TEST REPORT
IEC 60282-2
HIGH-VOLTAGE FUSES – Part 2: Expulsion fuses

Report Number.....:	HUAX2307110410KR
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Name of Testing Laboratory preparing the Report..... :	Shenzhen Huaxiang Testing Co., Ltd.
Applicant's name.....:	Zhe jiang Langao Power Technology Co., Ltd
Address.....:	Nanzhai Village , Liushi Town , Yueqing City , Zhejiang Province
Test specification:	
Standard..... :	IEC 60282-2:2008
Test procedure..... :	Test report
Non-standard test method..... :	N/A
Test Report Form No.....:	IEC60282_2A
Test Report Form(s) Originator..... :	Huaxiang
Master TRF..... :	2023-04-05

General disclaimer:

The test results presented in this report relate only to the object tested.
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Test item description.....:	Drop Out FUSE
Trademark(s)..... :	LEDL® LANGAO POWER
Manufacturer..... :	Same as applicant
Model/Type reference.....:	HRW12-15/200
Ratings..... :	15KV, 200A

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List of Attachments (including a total number of pages in each attachment):

Attachment 1: Photo documentation

Summary of testing:

Tests performed (name of test, test clause and date test performed):	**Testing location:**
The submitted samples were tested and found to comply with the requirements of: IEC 60282-2	201, Building A10, Fuhai Information Port, Fuhai Street, Bao'an District, Shenzhen City

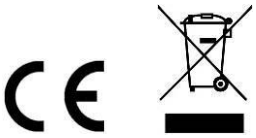
Summary of compliance with National Differences (List of countries addressed):

N/A

Copy of marking plate:

The artwork below may be only a draft.

Drop Out FUSE
Model: HRW12-15/200
Rating: 15KV, 200A



Zhe jiang Langao Power Technology Co., Ltd
Made in China

- The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.

Test item particulars..... :	
a) Fuse (complete)	
– Rated voltage .....:	15KV
– Rated current .....:	200A
– Rated frequency .....:	50Hz
– Rated breaking capacity ..... :	10KA
– Rated insulation level ..... :	$70U_d/80U_p$
b) Fuse-base	
– Rated voltage .....:	15KV
– Rated current .....:	200A
– Rated insulation level ..... :	$70U_d/80U_p$
c) Fuse-carrier	
– Rated voltage .....:	15KV
– Rated current .....:	200A
– Rated frequency .....:	50Hz
– Rated breaking capacity ..... :	10KA
d) Fuse-link	
– Rated voltage .....:	15KV
– Rated current .....:	200A
Possible test case verdicts:	
- test case does not apply to the test object.....:	N/A
- test object does meet the requirement.....:	P (Pass)
- test object does not meet the requirement.....:	F (Fail)
Testing..... :	
Date of receipt of test item.....:	2023-07-11
Date (s) of performance of tests.....:	2023-07-11 to 2023-07-18

General remarks:

"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.

Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

Name and address of factory (ies)..... :

General product information and other remarks:

1. The equipment is Drop Out FUSE.
2. TECHNICAL CHARACTERISTICS
   Rated operating Line Voltage: 15KV;
   Maximum equipment voltage: 17,5KV;
   Rated frequency:50Hz;
   Power frequency withstand voltage (1 min):
   - Phase to earth:50KV
   - Across isolating disntance:76KV;

Impulse withstand voltage (1.2/50 us, dry) :
- Phase to earth:110KV
- Across isolating disntance:115KV;

Rated current:200A;
Rated interrupt capacity:10KA;
Creepage distance:525mm;

IEC 60282-2			
Clause	Requirement + Test	Result - Remark	Verdict
1.0	**SCOPE**		P
	This part of IEC 60282 specifies requirements for expulsion fuses designed for use outdoors or indoors on alternating current systems of 50 Hz and 60 Hz, and of rated voltages exceeding 1 000 V.		P
	Expulsion fuses are fuses in which the arc extinguished by the expulsion effects of the gases produced by the arc.		P
	Expulsion fuses classified according to the TRV (transient recovery voltage) capability in classes A and B.		P
	This standard covers only the performance of fuses, each one comprising a specified combination of fuse-base, fuse-carrier and fuse-link which have been tested in accordance with this standard; successful performance of other combinations cannot be implied from this standard.		P
	This standard used for non-expulsion fuses in which the interruption process waits for natural current zero to clear the circuit.		N/A
7	**STANDARD CONDITIONS OF USE AND BEHAVIOUR**		P
7.1	**Standard conditions of use with respect to breaking capacity**		P
	Fuses capable of breaking correctly any value of prospective current, irrespective of the possible d.c. component, provided that:		P
	– the a.c. component is not higher than the rated breaking capacity;		P
	– the prospective transient recovery voltage and its rate of rise are not higher than those specified in Tables 8 and 9 for the relevant classes A and B;		P
	– the power-frequency recovery voltage is not higher than that specified in Table 6 (for special conditions, see 12.3.3 and 12.3.4);		P
	– the frequency is between 48 Hz and 62 Hz for fuses rated 50 Hz and 50/60 Hz, and between 58 Hz and 62 Hz for fuses rated 60 Hz;		P
	– the power factor is not lower than that specified in Tables 6 and 7.		P
	When used in systems with voltages less than the rated voltage of the fuse, the breaking capacity in kiloamperes is not less than the rated breaking capacity.		P
7.2	**Standard conditions of behaviour with respect to breaking capacity**		P
	According to the conditions of use indicated in 7.1, the behaviour of the fuse as follows:		P

