Electricity Engineers' Association

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TECHNICAL GUIDE: PORTABLE EQUIPMENT FOR WORK ON OR NEAR CONDUCTORS

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HEALTH + SAFETY
ASSET MANAGEMENT
PROF DEVELOPMENT
NCLW + LIVE WORK

Technical Guide

Portable Equipment for Work On or Near Conductors

Issued and published by the Electricity Engineers' Association of New Zealand (Inc.) (EEA).

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This guide has been prepared by representatives of the electricity supply industry to provide guidance on safety practices for use by the industry.

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Status of examples and case studies

Examples, including sample processes, or case studies in this guide are included to assist with consideration of health and safety issues. The examples or case studies are not a comprehensive statement of matters to be considered, nor steps to be taken, to comply with any statutory obligations pertaining to the subject matter of this guide.

Preface

The April 2024 issue of the *Guide to Portable Equipment for Work On or Near Conductors* has been reviewed and updated. The key amendments are:

- new section on low voltage (LV) bonds
- updates to include LV bonds references
- minor amendments to bring in line with updated guides and *Safety Manual – Electricity Industry (SM-EI*

Purpose

This Technical Guide *Portable Equipment for Work On or Near Conductors* provides guidance on, and clarifies issues and requirements relating to the terminology for, selected purchase specification, and the inspection and testing requirements of portable equipment used on:

- high voltage (HV) conductors for the purpose of isolation, testing, and earthing, and
- low voltage (LV) conductors for temporary insulation, application of LV bonds.

This guide is an 'industry procedure' as defined in the Safety Manual – Electricity Industry (SM-EI) and provides a recommended method of achieving SM-EI requirements for portable equipment used near conductors. Specific and general requirements of SM-EI must also be followed when selecting and using portable equipment near conductors, and work in association with such work, and are not repeated in this guide.

Note: This technical guide does not apply to equipment used for live work in accordance with ECP 46.

Definitions

The reference documents listed in Section 1 contain defined terms. The following definitions apply throughout this guide:

Associated equipment: As defined in the Electricity Act 1992, Section 2 (Interpretation) and means any equipment that is used, or designed or intended for use, in connection with any works or electrical installation, where such use is for construction, maintenance, or safety purposes and not for purposes that relate directly to the generation, conversion, transformation, conveyance, or use of electricity.

Earthing device: An approved device used for temporary earthing of isolated conductors. Examples include portable earths, earth switches, integral earthing and earthing trucks.

Note: Such devices include earth switches, earthing trucks and approved portable earths.

Portable earth / temporary earth: An approved portable earthing device for temporarily earthing isolated equipment.

Notes:

1. For three phase A.C., a "set of earths" consists of portable earths that, when applied, effectively short-circuit the three phases as well as connecting them to earth.
2. It does not include earthing trucks or other earthing devices supplied or designed for use on specific equipment.

LV bonds / LV bonding: A device used to electrically interconnect all LV conductors to bring then to the same potential.

Scope

This guide covers the following portable equipment as used in the electricity supply industry:

- Cable spiking equipment
- Competent Persons
- Insulating gloves
- Ladders used for accessing conductors
- Low Voltage insulating covers and mats
- Measurement devices
- Operating sticks or rods
- Portable / Temporary earths
- LV bonds
- Records
- Voltage Detection Devices (VDDs)

The guide covers purchasing, maintenance, pre-use inspection, and periodic inspection and testing. It does not cover the actual use of the equipment, or the suitability of particular items of equipment for particular tasks.

The content of this guide will be monitored and revised periodically. Suggestions for changes should be sent to admin@eea.co.nz or Electricity Engineers' Association, P O Box 5324, Wellington, 6145, www.eea.co.nz.

Contents

1. Legislative and Other Related Requirements

The requirements for the terminology used, and inspection and testing requirements of portable equipment used in the electricity supply industry, are governed by specific acts, regulations, codes of practice, standards and industry “best practice” guidelines.

2. Acts and Regulations

Electricity Act 1992: Provides definition of associated equipment and general provisions.

Electricity (Safety) Regulations 2010.

3. Electrical Code of Practice

Electrical Code of Practice for High Voltage Live Line Work (ECP 46): Part 1 of ECP 46 covers ‘Glove and Barrier’ work. Section 2.6.3 of the code covers ‘Insulating Gloves and Sleeves’.

Industry “Best Practice” Guidelines

(a) Safety Manual – Electricity Industry (SM-EI):

(b) EEA Technical guide: Guide to Live LV Electrical Work: This guide ‘Guide to Live LV Electrical Work’ provides the requirements for carrying out live LV work on electricity supply industry assets. It also covers the inspection and test requirements for safety equipment used for live LV work.

(c) EEA Technical Guide: Guide to Work on De-Energised Distribution Overhead Lines: This guide *‘Guide to Work on De-Energised Distribution Overhead Lines’* provides the requirements for the earthing of HV and Bonding of LV overhead distribution lines, including the use of portable earths and LV Bonds.

It refers to the *‘Guide for Portable Equipment for Work On or Near Conductors’* for specific requirements for portable earths and other portable equipment associated with work on poles, e.g. insulating gloves and cover-up.

4. Insulating Gloves

Guidelines for the inspection and testing of insulating gloves are contained in NZECP 46: (2003) *High Voltage Live Line Work*, ASTM F496-14a *Standard specification for in-service care of insulating gloves and sleeves* and in the EEA guide, *Guide to Live LV Electrical Work (2017)*. The requirements of ECP 46 shall be followed for all high voltage live line work.

In addition, the requirements for insulating gloves shall be followed for relevant situations where insulating gloves are used. In particular, the requirements for testing, including test intervals, shall apply.

