BRITISH STANDARD

BS EN 2812:2009

Aerospace series — Stripping of electric cables

ICS 49.060

BSI
British Standards

National foreword

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Foreword

This document (EN 2812:2009) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

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1 Scope

This standard specifies the conditions for stripping and inspection of stripping tools and the stripped ends of electric cables for aerospace applications.

Various stripping processes exist. The choice of a process depends upon the properties of the particular cables to be stripped and/or on the specific requirements for the end product to be achieved.

The processes specified today in this document are:

a) manual stripping;

b) mechanical stripping;

c) laser stripping;

d) thermal stripping.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 2083, *Aerospace series — Copper or copper alloy conductors for electrical cables — Product standard.*

EN 3475-701, *Aerospace series — Cables, electrical, aircraft use — Test methods — Part 701: Strippability and adherence of insulation to the conductor.*

EN 3719, *Aerospace series — Aluminium or aluminium alloy conductors for electrical cables — Product standard.*

EN 4434, *Aerospace series — Copper or copper alloy lightweight conductors for electrical cables — Product standard (Normal and tight tolerances).*

EN 4651, *Aerospace series — Copper-clad aluminium alloy conductors for electrical cables — Product standard.* [1)]

3 Stripping processes and associated tools

3.1 General recommendations

Precise definition of tools to use on a particular wire or cable standard is under the responsibility of the user.

It is particularly important to know from which ASD Product Norm conductors are coming (for examples: EN 2083, EN 3719, EN 4434, EN 4651) for the mechanical stripping process.

Availability of a common tool able to strip different gauges or cable sizes is recommended.

If tools are designed for particular applications, differentiation by colours is recommended.

1) Published as ASD Prestandard at the date of publication of this standard.

Size and weight of tools has to be appropriate for the envisaged use.

When it is essential to control the length of insulation to be removed an adjustable abutment must be part of the tool.

3.2 Manual stripping

3.2.1 Use

The use of this process must be strictly limited to insulations and jackets of the cables for which other methods are impractical. Nevertheless, with thermal stripping and the arrival of small laser machines, this manual practice must be progressively eliminated for aerospace use and stay permissible only for small batches.

3.2.2 Application

Manual stripping by scalpel, razor blade or other cutting tool is carried out on cables over 5 mm^2 cross-section, sheaths of shielded cables, fire-resistant cables and coaxial cables, unless another stripping process is specified.

3.3 Mechanical stripping

3.3.1 Use

This process is generally the most used in particular for single wires. Various power tools are also adapted to strip round cables, such as single wire screened jacketed and coaxial, and flat cables.

The simplicity of manual pliers makes these tools ideal for work in the field.

For illustration, see Annex B (Informative).

3.3.2 Stripping with manual tools

The blades of tools can have different profiles and dimensions. Various assembly shapes are now available.

A blade can have several marked cavities of different sizes. When the tool is closed, the edges of the blades shall be in the same plane and form a cutting circumference whose diameter is greater than the maximum diameter of the conductor of the cable to be stripped. Blades must be replaced as pairs.

The manual stripping tools with V shaped cutting blades or shearing type blades are forbidden (see Figure 1 and Figure 2).

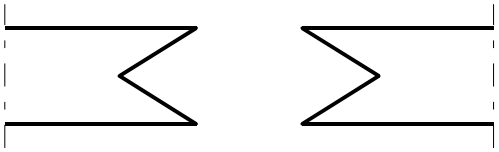


Figure 1 — V shaped cutting blades

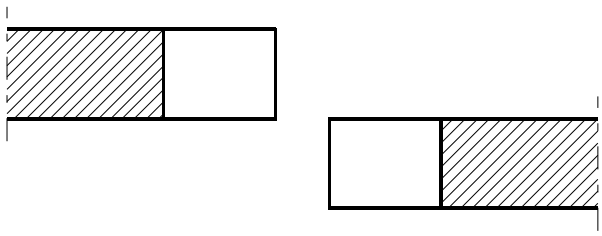


Figure 2 — Shearing type blades

3.3.3 Stripping with power tools

These tools use blades with the same general characteristics as those defined in 3.3.2.

