

Document Reference:-		NSP/004/122	Document Type:-		Code of Practice			
Version:-	3.0	Date of Issue:-	October 2023		Page	1	of	11

NSP/004/122 – Guidance on the Electrical Resistance Testing of O/H Line Joints and Terminations

1. Purpose

The purpose of this document is to detail the requirements of Northern Powergrid in relation to the carrying out of electrical resistance testing of Overhead Line Joints and Terminations

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

Document Reference	Document Title	Version	Published Date
NSP/004/122	Guidance on the Electrical Resistance Testing of O/H Line Joints and Terminations	2.1	Feb 2019

2. Scope

This document covers the application of DMO Digital Micro Ohmmeters and the acceptable test values obtained when it is applied to both new and existing overhead line joints and terminations.

The following appendices form part of this technical specification:

- Appendix 1 – Method of Operation

Document Reference:-		NSP/004/122	Document Type:-		Code of Practice			
Version:-	3.0	Date of Issue:-	October 2023		Page	2	of	11

2.1. Contents

1.	Purpose.....	1
2.	Scope	1
2.1.	Contents.....	2
3.	Technical Requirements	3
3.1.	General	3
3.2.	DMO – Principle of measurement	3
3.3.	Operating Procedure	3
3.4.	Recording Results	4
3.5.	Summary of Acceptable Values	4
4.	References.....	6
4.1.	External Documentation	6
4.2.	Internal Documentation	6
4.3.	Amendments from Previous Version.....	6
5.	Definitions	6
6.	Authority for Issue.....	7
6.1.	CDS Assurance	7
6.2.	Author.....	7
6.3.	Technical Assurance.....	7
6.4.	Authorisation	7
	Appendix 1 – Electrical Resistance testing on overhead line joints and terminations	8

Document Reference:-		NSP/004/122	Document Type:-		Code of Practice			
Version:-	3.0	Date of Issue:-	October 2023	Page	3	of	11	

3. Technical Requirements

3.1. General

The electrical resistance of all 33kV to 132kV line and earth current carrying clamps, joints and electrical bonding connections shall be measured when new joints or terminations are inserted or when circuits are being refurbished. This test shall always be carried out in advance of any major works on double circuit tower lines where one circuit is taken out for an extended period with all load being carried on the remaining circuit.

The Digital Micro Ohmmeter (DMO) is designed to enable rapid and extremely accurate measurements of the electrical resistance of these joints.

3.2. DMO – Principle of measurement

- The current terminals colour coded blue are connected to the joint under test to form a loop through which a known and stable current is injected.
- The voltage terminals colour coded red are connected between the blue terminals, at either side of the resistance to be measured.
- The polarity of both pairs of terminals is unimportant. The instrument's accuracy is unaffected by current and voltage lead resistance.
- To neutralise any thermal voltage effects, the DMO records a sequence of voltage readings with the injected current flowing in one direction and then repeats this voltage reading sequence with the injected current flowing in the reverse direction.
- The mean of all the readings is then computed and the resistance calculated and displayed from the current and voltage readings.

3.3. Operating Procedure

The leads are connected to the conductor or fittings as shown in Appendix 1, Figure 1.

Tables 1 and 2 detail the connections and maximum resistance values for the particular type of fittings used. The following codes are used in the tables:

LEAD	COLOUR	CONNECTION POINTS IN DIAGRAMS
Current	Blue	C1, C2 etc
Potential	Red	P1, P2 etc

- Before making any connections ensure that the clamps for making the connections to the conductor have jaws of the correct size for the conductors under test.
- Any connection to the conductor should make contact with as many of the outer strands as possible, the strands being previously cleaned by wire brushing.
- If the red lead clamps are to be attached where the conductor enters a fitting, the side of the clamp should be close to but not touching the end of the fitting.
- If a red lead is to be connected to the body of the fitting, the jaws should be adjusted to hold the clamp in position. If this is not possible a sharp corner of the jaw may be pressed against the fitting and held in position by hand.

