement shall be as specified on the appropriate drawing. Generally, where no obstruction, such as stays, exists, the jumpers shall hang under the crossarm. The centre conductor on single wood poles shall be taken over the top of the crossarm supported by a pilot pin and insulator to which the jumper is bound in (see NSP/004/106 for further information relating to binder types).

At section pole positions where copper, copper cadmium, aluminium or aluminium alloy conductors are used, the tail end of the conductors shall be short on the supply side and long on the remote side to facilitate fitting of non-tension connectors. The ends of the conductor jumper must be cut off neatly and left straight after the connection has been made.

Unless specified otherwise, all jumpers to cable terminations or pole mounted plant shall be formed from copper jumpers. To reduce the risk of interference from windborne materials or wildlife, where ever practical, all jumpers shall be of an insulated construction.

On LV lines the jumpers are generally very short, in a horizontal plane and are normally self-supporting.

3.3. Connections

To achieve the required electrical and mechanical performance from a connection, overhead line connectors shall be compatible with the material of the line conductors, be of the correct CSA range and be installed using the correct tooling.

Compression fittings are filled with contact grease to aid electrical and mechanical performance, care shall be taken to ensure that the grease is not contaminated. Fittings shall be applied as detailed in NSP/004/108 - Guidance on the installation of compression joints.

Before any connection is made, the conductor shall be thoroughly cleaned in order to remove surface oxidation. This shall apply particularly to aluminium conductors which shall be cleaned by dry wire brushing.

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Where available mechanical connectors shall include a torque related feature, which not only ensures that the correct clamping pressure is achieved and maintained, but can also be consistently reproduced.

Where two bolt (IPC's) insulation piercing connectors are used, care shall be taken to ensure that equal amounts are taken up on each bolt before the torque limiting action of the shear heads operate.

Care must always be taken to ensure that connectors without a shear bolt facility are properly tightened and due regard paid in the case of mechanical fittings to conductor relaxation and bedding down of strands (example when using parallel groove connectors).

Bi-Metal Connections

Bi-metal non-tension connections made with compression joints shall be made using the joints shown on drawing no 1091010649. Care shall be taken to ensure the conductors are thoroughly cleaned as shown above before any conductors are inserted, and the joint shall be arranged with the aluminium in the uppermost position so that it is not possible for water to drain copper salts down onto the aluminium.

3.4. LV Lines - Aerial Bundled Conductor Lines constructed to NSP/004/041

Distributors/Main Lines

ABC - ABC (Straight through connection)

All main line connections shall be made in the jumper loop at section points using aluminium non-tension compression joints to Drawing No 1000439204 sheet 2. The completed joints shall be completely covered and waterproofed with an approved insulated sleeve. ABC shall not be pieced or extended with tension joints.

ABC - ABC (Tee-offs)

All main line tee-off connections and service distribution boxes shall be connected through the use of double bolt IPC's as shown on drawing 1000431414 sheet 2.

ABC - Alum or Copper Open Wire

Connections shall be made to the open wire networks via the 150 mm tail which protrudes from the conductor termination utilising the IPC connectors shown on Drawing No 1000431414 sheet 3. The bare conductor shall be connected into the parallel groove side of the connector and the insulated ABC connected into the insulation piercing side of the connector.

3.4.1. Open Wire Construction renovated to NSP/004/041/001

Distributors/Main Lines

Copper - Copper Conductors

All main line connections shall preferably be made via the application of non-tension compression joints shown on 1000439202. The joints shall be applied as detailed on the arrangement drawing 1091193304.

Copper - Aluminium Conductors

All main line connections shall preferably be made via the application of bi-metal non-tension compression joints as shown on 1091010649. The joints shall be applied as detailed on the arrangement drawing 1091193304.

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Aluminium - Aluminium Conductors

All main line connections shall preferably be made via the application of non-tension compression joints shown on 1000439204 sheet 2. The joints shall be applied as detailed on the arrangement drawing 1091193304.

3.4.2. All Services Types – ABC (Mains Network End)

All Service Connections - Open Wire or Concentric Service Cables

Connections to the ABC main shall be made using single bolt IPC connectors to drawing number 1000431414 sheet 1 for both the phase and neutral connections, ensuring where possible that a phase balance of connections are made.

