SLOVENSKI STANDARD
SIST EN 61954:2002

01-september-2002

Moļ nostna elektronika za elektroenergetske prenosne in distribucijske sisteme ï Preskuġanje tiristorskih ventilov (elektronk) za statiļ ne kompenzatorje jalove moļ i (IEC 61954:1999)

Power electronics for electrical transmission and distribution systems - Testing of thyristor valves for static VAR compensators

Leistungselektronik für Übertragungs- und Verteilungsnetze - Prüfung von Thyristorventilen für statische Blindleistungskompensatoren

Electronique de puissance pour les réseaux électriques de transport et de distribution - Essais des valves à thyristors pour les compensateurs statiques d'énergie réactive

Ta slovenski standard je istoveten z: **EN 61954:1999**

ICS:

29.240.99	Druga oprema v zvezi z omreġji za prenos in distribucijo elektriļ ne energije	Other equipment related to power transmission and distribution networks
31.080.20	Tiristorji	Thyristors

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EUROPEAN STANDARD

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English version

Power electronics for electrical transmission and distribution systems Testing of thyristor valves for static VAR compensators (IEC 61954:1999)

Electronique de puissance pour les réseaux électriques de transport et de distribution
Essais des valves à thyristors pour les compensateurs statiques d'énergie réactive
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Leistungselektronik für Übertragungs- und Verteilungsnetze
Prüfung von Thyristorventilen für statische Blindleistungskompensatoren
(IEC 61954:1999)

This European Standard was approved by CENELEC on 1999-10-01. CENELEC 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 Central Secretariat or to any CENELEC 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 CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 22F/57/FDIS, future edition 1 of IEC 61954, prepared by SC 22F, Power electronics for electrical transmission and distribution systems, of IEC TC 22, Power electronics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61954 on 1999-10-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2000-07-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2002-10-01

Annexes designated "normative" are part of the body of the standard.
In this standard, annex ZA is normative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61954:1999 was approved by CENELEC as a European Standard without any modification.

CONTENTS

POWER ELECTRONICS FOR ELECTRICAL TRANSMISSION AND DISTRIBUTION SYSTEMS – TESTING OF THYRISTOR VALVES FOR STATIC VAR COMPENSATORS

1 Scope

This International Standard defines type, production and optional tests on thyristor valves used in thyristor controlled reactors (TCR), thyristor switched reactors (TSR) and thyristor switched capacitors (TSC) forming part of static VAR compensators (SVC) for power system applications. The requirements of the standard apply both to single valve units (one phase) and to multiple valve units (several phases).

Clauses 4 to 7 detail the type tests, i.e. tests which are carried out to verify that the valve design meets the requirements specified. Clause 8 covers the production tests, i.e. tests which are carried out to verify proper manufacturing. Clauses 9 and 10 detail optional tests, i.e. tests additional to the type and production tests.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of IEC 61954. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on IEC 61954 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60060 (all parts), *High-voltage test techniques*

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60060-2, *High-voltage test techniques – Part 2: Measuring systems*

IEC 60071 (all parts), *Insulation co-ordination*

IEC 60071-1:1993, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60270, *Partial discharge measurements*

IEC 60700-1:1998, *Thyristor valves for high-voltage direct current (HVDC) power transmission – Part 1: Electrical testing*

3 Definitions

For the purpose of this International Standard, the following definitions apply:

3.1
thyristor level
smallest assembly, consisting of a bi-directional pair of thyristors, their immediate auxiliaries for firing and protection and voltage dividing/damping components. The thyristor level can include parallel connected thyristors for each direction

3.2
thyristor (series) string
series connected thyristors forming one direction of a thyristor valve

3.3
valve reactor
reactor incorporated within some valves for limitation of stresses. For testing purposes it is considered an integral part of the valve

3.4
valve section
number of series-connected thyristor levels, together with distributed valve reactors (if any), which exhibit the same electrical properties as the complete valve but only a portion of the full voltage blocking capability of the valve, and that can be used for tests

3.5
thyristor valve
electrically and mechanically combined assembly of thyristor levels, complete with all connections, auxiliary components and mechanical structures, which can be connected in series with each phase of the reactor or capacitor of a SVC

3.6
valve structure
physical structure which insulates the valves to the appropriate level above earth potential and from each other