Document Reference:-		NSP/004/122	Document Type:-		Code of Practice			
Version:-	3.0	Date of Issue:-	October 2023		Page	4	of	11

- Normally any blue lead connection to the conductor should be made at least 600 mm from the fitting. Where this is near a Stockbridge damper, the connection can be made to the damper provided there is no corrosion under the clamp. The micrometer will indicate if this connection is unsatisfactory.
- Where the current from the blue leads can flow through any parallel routes additional to the route through the fitting being tested, these parallel routes should be disconnected where possible or otherwise taken into account. For example, parallel routes may exist through spacers, yoke plates etc on bundled conductor lines.
- When testing anchor clamps and jumper terminals, any conducting type of spacers in the span (e.g. Bowthorpe wire rope type) within 30m should be removed.
- When testing jumper compression spacers or joints in the jumper, all other jumper spacers and any conducting line spacers within 30m in either direction should be removed.

Note: The auxiliary measurements detailed in the tables are only required when the overall measurement of the joint/fitting exceeds the maximum value stated.

3.4. Recording Results

The results of all joint/fitting resistance measurements shall be recorded on the appropriate forms and be retained to form a history file.

3.5. Summary of Acceptable Values

Description of fittings		Resistance category			Max Resistance In Microhms					
			70mm ACSR	160mm ACCSR	175mm ACSR	200mm AAAC	300mm AAAC	400mm ACSR	500mm AAAC	Status
Anchor Clamp c/w bolted jumper terminal	Overall Measur ement P1 & P2	A2	42		30			30		Green
		A3	49		55			35		
		R1	126		90			54		Amber
R2		>126		>90			>78		Red	
Full Tension Mid span Joint		A2	60		40					Green
		A3	70		46					
		R1	180		120					Amber
		R2	>180		>120					Red

Notes

- A2 values represent the maximum acceptable values for new fittings installed on new clean conductor and would be expected to fall into a green or healthy risk status.
- A3 values represent the maximum acceptable values for new fittings installed onto old conductor and would be expected to fall into a green or healthy risk status.
- R1 values represent the maximum acceptable values for re-tested fittings. Re-inspected fittings found to be "R1" or Amber rating shall be separated, cleaned and re-tested, if the re-test value reduces to within 10% of the "A2" or "A1" figure then joint may be retained on the system until the next planned outage.
- R2 values represent values that are unacceptable or Red risk status fittings which shall be replaced immediately and the feeder route cannot be used as a backup route for a single circuit outage until the work is carried out.

Document Reference:-		NSP/004/122	Document Type:-		Code of Practice			
Version:-	3.0	Date of Issue:-	October 2023		Page	5	of	11

-
- When existing joints are separated and cleaned to try and improve the electrical resistance values of the fittings, it shall be standard practice to replace the load spreading washers and bolts rather than re-using the existing fittings.

Document Reference:-		NSP/004/122	Document Type:-		Code of Practice			
Version:-	3.0	Date of Issue:-	October 2023		Page	6	of	11

4. References

4.1. External Documentation

The products described within this specification shall comply with the latest versions of the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENATS) current at the time of supply

Reference	Title
n/a	

4.2. Internal Documentation

Reference	Title
n/a	

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 19/10/2023

5. Definitions

Term	Definition
DMO	Digital Micro Ohmmeter

Document Reference:-		NSP/004/122	Document Type:-		Code of Practice			
Version:-	3.0	Date of Issue:-	October 2023		Page	7	of	11

6. Authority for Issue

6.1. CDS Assurance

I sign to confirm that this document has been assured for issue on to the CDS system

		Date
Liz Beat	Governance Administrator	19/10/2023

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
Steven Salkeld	Policy and Standards Engineer	10/04/2014

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	09/04/2014
Paul McAdoo	Lead Policy and Standards Engineer	03/10/2023