Existing PVC insulated services or PVC insulated phase conductors shall be inserted into the IPC without removing the PVC insulation. Prior to the insertion of the neutral conductor into the IPC connector, the strands shall be prepared by twisting them together then covering them with a wrap of four layers of PVC insulating tape with a 50% overlap. In all cases the service conductors should be inserted such that the end of the conductor butts up against the grease filled end cap. All services shall be secured to the ABC using nylon cable ties to prevent movement that may result in work hardening and eventual failure of the conductor.

3.4.3. Existing Open Wire Services - Existing Open Wire Main (Mains Network End)

Copper service - Copper Main Conductors

All connections shall preferably be constructed using “C” crimp or “L” tap non-tension compression joints shown on 1091193151. Alternatively an insulated shear bolt tunnel connector can be applied to an open tail end.

Copper service - Aluminium Main Conductors

All connections shall preferably be constructed using a bi-metal “L” tap non-tension compression joints shown on 1091193151. Alternatively an insulated shear bolt tunnel connector can be applied to an open tail end.

Aluminium service - Aluminium Main Conductors

All connections shall preferably be constructed using “C” crimp or “L” tap non-tension compression joints shown on 1091193151. Alternatively an insulated shear bolt tunnel connector can be applied to an open tail end.

3.4.4. Concentric Service Cables – Existing Open Wire main (Mains Network End)

Connections to Copper Networks

All connections shall preferably be constructed using “C” crimp or “L” tap non-tension compression joints shown on 1091193151. Alternatively an insulated shear bolt tunnel connector can be applied to an open tail end.

For a bimetallic situation, the service aluminium phase conductor can be jointed as described in the paragraph below “Insulated Shear Bolt Tunnel Connector”, to a short length of 16 mm² (7/1.70) PVC insulated hard drawn copper.

Insulated Shear Bolt Tunnel Connector

Insulated Shear Bolt Tunnel Connectors are suitable for connecting load up to 90A and cover the conductor range 6 - 35mm copper and aluminium stranded and solid cables. The connectors consist of two halves, one

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side uses insulation piercing technology and the other side uses traditional stripped bare conductor inserted into the connector. Care must be taken to ensure that the ends of the conductor are cut square, the correct amount of insulation is removed from the “strip” end of the connector, the cores are fully inserted into the connector and the connector bolts are tightened until the plastic end cap is sheared off.

Connections to Aluminium Networks

Connections to 50 or 100 mm² aluminium networks shall be made with compression connectors as shown on drawing number 1091193151 sheet 1 with the fitting applied as detailed in NSP/004/108 - Guidance on the installation of compression joints.

3.4.5. Open Wire Services – Concentric Service Cable Connection (Premises End)

Connections between service cables and open wire copper services shall preferably be made using an insulated shear bolt tunnel connector. Compression “C” crimps may be used as an alternative.

3.5. HV Lines Constructed to NSP/004/042 & NSP/004/044

General

The types of connector applicable to HV lines are dependent upon conductor material. Additional guidance on specific pole mounted plant arrangements is provided in Appendix 1 & 2.

AAAC to AAAC Alloy Connections

Through connection

Aluminium non-tension compression connectors, shall be as shown on drawing number 1000439204 sheet 1,

Jumpers to Plant

Aluminium live line' bail clamp applied to the main line conductors – see drawing number 1091200012

Brass live line tap connected to the bail providing live line tapping facilities (Insulated flexible jumpers shall be inserted into pin connectors and supported with heat shrink sleeves prior to being insertion into the eye terminal of the live line tap). See drawing 1091210024 for details about the live line taps. Further details can be found in Appendix 1

Copper to Copper Connections

Through connection

Copper non-tension compression connectors, as shown on drawing number 1000439202.

Jumpers to Plant

Copper live line' bail clamp applied to the main line conductors – see drawing no 1091200012

Brass live line tap connected to the bail providing live line tapping facilities (Insulated flexible jumpers shall be inserted into pin connectors and supported with heat shrink sleeves prior to being insertion into the eye terminal of the live line tap). See drawing 1091210024 for details about the live line taps. Further details can be found in Appendix 1

ACSR to ACSR connections

Through connection

ACSR conductors are terminated using compression anchor clamps. Thus through jumpers at section positions shall be formed using small lengths of similar size ACSR conductors connected to the anchor clamp palms using

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aluminium compression lugs. See drawings numbers 1091010102, Sheet 9 (Versa Press pattern), 1091010420, Sheet 4 (Alcan pattern) and 1091010653 sheet 1 (CCL Hexpress design) for details of the anchor clamps and associated lugs.