4.1 Standards

Standards relating to insulating gloves and protectors include:

- AS 2225:1994 Insulating gloves for electrical purposes.
- AS/NZS 2161.1:2016 Occupational protective gloves – Selection, use and maintenance.
- ASTM D120-14a (2014) Standard specification for rubber insulating gloves.
- ASTM D1051-14a (2014) Standard specification for rubber insulating sleeves.
- ASTM F696-06(2011) Standard specification for leather protectors for rubber insulating gloves and mittens.
- IEC 60903:2014 Live working, Electrical insulating gloves.

Standards for in-service inspection include:

ASTM F496-14a Standard specification for in-service care of insulating gloves and sleeves.

ASTM F1236-18 Standard guide for visual inspection of electrical protective rubber products.

4.2 Specifications

Not used.

4.3 Marking

Insulating gloves, or their container, shall be marked with their maximum safe working voltage, and their next due date for test.

4.4 Before Use Inspection

Immediately before use, insulating gloves shall be visually examined for signs of damage, deterioration and legibility of marking. The insulating gloves shall then be stretched by hand to ensure that mechanical strength is adequate, and then tested by rolling the insulating glove from the cuff to force air into it and checking for leaks. Best practice supports the air test procedure being repeated with the gloves turned inside out to ensure there is no leak which is temporarily sealed by the initial test. Refer to the manufacturer's instructions for further advice on this procedure.

The due date for test shall be checked to ensure it has not passed.

If the equipment has any defect or its test due date has passed, it shall be withdrawn from service, tagged as faulty, and not used until repaired or tested. If not repairable, it shall be destroyed. Defects include cuts, snags, cracks, burns, ozone cutting, ozone checking, swelling, abrasions, contamination from injurious materials, and lost elasticity.

4.5 Periodic Inspection and Tests

At six monthly intervals, gloves and sleeves shall be tested as required by ASTM F496 or equivalent.

4.6 Storage

Insulating gloves shall be stored unfolded in a separate clean container or durable bag, in a cool, dry place not subject to direct sunlight.

Insulating gloves shall not be stored inside leather protective gloves.

4.7 Cleaning and Drying

Gloves shall be cleaned only with mild soap and water or mild dishwashing detergent, or other cleaner approved by the supplier. Petrol, kerosene, white spirits, acid-based products, etc shall not be used. Soaps, detergents, and bleaches shall not be used at strengths that would attack or harm the rubber surface.

After washing, the gloves shall be thoroughly rinsed and dried.

Mild household type chloride bleach may be used for disinfecting purposes.

Gloves that have become wet must be dried thoroughly, but not in a manner that will cause the temperature of the gloves to exceed 65ºC.

4.8 Harmful Liquids

Gloves coming into contact with acids, alkalis, creosote, grease, oil, petrol, or mineral turpentine shall be discarded or thoroughly cleaned as above, followed by an electrical test. Where compounds such as tar or paint continue to stick to the gloves, the affected parts may be wiped with a suitable solvent, avoiding excessive solvent use, and then immediately water washed and treated. Petrol, kerosene or white spirit shall not be used to remove such compounds

4.9 Over gloves

Over gloves shall be inspected before use to ensure they do not contain any sharp objects embedded in them. They shall also be in good condition.

4.10 Repairs

Gloves may be patched or repaired in the gauntlet area only. For repairs, the requirements of ASTM F 496-14a (2014) Standard specification for in-service care of insulating gloves and sleeves shall be complied with.

5. Voltage Detection Devices (VDDs)

VDDs shall be used with operating sticks or rods appropriate to the voltage and with sufficient insulating length to ensure the minimum approach distance is not encroached.

5.1 Standards

Standards for the purchasing of VDDs include:

- ASTM F1796-09(2014) Standard Specification for High Voltage Detectors – Part 1: Capacitive Type to be Used for Voltages Exceeding 600 Volts AC
- IEC 61243-1:2003 Live working – Voltage detectors – Part 1:
- Capacitive type to be used for voltages exceeding 1kV AC.
- IEC 61243-2:1995 Live working - Voltage detectors - Part 2:
- Resistive type to be used for voltages of 1kV to 36kV AC.
- IEC TR 61243-6:2017 Live working - Voltage detectors - Part 6: Guidelines on non-contact voltage detectors (NCVD) for use at nominal voltages above 1 kV AC

5.2 Specifications

5.2.1 Type

VDDs may be either the direct contact type or the non-contact type. The non-contact type must be able to withstand contact with live conductors.

5.2.2 Indication

VDDs shall give a clear, definite and unambiguous indication to the user when a voltage is detected. The indication must be effective in all circumstances, e.g. direct sunlight, at night, in all weather conditions, and in high noise conditions, such that the operator receives the indication when at the end of the operating stick or rod.

VDDs should provide both visual and audible indications. The indication must be independent of the orientation of the VDD.

5.2.3 Proving Device

VDDs shall be supplied with, or incorporate, a proving device for the user to establish that the VDD works correctly at the time of use.

Note that for some VDDs the proving device tests only the electronic circuitry and not the overall integrity of the device.

5.2.4 Test Certificate

VDDs shall be supplied with a test certificate or evidence that the manufactured product conforms to the relevant standard.

5.2.5 Operating Sticks or Rods

Operating sticks or rods which can be separated from the VDD shall comply with the requirements of section 6.

5.3 Marking and Instructions

VDDs shall be clearly and indelibly marked or labelled with:

- the manufacturer's name
- the nominal system voltage or range of voltages for which the VDD is suitable, and
- the next date on which a test is due, or a unique number for inclusion in a register.

Instructions for use shall be provided as required by the manufacturing standard.

Instructions for use for capacitive voltage detectors shall include information on the minimum distance to be maintained from conductor angle changes to avoid false 'voltage not present' indications.

5.4 Before Use Inspection

Before each use the VDD shall be visually examined for signs of damage, deterioration, cracks or scratches in insulation (particularly on the operating stick or rod), and legibility of marking. The due date for the next test shall be checked to ensure it has not passed.

