BS EN 3475-603:2011

Incorporating corrigendum November 2011

BSI Standards Publication

Aerospace series — Cables, electrical, aircraft use — Test methods

Part 603: Resistance to wet arc tracking

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 3475-603:2011, incorporating corrigendum November 2011. It supersedes BS EN 3475-603:2007 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ACE/6, Aerospace avionic electrical and fibre optic technology.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

ISBN 978 0 580 77399 0

ICS 49.060

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2011.

Amendments/corrigenda issued since publication

Date	Text affected
31 January 2012	Implementation of CEN corrigendum November 2011: Figure 2 updated

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 3475-603

May 2011

ICS 49.060

Supersedes EN 3475-603:2007
Incorporating corrigendum November 2011

English Version

Aerospace series - Cables, electrical, aircraft use - Test methods - Part 603: Resistance to wet arc tracking

Série aérospatiale - Câbles électriques à usage aéronautique - Méthodes d' essais - Partie 603: Résistance à l'amorcage et à la propagation d'arc èlectrique, essai humide

Luft- und Raumfahrt - Elektrische Leitungen für Luftfahrtverwendung - Prüfverfahren - Teil 603: Lichtbogenfestigkeit, feucht

This European Standard was approved by CEN on 20 February 2010.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

Page

Foreword

This document (EN 3475-603:2011) 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.

This document supersedes EN 3475-603:2007.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2011, and conflicting national standards shall be withdrawn at the latest by November 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European standard specifies a method of assessing the behaviour of cable insulation subject to an electric arc initiated and maintained by contaminating fluid along the surface of the insulation.

This standard shall be used together with EN 3475-100.

The primary aim of this test is:

— to produce, in a controlled fashion, continuous failure effects, which are representative of those, which may occur in service when a typical cable bundle is damaged and subjected to aqueous fluid contamination. Electrical arcing occurs along the surface of the insulation between damage sites on adjacent cables; and

— to examine the aptitude of the insulation to track, to propagate electric arc to the electrical origin.

Originally defined for 115 Vac network, this test also proposes conditions for 230 Vac network. Unless otherwise specified in product standard, only 115 Vac conditions shall be satisfied.

Six levels of prospective fault current have been specified for concerned cable sizes (see Clause 7). It is agreed that sizes larger than 051 need not be assessed since the short-circuit phenomenon becomes dominant at low line impedances.

Unless otherwise specified in the technical/product standard sizes 002, 006 and 020 cable shall be assessed.

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 2350, *Aerospace series — Circuit breakers — Technical specification*

EN 3197, *Aerospace series — Design and installation of aircraft electrical and optical interconnection systems*

EN 3475-100, *Aerospace series — Cables, electrical, aircraft use — Test methods — Part 100: General*

EN 3475-302, *Aerospace series — Cables, electrical, aircraft use — Test methods — Part 302: Voltage proof test*

A-A-52083, *Tape, lacing and tying, glass* [1)]

3 Specimen requirements

Cables to be tested shall be of traceable origin and shall have passed the high voltage dielectric test defined in the product standard.

1) Published by: Department of Defense Industrial Supply Center, ATTN: DISC-BBEE, 700 Robbins Avenue, Philadelphia, PA 19111-5096 – USA.

4 Preparation of specimen

Cut seven separate lengths approximately 0,5 m consecutively from one length of cable, and strip each of the ends of insulation to permit electrical connection. Clean each length of cable with a clean cloth moistened with propan-2-ol (isopropyl alcohol) fluid.

Damage two lengths of the cable by inflicting a cut around the total circumference at the mid-point of the length, taking care to ensure that the cut penetrates to the conductor around the full circumference and has a width of 0,5 mm to 1,0 mm.

