

Network Standard

NETWORK

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NW000-S0038

**NS253 TERMINATION OF WIRING IN SUBSTATION PROTECTION
AND CONTROL EQUIPMENT**



ISSUE

For issue to all Ausgrid and Accredited Service Providers' staff involved with the termination of wiring in substation protection and control equipment, and is for reference by field, technical and engineering staff.

Ausgrid maintains a copy of this and other Network Standards together with updates and amendments on www.ausgrid.com.au.

Where this standard is issued as a controlled document replacing an earlier edition, remove and destroy the superseded document

DISCLAIMER

As Ausgrid's standards are subject to ongoing review, the information contained in this document may be amended by Ausgrid at any time. It is possible that conflict may exist between standard documents. In this event, the most recent standard shall prevail.

This document has been developed using information available from field and other sources and is suitable for most situations encountered in Ausgrid. Particular conditions, projects or localities may require special or different practices. It is the responsibility of the local manager, supervisor, assured quality contractor and the individuals involved to make sure that a safe system of work is employed and that statutory requirements are met.

Ausgrid disclaims any and all liability to any person or persons for any procedure, process or any other thing done or not done, as a result of this Standard.

All design work, and the associated supply of materials and equipment, must be undertaken in accordance with and consideration of relevant legislative and regulatory requirements, latest revision of Ausgrid's Network Standards and specifications and Australian Standards. Designs submitted shall be declared as fit for purpose. Where the designer wishes to include a variation to a network standard or an alternative material or equipment to that currently approved the designer must obtain authorisation from the Network Standard owner before incorporating a variation to a Network Standard in a design.

External designers including those authorised as Accredited Service Providers will seek approval through the approved process as outlined in NS181 Approval of Materials and Equipment and Network Standard Variations. Seeking approval will ensure Network Standards are appropriately updated and that a consistent interpretation of the legislative framework is employed.

Notes: 1. Compliance with this Network Standard does not automatically satisfy the requirements of a Designer Safety Report. The designer must comply with the provisions of the Workplace Health and Safety Regulation 2017 (NSW - Part 6.2 Duties of designer of structure and person who commissions construction work) which requires the designer to provide a written safety report to the person who commissioned the design. This report must be provided to Ausgrid in all instances, including where the design was commissioned by or on behalf of a person who proposes to connect premises to Ausgrid's network, and will form part of the Designer Safety Report which must also be presented to Ausgrid. Further information is provided in Network Standard (NS) 212 Integrated Support Requirements for Ausgrid Network Assets.

2. Where the procedural requirements of this document conflict with contestable project procedures, the contestable project procedures shall take precedent for the whole project or part thereof which is classified as contestable. Any external contact with Ausgrid for contestable works projects is to be made via the Ausgrid officer responsible for facilitating the contestable project. The Contestable Ausgrid officer will liaise with Ausgrid internal departments and specialists as necessary to fulfil the requirements of this standard. All other technical aspects of this document which are not procedural in nature shall apply to contestable works projects.

INTERPRETATION

In the event that any user of this Standard considers that any of its provisions is uncertain, ambiguous or otherwise in need of interpretation, the user should request Ausgrid to clarify the provision. Ausgrid's interpretation shall then apply as though it was included in the Standard, and is final and binding. No correspondence will be entered into with any person disputing the meaning of the provision published in the Standard or the accuracy of Ausgrid's interpretation.