IEC 60282-2			
Clause	Requirement + Test	Result - Remark	Verdict
	a) Flashovers shall not occur during operation. It is the responsibility of the fuse manufacturer to include, in the documentation and on the packaging, a warning that there is a possibility of expulsion of hot gases and particles during fuse operation.		P
	b) After the fuse has operated, the components of the fuse, apart from those intended to be replaced after each operation, in substantially the same condition as before operation.		P
	In the case of expulsion fuses, exception is made for the erosion of the bore of the fuse-carrier.		P
	The fuse, after renewal of the components intended to be replaced after each operation, capable of carrying its rated current at rated voltage.		P
	Any mechanical damage after the operation shall not be such as to impair drop-out action (when applicable), nor the ability to easily remove and replace the fuse-carrier.		P
	However, it is permissible for the components designed to secure the fuse-link in renewable fuses to be slightly damaged, provided that such damage is not likely to prevent the replacement of the melted fuse-element, to decrease the breaking capacity of the fuse, to modify its operating characteristics or to increase its temperature rise in normal service.		P
	Such damage is normally verified by visual inspection of the fuse.		P
	c) After operation, the dielectric withstand of the fuse across its terminals may be limited to the power-frequency recovery voltage (see Clause 12).		P
	d) During the operation of a drop-out fuse, small points of arc erosion at the upper contact may occur, mainly at low levels of interrupting current and are acceptable.		P
	e) The pre-arcing time inside the limits of the time-current characteristic supplied by the manufacturer.		P
7.3	**Time-current characteristics**		P
7.3.1	**General**		P
	The time-current characteristics of fuse-links based on applying current to a new and unloaded fuse-link in a fuse-base specified by the manufacturer.		P
	Unless otherwise specified, the time-current characteristics deemed to apply at an ambient air temperature of 20 °C.		P

IEC 60282-2			
Clause	Requirement + Test	Result - Remark	Verdict
	The manufacturer shall make available curves from the values determined by the time-current characteristic type tests specified in 8.7.		P
	The time-current characteristics presented with current as abscissa and time as ordinate.		P
	Logarithmic scales used on both co-ordinate axes.		P
	The basis of the logarithmic scales (the dimensions of one decade) in the ratio 2:1 with the longer dimension on the abscissa.		P
	However, a ratio of 1:1 (5,6 cm) (North American practice) is also recognized.		P
	When the ratio of 2:1 is used, representation on size A3 or A4 paper.		P
	If the ratio 1:1 is used, representation may be on paper in accordance with North American practice.		P
	The dimensions of the decades selected from the following series:		P
	2 cm – 4 cm – 8 cm – 16 cm		P
	2,8 cm – 5,6 cm – 11,2 cm		P
	It is recommended to use wherever possible the underlined values.		P
	The curves shall show:		P
	– the pre-arcing time or the operating time;		P
	– the relation between the time and the r.m.s. symmetrical prospective current for the time range, at least, 0,01 s to 300 s or 600 s as appropriate to the fuse-link rated current;		P
	– the type and rating and speed designation of the fuse-link to which the curve applies;		P
	– if the curve represents minimum values of time and current, the actual points established by tests lie within a distance corresponding to 0−20 % on the current scale to the right of the curve.		P
	If the curve represents average values of time and current, the actual points established by tests lie within a distance corresponding to 10 % on the current scale on either side of the curve.		P
	Tolerances apply in range 0,01 s to 300 s or 600 s, as appropriate to the fuse-link rated current.		P
7.3.2	**Pre-arcing time-current characteristics for fuse-links designated type K and type T**		P
	The maximum and minimum pre-arcing time-current characteristics supplied by the manufacturer lie within the zones given in Tables 10 and 11.		P
7.4	Temperature and temperature rise		P

IEC 60282-2			
Clause	Requirement + Test	Result - Remark	Verdict
	The fuse-base, fuse-carrier and fuse-link shall carry their rated currents continuously without exceeding temperature and temperature-rise limits specified in Table 12.		P
	These limits not be exceeded, even when the rated current of the fuse-link is equal to the rated current of the fuse-carrier intended to accommodate this fuse-link.		P
	Fuse-link parts for which temperatures cannot be easily measured during tests (for example the small arc-quenching tube of distribution fuse-cut-outs), checked by visual examination for deterioration.		P
7.5	**Electromagnetic compatibility**		P
	Fuses within the scope of this standard are not sensitive to electromagnetic disturbances, and therefore no immunity tests are necessary.		P
	Any electromagnetic disturbance which may be generated by a fuse is limited to either radio interference or switching voltage.		P
	The former is deemed to be negligible in fuses of rated voltage below 123 kV.		P
	The latter is limited to the instant of operation of the fuse, and, with fuses other than current-limiting fuses, there is little significant overvoltage during operation; therefore no emission tests are deemed to be necessary.		P
	For fuses rated 123 kV and above, requirements for radio interference voltage specified in IEC 60694 apply.		P
7.6	**Mechanical requirements (for distribution fuse-cut outs)**		P
7.6.1	**Fuse-bases and fuse-carriers**		P
	When tested according to 8.8.1, the fuse capable of remaining in an operable condition.		P
7.6.2	**Fuse-links**		P
7.6.2.1	**Static strength**		P
	When tested according to 8.8.2.1, fuse-links capable of withstanding the specified tensile strength without change in the mechanical and electrical characteristics.		P
7.6.2.2	**Dynamic strength**		P
	When tested according to 8.8.2.2, fuse-links capable of withstanding 20 operations without change in the mechanical and electrical characteristics.		P
8	**TYPE TESTS**		P
8.1	**Conditions for performing the tests**		P

IEC 60282-2			
Clause	Requirement + Test	Result - Remark	Verdict
	Type tests are tests made to check whether a type of particular design of fuse corresponds to the characteristics specified, and operates satisfactorily under normal operating conditions, or under special specified conditions.		P
	Type tests are made on samples to check the specified characteristics of all fuses of the same type.		P
	These tests repeated if the construction is changed in a way which might modify the performance.		P
	For example, if a non-ceramic insulator is substituted for a ceramic insulator, dielectric, breaking, RIV, mechanical and artificial pollution tests repeated.		P
	For convenience of testing, and with the previous consent of the manufacturer, the values prescribed for the tests, particularly the tolerances, can be so changed as to make the test conditions more severe.		P
	Where a tolerance is not specified, type tests carried out at values not less severe than the specified values.		P
	The upper limits are subject to the consent of the manufacturer.		P
	Type tests at values above assigned ratings are not required.		P
	If conformance tests are made with conditions which are more severe than those obtained during the original type-tests, the responsibility of the manufacturer limited to the rated values.		P
8.2	**List of type tests and test reports**		P
8.2.1	**List of type tests**		P
	The type tests to be conducted, in any order, upon completion of a design, or following a change that affects the performance, are the following:		P
	– dielectric tests;		P
	– temperature-rise tests;		P
	– breaking tests;		P
	– tests for time/current characteristics;		P
	– radio-interference tests (for fuses rated 123 kV and above);		P
	– mechanical tests (for fuse-bases and fuse-links);		P
	– artificial pollution tests where applicable.		P
8.2.2	**Test reports**		P