Particular care is necessary during the use of rotating blades, and their depth shall be adjustable to adapt the cutting diameter to the need.

3.4 Laser stripping

3.4.1 Use

Laser wire stripping can be carried out on wires and cables of any gauge and on jackets. This process is particularly suitable for use in applications where damage of any sort to the conductor or the screen is unacceptable and when the external geometry of the cable to strip is incompatible with mechanical processes.

For illustration, see Annex C (Informative).

3.4.2 Application

Carbon Dioxide (CO_2) lasers are normally used, but other laser types may be applicable for certain applications.

Beam power shall be adjustable to be able to cut properly all various types of insulation and shapes.

3.5 Thermal stripping

3.5.1 Use

Thermal wire stripping can be carried out on wires and cables of any gauge and on jackets. This process is particularly suitable for use in applications where damage of any sort to the conductor or the screen is unacceptable, when the external geometry of the cable to strip is incompatible with mechanical process and when the size of tooling equipment investment must be limited. This process may not be suitable for all types of insulation or in particular environmental conditions such as where flammable vapours may be present.

For illustration, see Annex D (Informative).

3.5.2 Application

Generally the tool is in two parts, a generator to control the required temperature and a hand unit.

The hand unit can be equipped with various shape of blades.

4 Identification, inspection and calibration

4.1 Manual stripping tools

4.1.1 Identification

An identification number marked on the main body is recommended in order to facilitate the follow-up of the inspection of the cutting blade.

4.1.2 Inspection

The inspection of cutting area is carried out visually at regular intervals.

The inspection shall be completed by inspection of samples of stripped cable ends, see 5.3.1.

4.2 Mechanical stripping tools

4.2.1 Identification

An identification number shall be permanently marked on the main body of the tool and on the blade.

In addition, each stripping tool shall have an individual inspection sheet including:

— its identification number;

— date of first commissioning;

— dates of successive inspections;

— dates of rectification or repair;

— numbers of associated blades.

4.2.2 Inspection

The inspection of blades is carried out with the aid of measuring gauges, shadowgraph, calipers or other means permitting confirmation that the cavities are in accordance with the dimensions specified.

The inspection shall be completed by checking the mechanical condition of the manual tool or power tool and by stripping tests, followed by inspection of samples of stripped cable ends, see 5.3.2.

For the routine inspection of production tools, the gauging of blades may be omitted, provided double stripping is used for the inspection of stripped cable ends.

Stripping tools shall be inspected at least every 90 days.

If a worn blade requires replacement, the complete blade assembly shall always be replaced together.

4.2.3 Calibration

Some particular tools, for coaxial cables for example, may require calibration to obtain the necessary diameter to strip.

4.3 Laser stripping tools

4.3.1 Identification

An identification number shall be permanently marked on the main body of the tool.

In addition, each tool shall have an individual inspection sheet including:

— its identification number;

— date of first commissioning;

— dates of successive inspections;

— dates of rectification or repair;

— numbers of associated parts.

4.3.2 Inspection

The inspection shall be completed by checking the general behaviour of the laser tool accordingly to the laser tool manufacturer instructions and by stripping tests, followed by inspection of samples of stripped cable ends, see 5.3.3.

Laser tools shall be inspected at least every 90 days.

4.3.3 Calibration

Periodic laser power checks shall be made to ensure power levels remain within the limits as defined by the manufacturer's specification.

4.4 Thermal stripping tools

4.4.1 Identification

An identification number shall be permanently marked on the main body of the tool.

In addition, each stripping tool shall have an individual inspection sheet including:

— its identification number;

— date of first commissioning;

— dates of successive inspections;

— dates of rectification or repair;

— numbers of associated parts.