The operation of the VDD shall be checked immediately before and after it is used. Such checks may be made with either the proving device or by using a source of the appropriate voltage.

If the VDD is to be used in rainy conditions, or if the operating stick or rod insulating medium is being cleaned, insulated surfaces should be wiped with a clean absorbent lint-free silicon treated cloth, where permitted by the manufacturer, to remove contaminants and increase the beading of water.

The manufacturer's instructions shall be reviewed before use to ensure all relevant requirements and limitations of use are understood. In particular, any limitations relating to testing adjacent to terminations, tees, droppers etc shall be complied with.

If the VDD has any defect or its test due date has passed, it shall be withdrawn from service, tagged as faulty, and not used until repaired and/or tested.

5.5 Periodic Inspection and Tests

5.5.1 Six Monthly Checks

At six monthly intervals VDDs shall undergo the following inspections by a competent person as per section 11:

- Visually examined for signs of damage, deterioration and legibility of marking.
- Tested against an appropriate voltage source to confirm their indication and operation at their rated voltage or range of rated voltages.
- Have the proving device checked to ensure it operates correctly.

5.5.2 Two-yearly Checks

Every two years, VDDs shall be subject to electrical tests to confirm their indication and operation at their rated voltage or range of rated voltages. The proving device shall also be checked to ensure it operates correctly. Such tests shall be carried out by a competent person or by a testing facility, and all results recorded.

Operating sticks or rods shall be inspected and tested in accordance with section 6.

5.6 Storage

VDDs shall be stored and transported in suitable protective cases or supports designed to protect them from damage and moisture ingress.

6. Portable / Temporary Earths

6.1 Standards

Standards for the purchasing and manufacture of portable earths include:

- IEC 61230:2008: Live working - Portable equipment for earthing or earthing and short-circuiting;
- ASTM F855-17(2017): Standard Specifications for Temporary Protective Grounds to be used on De-energised Electric Power Lines and Equipment.

Standards for in-service inspection include:

- ASTM F2249-03(2015): Standard Specification for In-Service Test Methods for Temporary Grounding Jumper Assemblies Used on De-Energized Electric Power Lines and Equipment

6.2 Specifications

6.2.1 Ratings

The rating of the portable earth shall be expressed as the rated current, rated time, and rated peak factor. Rating shall be established by type test, in accordance with the Standard IEC 61230:2008 Live working – Portable equipment for earthing or earthing and short-circuiting or equivalent.

6.2.2 Visibility of Leads

Portable earths should be highly visible to help with identification when in use. Visibility marking can be on either the stick or the lead or both.

6.2.3 Terminations (Aluminum)

When crimp style aluminium cables and sockets are used, the inner surface of the socket is to be abraded with an appropriate stainless steel rotary brush loaded with conducting paste immediately prior to making the joint. The cable end is to be prepared immediately before the cable and socket are crimped, shall not be contaminated by handling and the joint shall be made as soon as possible.

Similar treatment is also to be applied to the lug to clamp joint(s).

6.2.4 Sleeving and Sealing

Sleeving, sealing and protection of cable terminations shall be such that the device passes the relevant type tests of the manufacturing standard.

Aluminium cable termination joints are to be covered by heat shrink or cold shrink sleeving and sealed with a mastic sealant to:

- exclude moisture in the joint and so inhibit corrosion, and

- relieve the stress point at the back of the lug and so reduce the chance of breakage or fraying of the conductor strands at the joint under fault conditions or, more importantly, during the normal mechanical stresses of everyday use.

(Transparent cable and joint sheathing materials are preferred where appropriate, to permit visual inspections of conductors/joints prior to each use.)

6.2.5 Cable Length

Cables should not be significantly longer than necessary for their designed range of applications.

6.2.6 Test Certificate

Portable earths shall be supplied with a type test certificate stating their rating, and the standard for the type test. Type testing shall be to IEC 61230:2008 or equivalent and carried out by a competent calibration laboratory.

Note: Operating sticks or rods used only for portable earths are not required to comply with the requirements for fully rated live work tools. However, fully rated live work sticks and rods may be used for portable earths.

6.3 Marking

Portable earths manufactured by an asset owner or employer shall be marked with their year of manufacture and should be marked to indicate their rating as per IEC 61230:2008, or equivalent.

Portable earths supplied by an equipment supplier shall be marked with:

- the model or type reference,
- the rating as per IEC 61230:2008, or equivalent,
- the conductor cross-sectional area,

and may be marked with the manufacturer's name or trademark.

All portable earths shall be marked to indicate the next date on which a test is due, or a unique number for inclusion in a register.

New portable earths should have their DC resistance measured and recorded as described in section 4.5(b). This data and in-service data can then be trended over time to determine the degree of deterioration.

6.4 Before Use Inspection

Before each use the portable earth shall be visually examined for signs of damage, deterioration, faulty connections, cracks or scratches in insulation (particularly on the operating stick or rod), and legibility of marking. The due date for the next test shall be checked to ensure it has not passed.

6.5 Periodic Inspection and Tests

6.5.1 Six-monthly Checks

Every six months portable earths shall be visually examined by a competent person as per section 11 for signs of damage, deterioration, faulty connections, cracks or scratches in insulation (particularly on the operating stick or rod), and legibility of marking.

Components of the portable earth shall meet the following test and inspection criteria:

(a) Clamps

- Must be free of cracks in the metal and not show any splaying of the jaws.
- Screw threads must operate freely and be securely fixed to moving jaws.
- Spring loaded clamps must tighten over the full range of conductor sizes.
- Jaws must be free of ridges or burrs that could prevent effective contact.
- Bolted joints must be free of corrosion and tightened to the recommended torque.
- Bayonet pins must be straight and secure in the spindle of detachable head clamps, and any other attachment mechanism must operate as designed.