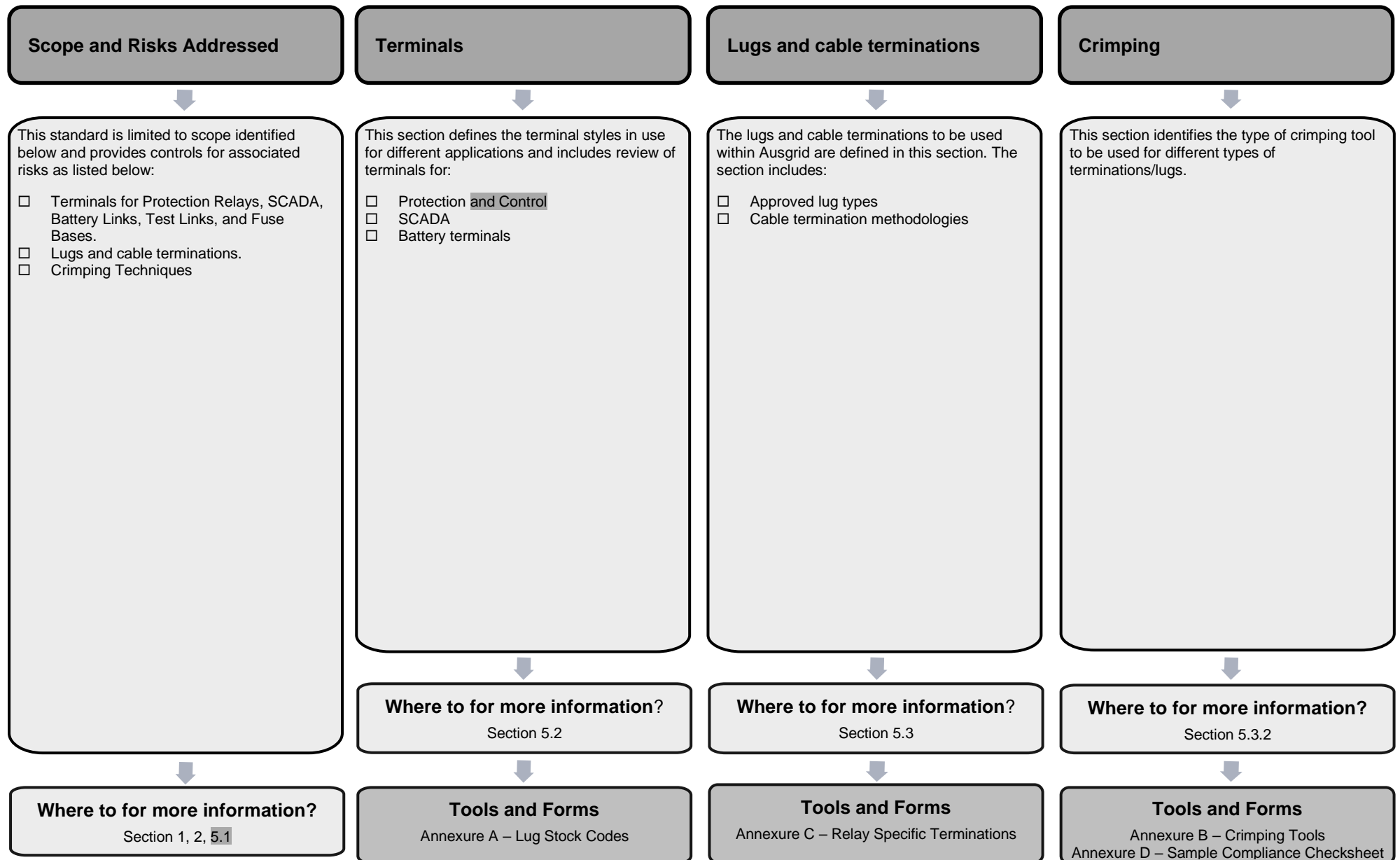
KEYPOINTS

This standard has a summary of content labelled "KEYPOINTS FOR THIS STANDARD". The inclusion or omission of items in this summary does not signify any specific importance or criticality to the items described. It is meant to simply provide the reader with a quick assessment of some of the major issues addressed by the standard. To fully appreciate the content and the requirements of the standard it must be read in its entirety.

AMENDMENTS TO THIS STANDARD

Where there are changes to this standard from the previously approved version, any previous shading is removed and the newly affected paragraphs are shaded with a grey background. Where the document changes exceed 25% of the document content, any grey background in the document is to be removed and the following words should be shown below the title block on the right hand side of the page in bold and italic, for example, Supersedes – document details (for example, "Supersedes Document Type (Category) Document No. Amendment No.")

KEY POINTS OF THIS STANDARD



Network Standard NS253 Termination of Wiring in Substations Protection and Control Equipment

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1.0 PURPOSE

This standard sets out the minimum requirements for control and protection terminals, lugs and cable termination methods used in substation wiring.

2.0 SCOPE

This standard applies to the termination of substation control and protection stranded wiring with a cross sectional area of 0.05 mm² to 16 mm².

The following is included:

- New work.
- Protection and control wiring lugs, terminals, links, fuse holders, and the associated crimping tools to be used.

The following is not included:

- The wiring in equipment supplied to Ausgrid covered by the original equipment manufacturer in which the method of wiring has been approved as part of the procurement contract, e.g. pre-wired switchgear panels and tap-changer control boxes mounted on transformers.
- Metering terminations.
- Terminations to AC Boards.

3.0 REFERENCES

All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards. Current Network Standards are available on Ausgrid's Internet site at www.ausgrid.com.au.

3.1 Ausgrid documents

- Company Form (Governance) - Network Document Endorsement and Approval
- Company Procedure (Governance) - Network Document Endorsement and Approval
- Company Procedure (Network) - Production / Review of Network Standards
- Electrical Safety Rules
- Electricity Network Safety Management System Manual
- NS181 Approval of Materials and Equipment and Network Standard Variations
- NS203 Telecommunications: Master Policy Document
- NS212 Integrated Support Requirements for Ausgrid Network Assets
- NS250 Secondary Systems – Requirements for CT, VT and tripping circuits
- NS251 Requirements for cables between panels
- NS252 Secondary Systems – Requirements for wiring within panels

3.2 Other standards and documents

- AS 4437 Solderless crimped connections – General requirements, test methods and practical guidance
- AS 4325.1 Compression and Mechanical Connectors for Power Cables With Copper or Aluminium Conductors
- ENA Doc 001-2008 National Electricity Network Safety Code

3.3 Acts and regulations

- Electricity Supply (General) Regulation 2014 (NSW)
- Electricity Supply (Safety and Network Management) Regulation 2014
- Work Health and Safety Act 2011 and Regulation 2011

4.0 DEFINITIONS

Accredited Service Provider (ASP)	An individual or entity accredited by the NSW Department of Planning and Environment, Energy, Water and Portfolio Strategy Division, in accordance with the Electricity Supply (Safety and Network Management) Regulation 2014 (NSW).
Approved Materials List (AML)	A dynamic list of materials and equipment approved (at that point in time) for installation on Ausgrid's network, a supporting document to NS181 Approval of Materials and Equipment and Network Standard Variations.
Business Management System (BMS)	An Ausgrid internal integrated policy and procedure framework that contains the approved version of documents.
Crimp	An electrical connector that is compressed onto a conductor.
Document control	Ausgrid employees who work with printed copies of document must check the BMS regularly to monitor version control. Documents are considered "UNCONTROLLED IF PRINTED", as indicated in the footer.
Link	A pair of terminals in-line with a wire connection that serves as a point for the electrical separation of a circuit, usually consisting of a screw-tightened sliding connector between the terminals.
Lug	A conducting fitting that can be connected to an electrical conductor.
Network Standard	A document, including Network Planning Standards, that describes the Company's minimum requirements for planning, design, construction, maintenance, technical specification, environmental, property and metering activities on the distribution and transmission network. These documents are stored in the Network Category of the BMS repository.
Panel	The cubicle in/onto which protection and control equipment is mounted. Panel may also refer specifically to the front sheet metal to which relays are mounted and then fixed to the rest of the cubicle.
Review date	The review date displayed in the header of the document is the future date for review of a document. The default period is three years from the date of approval however a review may be mandated at any time where a need is identified. Potential needs for a review include changes in legislation, organisational changes, restructures, occurrence of an incident or changes in technology or work practice and/or identification of efficiency improvements.
Terminal	A point of connection in an electric circuit for one or more wire ends or connectors.