IEC 60282-2			
Clause	Requirement + Test	Result - Remark	Verdict
	The results of all type tests recorded in test reports containing the data necessary to prove compliance with this standard.		P
	The reports record the manufacturer's name, type reference(s) of the fuse base, fuse-carrier, and fuse-link, and any specified details that may affect the performance of the fuse.		P
	Such data sufficient to enable unambiguous identification and assembly of the fuse by the test laboratory.		P
	Details of the test arrangements, including positions of any metalwork, also recorded.		P
	When the test reports do not include all five test duties for a given fuse type, this clearly stated in the front of the report.		P
8.3	**Common test practices for all type tests**		P
8.3.1	**Condition of device to be tested**		P
	The device new, clean, and in good condition.		P
	It assembled in accordance with the manufacturer's instructions which recorded.		P
8.3.2	**Mounting of fuse**		P
	The fuse to be tested mounted in conditions as close as possible to the normal service conditions, or to conditions indicated in the manufacturer’s written instructions, in the normal service position for which it is designed, with the mounting metal parts earthed.		P
	The connections so positioned that the normal electrical clearances are not reduced.		P
8.4	**Dielectric tests**		P
8.4.1	**Test practices**		P
	Dielectric test practices as specified in 8.3, with the following additional requirements:		P
	a) Mounting		P
	For multi-pole arrangements of fuses, the spacing between poles the minimum value specified by the manufacturer.		P
	b) Connections		P
	Electrical connections made by means of bare conductors connected to each terminal.		P
	These conductors shall project from the terminals of the fuse in substantially a straight vertical line for an unsupported distance of at least the isolating distance of the fuse.		P
8.4.2	**Application of test voltage for impulse and power-frequency tests**		P

IEC 60282-2			
Clause	Requirement + Test	Result - Remark	Verdict
	With reference to Figure 2, which shows a diagram of connection of a three-pole arrangement of fuses, the test voltage specified in Tables 4 or 5 applied according to Table 13:		P
	a) At the rated withstand voltage to earth and between poles:		P
	– between the terminals and all earthed metal parts with the fuse-link and its fuse-carrier completely assembled and ready for service in the “closed” position.		P
	Conditions 1 to 3 in Table 13 are applicable;		P
	– between each terminal and all earthed metal parts with the fuse-link fitted and fuse-carrier in the “open” position.		P
	Conditions 4 to 9 in Table 13 are applicable.		P
	b) Between terminals at the rated withstand voltage across the isolating distance:		P
	– for drop-out fuse, the fuse-carrier in the “drop-out” position;		P
	– for other types, the fuse-carrier removed from the base.		P
	Conditions 4 to 9 in Table 13 are applicable.		P
	For single-pole and double-pole fuses, consider only the applicable symbols in Figure 2 and Table 13 and disregard the others.		P
8.4.3	**Test voltages**		P
	The test voltages to be used the applicable ones given in Tables 4 and 5, corrected for atmospheric conditions according to IEC 60060-1.		P
	8.4.4 Lightning impulse voltage dry tests		P
	Fuses subjected to lightning impulse voltage dry tests.		P
	The tests performed with voltages of both positive and negative polarity, using the standard lightning impulse 1,2/50 µs, in accordance with IEC 60060-1.		P
	One of the following procedures according to Clause 20 of IEC 60060-1 can be followed:		P
	– procedure B with 15 consecutive impulses for each test condition and each polarity; ou		P
	– procedure C with three consecutive impulses for each test condition and each polarity.		P
	The fuse considered to have passed the test successfully if the requirements specified in IEC 60060-1 for the number of disruptive discharges met.		P

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Clause	Requirement + Test	Result - Remark	Verdict
8.4.5	**Power-frequency voltage dry tests**		P
	Fuses subjected to 1 min power-frequency voltage dry tests, as specified in IEC 60060-1.		P
	If flashover or puncture occurs, the fuse considered to have failed the test.		P
8.4.6	**Power-frequency voltage wet tests**		P
	Outdoor type fuses subjected to power-frequency voltage wet tests under the same conditions as specified in 8.4.5 and IEC 60060-1.		P
	Test duration as specified in Tables 4 or 5.		P
8.4.7	**Radio interference voltage test for fuses rated 123 kV and above**		N/A
	The test made in accordance with IEC 60694.		N/A
8.5	**Temperature-rise tests**		P
8.5.1	**Test practices**		P
	Temperature-rise tests carried out as specified in 8.3 on one single-pole fuse, with the test current equal to the rated current of the fuse-base or fuse-carrier, and with the following additional requirements.		P
	The tests carried out with the fuse-link of the largest current rating, i.e. of the same rating as the fuse-carrier.		P
8.5.2	**Arrangement of the equipment**		P
	The test made in a closed room, substantially free from air currents, except those generated by heat from the device being tested.		P
	The fuse mounted in the most unfavourable position within the directions specified by the manufacturer, and connected to the test circuit by bare copper conductors as follows:		P
	– each conductor approximately 1 m long, mounted in a plane parallel to the mounting surface of the fuse, but they may be in any direction in this plane.		P
	The sizes of the leads are given in Table 14.		P
	– Normal clearances need not be provided.		P
	Tests made at a frequency between 48 Hz and 62 Hz.		P
	Each test made over a period of time sufficient for the temperature rise to reach a constant value (for practical purposes this condition is regarded as being obtained when the variation of temperature rise does not exceed 1 K/h).		P
8.5.3	**Measurement of temperature and temperature rise**		P