(b) Leads

- Must not have any cracks or holes in the sheath.
- Heat-shrunk sleeves must be free of cracks, correctly located on cable terminations in accordance with the manufacturer's instructions and checked to determine that the sleeve properties have not significantly altered.
- Mechanical devices must be correctly fitted.
- Terminations must, as far as can reasonably be established, be correctly crimped.

(c) Wooden Earth Sticks or Rods

- Must have tight hose clips.
- Flexible hoses must be in good order.
- Must be free of splinters.
- No loss of or deterioration in varnish or paint, which could permit water ingress that would affect insulation quality.
- No impurities on or embedded in the surface.

(d) Fibreglass Earth Sticks or Rods

- Operating sockets of detachable sticks or rods must be free of debris and be in good condition.
- Be free of defects or contamination.

Note: Detachable fibreglass sticks or rods used for other purposes should be tested in accordance with section 5.5.

6.5.2 Three-yearly Checks

Every three years, portable earths shall also be maintained and tested as follows:

(a) The electrical conductivity shall be measured by a suitable method (between clamps).

(b) Acceptable resistance results for copper leads and fittings, based on cable length and temperature, are provided in ASTM F2249-18(2018) Standard Specification for In-Service Test Methods for Temporary Grounding Jumper Assemblies Used on De-Energized Electric Power Lines and Equipment.

(c) Acceptable DC resistance results for aluminium leads and fittings, based on cable length and temperature, are provided in Appendix A.

(d) As a supplement to the electrical conductivity test, it is recommended that a DC test current of between 100 and 250 amps is applied (for portable earths rated up to 25 kA). As cables of 25mm2 (copper equivalent area) will heat significantly with currents over 100 amp, testing times should be minimised, e.g. less than 3 seconds. If any hot spots are detected the item is deemed to be defective.

Note: An alternative methodology for acceptable deterioration against type test information is being researched.

(e) If the measured electrical conductivity is unacceptable then at each cable termination all cable support mechanisms, whether mechanical or of heat shrink tubing, shall be removed and the cable inspected. If more than 1% of any externally visible strands are broken, or a suspicion that internal strands may be broken due to the outward appearance of the cable, then the cable must be re-terminated. If there are any signs of overheating, then the whole cable assembly should be discarded. At the completion of maintenance, the termination supports must be renewed to the same specification as originally fitted.

(f) All cable palm-to-line clamp interfaces shall be disconnected, cleaned and re-connected using the specified torque values.

(g) Following maintenance, electrical conductivity tests shall be repeated as above.

6.6 Storage

Portable earths shall be stored and transported so that they are protected from damage or deterioration.

Wooden earth sticks or rods shall be stored in a dry place away from direct sunlight.

6.7 Re-use After Fault

Any portable earth that has been subject to fault current shall be subject to a three-yearly inspection before re-use. Any damaged parts must be replaced.

Head clamps and tail clamps may be reused if they meet the testing criteria described above.

7. LV Bonds

7.1 Background

The intention of LV bonds is to protect staff from the energisation of the LV network from

Small-scale embedded generation. A small-scale embedded generation connection has a potential capacity of up to a maximum of 10kW per phase.

A typical 10kW generation inverter has a maximum output current rating of 48A.

The connection of a large portable generator (12500w) has a maximum output of 52A.

This current value will be considered for each phase when determining the LV bond minimum construction and rating.

7.2 Specifications

7.2.1 Ratings

The components of LV bonds shall be able to withstand a minimum current of 52A, the minimum recommended LV bond lead size (25mm2) is capable of carrying 150A

7.2.2 Overhead LV Bonds

The general construction of the overhead LV bonds shall enable an appropriate electrical connection to the overhead network. The overhead LV bonds should consist of;

i. Minimum of 25mm^2 flexible copper conductor or equivalent rating for Aluminum flexible conductor.

ii. A minimum of four, line conductor clamps. Each clamp has a handle with non-conductive grip.

7.2.3 Underground LV Bonds

The general construction of the LV bonds shall enable an appropriate electrical connection to the required underground isolation points without causing damage to the network hardware. The underground short circuit equipment should consist of:

i. Minimum of 25mm^2 flexible copper cables or equivalent rating for aluminum flexible conductor.

ii. Four connection points suitable to be connected to (c).

iii. Suitable fittings to provide contact with underground isolation points in different scenarios.

7.2.4 LV Bonding cables

LV bonding cables shall comply with AS/NZS 5000.1:2005 and AS/NZS 1125:2001.

The LV bonding cables shall be a flexible, single-core insulated copper or aluminium conductor. The cross-sectional area (CSA) of the conductor is to be a minimum of 25mm^2 copper or equivalent rating for aluminium flexible conductor for both overhead and underground situations.

The insulation is to have a rating of 0.6/1kV and be resistant to chemical and ultraviolet (UV) damage.

The ends of the cables are to be terminated to the line conductor clamps with suitable lugs along with stainless steel bolts and components comprising of flat and spring washers.

The connections are to be covered with an insulating mastic-lined heat-shrink of suitable length to provide water ingress protection and stress relief at the terminations.

A suitable label shall be placed on each of the LV bonds cables. The label shall display the following bold print:

NOT TO BE USED FOR HV EARTHS OR LV BRIDGING

7.3 Testing, Inspection Requirements

7.3.1 Before use inspection

Before each use LV bonds shall be visually examined for signs of damage, deterioration, or faulty connections.

If the equipment has any defect identified, it must be withdrawn from service, tagged as defective and alerted to the appropriate party for repair or disposal.

7.3.2 Six-monthly Checks

Every six months and irrespective of any other inspection, LV bonds shall be inspected as set out in section 4.5 by a competent person and the inspection recorded in a company's equipment register.

If the equipment is defect free an appropriate inspection tag must be applied to the LV bond stating the next inspection date.

Any LV bond that has a defect identified with it must be withdrawn from service, tagged as defective and not used until repaired, reinspected and tagged.