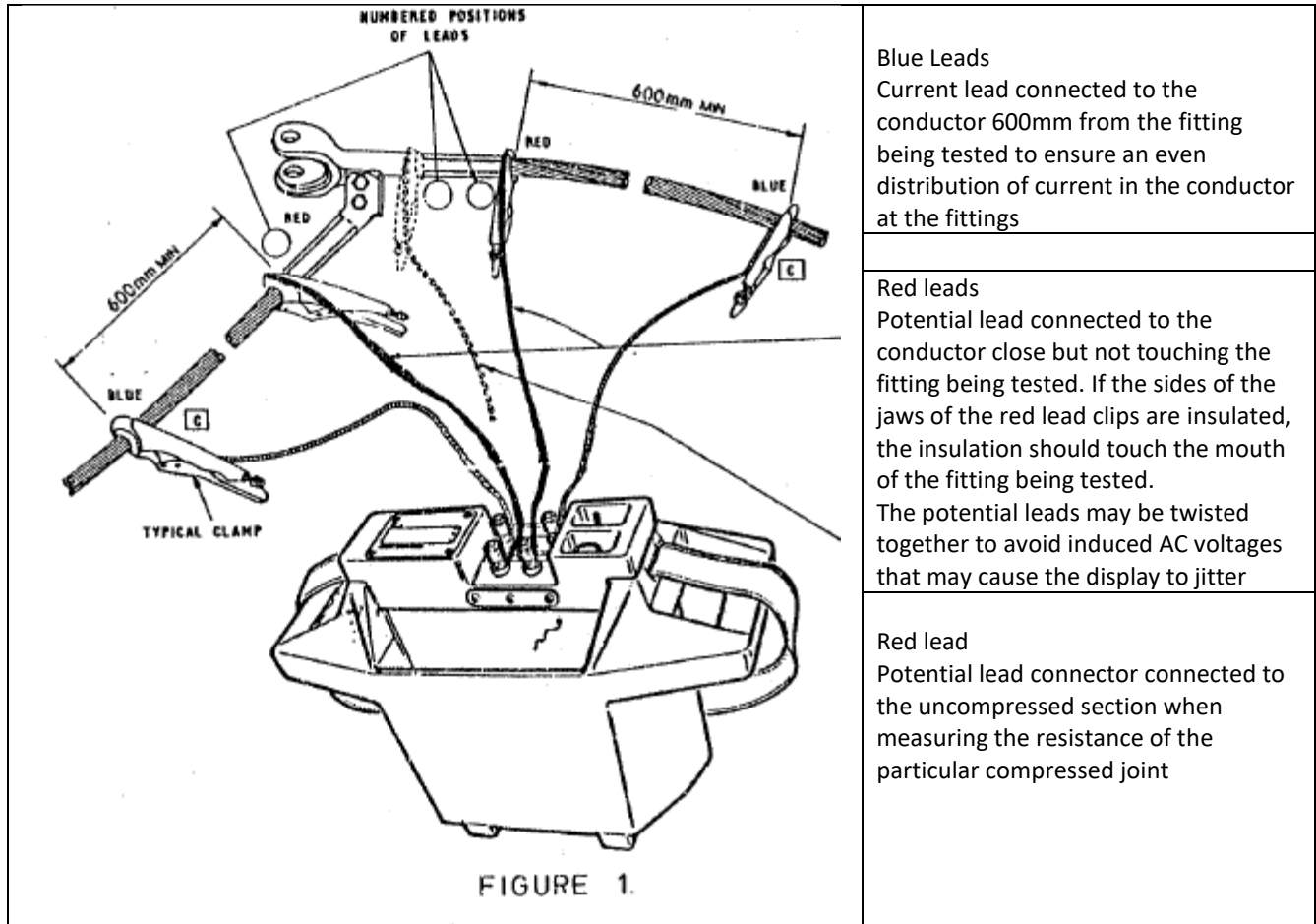
6.4. Authorisation

Authorisation is granted for publication of this document

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

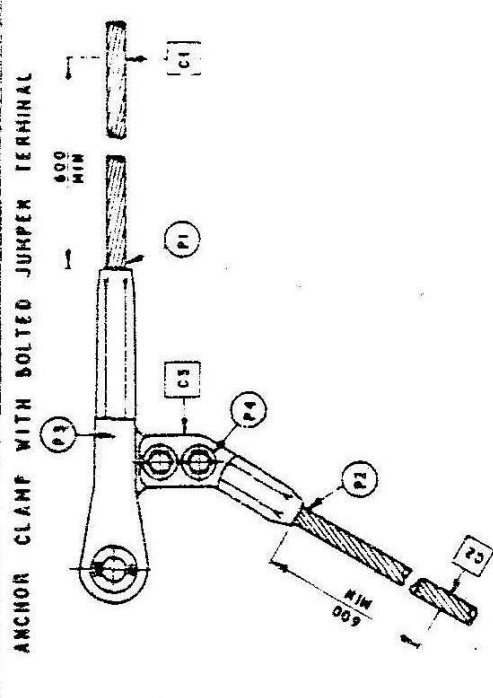
Document Reference:-		NSP/004/122	Document Type:-		Code of Practice		
Version:-	3.0	Date of Issue:-	October 2023	Page	8	of	11

Appendix 1 – Electrical Resistance testing on overhead line joints and terminations

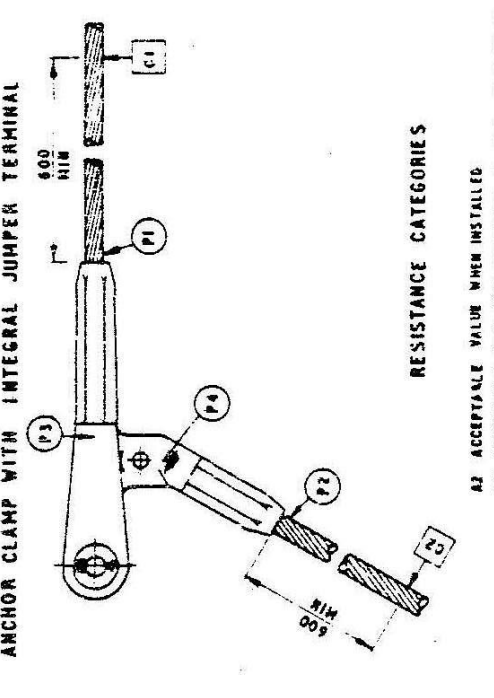


Document Reference:-	NSP/004/122	Document Type:-	Code of Practice
Version:-	3.0	Date of Issue:-	October 2023
		Page	9 of 11

APT/CPL DIGITAL MICROHMMETER LEADS		PART & PURPOSE	RESISTANCE CATEGORY	MAXIMUM RESISTANCE microhms	
BLUE LEADS	RED LEADS			CONDUCTOR SIZE mm ²	
				70	175
C1 & C2	P1 & P2	OVERALL (PRIMARY MEASUREMENT)	A2	42	30
		A3	49	35	
		R2	—	90	
C1 & C2 OR C3	P1 & P3	LINE END COMPRESSION (AUXILIARY MEASUREMENT)	A2	24	15
		A3	26	15	
		R2	—	39	
C1 OR C3 & C2	P4 & P2	JUMPER END COMPRESSION (AUXILIARY MEASUREMENT)	A2	14	11
		A3	17	13	
		R2	—	32	
C1 & C2	P3 & P4	BOLTED JUMPER CONNECTION (AUXILIARY MEASUREMENT)	A2	7	7
		A3	8	8	
		R2	—	22	
LONG OLD NON - STANDARD FITTINGS			EXTRA LENGTH UNITS		
R2 VALUE MAY BE INCREASED BY 1 MICROHM FOR EACH UNIT OF EXTRA LENGTH OF COMPRESSION				12 mm	12 mm
BASIC COMPRESSION LENGTH FOR THIS PURPOSE ONLY				160 mm	160 mm
NOTE - AUXILIARY MEASUREMENTS ARE ONLY REQUIRED TO ISOLATE A BAD SECTION FROM THE COMPLETE ARRANGEMENT					



