

# **IEC TR 62757**

Edition 1.0 2015-07

# TECHNICAL REPORT

Fire prevention measures on converters for high-voltage direct current (HVDC) systems, static var compensators (SVC) and flexible ac transmission systems (FACTS) and their valve halfs

<u>IEC TR 62757:2015</u> https://standards.iteh.ai/catalog/standards/sist/13f3a9cd-2f22-4cc5-b192-677503c0be10/iec-tr-62757-2015





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# TECHNICAL REPORT

Fire prevention measures on converters for high-voltage direct current (HVDC) systems, static var compensators (SVC) and flexible ac transmission systems (FACTS) and their valve halls

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#### INTERNATIONAL ELECTROTECHNICAL COMMISSION

#### FIRE PREVENTION MEASURES ON CONVERTERS FOR HIGH-VOLTAGE DIRECT CURRENT (HVDC) SYSTEMS, STATIC VAR COMPENSATORS (SVC) AND FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS) AND THEIR VALVE HALLS

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IEC/TR 62757, which is a technical report, has been prepared by subcommittee 22F: Power electronics for electrical transmission and distribution systems, of IEC technical committee 22: Power electronic systems and equipment.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
22F/347/DTR	22F/353A/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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#### FIRE PREVENTION MEASURES ON CONVERTERS FOR HIGH-VOLTAGE DIRECT CURRENT (HVDC) SYSTEMS, STATIC VAR COMPENSATORS (SVC) AND FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS) AND THEIR VALVE HALLS

#### 1 Scope

IEC TR 62757, which is a technical report, deals with fire prevention measures on converters and their valve halls for high voltage direct current (HVDC) systems, static VAR compensators (SVC) and flexible AC transmission systems (FACTS). It is intended to be primarily for the use of the utilities and consultants who are responsible for issuing technical specifications for new converter valves and valve halls. It concerns fire incidents in HVDC projects using line commutated converters (LCC) or voltage sourced converter (VSC) technology and it is from these projects that most examples of fires and fire incidents are taken. This technical report also addresses converter valves and valve halls for SVC and FACTS.

This technical report provides general recommendations to be considered while preparing specifications for these systems. Specific requirements for a particular project need to be clearly specified and mutually agreed upon between the supplier and the purchaser.

# 2 Normative references STANDARD PREVIEW

## (standards.iteh.ai)

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. 677503c0be10/iec-tr-62757-2015

Void.

#### 3 Terms and definitions

For the purpose of this document the following terms and definitions apply.

#### 3.1

#### alarm system

installation for initiating a fire alarm

#### 3.2

#### automatic fire detector

device that detects abnormally high temperature, rate of temperature rise, visible or invisible particles, infra-red or visible radiation, or gases produced by a fire

#### 3.3

#### automatic fire extinguishing system

any system designed and installed to detect a fire and subsequently discharge an extinguishing agent without the necessity of human intervention

**3.4 burn**, intransitive verb undergo combustion

[SOURCE: ISO 13943:2008, 4.28]

**3.5 burn**, transitive verb cause combustion

[SOURCE: ISO 13943:2008, 4.29]

#### 3.6

**ignite**, intransitive verb catch fire with or without the application of an external heat source

[SOURCE: ISO 13943:2008, 4.184]

**3.7 ignite**, transitive verb initiate combustion

[SOURCE: ISO 13943:2008, 4.185]

**3.8 char**, noun carbonaceous residue resulting from pyrolysis or incomplete combustion

[SOURCE: ISO 13943:2008, 4.38] iTeh STANDARD PREVIEW

**3.9 char**, verb form char

# (standards.iteh.ai)

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[SOURCE: ISO 13943:2008; a4d39] h.ai/catalog/standards/sist/13f3a9cd-2f22-4cc5-b192-677503c0be10/iec-tr-62757-2015

3.10 combustion

exothermic reaction of a substance with an oxidizing agent

Note 1 to entry: Combustion generally emits fire effluent (4.105) accompanied by flames (4.133) and/or glowing (4.168).