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Clause	Requirement + Test	Result - Remark	Verdict
	Precautions taken to reduce the variations and the errors due to the time lag between the temperature of the fuse and the variations in the ambient air temperature.		P
	The temperature of the various parts for which limits are specified measured with thermocouples or thermometers of any suitable type, located and secured to provide good heat conduction at the hottest accessible point.		P
	For measurement with thermometers or thermocouples, the following precautions taken:		P
	a) the bulbs of the thermometers or the thermocouples protected against cooling from outside (dry clean wool, etc.).		P
	The protected area shall, however, be negligible compared to the cooling area of the apparatus under test;		P
	b) good heat conductivity between the thermometer or thermocouple and the surface of the part under test ensured;		P
	c) when bulb thermometers are employed in places where there is a varying magnetic field, it is recommended to use alcohol thermometers in preference to mercury thermometers, as the latter are more liable to be influenced under these conditions.		P
8.5.4	**Ambient air temperature**		P
	The ambient air temperature is the average temperature of the air surrounding the fuse (for the fuse in an enclosure, it is the air outside the enclosure).		P
	It measured during the last quarter of the test period by means of at least three thermometers, thermocouples or other temperature detecting devices, equally distributed around the fuse at about the average height of its current-carrying parts at a distance of about 1 m from the fuse.		P
	The thermometers or thermocouples protected against air currents and undue influence of heat.		P
	In order to avoid indication errors due to rapid temperature changes, the thermometers or thermocouples may be immersed in small oil-filled bottles with oil contents of about half a litre.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	During the last quarter of the test period, the change of ambient air temperature shall not exceed 1 K in 1 h. If this is not possible because of unfavourable temperature conditions of the test room, the temperature of an identical fuse under the same conditions, but without current, can be taken as a substitute for the ambient air temperature.		P
	The ambient air temperature during tests between 10 °C and 40 °C.		P
	No correction of the temperature-rise values made for ambient air temperature within this range.		P
8.6	**Breaking tests**		P
8.6.1	**Test practices**		P
8.6.1.1	**General**		P
	Test practices as specified in 8.3 and as follows:		P
8.6.1.2	**Description of tests to be made**		P
	The breaking tests made with single-phase alternating current.		P
	Tests made in accordance with Tables 6 to 9 where applicable, and include the following five test duties:		P
	Test duty 1:		P
	Verification of the rated breaking capacity (I1)		P
	Test duties 2 and 3:		P
	Verification of breaking capacity in the following two ranges of fault currents (I2 and I3)		P
	– Test duty 2 : from 0,6 I1 to 0,8 I1		P
	– Test duty 3 : from 0,2 I1 to 0,3 I1		P
	Test duties 4 and 5:		P
	Verification of breaking capacity when the fuse is required to operate at comparatively low fault currents (I4 and I5)		P
	– Test duty 4: from 400 A to 500 A		P
	– Test duty 5: from 2,7 Ir to 3,3 Ir with a minimum of 15 A		P
	(Ir being the rated current of the fuse-link)		P
	If the fuse is rated to be used only in three-phase circuits, test duty 1 may be replaced by:		P
	– a test duty 1 at voltage 87 % Ur and current I1, and		P
	– a test duty 1 at voltage Ur and current 87 % I1.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	87 % Ur represents phase-neutral voltage multiplied by a first phase to clear factor of 1,5.		P
	87 % I1 represents a phase-to-phase fault current cleared by one fuse, or the current broken by the second fuse to clear a three-phase unearthed fault.		P
	It is not necessary to perform breaking tests on fuses fitted with fuse-links, or refill units of all current ratings of a homogeneous series.		P
	See 8.6.3.1 for the requirements to be met, and Table 6, where applicable, for the tests to be made.		P
8.6.1.3	**Characteristics of test circuit**		P
	The circuit elements used to control the current and power factor in series arrangement, as shown in Figure 3.		P
	The test circuit power frequency between 58 Hz and 62 Hz for fuses rated 60 Hz, and between 48 Hz, and 52 Hz for fuses rated 50 Hz or 50/60 Hz.		P
	The characteristics of the test circuit specified in Tables 6 to 9.		P
	If the specified prospective TRV cannot be achieved with the conventional single-phase test circuit, earthed as shown in Figure 3, then the test laboratory may earth the circuit at whatever point is necessary to achieve the specified TRV.		P
	In all cases, the test laboratory shall record the actual test circuit, and if necessary, the justification for the earthing point.		P
8.6.1.4	**Test samples**		P
	Fuse-links, refill units of the same manufacturer as that of the fuse-carrier, or as specified, used in carrying out tests on fuses.		P
	In performing tests on renewable fuses, only the fuse-link, refill unit, or other parts normally replaceable after operation replaced. However, a new fuse-carrier or fuse-base may be used, as specified in Table 6, where appropriate.		P
	Where the same fuse-carrier is to be used for tests on both the minimum and maximum rated currents of a homogeneous series (e.g. test duty 3), the order of the tests from the lowest to the highest rated current of the series.		P
	Any attachment intended for use with the fuse incorporated in the samples for test.		P
	Modification and/or addition of some attachments create new combinations that subjected to a full test series.		P
	The following list gives some examples:		P

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Clause	Requirement + Test	Result - Remark	Verdict
	– pressure relief cap;		P
	– optional exhaust-control device;		P
	– arc-shortening rod for use with single-venting expulsion fuses.		P
8.6.1.5	**Arrangement of the equipment**		P
	For test duties 1 and 2, the test connections securely supported at a distance (d) from the fuse-base terminals, as shown in Figure 4, to prevent the movement of the test conductors causing excessive mechanical stresses in the fuse-base.		P
	Fuses which emit ionized gases during operation (e.g. expulsion fuses), mounted in such a manner that any nearby metalwork, at earthed or line potential, which may commonly be present under practical service conditions is simulated for the short-circuit tests, e.g. the other two fuses of a three-phase set.		P
	When fuses used in enclosures, the proper performance of the fuses within the enclosure and the structural integrity of the enclosure verified.		P
	In these cases, three-phase short-circuit tests may be necessary.		P
8.6.2	**Test procedure**		P
8.6.2.1	**Calibration of the test circuit**		P
	The fuse, or the fuse-link B under test replaced by a link A of negligible impedance compared with that of the test circuit, as shown in Figure 3.		P
	The circuit adjusted to give the specified prospective current.		P
	This verified by an oscillographic record.		P
8.6.2.2	**Test method**		P
	The link A is removed, and replaced by the fuse, or the fuse-link B under test.		P
	The making switch E is closed at such an instant as to provide the conditions specified in Table 6.		P
	Methods of determining TRV parameters in accordance with IEC 62271-100.		P
	After the fuse has operated, the recovery voltage maintained across the fuse for the periods specified in Table 6.		P
8.6.2.3	**Interpretation of oscillograms (see Figure 5)**		P
	For test duties 1 to 4, the prospective breaking current the r.m.s. value of the a.c. component of the current, measured one half-cycle after the initiation of short circuit in the calibration of the test circuit (see Figure 5a).		P