7.3.3 Three-yearly Checks

Every three years, LV bonds shall also be maintained and tested following the principles outlined on ASTM F2249-03(2015):

See Appendix B

7.4 Storage

LV Bonds shall be stored and transported so that they are protected from damage or deterioration.

7.5 Re-use After Fault

Any LV Bond that has been subject to an inadvertent livening shall be subject to a full inspection. Any damaged parts must be replaced.

8. Operating and Measuring Sticks or Rods

This section applies to operating sticks or rods used for VDDs, measuring sticks or rods and similar, but not to live-line tools. Operating sticks or rods may also be used for portable earths. This section does not apply to wooden sticks.

Operating sticks or rods may:

- consist of separate poles that have a dedicated insulating section and a handle section, or
- consist entirely of one or more sections that all or singularly meet the insulating requirements of the specification standard.

When using operating sticks or rods the minimum approach distance (MAD) applicable to the voltage shall not be encroached by the user or any part of the stick or rod which the user is in contact with, and which is not proven to be insulating. This requires that the insulating section is of sufficient length to meet these criteria.

Any part of the operating stick (including the attachments) shall be fit for the purpose for which it is to be used.

8.1 Standards

Standards for the purchasing of operating and measuring sticks or rods include:

- IEC 60832-1:2010 Live working. Insulating sticks and attachable devices.
- Part 1: Insulating sticks
- IEC 60832-2:2010 Live working. Insulating sticks and attachable devices.
- Part 2: Attachable devices
- IEC 60855-1:2016 Live working. Insulating foam-filled tubes and solid rods. Part 1: Tubes and rods of a circular cross section.
- IEC 61235:1993 Live working – Insulating hollow tubes for electrical purposes.
- IEC 62193:2003 Live working – Telescopic sticks and telescopic measuring sticks.
- ASTM F1825-03(2013) Standard Specification for Clampstick Type Live Line Tools
- ASTM F1826-00(2016) Standard Specification for Live Line and Measuring Telescoping Tools
- ASTM F711-17(2017) Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live-Line Tools.

8.2 Specification

8.2.1 Materials – Insulating Section

Must comply with a relevant IEC or ASTM Standard, or equivalent. The insulating section must be of a length and construction configuration, e.g. with a foam filled section, set by the manufacturer, to which attachments may be connected. The insulating section may also comprise of telescopic sections provided they meet the manufacturing standard for insulating materials.

8.2.2 Materials - Handle Section

Must have mechanical properties specified in a relevant IEC or ASTM Standard or equivalent.

The handle section may be of the same material as the insulating section and be integral with it, or it may be separate. Where practicable, the handle sections should be foam-filled or otherwise adequately sealed to prevent the ingress of moisture and other contaminants, which may affect the designated insulation properties required of those sections.

8.2.3 Couplings

Sticks or rods made up of sections that are coupled together must be rigid and must remain locked when being twisted for operation.

8.2.4 Handguard

If the operating stick or rod consists of a dedicated insulating section and a handle section with no designated insulating properties, then a handguard or warning marker must distinguish the insulating section from the handle section.

8.2.5 Length

The handle section must allow a comfortable two-handed grip suitable for controlling the movement of the stick or rod.

Extra length or reach may be achieved by coupling sections together. Where a higher voltage rating is required, the extra length should be added to the insulating section, and where additional reach is required, the extra length should be added to the handle section.

The minimum length of the insulating section is the minimum approach distance (MAD) for the relevant voltage for which the stick or rod may be used. The insulating section may comprise foam-filled sections, or a foam-filled section plus telescopic sections.

8.2.6 Finish

The finish of the sticks or rods must be free of cracks, surface damage or mechanical defects. Minor surface damage such as light scratches may be acceptable. If there is any doubt, then the stick or rod must be subjected to the insulation acceptance test covered in section 6.2(h).

8.2.7 Voltage Rating

Sticks and rods shall have a voltage rating corresponding to at least the system voltage on which they are to be used.

The voltage rating determines the minimum length of the insulating section.

The required voltage rating may be achieved by coupling sections together.

8.2.8 Insulating Section Acceptance Test

The insulating section shall be of material which has been proven with a power-frequency voltage withstand test of 100kV per 300mm of stick or rod for a period specified in accordance with an IEC or ASTM Standard (See 6.1 above).

The test may be applied over either:

- the whole length of the insulating material, or
- individual lengths of 300mm.

Test results shall comply with the manufacturing standard.

8.2.9 Acceptance Inspection

For acceptance each stick or rod shall be:

- marked as required in 6.3, and
- free of cracks, surface damage or mechanical defects.

8.3 Marking

Each stick or rod shall be marked or labelled with:

- the manufacturer’s name or trademark
- month and year of manufacture
- that it meets the requirement of the manufacturing standard
- the manufacturing standard reference, and
- where the voltage rating requires a number of sections to be coupled together the marking shall indicate the number of sections corresponding to each rated voltage. Marking of individual insulating sections should indicate the voltage rating based on their length.

8.4 Before Use Inspection

Before use, sticks or rods should be wiped with a clean lint free cloth and examined. There shall be no cracks, surface damage or mechanical defects.

The application of a silicone compound, e.g. with a treated lint free cloth, is recommended for all operating sticks or rods where permitted by the manufacturer, particularly before use in wet weather or damp conditions.

Sticks or rods used during rain or fog may require the fitting of weathersheds.

8.5 Periodic Inspection and Tests

8.5.1 Six-monthly Checks

At a maximum of six-monthly intervals, sticks and rods shall:

- be visually examined for signs of damage, deterioration and legibility of marking by a competent person as per Section 11
- be cleaned, then wiped down with a silicone impregnated cloth where permitted by the manufacturer, and
- have a surface leakage current test applied over the entire insulating section length, using a tester rated at 75kV/300mm. During the testing there shall be no sign of surface flashover, puncture, erosion or fluctuating or excessive leakage current (≥100 μA).