5.0 TERMINATION OF WIRING

5.1 General

A basic summary of the requirements in this document is as follows:

- All protection and control wiring terminations must meet the requirements of AS 4437 or AS 4325.1.
- Compression type solderless lugs shall be used at the terminations of all stranded wires.
- The lugs shall be manufactured from high conductivity copper.
- The correct size lug shall be used to suit the wire size.
- Only lugs with a pre-insulated crimp barrel shall be used to prevent direct or accidental contact with adjacent terminations.
- The un-lugged termination of bare wire strands into terminals is not permitted.
- All lugs shall be crimped with the correct compression crimping tool recommended by the lug manufacturer.
- Under no circumstances shall lugs be bent, filed, cut or modified in any way to fit a termination. The lug's insulation shall not be removed.

5.2 Terminals

5.2.1 Protection and control terminals

Terminals for protection and control connections are required to meet the performance criteria outlined in Table 1 (see drawing 50993 for further details).

Table 1 – Performance Criteria

Parameter	Preferred	Alternative (retrofits and to match existing installations)
Connection type	M5 stud	M6 stud
Current carrying capacity, continuous	30 A	30 A
Insulation voltage withstand	500 V	500 V
Temperature index of insulating material (minimum)	120 °C	120 °C
Stud material	Passivated stainless steel (18/8 family)	Passivated stainless steel (18/8 family)
Nuts and washers	Passivated stainless steel (18/8 family)	Passivated stainless steel (18/8 family)
Links, link plates	Passivated stainless steel (18/8 family)	Passivated stainless steel (18/8 family)

Note: 18/8 is also known as 300 series (type 304, 305, 316) and consists of 18% chromium & 8% nickel.

To reduce the propensity for galling nuts should only be driven at low speed by hand. The threads should be clean and smooth and the correct torque applied.

5.2.1.1 General protection terminals (not including wiring in OEM supplied packages)

Terminals for protection connections are required to accept ring terminals using a dual bolt, nut and bolt connection terminal block with M5 studs (e.g. Utilux H3820 terminals as per Figure 1). Slotted screw terminals are not to be used due to the risk of either slot damage or subsequent under-torquing due to a damaged slot.

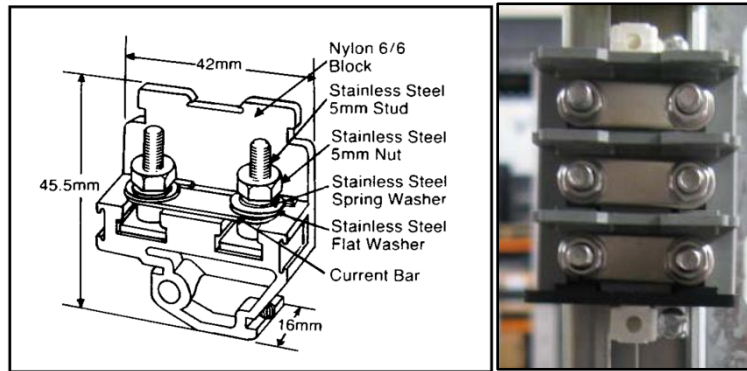


Figure 1: Utilux H3820 Dual Stud Terminals

5.2.2 SCADA terminals

SCADA wiring is generally a smaller cross sectional area than control and protection cabling and hence dual post terminals are not necessary for use as terminals for SCADA. Terminal blocks with DIN rail mountings (e.g. Weidmuller Din Rail Mount Terminals as per Figure 2) are generally used for termination of SCADA and associated control wiring.



Figure 2: Example Weidmuller SAKR Terminals

5.2.3 Moulded links

Where moulded links are installed in protection or control circuits they shall have an M5 or M6 stud size and be installed as shown in Figure 3 and Figure 4 respectively (unless specified differently by the manufacturer of the link).

Moulded links are to be mounted such that if the sliding section is loosened it will fall to the open position.

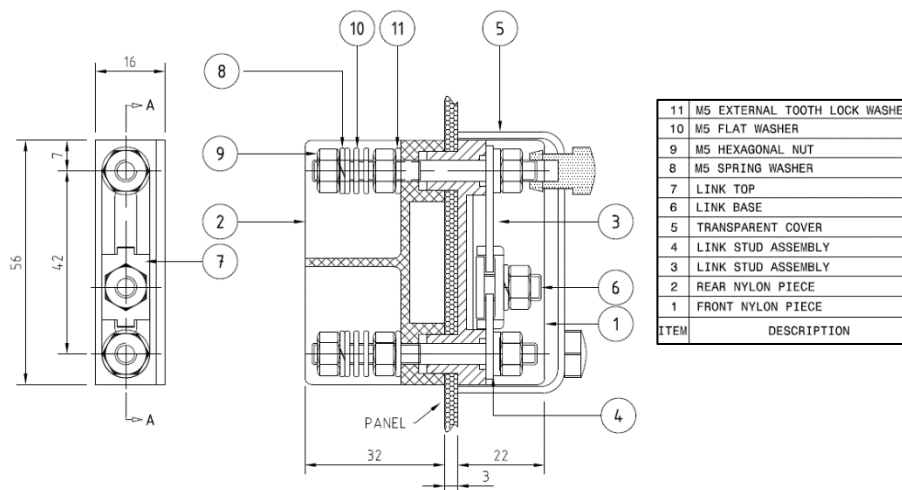


Figure 3: M5 Moulded Type Link Assembly (drawing 507111)