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Clause	Requirement + Test	Result - Remark	Verdict
	For test duty 5, the breaking current the r.m.s. symmetrical current measured at the instant of the initiation of the arc in the breaking test (see Figure 5b).		P
	The value of the power-frequency recovery voltage measured between the peak of the second non-influenced half-wave, and the straight line drawn between the peaks of the preceding and following half-waves.		P
8.6.3	**Breaking tests for fuses of a homogeneous series**		P
8.6.3.1	**Characteristics of a homogeneous series of distribution fuse-cut-outs**		P
	Experience has shown that to test distribution fuse-cut-outs using a homogeneous series, the homogeneous series is defined as follows:		P
	a) The minimum current rating of fuse-links for 50 A and 100 A rated expulsion fuses class A and B is a 6,3K fuse-link, and for 200 A rated devices it is a 125 K fuse-link.		P
	In some countries 6,3 K and 125 K are not used and 6 K and 14 0K fuse-links can be substituted.		P
	b) The maximum current rating of fuse-links for 50 A rated devices is a 50 T fuse-link, for 100 A rated devices it is a 100 T fuse-link, and for 200 A rated it is a 200 T fuse-link.		P
	Types of fuse-links other than those meeting the K and T criteria are also suitable for use in a tested distribution fuse-cut-out, provided they are produced by the same manufacturer, and the only difference between the tested K and T fuse-links and the other types being:		P
	1) they use the same materials and construction;		P
	2) the element mass is within the maximum and minimum fuse-links tested;		P
	3) the flexible fuse-link tail diameter and number of strands is within that of the maximum and minimum fuse-links tested;		P
	4) the element length is within 75 % of the shortest element length and 133 % of the longest element of the fuse-links tested;		P
	5) the pre-arcing time-current characteristics lies to the left of the largest fuse-link tested.		P
	If the distribution fuse-cut-out manufacturer does not make K or T fuse-links, the distribution fuse-cut-out can be qualified by using an alternate homogeneous series determined by the smallest size fuse-link and the largest size fuse-link of the links that they do manufacture.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	The fuse-links in this alternate homogeneous series shall meet all the conditions detailed above related to the minimum and maximum sizes of the fuse-links tested.		P
	If a distribution fusecutout manufacturer does not make any fuse-links, they shall use a single manufacturer's K and/or T fuse-links for all the required tests.		P
	If any of these conditions are not met, then the fuse-link and cut-out can be qualified together by following the rules in 8.6.3.2		P
8.6.3.2	**Homogeneous series requirements**		P
	Fuse-links are considered as forming a homogeneous series when their characteristics comply with the following:		P
	a) Rated voltage, breaking capacity and frequency the same.		P
	b) All materials, except for the fuse-element, the same.		P
	c) All dimensions, except the cross-section and number of fuse-elements, the same.		P
	d) The law governing any variation of the cross-section of individual fuse-elements along their length the same.		P
	e) All variations in thickness, width, diameter and number of main fuse-elements monotonous) with respect to the rated current.		P
	When determining compliance with homogeneous series, the following may be ignored:		P
	i) Any strain wire connected in parallel with the fuse-element in order to relieve it of tensile strain.		P
	ii) The material and dimensions of the conductor(s) which complete the electric circuit between the terminals of a fuse-holder of a fuse, for example, the flexible tails of fuse-links used in certain types of expulsion fuses.		P
	iii) The length of the main fuse-elements provided that the variation in length is monotonous.		P
	iv) The material of the fuse-element provided that the material variation is within the same general category, for example tin and tin alloys, silver and silver alloys, copper and copper alloys.		P
	For fuse-links used in distribution fuse-cut outs, the dimensions of the smaller diameter arc-quenching tube are excluded when determining homogeneity for test duties 1, 2 and 3 of Table 6.		P
8.6.3.3	**Test requirements**		P

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Clause	Requirement + Test	Result - Remark	Verdict
	In Tables 6 and 7, the test requirements are given for the minimum and maximum current ratings of a series of homogeneous design.		P
8.6.4	**Interpretation of breaking-test results**		P
	If the results of tests made according to the Tables 6 to 9 meet the requirements of 7.2, any current rating of fuse-links within the homogeneous series deemed to comply with the breaking requirements of this standard.		P
	If a fuse-link does not perform satisfactorily according to 7.2 on one or more test duties, that fuse-link rejected from the homogeneous series, but such failure does not necessarily entail the rejection of any other current rating.		P
	Any failure to clear and, for drop-out fuses, any failure to drop out or move into the disconnected position, during any test, is a failure for test duties 1 to 5 for that rated current.		P
	For TRV class A drop-out fuses, arcing times longer than 100 ms are considered to be a failure due to external arcing. For TRV class B, this time may be longer.		P
	After the test, in case of doubt concerning the dielectric withstand of the fuse base across its terminals, a power-frequency voltage dry test with 80 % of the appropriate value given in Tables 4 or 5 may be made.		P
8.7	**Time-current characteristics tests**		P
8.7.1	**Test practices**		P
8.7.1.1	**General**		P
	Time-current test practices as specified in 8.3 and as follows:		P
8.7.1.2	**Ambient air temperature**		P
	The time/current characteristics verified at any ambient air temperature between 15 °C and 30 °C.		P
	At the beginning of each test, the fuse approximately at ambient air temperature.		P
8.7.1.3	**Arrangement of the equipment**		P
	The tests made on a single-pole fuse and with the same arrangement of the equipment as for the temperature-rise tests in 8.5.		P
8.7.2	**Test procedure**		P
8.7.2.1	**Operating time-current tests**		P
	Operating time-current tests performed at rated voltage under the test circuit conditions specified for breaking tests in 8.6.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	Operating time-current curves shall represent maximum values determined by adding the pre-arcing time (at the current from the pre-arcing test) to its tolerance, plus the maximum arcing time.		P
	Maximum arcing time determined by the operating time-current tests specified in this subclause. If arcing time factors used in place of tests at rated voltage, the method used in arriving at the operating time made available.		P
8.7.2.2	**Pre-arcing time-current tests**		P
	Pre-arcing time-current tests made at any convenient voltage, with the test circuit so arranged that the current through the fuse is held to an essentially constant value.		P
	Time-current data obtained from breaking tests may be used.		P
8.7.2.3	**Time range**		P
	Tests made in the time range of 0,01 s to 300 s or 600 s.		P
8.7.2.4	**Measurement of current**		P
	The current through the fuse during time-current tests measured by ammeter, oscillograph or other suitable instrument.		P
8.7.2.5	**Determination of time**		P
	The determination of the time made by any suitable means.		P
8.7.2.6	**Test currents**		P
	For verification of the pre-arcing time-current characteristics, apply the minimum values of current from the curves supplied by the manufacturer for the times 0,1 s, 10 s and 300 s (or 600 s).		P
	The current applied during a time sufficient to melt the fuse-link, or in the case of 300 s (or 600 s) currents, for a time sufficient to permit the verification of the test results.		P
8.7.2.7	**Test results**		P
	The pre-arcing times obtained shall lie within the limits of the curves and tolerances supplied by the manufacturer.		P
8.7.3	**Verification of arcing and operating time**		P
	When necessary, for example in the interpretation of breaking-test results, arcing and total operating times verified from the breaking-test oscillograms.		P
8.8	**Mechanical tests (for distribution fuse-cut-outs)**		P