Jumpers to Plant

Aluminium live line' bail clamp applied to the main line conductors – see drawing number 1091200012

Brass live line tap connected to the bail providing live line tapping facilities (Insulated flexible jumpers shall be inserted into pin connectors and supported with heat shrink sleeves prior to being insertion into the eye terminal of the live line tap). See drawing 1091210024 for details about the live line taps. Further details can be found in Appendix 1

XLPE Covered Conductor Connections

XLPE Covered Conductor shall be terminated using compression anchor clamps as shown on 1091010667 sheet1. This fitting includes the facility for the installation of permanently attached jumper connections.

Where non tension connections are required in jumper loops they shall be connected using aluminium connectors to drawing no 1000439204 sheet 1.

Where live line connections are required to pole mounted plant, this shall be accommodated through the use of special IPC style bail clamps and the traditional live line taps. See drawing 1091010667 sheet 2 for details.

Note – Standard 1.2m width cross arms shall be used on poles fitted with ADSD's as narrow XLPE cross arms do not allow safe hot glove disconnection.

Connections between Aluminium and Copper Conductors

In situations where live line facilities are not necessary, bimetal non-tension connections shall be made as follows:

a) When termination is preformed helical design:

A bimetal non-tension connector, shown on Drawing No 1091010649, shall be installed in the bare jumper at section/terminal situations. No part of the completed joint shall be less than 100 mm from the nearest point of any other line fitting, e.g. termination, binder. Bimetal non-tension connection of conductors should be in accordance with clause 3.3.1.

b) When termination's is compression anchor clamp design:

- i. The standard jumper lug of the Versa Press design (VPAL series) shall be jointed to PVC covered flexible jumper.
- ii. The standard jumper lug of the Alcantrip and Hexpress designs shall be substituted by the type that is bored to accept PVC covered, flexible jumper as shown on drawings no's 1091010420, Sheet 4 and 1091010653 sheet 1 or sheet 2 respectively, and assembled as detailed in NSP/004/108.

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4. References

4.1. External Documentation

Reference	Title
N/A	

4.2. Internal Documentation

Reference	Title
NSP/004/041	Specification for LV ABC Overhead Lines
NSP/004/041/001	Specification for the renovation of existing LV Overhead 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/004/106	Guidance on the selection and application of conductor joints, terminations & binders
NSP/004/108	Guidance on the installation of compression joints

4.3. Amendments from 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 18/10/2023

5. Definitions

Term	Definition
ABC	Aerial bundled conductor
ACSR	Aluminium conductor steel reinforces
CSA	Cross sectional area
IPC	Insulation piercing connector
PVC	Poly vinyl chloride
XLPE	Cross linked polyethylene

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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	18/10/2023

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 & Reason	
Yes	Period: n/a	Reason: n/a
Should this document be displayed on the Northern Powergrid external website?		Yes
		Date
Steve Salkeld	Policy and Standards Engineer	03/09/2015

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	03/09/15
Paul McAdoo	Lead Policy and Standards Engineer	03/10/2023

6.4. Authorisation

Authorisation is granted for publication of this document

		Date
Paul Black	Head of System Engineering	05/10/2023

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Appendix 1 - Approved Jumper Arrangements

Transformers - Live Line Disconnection Required – default assumption

Main	Connection	Jumper	Connection to Plant
Al or Cu	Bail Clamp / Live Line Tap	32 mm2 HD PVC Cu 7/2.46	Angled Lug (1.09.101.0237 sheet 2) and HV bushing shroud

Notes

The default arrangement shall be such that it is possible to isolate transformers from the main line using live line techniques

Transformers - Live Line Disconnection Not Required

0.017 Cad Cu – 16mm HDBC	Preform Term / Non Ten Joint	32 mm2 HD PVC Cu 7/2.46	Angled Lug (1.09.101.0237 sheet 2) and HV bushing shroud
32 - 70 mm2 HDBC	Preform Term / Non Ten Joint		
100 - 125 mm2 HDBC	Compression Term. / Lug		
50 - 175 mm2 AAAC	Preform Term / Non Ten Joint		
100 - 175 ACSR & 175 AAAC	Compression Term. / Lug		

Notes

Where transformers are individually isolatable via drop out expulsion fuses or no additional CML benefits can be achieved by the provision of live line disconnection facilities, the main line jumper connection shall be made solid using non-tension compression fittings 'or' 'L' tap compression fitting.