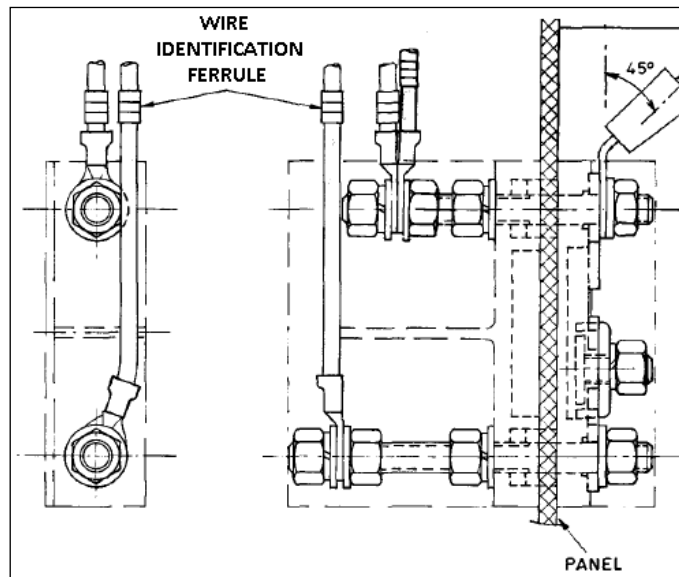


Figure 4: Moulded type link assembly (drawing 38841)

The main panel terminations to moulded links shall use the nut/washer combination as shown in Figure 5 wherever practical. When terminated all connections must have at least one thread of the stud protruding from the end of the nut. All lug termination nuts shall be torqued with a torque wrench to the correct value for the size and material of the stud. Unless otherwise specified by the manufacturer, nuts shall be torqued to 4nm for M5 and M6 studs.

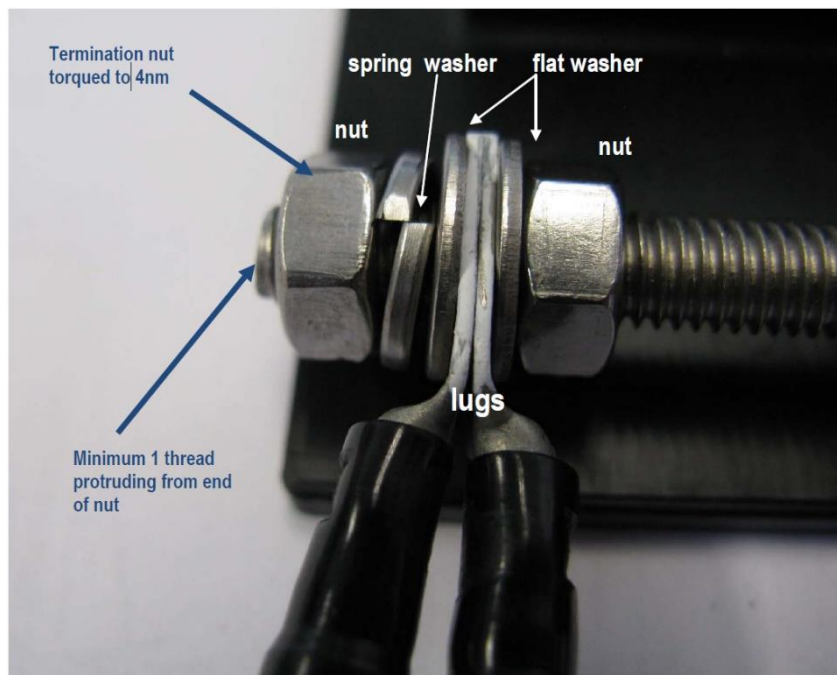


Figure 5: Connections on to a stud

The front of all links should be checked to ensure that all washers are present, nuts are free to move and sliding link will fall open.

5.2.3.1 Anti-seize

The use of anti-seize is permissible on stainless steel links to prevent galling and cold welding. The anti-seize product must be suitable for use with stainless steel, non-reactive, chemical resistant and suitable for high temperature environments.

5.2.3.2 Tightness checks

All link nuts to be tightened with a correct size socket driver (e.g. PE test spanner shown in Figure 6) and tightness to be checked (e.g. as per Figure 7), after the cable connections have been made and the links have settled.



Figure 6: PE test spanner



Figure 7: PE Test Spanner being used to check back panel holding nut

5.2.3.3 CT shorting security nut

To prevent shorting and earthing the wrong side of a mandatory CT link, CT shorting security nuts (Figure 8) will be installed on the non-CT side of mandatory CT links. Security nuts cannot be removed with standard tools.



Figure 8: CT shorting security nut and tool

5.2.4 Red spot back stud connected fuse holder

Wiring connected to the 6 mm stud employs the same techniques as for the moulded test links. Red spot fuses are supplied with brass half nuts; these are to be replaced with brass full nuts.

5.3 Lugs and cable terminations

5.3.1 Termination types

All terminations (except bootlace) must utilise pre-insulated crimp barrel lugs (as per AS 4437). The lugs and terminals used throughout Ausgrid must be appropriately chosen for the application. See manufacturers' manuals and AML.

All lugs should be chosen correctly to fit the size of the conductor and under no circumstances should lugs be modified in any way to fit a termination including bending and trimming the lugs.

5.3.1.1 Solid barrel lugs

Solid barrel ring lugs constructed from seamless annealed copper tubes, as per Figure 9, are preferred for terminating protection cabling to stud type terminal blocks (e.g. Utilux H3820) and non-captive / captive screw type relay terminals.

The appropriate palm construction (i.e. flat or 90 degree) must be chosen for the relay type, see Annexure C for guidance.

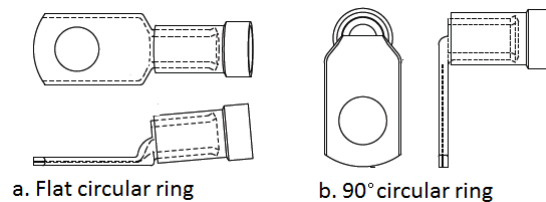


Figure 9: Acceptable solid barrel pre-insulated cable terminations

5.3.1.2 Split barrel lugs

Double grip split barrel ring lugs manufactured from annealed copper are permitted in lieu of solid barrel lugs for control and protection wiring if constructed as shown in Figure 10, i.e. includes an additional copper sleeve.