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Clause	Requirement + Test	Result - Remark	Verdict
	The tests performed at a temperature between 10 °C and 40 °C.		P
8.8.1	**Mechanical test of fuse-bases and fuse-carriers**		P
	Three fuses closed and opened 200 times.		P
	The fuses mounted and operated according to the manufacturer's specifications for normal handling.		P
	At the conclusion of the operations, all fuses in an operable condition, with no cracks in the insulator(s), or loose hardware.		P
	The fuse-carriers should contain fuse-links of high current rating, or dummy links, so that the fuse-links not subjected to the same endurance test as the fuse-bases and fuse-carriers.		P
8.8.2	**Mechanical tests of fuse-links**		P
8.8.2.1	**Static test**		P
	One fuse-link tested in a mechanical apparatus in which it is possible to apply the specified axial tensile force of 60 N.		P
	The force applied gradually, with no precipitous action.		P
	The fuse-link considered to be approved if no damage such as rupture, loosening, slipping of connections, or elongation of components, is observed after a minimum time of 30 min after full load is applied.		P
8.8.2.2	**Dynamic test**		P
	One fuse-link installed in a fuse, which mounted according to the manufacturer's specification for normal service.		P
	The fuse closed and opened 20 times and according to the manufacturer's instructions for operation.		P
	After the operations, there no damage such as rupture, elongation of components, loosening or slipping of connections as verified by visual inspection.		P
8.9	**Artificial pollution tests**		P
8.9.1	**Ceramic insulators**		P
	For ceramic insulators artificial pollution tests performed if the insulator does not meet the creepage distances specified in Clause 4 of IEC 60815.		P
	Such tests are subject to agreement between the manufacturer and the user.		P
8.9.2	**Non-ceramic insulators**		P

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Clause	Requirement + Test	Result - Remark	Verdict
	For fuse-bases that use non-ceramic post insulators, these insulators tested according to IEC 61952.		P
	For fuse-bases that use suspension insulators, these insulators tested according to IEC 61109.		P
	For fuse-bases that use insulators that are not covered by these standards, such as certain distribution fuse-cut-outs, tests requirements are subject to agreement between the manufacturer and user.		P
9	**SPECIAL TESTS**		P
9.1	**General**		P
	Special tests made to check whether a type or particular design of fuse corresponds to the characteristics specified and behaves satisfactorily under special specified conditions.		P
	They made on samples to check the specified characteristics of all fuses of the same type.		P
	These tests repeated only if the construction changed in a way that might modify its behaviour.		P
	For convenience of testing, and with the previous consent of the manufacturer, the values prescribed for the tests, particularly the tolerances, can be changed so as to make the test conditions more severe.		P
	The following tests are to be made after agreement between manufacturer and user for certain types of fuses or for special applications.		P
	The results of all tests recorded in test reports containing the data necessary to prove compliance with this standard.		P
	Unless otherwise specified, the tests made according to the test practices specified in 9.2.		P
9.2	**Lightning surge impulse withstand test**		P
9.2.1	**General**		P
	This test is intended to check the withstand, of a particular design of fuse-link, to a specific lightning surge impulse current.		P
	Fuse-links subjected to this test intended to be used in areas where the architecture of the network allows surge arrester discharges to pass through a fuse-link, and it is desired to minimize the number of fuse-link operations caused by these currents.		P
9.2.2	Test sample		P
	The test sample is a fuse-link, representative of its type.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	A fuse-link of each rated current tested unless the manufacturer can show that all the fuse-links, of the type intended to be qualified, have a higher pre-arcing I2t than the current rating tested.		P
9.2.3	**Arrangement of the equipment**		P
	The tests made on a single-pole fuse and with the same arrangement of the equipment as for the temperature-rise tests in 8.5.		P
9.2.4	**Test procedure**		P
	Three test samples subjected to a single standard current impulse, 8/20 type, according IEC 60060-1 with a peak value of 15 kA.		P
9.2.5	**Acceptance criteria**		P
	Following the tests specified in 9.2.4, a fuse-link is qualified as lightning surge impulse resistant if the following criteria are met:		P
	a) the mechanical strength of the fuse-link is according to 7.6.2.1, static strength;		P
	b) the electrical resistance of the fuse-link is within the values specified by the manufacturer for a new fuse-link;		P
	c) pre-arcing time-current characteristics of the fuse-link shall meet the requirements of 8.7.2.6 and 8.7.2.7 but for a time of 1 s.		P
10	**ACCEPTANCE TESTS**		P
	If acceptance tests are agreed between user and manufacturer, they should be selected from the type tests.		P
	In addition, further tests or verifications may be requested, for example: a) dimensional verification;		P
	b) measurement of resistance of fuse-links.		P
11	**MARKINGS AND INFORMATION**		P
11.1	**Identifying markings**		P
	If the fuse is designed for indoor service only, this indicated by means of an appropriate marking.		P
	The minimum identifying markings on fuse-links, fuse-carriers and fuse-bases are given below.		P
	The identifying markings legible and durable for the service conditions. In case of doubt, a test according to 9.3 of IEC 60898-1 may be used.		P
	The figures representing ratings in all cases be followed by the symbol of the unit in which they are expressed.		P
	a) On the fuse-base:		P
	– manufacturer's name or trademark;		P