[SOURCE: ISO 13943:2008, 4.46]

**3.11** exit designated point of departure from a building

[SOURCE: ISO 13943:2008, 4.86]

#### 3.12

explosion

abrupt expansion of gas that can result from a rapid oxidation (see 4.245 of ISO 13943:2008), decomposition reaction or other means, with or without an increase in temperature

[SOURCE: ISO 13943:2008, 4.87]

3.13
extinguishing medium"
extinguishing agent
solid, liquid or gaseous substance especially suited to the extinction of fires

#### 3.14

#### fire

process of combustion characterized by the emission of heat accompanied by smoke and/or flame

#### 3.15

#### fire alarm

#### alarm

alarm signal for alerting the fire service or people endangered by fire

#### 3.16

fire alarm box call box pull station part of a fire alarm system from which a fire call is made, either by hand or automatically

#### 3.17

#### fire barrier

#### fire separation

separating element which provides, for a stated period of time, simultaneous integrity and thermal insulation under specified test conditions

[SOURCE: ISO 13943:2008, 4.99]

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#### 3.18 fire control system

system which provides integrated control of fire detection, fire alarm, fire suppression, smoke management and other services as part of a total fire protection scheme

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3.19

https://standards.iteh.ai/catalog/standards/sist/13f3a9cd-2f22-4cc5-b192fire damper 677503c0be10/iec-tr-62757-2015

#### smoke damper

mechanical plate or shutter which is closed to restrict the passage of fire/smoke in a flue or duct

#### 3.20

#### fire department connection

connection through which the fire department can pump supplemental water into the sprinkler system, standpipe, or other system furnishing water for fire extinguishment to supplement existing water supplies

#### 3.21

#### fire door

door of at least 30 min fire resistance which is prescribed for fire safety reasons and which has to be kept closed in accordance with the authorities instructions

#### 3.22

#### fire hazard

physical object or condition with a potential for an undesirable consequence from fire

[SOURCE: ISO 13943:2008, 4.112]

#### 3.23

#### fire load

quantity of heat which can be released by the complete combustion of all the combustible materials in a volume, including the facings of all bounding surfaces

[SOURCE: ISO 13943:2008, 4.114, modified - The notes have been deleted.]

#### 3.24

#### fire suppression system

any system provided for the extinguishing of a fire

#### 3.25

#### fire wall

partition wall of specified fire resistance rating

#### 3.26

#### fire-fighting

all measures involved in the combat against fire

3.27

flame, noun

rapid, self-sustaining, sub-sonic propagation of combustion in a gaseous medium, usually with emission of light

- 10 -

[SOURCE: ISO 13943:2008, 4.133]

3.28 flame, verb produce flame

# [SOURCE: ISO 13943;2008,4.334] ANDARD PREVIEW

#### 3.29 flammable

# (standards.iteh.ai)

capable of flaming combustion (see 4.148 of ISO 13943:2008) under specified conditions

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#### 3.30

#### foam

emulsive extinguishing agent, consisting of water, bubbles of gas or air, and a foam stabilizer (foam compound which is used to extinguish burning liquids)

#### 3.31

#### heat release rate

burning rate (deprecated) rate of burning (deprecated) rate of thermal energy production generated by combustion

Note 1 to entry: The typical units are watts (W).

[SOURCE: ISO 13943:2008, 4.177]

#### 3.32

**ignite**, intransitive verb catch fire with or without the application of an external heat source

[SOURCE: ISO 13943:2008, 4.184]

**3.33 ignite**, transitive verb initiate combustion, light

[SOURCE: ISO 13943:2008, 4.185]

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#### 3.34

ignition

sustained ignition (deprecated) general: initiation of combustion

[SOURCE: ISO 13943:2008, 4.187]

#### 3.35

#### ignitability, ease of ignition

measure of the ease with which a test specimen can be ignited, under specified conditions; ignition time, conditions; ignition time

[SOURCE: ISO 13943:2008, 4.182]

#### 3.36

#### ignition source source of energy that initiates combustion

[SOURCE: ISO 13943:2008, 4.189]

3.37 incipient fire initial fire

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#### 3.38 means of egress

## (standards.iteh.ai)

continuous and unobstructed way of exit travel from any point in a building or structure to a public way and consists of three separate and distinct parts: a) the exit access, b) the exit and c) the exit discharge https://standards.iteh.ai/catalog/standards/sist/13f3a9cd-2f22-4cc5-b192-

Note 1 to entry: A means of egress comprises the vertical and horizontal travel and should include intervening room spaces, doorways, hallways, corridors, passageways, balconies, ramps, stairs, enclosures, lobbies, escalators, horizontal exits, courts, and yards.

## 3.39

#### non-combustible

not capable of undergoing combustion (under specified conditions)

Note 1 to entry: In some regulations a material is classified as being non-combustible even if it is capable of combustion, provided that its heat of combustion (4.174) is less than defined amount.