Double grip split barrel flat blade lugs manufactured from annealed copper are permitted in lieu of double bootlace lugs for protection and control wiring where the double bootlace lug cannot fit into the terminal or exerts unacceptable pressure on the adjacent terminations.

Double grip split barrel fork lugs are only permitted for control wiring where terminating onto clamp type receptacles on auxiliary relays where:

1. The screw penetrates the clamp plate and cannot be removed; and,
2. Utilisation of a bootlace lug results in inadequate contact pressure between the lug and terminal.

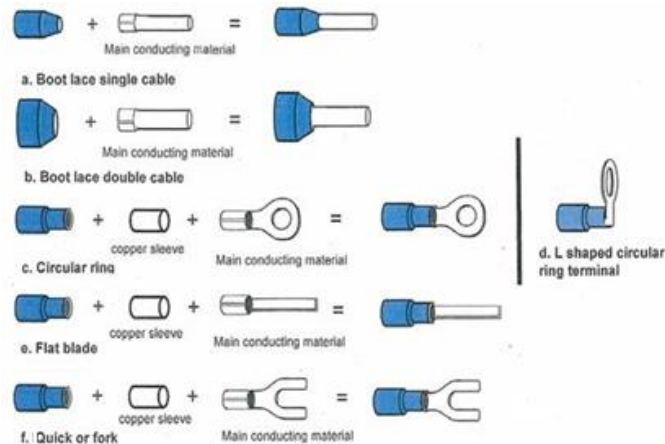


Figure 10: Acceptable double grip split-barrel and bootlace pre-insulated cable terminations

5.3.1.3 Bootlace lugs

Bootlace lugs manufactured from annealed cooper are only permitted for protection and control wiring where terminating onto clamp type receptacles, i.e. screw and plate terminals or where the terminal screws make direct contact onto the crimp (e.g. Phoenix terminals as shown in Figure 11).



Figure 11: Phoenix terminal block

Double bootlace lugs are acceptable for use on clamp type receptacles; provided that the termination does not impinge on the adjacent terminations or relay case and a visible separation is available between the termination and the adjacent termination or receptacle. The equivalent clearance must be maintained even if the adjacent receptacle is not in immediate use, so that the adjacent receptacle may be used in the future.

5.3.2 Cable termination crimping

Cables shall be terminated in the following way:

- Stranded conductors shall be terminated by means of approved pre-insulated crimp lugs that comply with 5.3.1.
- The conductive parts of all terminations shall comprise of electro-tinned annealed copper.

Washers and spring washers or other approved locking devices shall be used on all terminations, as per Section 5.2. See Annexure C for the relay specific terminations and maximum number of connections per terminal.

Cable insulation shall be stripped using the appropriate wire strippers (pliers and side cutters are not permitted to strip insulation). Refer to Figure 12 for correct stripping procedure. Care must be taken to ensure that the wire be stripped to the correct length for the copper barrel of the lug.

Each cable core shall have sufficient spare length to allow for replacement of the crimp lug if required.

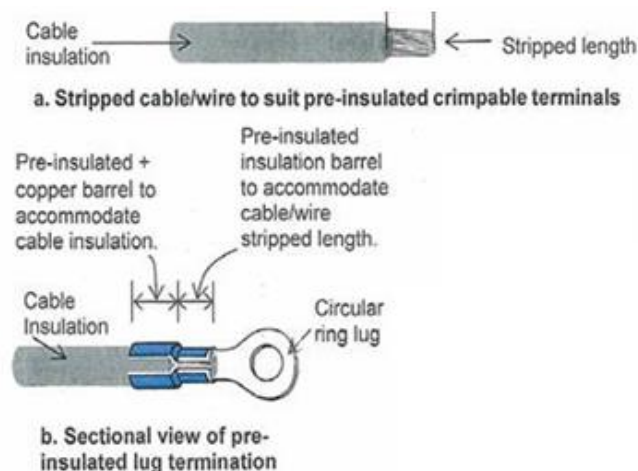


Figure 12: Recommended wire stripping for pre-insulated cable termination

All lugs shall be crimped with the correct crimping tool (using a single action) for the lug type and size intended to be used and recommended by the lug manufacturer or as approved for use by

Ausgrid. On solid barrel lugs the crimp should be made in the middle of the top side of lug, unless otherwise instructed by the lug manufacturer, to ensure correct crimping is achieved.

On completing all crimps a visual inspection and pull test shall be carried out to ensure that there is no movement of the wire inside the ferrule within the crimped connection. The lug or stud shall then be marked with a marking pen to indicate that it has been checked.

5.3.3 Cable sheath terminations

Where screened multi-core cables are required to be connected to earth they are to be terminated as per Ausgrid drawings 140401 and 140402.

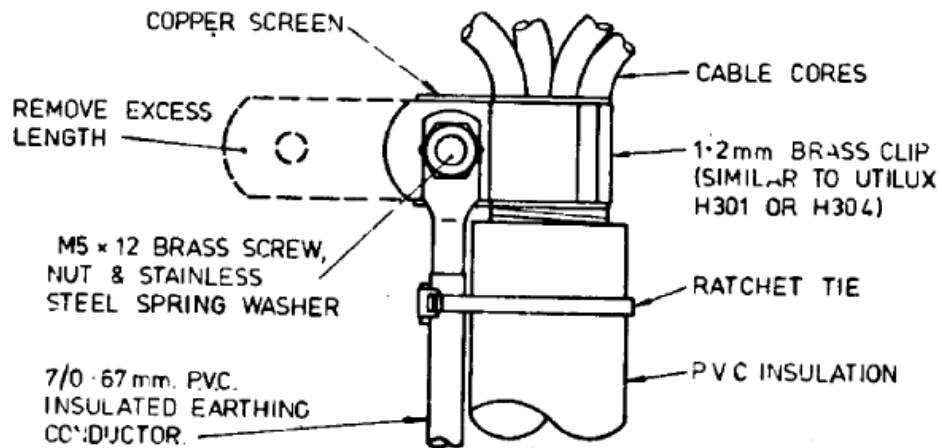


Figure 13: Extract from Ausgrid drawing 140402

5.4 Exclusions

5.4.1 Splicing joining

Under no circumstances will jointing or splicing of protection (including current transformer and voltage transformer circuits) or control cables be allowed. Protection and control cabling should be continuous from source to destination.