3.7
valve base electronics (VBE)
electronic unit at earth potential which is the interface between the SVC control system and the valves for all tasks concerning delivery of information to the valves for firing and of receiving information from the valves for control and monitoring

3.8
multiple valve unit (MVU)
assembly of several valves in the same physical structure which cannot be separated for test purposes (e.g. three-phase valves)

3.9
redundant thyristor levels
thyristor levels in the thyristor valve which may be short-circuited while the specified type test performance of the valve is still met

3.10
voltage breakover (VBO) protection
means of protecting the thyristors from excessive voltage by firing them at a predetermined voltage

4 General requirements for type and optional tests

4.1 Summary of tests

The table below lists the type tests given in the following clauses and subclauses.

Table 1 – List of type tests and optional tests

Test	Clause or subclause		Test object
	TCR/TSR	TSC	
Dielectric tests between valve terminals and earth			
AC test	5.1.1		Valve
AC-DC test		6.1.1	Valve
Lightning impulse test	5.1.2	6.1.2	Valve
Dielectric tests between valves (MVU only)			
AC test	5.2.1		MVU
AC-DC test		6.2.1	MVU
Lightning impulse test	5.2.2	6.2.2	MVU
Dielectric tests between valve terminals			
AC test	5.3.1		Valve
AC-DC test		6.3.1	Valve
Switching impulse test	5.3.2	6.3.2	Valve
Operational tests			
Periodic firing and extinction test	5.4.1		Valve or valve section
Overcurrent test		6.4.1	Valve or valve section
Minimum a.c. voltage test	5.4.2	6.4.2	Valve or valve section
Temperature rise test	5.4.3	6.4.3	Valve or valve section
Electromagnetic interference tests			
Switching impulse test	7.2.1	7.2.1	Valve
Non-periodic firing test	7.2.2	7.2.2	Valve
Production tests			
Visual inspection	8.1	8.1	
Connection check	8.2	8.2	
Voltage dividing/damping circuit check	8.3	8.3	
Voltage withstand check	8.4	8.4	
Check of auxiliaries	8.5	8.5	
Firing check	8.6	8.6	
Cooling system pressure test	8.7	8.7	
Optional tests			
Overcurrent test	9.1		Valve or valve section
Positive voltage transient during recovery test	9.2	10.1	Valve or valve section
Non-periodic firing test	9.3	10.2	Valve

4.2 Objectives of tests

The tests described apply to the valve (or valve sections), the valve structure and those parts of the coolant distribution system and firing and monitoring circuits which are contained within the valve structure or connected between the valve structure and earth. Other equipment, such as valve control and protection and valve base electronics may be essential for demonstrating the correct function of the valve during the tests but are not in themselves the subject of the tests.

4.2.1 Dielectric tests

Tests for the following dielectric stresses are specified:

- a.c. voltage;
- combined a.c. and d.c. voltage (TSC only);
- impulse voltages.

In the interest of standardization with other equipment, lightning impulse tests between valve terminals and earth and between phases of an MVU are included. For tests between valve terminals, the only impulse test specified is a switching impulse.

4.2.1.1 Tests on valve structure

Tests are defined for the voltage withstand requirements between a valve (with its terminals short-circuited) and earth, and also between valves for MVU. The tests shall demonstrate that

- sufficient clearances have been provided to prevent flashovers;
- there is no disruptive discharge in the insulation of the valve structure, cooling ducts, light guides and other insulation parts of the pulse transmission and distribution systems;
- partial discharge inception and extinction voltages under a.c. and d.c. conditions are above the maximum steady-state operating voltage appearing on the valve structure.

4.2.1.2 Tests between valve terminals

The purpose of these tests is to verify the design of the valve with respect to its capability to withstand overvoltages between its terminals. The tests shall demonstrate that

- sufficient internal insulation has been provided to enable the valve to withstand specified voltages;
- partial discharge inception and extinction voltages under a.c. and d.c. conditions are above the maximum steady-state operating voltage appearing on the valve;
- the protective overvoltage firing system (if provided) works as intended;
- the thyristors have adequate d*u*/d*t* capability for in-service conditions. (In most cases the specified tests are sufficient; however in some exceptional cases additional tests may be required).