4.4.2 Inspection

The inspection shall be completed by checking the general behaviour of the thermal tool according to the thermal tool manufacturer instructions and by stripping tests, followed by inspection of samples of stripped cable ends, see 5.3.4.

Thermal tools shall be inspected at least every 90 days.

4.4.3 Calibration

Periodic calibration checks of the tool shall be made to ensure power levels, and consequently temperature at the tip of the respective blade remain within the limits as defined by the manufacturer's specification.

5 Qualification

5.1 General

Wires and cables must be strippable as normally defined in their technical specification or product standard. The test method generally used to assess this is EN 3475-701.

The stripping operation must remove the insulator from the conductor over a length defined with tolerances, to allow correct connection of cables, without damaging the core strands or the screen or the insulator and without reducing the original performances of the cable as defined in its technical specification.

The stripping length depends on the length required to connect the conductor into the end component.

Each process must be applied by trained operators.

For qualification to a wire and cable standard, there must be an agreement between the wire and cable manufacturer and the qualifying authority on exact tool reference to use. The exact reference of this tool must be written in the associated test report.

5.2 Method

Qualification of a dedicated tool to strip a cable type will be performed by stripping of samples coming from at least two different batches (ideally for manual stripping pliers used for single wires, batches shall have conductors not coming from the same conductor batch, and if possible one at the maximum conductor diameter and the other at the minimum).

The inspection of stripped cable ends, for which the tool will be used, shall be carried out on 10 samples coming from the same manufacturing batch for each cable size. Five samples will have one stripping at each extremity and the other 5 samples a double stripping at each extremity.

The first strip shall be made approx. 10 mm from end of the cable and the second strip approx. 20 mm from end of cable. All slugs of insulation shall be cut cleanly, with no residual insulation remaining on the conductor (see Figure A.6). Using a 10 times magnification aid, the conductor of the cable shall be examined for damage, at the position of the first strip.

5.3 Requirements

5.3.1 Manual stripping

As this process is of high risk to damage conductors or screen, particular care will have to be taken for the visual examination of possible defects mentioned in Annex A (Normative), see Table A.

5.3.2 Mechanical stripping

The geometrical configuration of the blade assembly shall allow automatic centring of the cables without damaging or cutting the strands.

During the stripping, the cable shall be maintained at 90° in relation to the blade and the separation of the insulation shall be made parallel to the cable.

Each blade profile shall be calibrated in relation to the dimensions of the cable, as shown in Annex B (Informative) (Figure B.1).

For stripping with power tools, the rotating of the blade(s) shall be in the same plane and form a cutting circumference whose diameter is greater than the maximum diameter of the conductor of the cable to be stripped.

After stripping, the conductor shall show no damage to or untwisting of the strands according to Annex A (Normative). Taking into account expansion of conductor cross-sections larger than 2 mm^2, some marks on the strands are permissible (see Figure A.4), however the material of the conductor beneath the plating shall not be visible.

The insulation remaining on the wire or cable shall show no damage due to the tooling, however light marks may be tolerated (see Figure A.9).

5.3.3 Laser stripping

During the stripping, the wire insulation or cable jacket shall be maintained at the focal point of the laser beam.

The rotating of the cutting beam shall be in the same plane to form a perfect perpendicular cutting circumference.

After stripping the insulation or jacket can be removed by hand or other mechanical means; removal shall be made parallel to the cable.

After stripping, the conductor and/or screen shall show no damage to or untwisting of the strands according to Annex A (Normative).

The insulation remaining on the wire or cable shall show no damage due to the process (see particularly Figure A.5). However a heat affected zone adjacent to the strip point may be present, caused by the heating effect of the laser on the insulation, and this is acceptable. The heat affected zone shall be in accordance with Annex A (Normative), particularly Figure A.11. The heat affected zone shall be ≤ 1 mm in length; within the heat affected zone a degree of discoloration and/or melting of the insulation may be visible to the naked eye. Discolouration of the insulation may be particularly noticeable with pure polyimide or polyimide composite constructions.