Where continuous cables are not practical connection shall be achieved via terminal blocks firmly secured to the structure of the panel or marshalling cubicle.

5.4.2 Terminals in OEM / pre-built packages

The terminals and terminations used in these circumstances must conform to AS 4437 or AS 4325.1 or an equivalent international standard.

6.0 RECORDKEEPING

The table below identifies the types of records relating to the process, their storage location and retention period.

Table 2 – Recordkeeping

Type of Record	Storage Location	Retention Period*
Approved copy of the network standard	BMS Network sub process Standard – Company	Unlimited
Draft Copies of the network standard during amendment/creation	HPRM Work Folder for Network Standards (HPRM ref. 2014/21250/254)	Unlimited
Working documents (emails, memos, impact assessment reports, etc.)	HPRM Work Folder for Network Standards (HPRM ref. 2014/21250/254)	Unlimited

* The following retention periods are subject to change e.g. if the records are required for legal matters or legislative changes. Before disposal, retention periods should be checked and authorised by the Records Manager.

7.0 AUTHORITIES AND RESPONSIBILITIES

For this network standard the authorities and responsibilities of Ausgrid employees and managers in relation to content, management and document control of this network standard can be obtained from the Company Procedure (Network) – Production/Review of Network Standards. The responsibilities of persons for the design or construction work detailed in this network standard are identified throughout this standard in the context of the requirements to which they apply.

8.0 DOCUMENT CONTROL

Content Coordinator : Manager - Secondary Systems

Distribution Coordinator : Senior Engineer – Guidelines, Polices and Standards

Annexure A - Lug Stock Codes

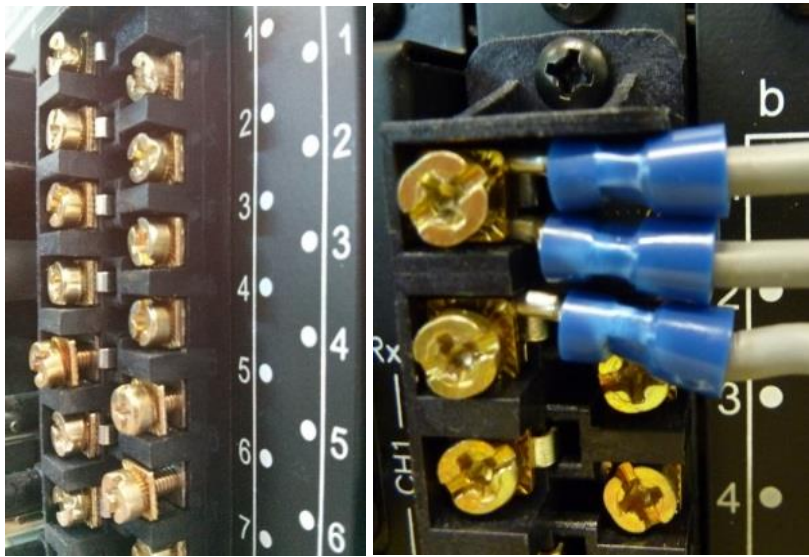
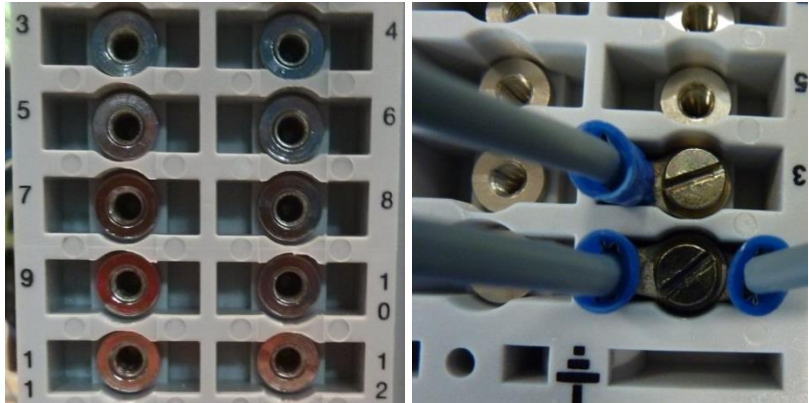
See NS181 Approval of Materials & Equipment and Network Standard Variations.