Lay up the seven cables as follows:

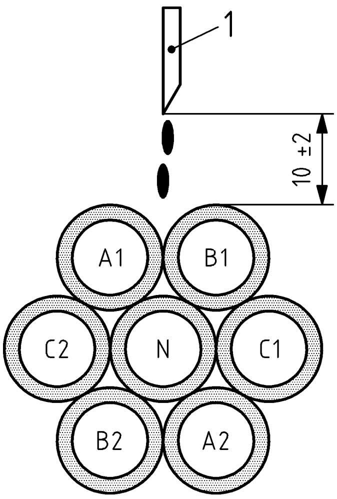
a) Form the cables in a six around one configuration as shown in Figure 1.

b) Displace the damaged cables longitudinally such that a separation of (10 ± 0,5) mm of undamaged insulation is provided as shown in Figure 2. This is called the test zone.

c) Ensure that cables are straight and geometrically parallel, and restrained by ties such that they are in continuous contact within the test zone.

d) Position the ties or PTFE glass lacing tape (4±1,0) mm away from each outer notch and then at 15 mm to 20 mm spacing towards the ends of the specimen as show in Figure 2. The tie material used adjacent to the notch shall be PTFE glass lacing tape conforming to A-A-52083 type IV, finish D, size 3.

e) Figure 1 — Number the cables as shown in Figure 1 such that the fault cables are numbers A1 and B1 and the centre is N. Cables C1, A2, B2 and C2 are grouped around N.