This check should be carried out more frequently if the stick or rod has frequent use or is used in wet conditions.

8.5.2 Two-yearly Checks

Every two years, the insulating section(s) of sticks and rods shall have a power-frequency voltage withstand test of 75kV per 300mm of stick or rod for a period of one minute. Both dry tests and wet tests shall be carried out. During the testing there shall be no sign of surface flashover, puncture or erosion.

An increasing or fluctuating leakage current may indicate degradation of the rod under test, and may indicate moisture absorption, dirt, or damage. The leakage current for the dry test should not exceed 100μA, and should level out during the test.

8.6 Care and Storage

Sticks or rods shall be handled carefully to avoid damage to the surface finish.

Repairs to the surface finish may be made by light sanding and re-coating with an epoxy varnish or coating recommended by the manufacturer, but the stick or rod shall then be retested in accordance with 6.5(b).

Sticks or rods shall be stored in a dry place away from items that could damage their surface finish.

Cleaning may be carried out by washing with a soft cloth or sponge using dishwashing liquid or other similar non-abrasive and non-corrosive detergent and warm, fresh water followed by a cold, freshwater rinse.

8.7 Transport

Sticks or rods must be carried in suitable carrying rolls or containers, or on racks or supports designed for the purpose. They shall not be carried loose.

9. Cable Spiking Equipment

9.1 Standards

Not used.

9.2 Specification

9.2.1 Characteristics

(a) Must have mechanical strength sufficient to withstand the forces developed when an energised cable is spiked, without injury to the operator. (Equipment does not have to survive the fault without damage).

(b) Spikers designed for use with an earth cable shall be able to be connected to the earthed cable sheath or armour, or to a remote permanent earth or earth stake. If a remote earth is used:

- earthing cable sufficiently flexible to allow easy installation and storage.
- earthing cable capable of carrying the maximum potential fault current available at the site for a time sufficient for the protection to operate.
- earthing cable terminations protected from conductor fatigue due to cable flexing, and

(c) earthing cables to have insulation sufficient to provide continuing mechanical, chemical and electrical protection.

(d) For hydraulically powered spikers, the hydraulic hoses and fluid shall be non-conductive.

9.2.2 Type Tests

Adequacy of spikers and attached cables shall be determined by type-test.

9.2.3 Acceptance Inspection

At acceptance, spiking tools, cables and clamps shall:

- be accompanied by a test certificate that states that they were type-tested, and
- have their rated current identified, and for cables and clamps have the rated time identified.

9.3 Marking

Flexible cables and clamps used for connection to a remote earth should be marked or tagged with their current rating and their rated time as established by type testing.

The clamp or head should be marked for the maximum cable cross sectional area that can be accepted.

9.4 Before Use Inspection

Before each use, spiking equipment shall be inspected for any visible signs of damage, deterioration, or faulty connections. If there is any defect the equipment shall not be used.

The date of the tests required by clause 7.5 shall also be reviewed to ensure that a test date has not passed.

9.5 Periodic Inspection and Tests

9.5.1 Six-monthly checks

Every six months, spiking equipment shall be inspected by a competent person as per section 11. Hydraulic hoses and fluid shall also be tested to ensure they remain electrically non-conductive.

9.5.2 Three-yearly checks

Every three years, flexible cables and clamps shall also be tested by either of the following methods. Where the electrical conductivity test result is unacceptable, the physical inspection method shall be used:

- For electrical conductivity by a suitable method. The measured resistance or voltage drop must not be more than that of an identical new system plus 5%.
- All opaque heat shrink tubing or other termination support is removed and the outer strands of the cable inspected at each termination. There must be no more than 1% broken strands and no visible corrosion or signs of overheating, otherwise the cable must be re-terminated. At the completion of testing the termination support must be renewed to the same specification as originally fitted.

9.6 Cleaning and Storage

Hydraulic hoses should be regularly cleaned using warm water with soap or mild household detergent. Solvents or abrasives shall not be used.

Spiking equipment shall be stored so that it is protected against damage or deterioration.

10. Ladders

10.1 Standards

Standards for the purchasing of ladders include:

- AS/NZS 1892.1:1996 Part 1 - Portable ladders - Metal
- AS 1892.2:1992 Part 2 – Portable ladders - Timber
- AS/NZS 1892.3:1996 Part 3 – Portable ladders - Reinforced Plastic
- CAN3-Z11-M81:1981(2011) Portable ladders
- ANSI-ASC A14.1:2017 Wood ladders
- ANSI-ASC A14.2:2017 Portable metal ladders
- ANSI-ASC A14.5:2017 Portable reinforced plastic ladders
- BS EN 131 (Set of standards)

Standards for the selection, use and care of ladders include:

- AS/NZS 1892.5 Part 5:2000 - Portable ladders – Selection, safe use and care.

Note: That Rule 2.1407 of Safety Manual – Electricity Industry also provides advice on the precautions to be taken before and during the use of ladders.

10.2 Specification

Ladder procurement specification to require ladders manufactured only to recognised manufacturing standards for industrial use ladders.

10.3 Marking

Ladder marking shall include markings required by the relevant manufacture/supply standards. Marking may include:

- batch number
- ladder grade
- ladder duty (must be ‘industrial’)
- design load rating, or
- working length.

Ladder marking should also include:

- ladder serial number or unique identifier assigned by the ladder owner for asset register and ladder management purposes.
- due date for inspection, and
- ladder defective, or withdrawn from service as not fit for use, out of inspection date or for any other reason.

Individual ladder information that cannot practicably be marked on the ladder should be held in the ladder register against the individual ladder record. The register should record ladder management information such as ladder marking details above, supplier and contact details, ladder service/inspection agency, manufacturer and standard, periodic inspection due dates and results, repairs, removal from service for any reason as outlined above.