4.2.2 Operational tests

The purpose of these tests is to verify the valve design for combined voltage and current stresses under normal and abnormal repetitive conditions as well as under transient fault conditions. They shall demonstrate that, under specified conditions:

- the valve functions properly;
- the turn-on and turn-off voltage and current stresses are within the capabilities of the thyristors and other internal circuits;
- the cooling provided is adequate and no component is overheated;
- the overcurrent withstand capability of the valve is adequate.

4.2.3 Electromagnetic interference tests

The principal objective of these tests is to demonstrate the immunity of the valve to electromagnetic interference from within the valve and from outside the valve. Generally, immunity to electromagnetic interference is demonstrated by monitoring of the valve during other tests.

4.2.4 Production tests

The objective of tests is to verify proper manufacture. The production tests shall demonstrate that

- all materials, components and sub-assemblies used in the valve have been correctly installed;
- the valve equipment functions as intended, and predefined parameters are within prescribed acceptance limits;
- thyristor levels and valve or valve sections have the necessary voltage withstand capability;
- consistency and uniformity in production is achieved.

4.2.5 Optional tests

Optional tests are additional tests which may be performed, subject to agreement between purchaser and supplier. The objectives are the same as for the operational tests specified in 4.2.2.

4.3 Guidelines for the performance of type and optional tests

The following principles shall apply:

- type tests shall be performed on at least one valve or on an appropriate number of valve sections, as specified, to verify that the valve design meets the specified requirements. All type tests shall be performed on the same valve(s) or valve section(s);
- provided that the valve is demonstrably similar to one previously tested, the supplier may submit a certified report of any previous type test, at least equal to the requirements specified in the contract, in lieu of the type test;
- certain type tests may be carried out either on a complete valve or on valve sections, as indicated in table 1 (see 4.1);
- for type tests performed on valve sections, the total number of thyristor levels subjected to such type tests shall be at least equal to the number of thyristor levels in a valve;
- the valve or valve sections used for type tests shall first pass all production tests. On completion of the type test programme, the valve or valve sections shall be checked again for compliance with the production test criteria;
- material for the type tests shall be selected at random;

– the dielectric tests shall be performed in accordance with IEC 60060-1 and IEC 60060-2 where applicable;

– individual tests may be performed in any order.

NOTE – Tests involving partial discharge measurement may provide added confidence if performed at the end of the dielectric type test programme.

4.4 Test conditions

4.4.1 General

Dielectric tests shall be performed on completely assembled valves, whereas some operational tests may be performed on either complete valves or valve sections. Tests that may be performed on valve sections are identified in 4.1.

4.4.1.1 Dielectric tests

The valve shall be assembled with all auxiliary components except for the valve arrester, if used. Unless otherwise specified, the valve electronics shall be energized. The cooling and insulating fluids in particular shall be in a condition that represents service conditions such as conductivity, except for the flow rate and antifreezing media content, which can be reduced. If any object or device external to the structure is necessary for proper representation of the stresses during the test, it shall also be present or simulated in the test. Metallic parts of the valve structure (or other valves in a MVU) which are not part of the test shall be shorted together and connected to earth in a manner appropriate to the test in question.

Where standard values for a.c. power frequency and lightning impulse tests per IEC 60071 are being used, the normal procedures as per IEC 60060 apply. Where non-standard test levels are defined by this standard, a site air density correction factor k_d, defined below shall be applied where stated.

The value of k_d shall be determined from the following expression:

$$k_d = \frac{b_1}{b_2} \times \frac{273 + T_2}{273 + T_1}$$

where

b_1 is the laboratory ambient air pressure, expressed in pascals (Pa);

T_1 is the laboratory ambient air temperature, expressed in degrees Celsius (°C);

b_2 is the standard reference atmosphere of 101,3 kPa (i.e. 1 013 mbar), corrected to the altitude of the site at which the equipment will be installed;

T_2 is the design maximum valve hall air temperature, expressed in degrees Celsius (°C).

4.4.1.2 Operational tests

When it is specified that a test may be performed on a valve section, full account shall be taken of the particular design characteristics of the valve when selecting the number of thyristor levels under test.

Sometimes, operational tests may be performed at a power frequency different from the service frequency, e.g. 50 Hz instead of 60 Hz. Some operational stresses such as switching