5.3.4 Thermal stripping

Each blade profile shall be calibrated in relation to the dimensions of the wire or cable. During the stripping, the wire or cable shall be maintained at 90° in relation to the blade.

After stripping the insulation or jacket can be removed by hand or other mechanical means; removal shall be made parallel to the cable.

After stripping, the conductor and/or screen shall show no damage to or untwisting of the strands according to Annex A (Normative).

The insulation remaining on the wire or cable shall show no damage due to the process (see particularly Figure A.5). However a heat affected zone adjacent to the strip point may be present, caused by the heating effect of the laser on the insulation, and this is acceptable. The heat affected zone shall be in accordance with Annex A (Normative), particularly Figure A.11. The heat affected zone shall be ≤ 1 mm in length; within the heat affected zone a degree of discoloration and/or melting of the insulation may be visible to the naked eye. Discolouration of the insulation may be particularly noticeable with pure polyimide or polyimide composite constructions.

6 Health, safety and environmental aspects

The locally applicable regulations and laws shall be observed.

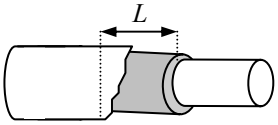
Nevertheless we wish to draw attention to the following points:

- Manual stripping
  - Precautions must be taken to avoid the risks of injury to the operator.
- Laser stripping
  - Some of the insulation materials generate toxic fumes or vapours under heating. Suitable precautions should be included in the laser tool design. If not, applications in confined spaces are to be carried out beneath suitable extraction.
- Thermal stripping
  - During the application the blade of the unit will be hot.
  - Some of the insulation materials generate toxic fumes or vapours under heating. Suitable precautions should be taken during use. Applications in confined spaces are to be carried out beneath suitable extraction.

Annex A
(normative)

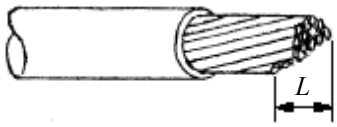
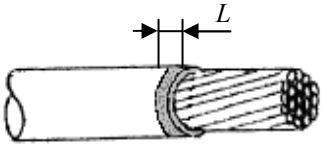
Defects illustrations

Table A.1 — Inspection of stripped cable ends

Defect #	Defect illustration	Defect description	Sanction	Limits
1	 **Figure A.1**	Strands cut	Rejected	—
2	 **Figure A.2**	Core unstranded and splayed	Rejected	—
3	 **Figure A.3**	Mark on insulator (notch, burned, visible core, …)	Rejected	Acceptable when only an external varnish is removed
4	 **Figure A.4**	Core marked along a generating line	Rejected	Acceptable only when copper or aluminium are non visible
5	 **Figure A.5**	Superficial contamination (burned insulator, glue residues, dust, …)	Rejected	Acceptable if non visible with naked eye
6	 **Figure A.6**	Residual insulator	Rejected	Acceptable if $L \leq 1$ mm

continued

Table A 1— Inspection of stripped cable ends *(concluded)*

Defect #	Defect illustration	Defect description	Sanction	Limits
7	 **Figure A.7**	Strands cut out of line	Rejected	Acceptable if $L \leq$ 1mm
8	 **Figure A.8**	Strands marked (on the stripping dies zone)	Rejected	Acceptable only when copper or aluminium are non visible
9	 **Figure A.9**	Superficial mark on insulator (stripping jaws, clamping jaws, …)	**Accepted**	—
10	 **Figure A.10**	Core unstranded (no splaying)	**Accepted**	—
11	 **Figure A.11**	Heat affected zone	**Accepted**	Acceptable if $L \leq$ 1 mm

Annex B
(informative)

Mechanical stripping

Example of blade for mechanical stripping (hand plier tool)