Key

1 Drop needle

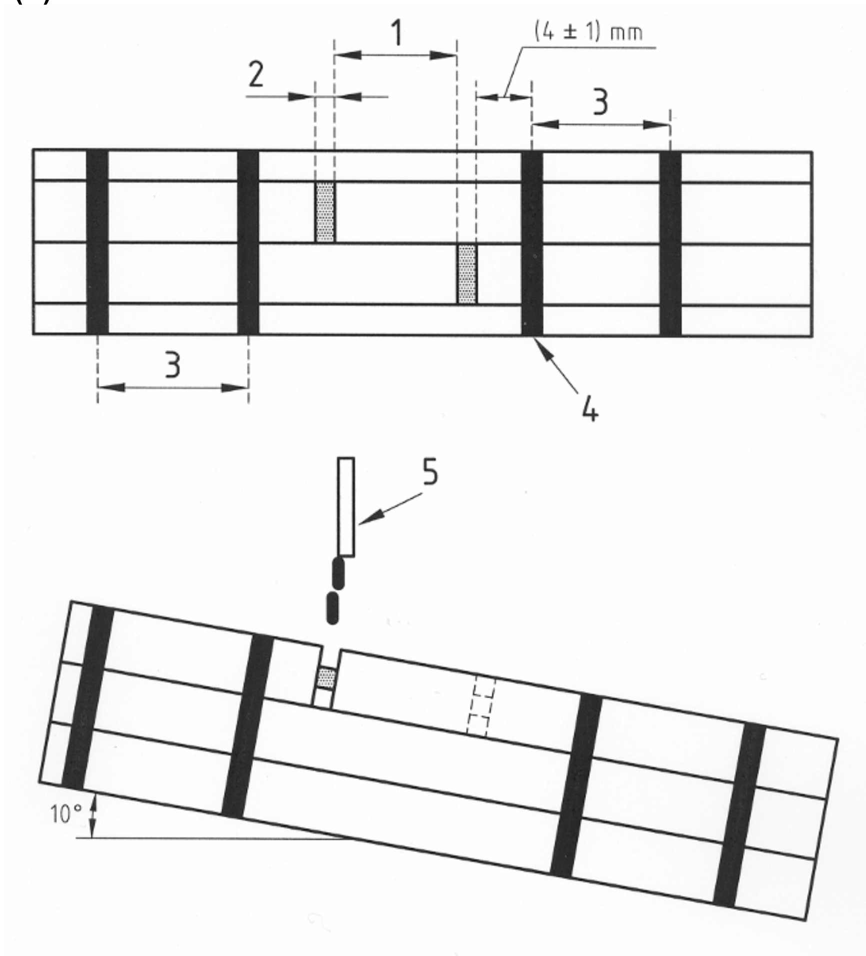
A1-A2 : Phase A

B1-B2 : Phase B

C1-C2 : Phase C

N : Neutral cable connected to earth

Figure 1 — Specimen configuration



Key

1 Test zone (10 ± 0,5) mm
2 Notch 0,5 mm to 1 mm
3 15 mm to 20 mm
4 Tape lacing
5 Drop needle

Figure 2 — Test configuration

5 Apparatus

5.1 Electrical equipment

Connect the seven cables of the test specimen within the circuit shown in Figure 3. This circuit shall have the following requirements:

a) The provision of adjustable levels of prospective fault currents for the six A, B and C cables and an electrical return path for the N cable.

b) A three phase 115/200 V 400 Hz (115 Vac network) or 230/400 V 400 Hz (230 Vac network) star (Y) connected supply shall be derived from a dedicated rotary machine capable of sustaining the maximum prospective fault current given in Table 1 for at least sufficient time for the circuit protection to operate. In any case the generator shall have a sufficient rating to provide these prospective fault currents.

c) The (115 Ω - 115 W per phase for 115 Vac network or 230 Ω - 230 W per phase for 230 Vac network) ballast resistors R1, are fitted in order to prevent over voltage during the arc extinction phases (opening of an inductive circuit).

d) 115 Vac or 230 Vac circuit breakers shall be single pole units rated at the values specified in Table 2. They shall have trip characteristics in accordance with EN 2350 or as required by the product specification.

NOTE 1 Reference of circuit breakers used shall be recorded.

NOTE 2 In particular case, others ratings of thermal breaker protection could be employed in accordance with aircraft manufacturer rules.

e) The electrical power source shall be appropriately protected and should be established that no combination of test circuit events would activate this protection.

f) The resistors shall be non-inductive and have appropriate power rating. Care shall be taken to position all laboratory wiring such that inductive effects are reduced to a practical minimum. Supply cables shall be as short as possible.

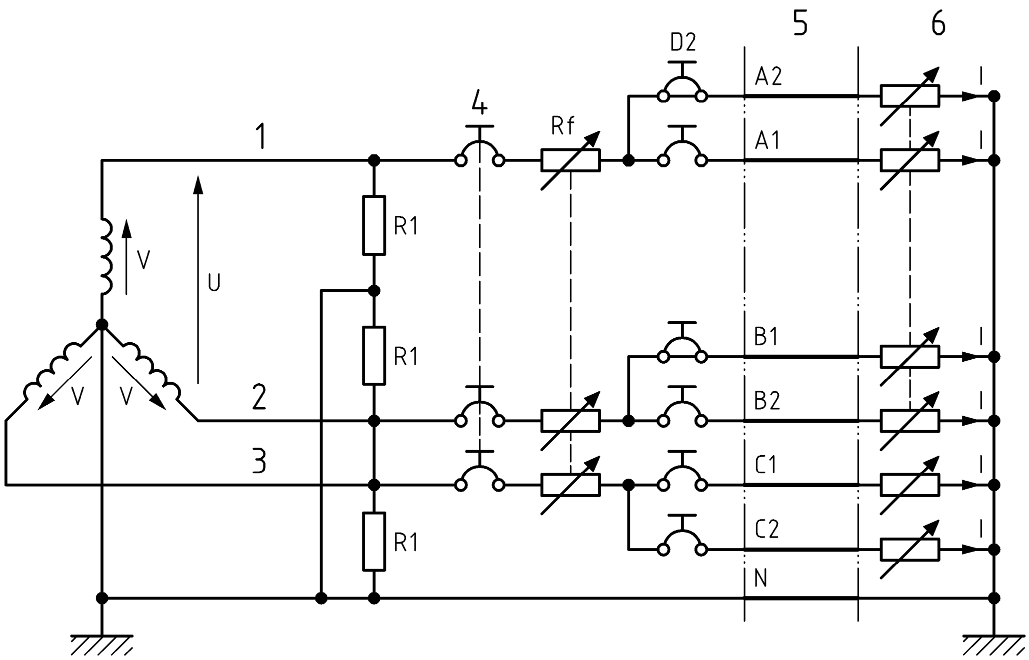
g) Cables A, B and C shall be connected to indication and open circuit detectors (Rg) at the entry into the grounded star point. These components shall limit the standing current to no more than 10 % of the circuit breaker rating.