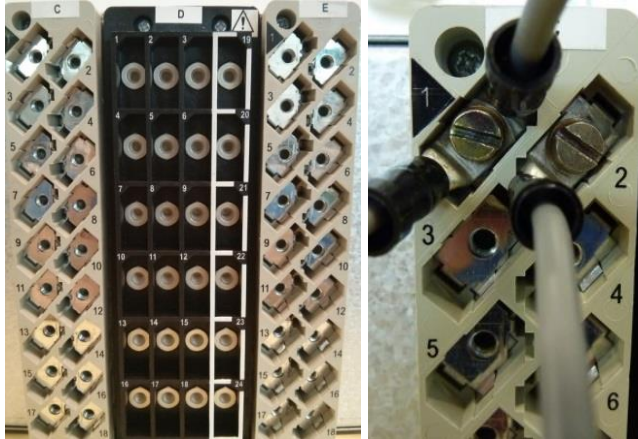
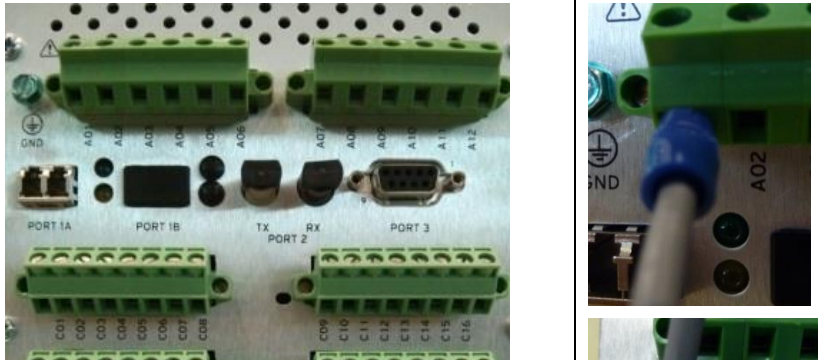
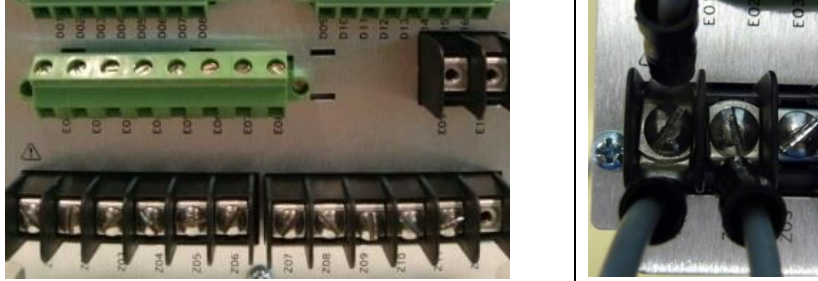
Annexure B - Crimping Tools

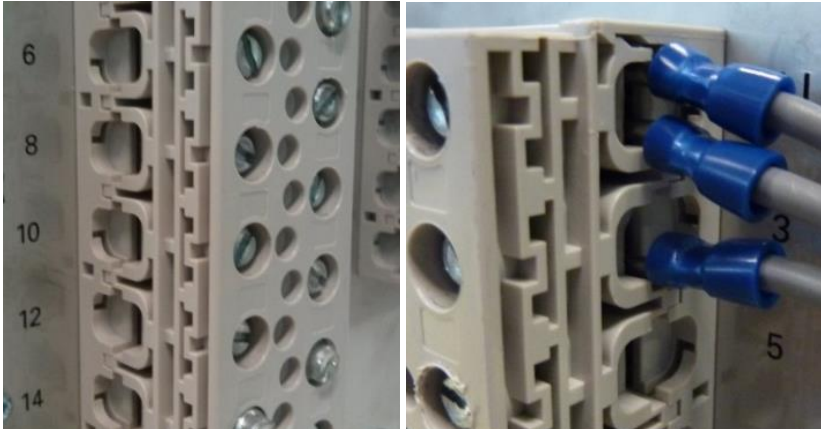
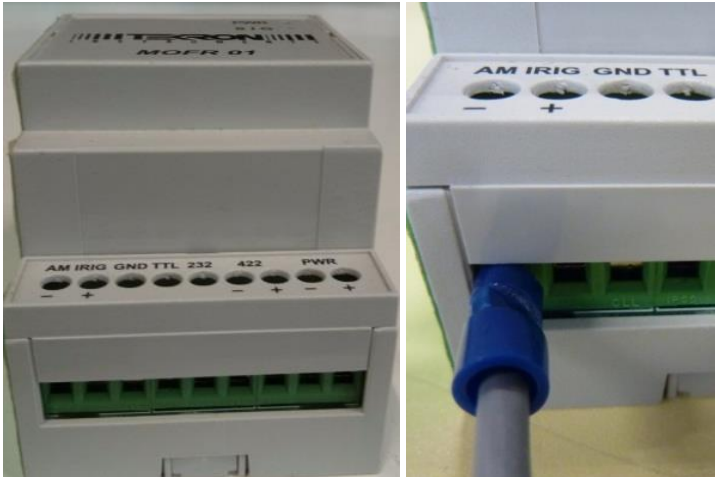
Terminations are to be crimped using methods and tools as approved by the manufacturer or as risk assessed by H-AEPS. See NS181 Approval of Materials & Equipment and Network Standard Variations.

Annexure C - Relay Specific Terminations

C1 Table of relay terminals





Manufacturer	Example Relay Type	Termination Type	Lug	Max No. Connections	Example Common Relay Terminals
GE	C70 L90 T60	Screw	M4 90° Ring	2	
		Screw and Plate	Bootlace	2	
RMS	2C63K12 2V164 3A32KXX TR12	Screw	M4 90° Ring	2	

Manufacturer	Example Relay Type	Termination Type	Lug	Max No. Connections	Example Common Relay Terminals
Schneider	P142 P545	Screw	M4 90° Ring/Blade	2	
SEL	SEL 241101 SEL 751 SEL 787	Screw	90° Ring	2	
		Screw and Plate	Bootlace	1	
SEL	SEL 2505 SEL 2506 SEL 25943C3XX SEL 259503C31X SEL 487E	Screw and Plate	Bootlace	2	

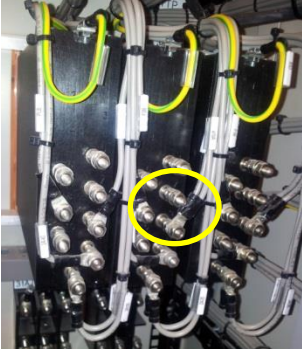
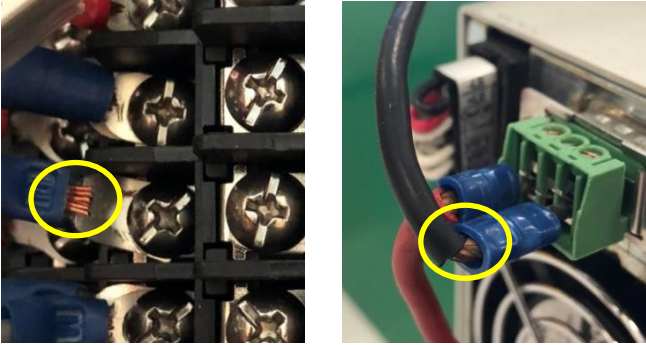