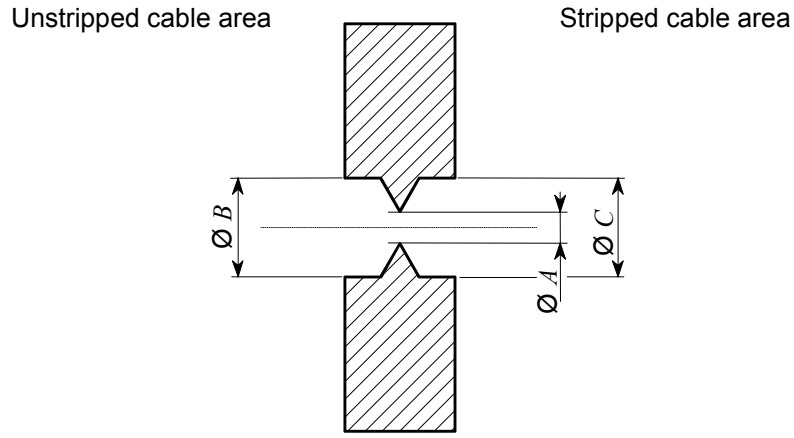


Figure B.1 — Profiles of blades

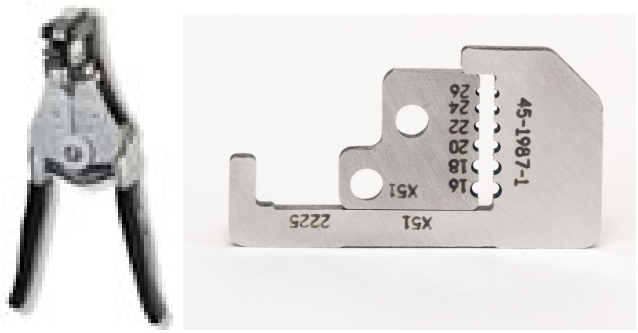


Figure B.2 — Examples of parts

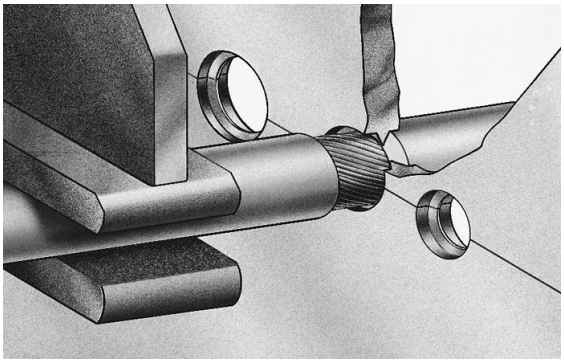


Figure B.3 — Stripping principle illustration

Annex C
(informative)

Laser stripping

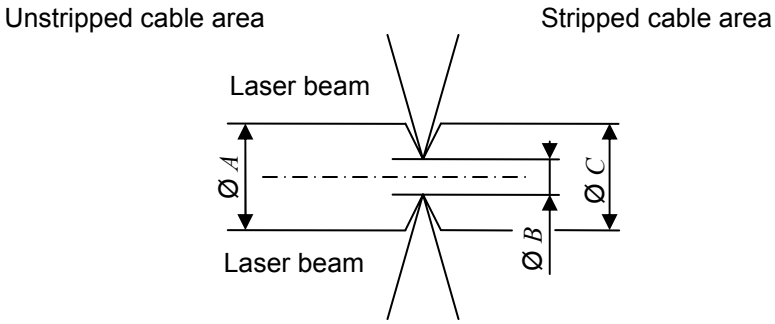


Figure C.1 — Laser beam

Figure C.2 — Example of laser stripping tool

Annex D
(informative)