[SOURCE: ISO 13943:2008, 4.239]

#### 3.40 non-flammable not capable of burning with a flame (3.27 and 3.28) under specified conditions

[SOURCE: ISO 13943:2008, 4.240]

#### 3.41 overheating excessive rise in temperature of a material or body

#### 3.42

#### quick response sprinkler

type of sprinkler that is both a fast response and a spray sprinkler

3.43 flame spread propagation of a flame front

[SOURCE: ISO 13943:2008, 4.142]

3.44 self-extinguish, verb auto-extinguish, verb cease combustion without being affected by any external agent

[SOURCE: ISO 13943:2008, 4.284]

#### 3.45

#### self-extinguishing

the characteristic of a material ceasing to burn, under specified test conditions, after the igniting source has been removed

Note 1 to entry: Although in common usage (including this report), this term is deprecated in international standards because it may convey a false sense of security and lead to misunderstanding. The properties of materials after removal of an ignition source are better described by the afterflame time, the afterglow time, the extent of combustion and the damaged area (length) under specified test conditions (compiled from various sources).

#### 3.46

### semiconductor device Teh STANDARD PREVIEW

one of the series connected devices used in valves such as thyristors, diodes or insulated gate bipolar transistors (IGBTs) (Standards.iten.al)

#### 3.47

IEC TR 62757:2015 smoke https://standards.iteh.ai/catalog/standards/sist/13f3a9cd-2f22-4cc5-b192visible part of fire effluent 677503c0be10/iec-tr-62757-2015

[SOURCE: ISO 13943:2008, 4.293]

#### 3.48

#### smoke detector

fire detector which initiates an alarm on the presence of a certain quantity of smoke

#### 3.49

#### smoke development rating

smoke development rating means an index or classification indicating the smoke development characteristics of a material or an assembly of a material as determined in a standard fire test

#### 3.50

#### smoke management system

any system designed and installed to control the accumulation and spread of smoke in a building

#### 3.51

#### water spray deluge system

special fixed pipe system connected to a reliable source of fire protection water supply and equipped with water spray nozzles for specific water discharge and distribution over the surface or area to be protected

Note 1 to entry: The piping system is connected to the water supply through an automatically or manually actuated valve that initiates the flow of water. An automatic valve is actuated by operation of automatic detection equipment installed in the same areas as the water spray nozzles. (in special cases the automatic detection equipment may also be located in another area).

#### 4 Fire hazards in valves and valve halls

#### 4.1 General

Converter valve halls house the converter valves, wall bushings or converter transformer bushings, valve and group arresters as well as, in certain designs, other high voltage components such as high voltage capacitors or voltage dividers.

The valve equipment is subjected to various mechanical and electrical stresses during operation. They are designed and constructed from many series and parallel connected components such as thyristors, diodes, IGBTs (and similar packages), capacitors, resistors and saturable reactors.

To minimize the space requirement in the valve hall, the valves are often vertically stacked to take advantage of the graded insulation level. The necessary creepage and electrical clearances between and within the valves are achieved by the use of porcelain insulators and/or composite insulators. Extensive use of composite materials is made in the structural components of the valves.

Several years ago, following the spate of fires that culminated in the generation of CIGRÉ Technical Brochure 136, several purchasers demanded that no oil-filled components be in the valve hall and that valve components be generally fire retardant. Today also, the valve structure comprises various materials such as plastics, composites, and rubbers, the non-metallic materials being fire retardant, self-extinguishing, generally to UL94V-0 or equivalent.

There is essentially minimal combustible material in the converter valve equipment, however, materials will burn if there is sufficient heat input from the ignition source. The possible sources of fire in a valve hall are discussed in detail in the following clauses, and cover HVDC and FACTS equipment (thyristor valves, SVQs, STATCOMs, VSC, etc.).

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#### 4.2 Possible causes 677503c0be10/iec-tr-62757-2015

#### 4.2.1 Valve insulation failure

Breakdown of electrical insulation within or between parts of the valve which are common to more than one semiconductor device level can lead to arcing which could ignite flammable materials.

Insulation failure could be internal, for example due to partial discharges in a dielectric material, or external due to corona or contamination of insulating surfaces (e.g. as a result of a coolant leak). Smoke or other ionised by-products arising from, for example, an overheated electrical component can reduce the withstand voltage of the air insulation within the valve.

The consequences of insulation failure will strongly depend on the location, materials and energy associated with the event. It should be noted that it is not necessary for total breakdown of an insulation system to occur before hazardous conditions can arise. High surface leakage currents, for example on a contaminated insulating surface can, depending on the materials, present a direct risk of combustion.

#### 4.2.2 Loose connections or high resistance joints in the power circuit

An overheated connection or series arc can arise from improper connection of bus bars used for carrying the load current. These could be connections between different sections of the valve, with the series reactor, with the semiconductor device or any other connector which forms the path of the load current. Any loose connection or high resistance joint will overheat. In the case of an open circuited connection, a series arc will develop. In either case the heat generated will depend on the level of the current and may cause damage to adjacent components, especially insulating material. If the temperatures reached are high enough then it may lead to a fire.