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Clause	Requirement + Test	Result - Remark	Verdict
	– manufacturer's type designation (if any);		P
	– rated insulation level (see 6.6);		P
	– rated voltage (Ur) (see 6.2);		P
	– rated current (Ir) (see 6.3.3).		P
	b) On the fuse-carrier:		P
	– manufacturer's name or trademark;		P
	– rated voltage (Ur) (see 6.2);		P
	– rated current (Ir) (see 6.3.4);		P
	– rated breaking capacity (see 6.5) and TRV class (see 5.1);		P
	– rated frequency (see 6.4).		P
	c) On the fuse-links:		P
	– manufacturer's name or trademark;		P
	– manufacturer's type designation (if any);		P
	– rated current (Ir) and speed designation (if any) (see 5.2);		P
	– rated voltage (Ur) (see 6.2).		P
11.2	**Information to be given by the manufacturer**		P
	The manufacturer shall make available to the purchaser the following information:		P
	a) the time-current characteristics for fuse-links;		P
	b) mounting angle of the fuse, if applicable.		P
12	**APPLICATION GUIDE**		P
12.1	**Object**		P
	The object of this clause is to present suggestions on the application, operation and maintenance as an aid in obtaining satisfactory performance with expulsion and similar fuses.		P
12.2	**General**		P
	A fuse in an electric circuit stands guard at all times to protect the circuit, and the equipment connected to it, from overcurrent damage within the limits of its rating.		P
	How well this fuse will perform depends not only upon the accuracy with which it was manufactured, but also the correctness of the application and the attention it receives after it is installed.		P
	If not properly applied and maintained, considerable damage may occur to costly equipment.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	As an example, drop-out fuse-carriers that remain in the open position for prolonged periods of time, may accumulate water and pollution in their internal parts, which may result in the degradation of their operational properties.		P
	In this respect, operational procedures that may lead to fault making or load switching (for fuses not complying with the additional requirements of IEC 60265-1 avoided due to the operational risks, and are not covered by this standard.		P
	It cannot be stressed too strongly that prescribed safety rules should be adhered to at all times when handling or maintaining fuses near energized equipment or conductors.		P
	For all application purposes, the ratings of a given fuse (current, voltage, breaking-capacity, etc.) are to be considered the maximum values, which shall not be exceeded in service; see also 8.1.		P
12.3	**Application**		P
12.3.1	**Mounting**		P
	Fuses mounted in the position specified by the manufacturer.		P
	For multiple arrangements of fuses, when the distance between poles is not fixed by the construction, the poles mounted with clearances not less than those specified by the manufacturer.		P
	Precautions taken concerning the selection of the site of installation of expulsion type fuses, due to the high level of noise and emission of hot gases during operation which are inherent in some types.		P
12.3.2	**Selection of the rated current of the fuse-link**		P
	The rated current of the fuse-link should be selected with due regard to the following parameters:		P
	a) normal and permissible overload currents of the circuit, including sustained harmonics;		P
	b) transient phenomena in the circuit related to switching such equipment as transformers, motors, or capacitors;		P
	c) coordination with other protective devices, if any;		P
	d) enclosure of the fuse or other variation in the cooling conditions, which may affect the temperature of the fuse-link.		P
	The rated current of a fuse-link is usually higher than the normal service current.		P
	Recommendations for selection are usually provided by the manufacturer.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	If the rated current of the fuse-link is less than that of the fuse-base or fuse-carrier, the effective current rating of the fuse is that of the fuse-link.		P
	The rated current defined with reference to the temperature rise of a fuse tested in free air.		P
	When fuses used in an enclosure, the rated current may have to be reduced, in order that the maximum temperature requirements specified in this standard may still be met, and consequently, the fuse may have many different current ratings depending upon the type of enclosure.		P
	For the short pre-arcing times, generally used in predicting discrimination, the time-current characteristic is not significantly changed by mounting the fuse in such an enclosure.		P
	Fuses, which are loaded with a current exceeding the rated current for a time longer than that recommended by the manufacturer, may be subject to deterioration, which may influence the time-current characteristics.		P
	More details may be found in IEC 60787 for transformer protection, and in IEC 60549 for capacitor protection, where applicable.		P
12.3.3	**Selection of the rated voltage of the fuse-base**		P
	The rated voltage of the fuse-base should not be less than the highest phase-to-phase service voltage of the multiphase or single-phase system.		P
	Successful completion of the dielectric withstand tests does not ensure that fuses providing an isolating distance, when open, will always flash over to earth instead of across the isolating distance.		P
	Selection of a higher insulation level than given in Tables 4 and 5 is permissible for each rated voltage.		P
12.3.4	**Selection of class of fuses**		P
	• Class A		P
	These fuses are generally applicable for the protection of small transformers and small capacitor banks for power-factor correction or voltage control, located on power distribution systems of open-line type or cable type, and remotely placed from major substations.		P
	They are also applicable as protective devices at sectionalizing points on such systems.		P
	TRV conditions are described by TRV test parameters, having lower values of uc and longer values of t3 than those for class B fuses.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	• Class B		N/A
	These fuses are generally applicable to protect similar equipment such as class A fuses but in closer proximity to a major supplying substation and feeder circuits leaving such substations.		N/A
	TRV conditions are more severe than those for class A fuse applications, and therefore have more severe TRV test parameters specified.		N/A
12.3.5	**Selection of the rated insulation level**		P
	Table 4 specifies two lists for the values of the rated lightning impulse withstand voltage.		P
	The choice between lists 1 and 2 made by considering the degree of exposure to lightning and switching overvoltages, the type of system neutral earthing, and the type of overvoltage limiting device (see IEC 60071-1).		P
	Equipment designed to list 1 is suitable for installations such as the following:		P
	1) In systems and industrial installations not connected to overhead lines:		P
	a) where the system neutral is earthed, either solidly, or through an impedance which is low compared with that for an arc-suppression coil.		P
	Surge protective devices, such as diverters, are generally not required;		P
	b) where the system neutral is earthed through an arc-suppression coil, and adequate overvoltage protection is provided in special systems, for example an extensive cable network, where surge diverters capable of discharging the cable capacitance may be required.		P
	2) In systems and industrial installations connected to overhead lines through transformers where cables or additional capacitors of at least 0,05 µF per phase are connected between the transformer lower voltage terminals and earth, on the transformer side of the fuses and as close as possible to the transformer terminals. This covers the cases:		P
	a) where the system neutral is earthed either solidly or through an impedance which is low compared with that of an arc-suppression coil.		P
	Overvoltage protection by means of surge diverters may be desirable;		P
	b) where the system neutral is earthed through an arc suppression coil, and where adequate overvoltage protection by surge diverters is provided.		P