ANCHOR CLAMP WITH BOLTED JUMPER TERMINAL



ANCHOR CLAMP WITH INTEGRAL JUMPER TERMINAL

RESISTANCE CATEGORIES

A2 ACCEPTABLE VALUE WHEN INSTALLED

A3 ACCEPTABLE FOR NEW FITTINGS ON OLD CONDUCTOR

R2 EXISTING FITTINGS REPLACE URGENTLY

TABLE 1.

Document Reference:-	NSP/004/122	Document Type:-	Code of Practice
Version:-	3.0	Date of Issue:-	October 2023
		Page	10 of 11

TENSION MIDSPAN JOINT

RESISTANCE CATEGORIES

- A2 ACCEPTABLE VALUE WHEN INSTALLED
- A3 ACCEPTABLE FOR NEW FITTINGS ON OLD CONDUCTOR
- R2 EXISTING FITTINGS REPLACE URGENTLY

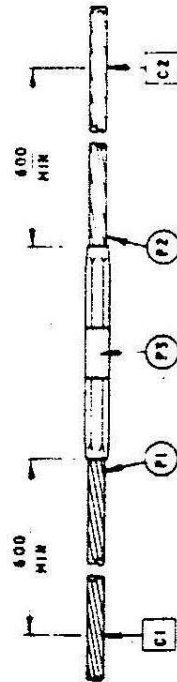
APT/CERT DIGITAL MICROMETER LEADS		PART & PURPOSE	RESISTANCE CATEGORY	MAXIMUM RESISTANCE microhms		
BLUE LEADS	RED LEADS			70	175	
C1 & C2	P1 & P2	OVERALL (PRIMARY MEASUREMENT)	A2	60	40	
			A3	70	46	
			R2	—	120	
C1 & C2	P1 & P3 OR P3 & P2	ENDS ONLY (AUXILIARY MEASUREMENT) SEE NOTE BELOW	A2	30	20	
			A3	35	25	
			R2	—	60	
LONG OLD NOM - STANDARD FITTINGS		EXTRA LENGTH UNITS				
R2 VALUE MAY BE INCREASED BY 1 MICROHM FOR EACH UNIT OF EXTRA LENGTH OF COMPRESSION		12mm				
BASIC COMPRESSION LENGTH FOR THIS PURPOSE ONLY		160mm				

NOTES:-

FOR NON STANDARD EXTENDED JOINTS, MEASURE EACH END SEPARATELY TO AVOID THE EFFECT OF THE LONG MIDDLE SECTION.