Before Use Inspection

Inspect newly purchased ladders for any manufacturing defect including, in timber ladders, non-compliant stile wood grain slope or encased knots.

Each time before a ladder is used it must be examined for any signs of damage, splitting or major defects, including:

- signs of fibreglass reinforcing rod resin degradation or failure
- internal corrosion
- the rung/tread to stile connection and deformed flanges
- stress fractures at rivet points, loose rivets
- stile bowing or twisting
- locking stays, clips
- traction on feet
- visually check wood ladders to ensure that the top fly stop bolt is below the pulley bracket, preventing inadvertent over-extension, and
- check the due date for the next six-monthly inspection.

10.4 Periodic Inspection and Tests

Ladders shall be inspected by a competent person as per section 11 of this guide at intervals not exceeding six months. It is recommended that every second (i.e. twelve-monthly) inspection be done by a competent ladder service agent. Where any ladder fails the inspection criteria, mark it unfit for use and remove it from service, and implement appropriate corrective actions.

Inspection items include:

- Stiles and rungs – no cracking, splintering or looseness. Wooden stiles that are not treated for rot must be thoroughly inspected, including tapping suspect areas with a blunt instrument. Good wood has a hard resonant sound, while rotting wood emits a dull sound.
- Wood rungs: check for rot and 'scalloped out' areas, particularly at the part of the rung adjoining the stile.
- Laminated wood ladders: check for glue bonding degradation, evident by slight opening/movement between stile laminations when load applied to the ladder.
- Solid timber ladders: when load is applied, check for hairline fractures in rung surrounds and solid wood stile. This can predict stile failure and can become evident particularly after ladder abuse such as being dropped or run over by a vehicle.
  - Fibreglass ladders:
    - check for bent rung at ladder support (pole) end
    - check for twisted fly, characterized by top and bottom flies binding while ladder being extended, and
    - load the ladder fully extended horizontally and check for hairline cracks in longitudinal corners of the stile sections, particularly long the sectors where the two flies press together while extended.
- Metal parts: check for cracking, bending or corrosion.
- Moving parts: check for signs of excessive wear.
- Bolts and pins: satisfactory security.
- Ropes: fitted and in good order, including head rope.
- Bucket or chain: secure and undamaged especially at fastenings to stiles.
- Remove foot covers if fitted. Check stile foot material for excessive wear, cracks or splitting, and rot.
- Timber ladders: no signs of decay, or borer.
- Fibreglass ladders: surface smooth, clean and polished, of uniform colour and without pits, chips or voids.

The following checks shall also be carried out on wooden extension ladders:

10.4.1 Stile Reinforcing Check

Note: That steel wire reinforcing is not permitted on ladders used by the electricity supply industry:

- Resin surrounding and embedding the fibreglass rod in the stile recess should be hard, firmly bonding the fibreglass reinforcing with the ladder stile. Check along its entire length.
- Penetrable soft resin indicates potential inadequacy in the bonding arrangement, leading to possible reduction in stile strength. Carefully test the resin by hand-pushing a narrow but blunt end instrument such as a screwdriver or key towards the resin. If it can be penetrated, remove the ladder from service and seek advice from a competent service agent.

10.4.2 Potential Top Fly Over-Extension

Some ladders may inadvertently be used over-extended on occasions, significantly reducing stile strength.

10.4.3 Ladders with Stop Bolts

Certain ladders are fitted with stop bolts that should prevent top fly over-extension by the bolt/s striking the top iron (pulley bracket) when the top fly is extended to the limit. Some stop bolts can inadvertently pass the strike point, allowing the ladder to be used beyond the maximum design extension, significantly reducing stile strength. This can cause immediate or latent stile failure. Check that the stop bolt functions consistently to prevent over-extension. If not, withdraw the ladder from service and re-fit stop bolt/s sufficient to meet the required performance.

Rope Controlled Over-Extension:

Some ladders rely on the rope configuration to limit over-extension. The ladder shall be checked to ensure the rope is correctly fitted and will not permit over-extension.

10.5 Storage

Ladders shall be stored in well-ventilated places

Except when stored on trucks, ladders stored horizontally should be supported along their whole length to prevent sagging or the creation of a permanent set.

10.6 Care of Timber Ladders

Timber ladders must be protected as required.

Linseed oil (or similar timber finish, e.g. CD50) must occasionally be applied to all bare or worn areas, as required.

10.7 Transport

Ladders shall be transported on racks that:

- do not allow them to sag unduly
- have secure fastenings, and
- minimise chafing and the effects of movement.

11. Low Voltage Insulating Mats and Covers

11.1 Standards

Standards for constructional and test requirements of insulating mats and covers include the following. The standards also provide storage and inspection guidance:

- AS/NZS 2978 :1995 Insulating mats for electrical purposes
- AS 4202 :1994 Insulating covers for electrical purposes
- ASTM D1048-14(2014) Standard Specification for Rubber Insulating Blankets
- ASTM D1049-98(2017) Standard Specification for Rubber Insulating Covers
- ASTM F478-14a(2014) Standard Specification for In-Service Care of Insulating Line Hose and Covers
- ASTM F479-06(2017) Standard Specification for In-Service Care of Insulating Blankets

(IEC 61111:2009 *Live working. Electrical insulating matting and IEC 61112:2009 Live working. Electrical insulating blankets* may also be appropriate standards.

These standards are also available as BS EN Standards of the same number and title.)

11.2 Specification

Insulating mats and covers shall satisfy the following requirements:

- The effective insulating area of any stitched or punched cover or mat shall be deemed to be that area enclosed within a border 10mm inside the stitch or punch line.
- An insulating cover shall be provided with a securing means that will effectively prevent inadvertent dislodgement from the protected area.
- The securing means shall be non-conductive and shall not significantly reduce the mechanical strength of the cover.
- The material used may be any good quality insulating materials that meet the test requirements of an appropriate Standard, e.g. AS/NZS 2978:1995 Insulating Mats for Electrical Purposes or AS 4202:1994 Insulating covers for Electrical Purposes.
- Mechanical properties shall be sufficient for the purpose of use, e.g. general purpose, standing on, brush contact etc.