h) An automatic shut down facility shall be provided, which shall upon the detection of any open circuit during the test and after a 10 s delay, shutdown the flow of electrolyte and electrical power. An open circuit in this case means either a physical break in the specimen or a thermal breaker trip. The facility to override this shut down facility shall be provided so as to restore the power whilst still inhibiting the flow of electrolyte.

   The physical break in the specimen is to be indicated by lamps in series with resistor Rg.

i) Appropriate instrumentation, recording and switching control shall be installed in accordance with good laboratory practice.

j) Adjust resistor Rg so that the current (I) in the circuit is 10 % of value of the circuit breaker rated current.



Key

1 Phase A

2 Phase B

3 Phase C

4 Supply protection

5 Test bundle

6 Indicators (lamp) + Rg

Figure 3 — Test schematic circuit

5.2 Test equipment

Construct an apparatus as shown diagrammatically in Figure 3 which includes the following minimum provisions:

a) Electrical terminations to provide a ready means of connecting test specimens into the circuit as shown in Figure 2.

b) A transparent enclosure to protect personnel from ejected molten metal and short wavelength ultra violet light.

c) An electrolyte delivery system which provides a constant rate of (100 ± 10) mg per minute and dispenses drops from an 18 gauge needle cut square at the outlet.

NOTE The needle wall thickness should be selected such that the specified flow rate will be delivered at approximately 6-10 drops per minute.

5.3 Test protocol

5.3.1 The procedure embraces copper cable sizes 001 to 051 (26 to 10) or aluminium cable sizes 002 to 051 (24 to 10) and for each size six values of prospective maximum fault current to be set by adjustment of resistances Rf have been defined in Table 1. Performance of the cable at a given fault current shall be determined by testing three specimens. Thus 18 specimens are required for each cable size.

5.3.2 For the purpose of cable qualification at least sizes 002, 006 and 020 shall be tested. Additional testing of other sizes may be deemed necessary in particular cases and values of prospective fault currents, the ratings of thermal breaker protection which are typical of aircraft use have been included in Table 1.

5.3.3 It is emphasised that electrical arcing tests are essentially destructive and can be hazardous to personnel. Therefore tests should be undertaken with all observers shielded from direct physical and visual exposure as noted in 5.2 b). The use of video recording for all tests is required.

5.4 Test rig set-up

5.4.1 Install the rating of circuit breaker appropriate to the cable type and size to be tested (Table 2).

5.4.2 Heavy-duty electrical connections shall be fitted in substitution of test specimen to enable prospective fault currents to be set by adjustment of resistances Rf. Because these currents would trip the thermal breakers very rapidly these shall be shunted to permit the pulsing of current until the desired value is obtained. Re-instate the thermal protection.

5.4.3 Prepare an electrolyte solution made by dissolving (3 ± 0,5) % by weight of sodium chloride in distilled water.

5.4.4 Support the specimen in free air inclined at an angle of 10° to the horizontal with the electrical input connections at the higher end and with the cables forming the test zone uppermost.

5.4.5 Position the delivery system so that the electrolyte contacts the loom from a height of (10 ± 2) mm above the uppermost cables in the loom at a point which shall position the droplets into the upper cut or no more than 2 mm towards the higher end of the specimen. Ensure that the drops strike the cables in the middle of the test zone, the top centre of the circumference such that they fall into the crevice between cables at A1 and B1.

6 Method

6.1 Test procedure

6.1.1 Install a test specimen with electrical connections as shown in Figure 1 and with Rf set, as in 5.4.2 above, to give the required fault current specified in Table 1.