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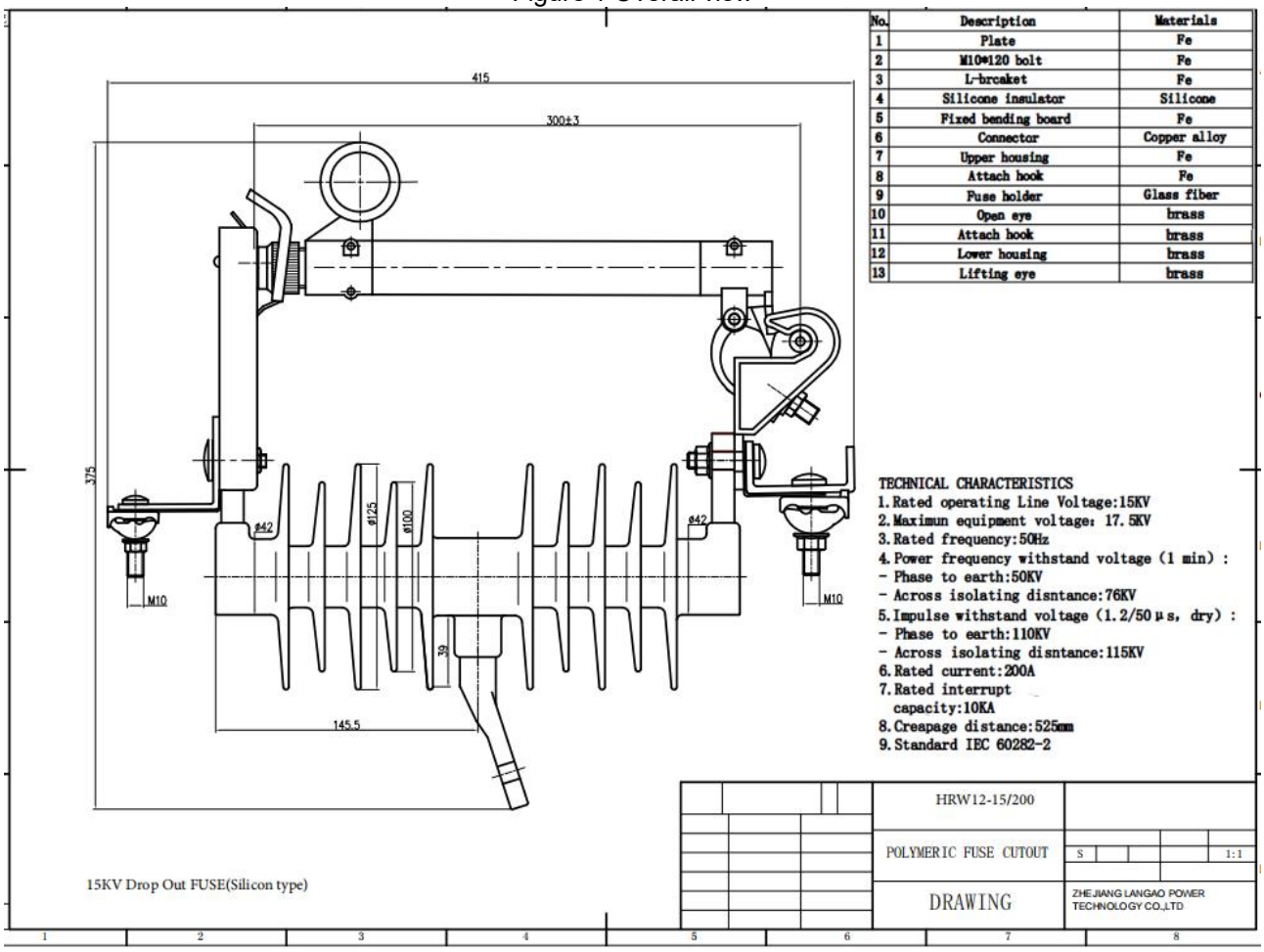
Clause	Requirement + Test	Result - Remark	Verdict
	3) In systems and industrial installations connected directly to overhead lines:		P
	a) where the system neutral is earthed solidly or through an impedance which is low compared with that of an arc-suppression coil, and where adequate overvoltage protection by spark gaps or surge diverters is provided, depending on the probability of overvoltage amplitude and frequency.		P
	b) where the system neutral is earthed through an arc-suppression coil and where adequate overvoltage protection by surge diverters is provided.		P
	In all other cases, or where a very high degree of security is required, equipment designed to list 2 should be used.		P
12.3.6	**Disposal**		P
	When applicable, the manufacturer shall provide information concerning the disposal of fuses with due regard to environmental considerations.		P
	It is the responsibility of the user to consider and comply with all local relevant regulations concerning disposal.		P
12.4	**Operation**		P
	It is advisable to replace all three fuse-links, when the fuse on one or two phases of a three-phase circuit has operated, unless it is definitely known that no overcurrent has passed through the unmelted fuse-links.		P
12.5	**Information about special requirements not covered by this standard**		P
	Some national standards include additional requirements, including classifications related to special conditions of fuse applications.		P
	For informative purposes only, some of these include:		P
	– spark production tests (AS 1033-1 [10]);		P
	– mechanical robustness of fuse-links;		P
	– measurement of the resistance of fuse-links;		P
	– verification of mechanical forces to open and to close drop-out fuses after mechanical operations;		P
	– verification of pre-arcing time-current characteristics after thermal preconditioning.		P

Attachment 1: documentation

Figure 1 Overall view



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