11.3 Marking

Every cover or mat shall be provided with a means of establishing the test due date and shall be marked with their maximum safe working voltage or class.

Before Use Inspection

Before each use mats and covers shall be examined with particular attention to:

- blisters, cracks, punctures, cuts, tears, perishing and holes
- embedded foreign matter, and
- defective fastenings

During checks, the area being examined shall be rolled, stretched or flexed. The due date for test shall be checked to ensure it has not passed.

If the equipment has any defect or its test due date has passed, it shall be withdrawn from service, tagged as faulty, and not used until repaired and tested.

11.4 Periodic Inspection and Tests

Every six months, all covers and mats shall be cleaned and dried (see 9.7 below) and inspected as per clause 9.4.

Electrical tests shall be periodically carried out on covers in accordance with the requirements of ASTM Standards F478-14a;(2014) *Standard Specifications for In-Service Care of Insulating Line Hose and covers* or F479-06(2017), *Standard Specifications for In-Service Care of Insulating Blankets*.

Electrical tests on insulating mats shall be carried out in accordance with AS/NZS 2978:1995 *Insulating Mats for Electrical Purposes*, which requires that insulating mats in regular use are subjected to repeat electrical insulation tests in accordance with Appendix B of the standard at six-monthly intervals.

11.5 Storage

When not in use, covers and mats shall be protected against damage and deterioration, kept away from direct sunlight, and laid flat or rolled.

Cleaning and Drying

Covers and mats may be washed with soap, mild non-bleaching detergent, or cleaner recommended by the supplier. After washing, the covers and mats shall be rinsed thoroughly with water.

Covers and mats shall be air dried, but not such that the cover or mat temperature will exceed 65ºC.

11.6 Records

Records of periodic testing as required by this guide shall be maintained for seven years.

Competent Persons

Competent persons required to carry out duties under this guide shall be adequately trained and be familiar with the testing requirements and the manufacturer’s maintenance instructions.

Appendix A Portable Earthing Assembly Resistance (Aluminium)

Table 1: Maximum permissible measured DC resistance for aluminium portable earthing assembly at 20°C.

Resistance correction factors for temperatures other than 20°C are provided in Table 2.

Lead Length metres	147 mm² Earth Lead Resistance in microhms	185 mm² Earth Lead Resistance in microhms
2.0	561	491
2.5	670	582.5
3.0	779	674
3.5	888	765.5
4.0	997	857
4.5	1106	948.5
5.0	1215	1040
5.5	1324	1131.5
6.0	1433	1223
6.5	1542	1314.5
7.0	1651	1406
7.5	1760	1497.5
8.0	1869	1589
8.5	1978	1680.5
9.0	2087	1772
9.5	2196	1863.5
10.0	2305	1955
10.5	2414	2046.5
11.0	2523	2138
11.5	2632	2229.5
12.0	2741	2321

		147 mm² cable	185 mm² cable
A =	Lead resistance in microhms /m	218 (Alloy 1350)	183 (Alloy 1120)
B =	*Headclamp* resistance in microhms	30	30
C =	*Tailclamp* resistance in microhms	25	25

Maximum DC assembly resistance measured between *headclamp* and *tailclamp*

= (A x lead length) + t + B + C where tolerance t = 70 microhms.

This tolerance figure allows for crimping and lead size variation.

To determine 'A' for other cross sectional areas of aluminium conductor, the formula *in AS/NZS 1125:2001 Appendix A2* may be used.

Table 2: Resistance correction factors for temperature.

Temperature (T) °C	Correction factor
15	1.02
16	1.02
17	1.01
18	1.01
19	1.00
20	1.00
21	1.00
22	0.99
23	0.99
24	0.98
25	0.98
26	0.98
27	0.97
28	0.97
29	0.97
30	0.96
31	0.96
32	0.96
33	0.95
34	0.95
35	0.94

Actual resistance at 20°C =

Measured resistance at temperature T x correction factor for temperature T

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Appendix B Portable LV Bond Assembly Resistance

Typical measured DC resistance for copper and aluminium portable LV bond assembly at 20°C. Values are supplied for guidance only.

Resistance correction factors for temperatures other than 20°C are provided in Table 2.

Copper Bond Typical Resistance Guide					
Bond Length (m)	**25mm Cu Conductor Max Res in Microhms**	**35mm Cu Conductor Max Res in Microhms**	**50mm Cu Conductor Max Res in Microhms**	**70mm Cu Conductor Max Res in Microhms**	**95mm Cu Conductor Max Res in Microhms**
1	820	620	470	380	310
2	1510	1110	810	630	490
5	3580	2580	1830	1380	1030

Aluminium Bond Typical Resistance Guide					
Bond Length (m)	**35mm Ali Conductor Max Res in Microhms**	**50mm Ali Conductor Max Res in Microhms**	**70mm Ali Conductor Max Res in Microhms**	**95mm Ali Conductor Max Res in Microhms**	**120mm Ali Conductor Max Res in Microhms**
1	890	660	510	410	350
2	1650	1190	890	690	570
5	3930	2780	2030	1530	1230

Values are based on electrical resistivity for copper of 1.724 x 10-8 Ω m (0.0172 μΩ m) and electrical resistivity for aluminium 2.65 x 10-8 Ω m (0.0265 μΩ m)

Typical DC assembly resistance measured between conductor clamps

Total resistance = (A x lead length) + t +(2 x B) where

A = Electrical resistance of bond in Microhms / m

t = 70 microhms. This tolerance figure allows for crimping and lead size variation.

B = 30 microhms. Clamp resistance.