ABSD (Air Break Switch Disconnecter)

32 mm2 HDBC	Bail / Live Line Tap (with live line tap size to suit the rating of the circuit)	70 mm2 PVC Insulated Flexible Jumper terminated into LL tap using compression Pin terminal	2 Hole Compression Lug to drawing number 1000439203
50 mm2 AAAC			
70 mm2 or 100 mm2 HDBC			
100 mm2 AAAC or ACSR			
125 mm2 HDBC			
150 - 175 mm2 AAAC or ACSR		120 mm2 PVC Insulated Flexible Jumper terminated into LL tap using compression Pin terminal	

PMAR (Pole Mounted Auto Reclosers)

Main Line	Connection	Jumper	Connection to Plant
0.017 Cad Cu	Bail Clamp / Live Line Tap (See Note)	70 mm2 PVC Insulated Flexible Jumper terminated into LL tap using compression Pin terminal	Pin terminal inserted into bolted clamp; c/w insulated shroud.
32 mm2 HDBC			
50 mm2 AAAC			
70 - 100 mm2 HDBC			
100 mm2 AAAC or ACSR			
125 mm2 HDBC			
150 - 175 mm2 AAAC or ACSR		120 mm2 PVC Insulated Flexible Jumper terminated into LL tap using compression Pin terminal	

Notes

Where new reclosers are installed the preferred arrangement shall be to install "in line isolators" adjacent to the recloser as the means of line isolation.

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Live Line Section

Main Line		Connection	Jumper	Connection to Plant
0.017 Cad Cu	Bail Clamp / Live Line Tap		32 mm ² HDBC 7/2.46	Bail Clamp / Live Line Tap
32 mm ² HDBC				
50 mm ² AAAC				
70 - 100 mm ² HDBC			70 mm ² Ann Bare Cu 19/2.14	
100 mm ² AAAC or ACSR				
125 mm ² HDBC				
150 - 175 mm ² AAAC or ACSR			100mm ² or 125mm ² HDBC or 120 mm ² PVC Insulated Flexible Jumper terminated into LL tap using compression Pin terminal	

Note

Live line sections shall only be created using the approved ball/ball tension insulators. The use of tension insulators across existing section poles is no longer acceptable for new installations.

Cable Terminations

Main Line	Connection	Jumper	Connection to Plant
0.017 Cad Cu or 32 mm ² HDBC	Bail Clamp / Live Line Tap	70 mm ² PVC Insulated Flexible Jumper terminated into LL tap using compression Pin terminal	Live Line Tap / Spill connector
50 mm ² AAAC			
70 - 100 mm ² HDBC			
100 mm ² AAAC or ACSR			
125 mm ² HDBC	Compression Anchor and Lug or Preformed Dead- end and bi-metal non ten connector	120 mm ² PVC Insulated Flexible Jumper terminated into LL tap using compression Pin terminal	Lugged connection
150 - 175 mm ² AAAC or ACSR			

Note

Where 175 mm² conductor has been used for voltage purposes and is not expected to be loaded above 400 amps, then a bail clamp may be fitted and a 70 mm² flexible PVC insulated jumper used to connect to the cable termination via a live line tap and spill bracket. Where the feeder route requires in excess of 400A capability the live line tap provision shall be replaced with solidly connected lugged jumpers. I.e. if helical fittings are used the 175mm² AAAC tail shall be extended with a bi-metal non tension joint and connected direct to cable termination with a copper compression lug.

Fused Section

Main Line	Connection	Jumper	Connection
Cu or Al	Bail Clamp / Live Line Tap	32 mm ² HDBC 7/2.46	Bail Clamp / Live Line Tap

Fused Tee Off (either fused or connected solid)

Main Line	Connection	Jumper	Connection	Tee Conductor
Copper	Bail Clamp / Live Line Tap	32 mm ² HDBC 7/2.46	Preform Term. / Non Ten Joint	Copper
Copper	Bail Clamp / Live Line Tap	32 mm ² HDBC 7/2.46	Preform Term. / Bi-metal Non Ten Joint	Aluminium
Aluminium	Bail Clamp / Live Line Tap	32 mm ² HDBC 7/2.46	Preform Term. / Non Ten Joint	Copper
Aluminium	Bail Clamp / Live Line Tap	32 mm ² HDBC 7/2.46	Preform Term. / Bi-metal Non Ten Joint	Aluminium