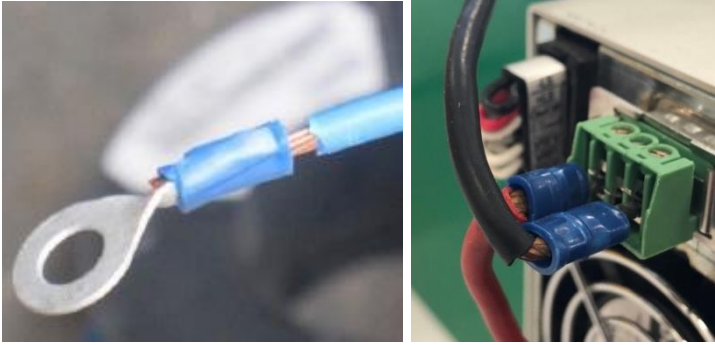

Manufacturer	Example Relay Type	Termination Type	Lug	Max No. Connections	Example Common Relay Terminals
Siemens	7SD610	Screw and Plate	Bootlace M4 Ring	2	
Tekron	ITR D2-3K, TTM01-E T2-TL60- NLA	Screw and Plate	Bootlace	1	

C2 Multiple lugs on one terminal

If two lugs need to be connected to the same terminal, they shall be connected in the following arrangements.

Termination Arrangement	
<p>Back to back.</p>	
<p>On top same way (one straight one right angle).</p>	
<p>On top, offset by 90° or 180°.</p>	
<p>Three lugs per terminal will only be accepted where the stud is long enough, and an alternate connection is not available. If required, two lugs shall be oriented back to back with the third offset by 90° or 180°.</p>	

C3 Unacceptable terminations

Unacceptable Terminations	
<p>Insufficient gap between terminals & adjacent lugs</p>	
<p>Wires not stripped to the correct length</p>	
<p>Termination crimped with incorrect crimping tool</p>	
<p>Termination not gripping the insulation</p>	
<p>Lugs modified in any way, for example bent by hand or with pliers</p>	

Annexure D – Sample Compliance Checklist



Network Standard Compliance Checklist Form

NS253 Wiring of terminations in substation protection and control equipment

Project Identification:	
Prepared by:	Date:

This checklist is for internal Ausgrid use only and does not apply to ASPs or contractors who have specific compliance requirements in relation to Contestable project works. The checklist is unique for each network standard and is available within BALIN and the BMS as a separate form that can be amended as required, completed and saved in TRIM with the other project documentation.

This section is used to identify compliance checks that when applied to the work associated with this Network Standard will satisfy an audit process to establish that the requirements of the standard have been followed. It is expected that applicable items would normally be checked as Comply (Yes) as non-compliance is generally not tolerated.

Where non-compliance is the result of specific site conditions or design decisions this needs to be identified in the notes section of the form for each non-compliance and approval sought from an appropriately authorised Ausgrid manager responsible for design approval per NS261 Compliance Framework for Network Standards.

Should additional information be available to document non-compliance decisions, these can be attached to the checklist form. The checklist and any attached explanatory notes should be saved in the project document repository.

Item	Description	Refer Clause	Completed/ Actioned
Scope			
	The purpose of this standard is to standardise the types of cable termination methods, lugs, and crimping tools used across the Ausgrid Network in the wiring of substation control and protection panels and other related substation equipment. This standard applies to the termination of substation control and protection stranded wiring with a cross sectional area of 0.05 mm ² to 16 mm ² as per AS 4437 or AS 4325.1 Solderless crimped connections – General requirements, test methods and practical guidance.		
	The following is included: <ul style="list-style-type: none"> • New work • Secondary wiring lugs, terminals, links, fuse holders, and the associated crimping tools to be used 		
	Not included is wiring in equipment supplied to Ausgrid covered by purchase orders or period contracts in which the method of wiring has been approved as part of the contract; metering terminations; AC boards.		
Terminals			
1	Compression type solderless, high conductivity copper lugs used at terminations of all stranded wires.	5.1	Yes/No/NA
2	Bare wire strands directly into terminals not permitted.	5.1	Yes/No/NA
3	Correct sized lug used to suit the wire size.	5.1	Yes/No/NA
4	Lugs crimped with the correct crimping tool.	5.1	Yes/No/NA
5	Shank of lugs protected using insulated tubing.	5.1	Yes/No/NA

Item	Description	Refer Clause	Completed/ Actioned
6	Lugs not modified in any way to fit terminal blocks.	5.1	Yes/No/NA
7	Dual bolt, nut and bolt connection terminal block with M5 studs (e.g. Utilux H3820 terminals) employed for protection wiring.	5.2.1.1	Yes/No/NA
8	Weidmuller type terminals used for termination of SCADA wiring.	5.2.1.2	Yes/No/NA
9	Moulded links mounted so that sliding section falls to open position.	5.2.2	Yes/No/NA
10	Stainless steel washers, nuts, spring washers and studs used for battery and test links.	5.2.2	Yes/No/NA
11	Red spot fuse holders fitted with full brass nuts.	5.2.4	Yes/No/NA
	Lugs and Cable Terminations		
12	All protection and control cabling terminated using pre-insulated solid barrel lugs or double grip split lugs.	5.3.1	Yes/No/NA
13	Joining or splicing of protection and control cables is not permitted.	5.3.2.1	Yes/No/NA
14	Conductive parts of all terminations consist of copper material with tinned electroplating.	5.3.2	Yes/No/NA
15	Wiring in panels complies with NS252	5.3.2	Yes/No/NA
16	All crimping performed with the correct crimping tool for the application.	5.3.2	Yes/No/NA

Notes:

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