6.1.2 Apply electrical power to the specimen and start the flow of electrolyte at a rate of (100 ± 10) mg/min. Particular care should be taken to ensure that the electrolyte flows between the damage sites as the evidenced by the steaming of the electrolyte and the development of scintillation.

6.1.3 Run the test continuously for a period of 8 hours or until an automatic shut down (CB tripping or/and an extinction of lamps occur), whichever is the sooner.

6.1.4 In the event of an automatic shutdown adopt the following procedure:

a) After not less than 3 min, nor more than 10 min, and with all thermal circuit breakers closed, reapply power to the specimen with the automatic trip circuit deactivated and with no further flow of electrolyte.

b) Maintain the power for 15 min to allow any fault condition to develop fully but do not reset any of the thermal circuit breakers.

6.1.5 Repeat the test to obtain three tested specimens and then repeat the procedure for all the fault currents until all 18 specimens have been tested.

6.2 Examination

EN 3197, can be used as a guideline to differentiate short-circuit and arc-tracking effects.

Noticeable damages may come from ever:

- aptitude of the insulation to become an electrically conducting material (arc-tracking phenomenon);
- propagation of thermal effects due to established arcs;
- duration of the test causing electro-erosion;
- as result of thermal effects due to possible short-circuit.

6.2.1 Carefully remove the test specimen from the apparatus and photograph the cable bundle.

6.2.2 Examine visually and record the damage to the insulation including the length of char. Also record if there is evidence of tracking effect to the electrical source.

6.2.3 Carry out a continuity test on all wires except A1 and B1 and record those that are open circuit.

6.2.4 For 115 Vac network and if required by the relevant product standard, with minimal mechanical disturbance to the test specimen, carry out a voltage proof test EN 3475-302 – Immersion test at 1 000 V 1mn, in turn on each of the cables except cables A1 and B1.

6.2.5 For 230 Vac network, considering that short-circuit effect become preponderant and produce strong collateral damages, a voltage proof test shall be un-necessary.

6.3 Test report

The test report shall include details of the following:

a) Clearly mentioned which type of tension was tested (115 Vac or 230 Vac);

b) Identity of the cable type and size and details of the origin and release certification permitting traceability to a production batch;

c) Identity of circuit breakers used;

d) Characteristics of the power source;

e) Operation of individual circuit breakers;

f) Record of the damage as required in 6.2.2 to 6.2.4 and the result of voltage proof test as required in 6.2.3.

7 Requirements

The detail product specification shall define, tension to test if different from 115 Vac, the pass/fail criteria for each cable size, in any series of tests. In any case the cable shall not present evidence of tracking effect longer than the value mentioned in the related product specification.

Table 1 — Prospective fault currents

Type of cables	Size code	AWG [1]	Prospective fault currents (Amps)					
Copper conductors	001/002	26/24	8	15	25	40	60	80
	004/006	22/20	20	30	45	60	80	160
	010 to 051	18 to 10	40	60	80	100	125	250
Copper Clad Aluminium conductors	002/004	24/22	8	15	25	40	60	80
	006/010	20/18	20	30	45	60	80	160
	012/090	16 to 8	40	60	80	100	125	250

NOTE As the maximum current acceptable by a cable size is directly linked to its cross-section, the same prospective fault currents shall be retained per size for 115 Vac and 230 Vac networks.

[1] AWG = Closest American Wire Gage.

Table 2 — Circuit breaker ratings

Type of cables	Size code	001	002	004	006	010	012	020	030	050 051	090
	AWG [1]	26	24	22	20	18	16	14	12	10	8
Copper conductors	CB ratings (Amps)	3	5	7,5	10	10	15	20	25	50	—
Copper Clad Aluminium conductors		—	3	5	7,5	10	10	15	20	35	50

[1] AWG = Closest American Wire Gage.

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.

...making excellence a habit.™