Thermal stripping

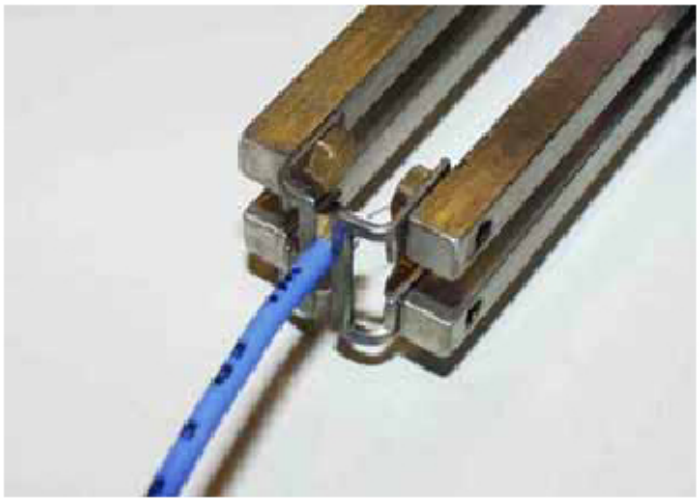


Figure D.1 — Stripping principle (rotating electrodes)

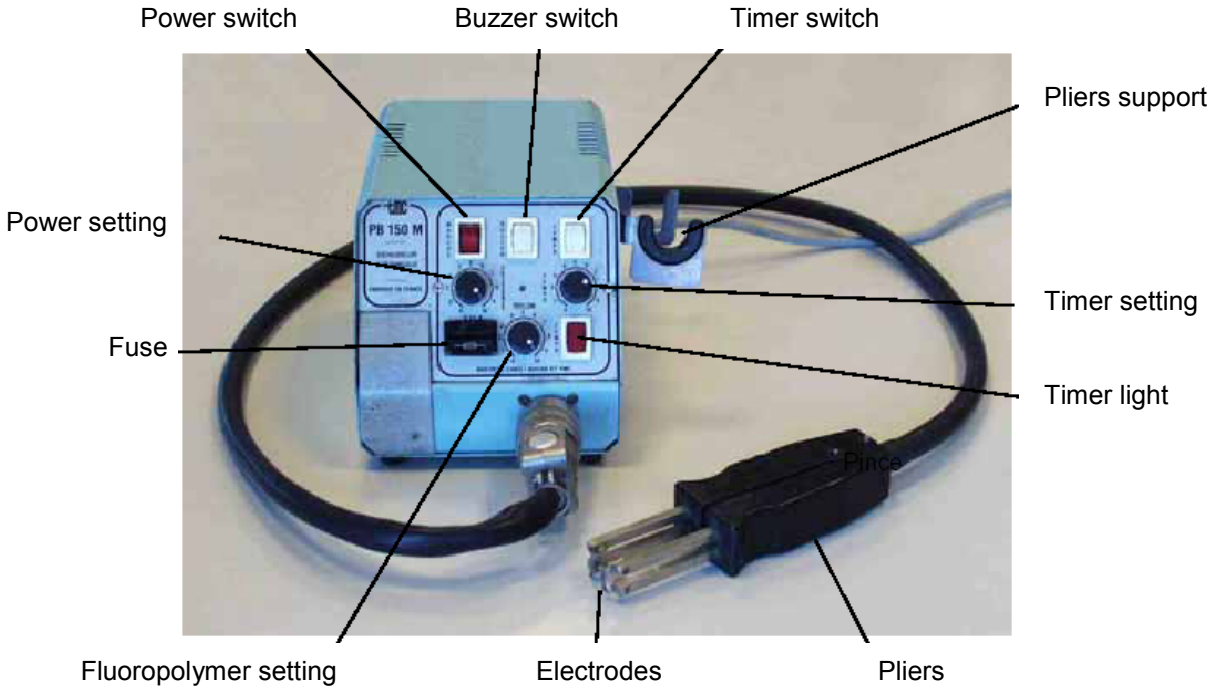


Figure D.2 — Example of thermal stripping tool

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