AUXILIARY MEASUREMENTS ARE ONLY REQUIRED WHEN CHECKING PARTIALLY ASSEMBLED JOINT

TENSION MIDSPAN JOINT

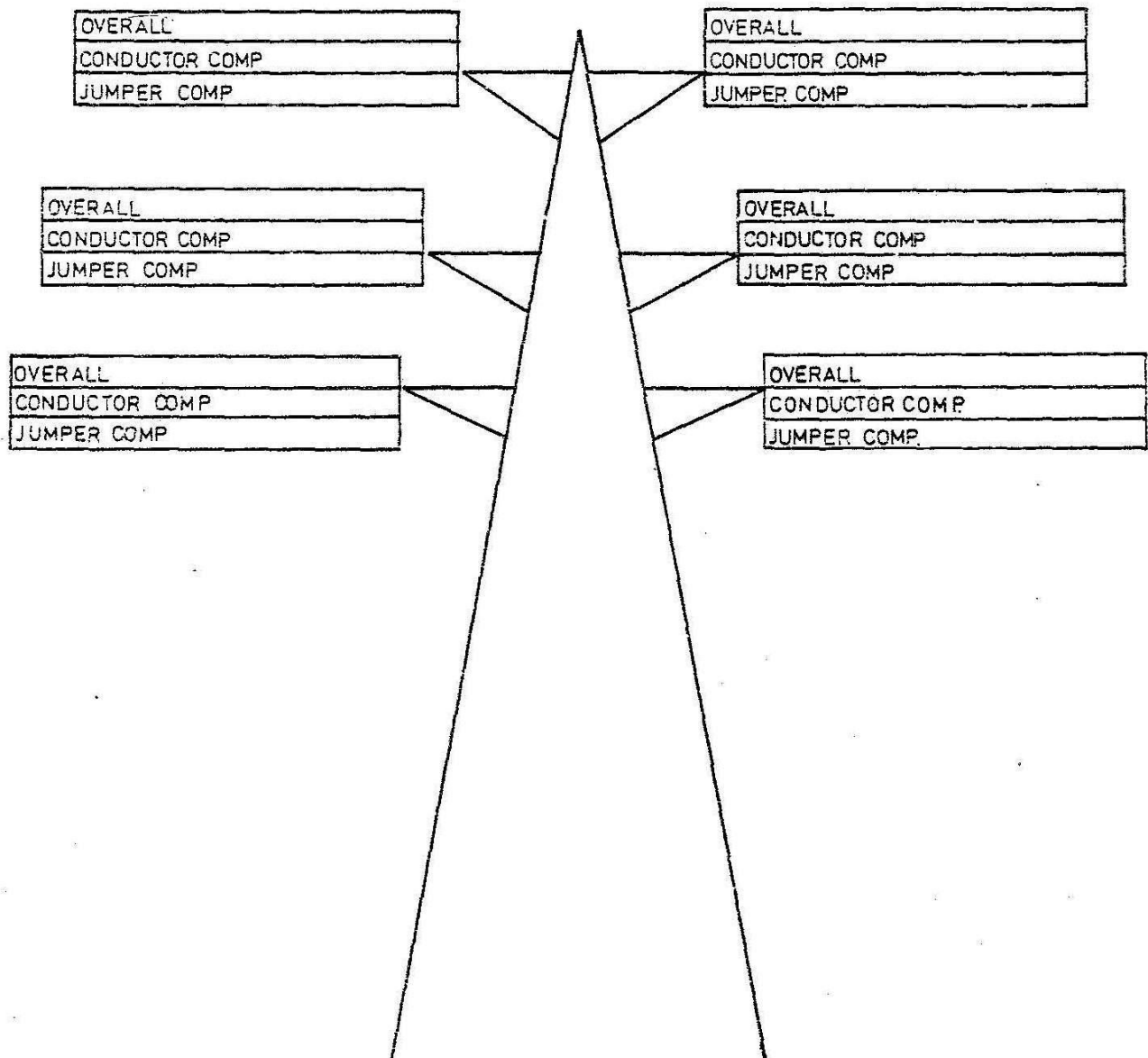


RESISTANCE CATEGORIES

- A2 ACCEPTABLE VALUE WHEN INSTALLED
- A3 ACCEPTABLE FOR NEW FITTINGS ON OLD CONDUCTOR
- R2 EXISTING FITTINGS REPLACE URGENTLY

Document Reference:-		NSP/004/122	Document Type:-		Code of Practice			
Version:-	3.0	Date of Issue:-	October 2023	Page	11	of	11	

D.M.O. JOINT TEST REPORT
SINGLE CONDUCTOR.



_____ LOWER NUMBER. TOWER NUMBER _____ HIGHER NUMBER. _____

CIRCUIT _____

CIRCUIT COLOUR _____

DATE _____

SIGNED. _____

ELECTRICAL RESISTANCE TESTING OF O/H LINE JOINTS & TERMINATIONS