

# **Investigating R&D Committee on Precursor Phenomena in Electrical Breakdown in Electrical Power Apparatus and Equipment and Sensing Technologies**

Technical Committee on Dielectrics and Electrical Insulating Materials

## **1. Objective**

In recent times, with the advent of a global advanced information society, increasingly sophisticated urban functions, and high demand for electric power, highly safe electric power systems are being sought. This includes electric power apparatus and equipment central to maintaining social infrastructure. When accidents occur at such apparatus and equipment and cause power outages, the social impact is substantial, and economic losses become significant. Therefore, the maintenance of electric power apparatus and equipment is extremely important, and diagnostic methods to ascertain deterioration and abnormalities in electric power apparatus and equipment have been utilized for a long time. The Technical Committee on Dielectrics and Electrical Insulating Materials has established Investigating R&D Committees 10 times since 1980, continuously investigating changes in insulating materials, insulation deterioration diagnostic methods, deterioration assessment criterion, and lifetime estimation methods for cables, transformers, rotating machines, gas-insulated switchgears, and circuit breakers of 3.3–77 kV.

Developments are underway to use nanocomposites as new insulating materials and vegetable oils and alternatives to SF<sub>6</sub> gas, considering the current global environment. In addition, electric power apparatus and equipment developed overseas are used domestically; thus, insulating materials different from those used in domestically produced electric power apparatus and equipment can be used. As there is a possibility that the demand for developing new insulating materials may increase considering a carbon-free environment, insulating materials and designs will continue to change in the future.

Under such circumstances, insulation deterioration diagnosis is performed for many kinds of electric power apparatus and equipment, e.g., cables, transformers, rotating machines, gas-insulated switchgears, circuit breakers, and disconnectors. However, the precursor phenomena of electrical breakdown and process through which deterioration leads to electrical breakdown differ with changes in insulation design and usage environment of electric power apparatus and equipment. In some electric power apparatus and equipment, e.g., molded transformers, the precursor phenomena of electrical breakdown have not been sufficiently clarified. It is important to discover these precursor phenomena at an early stage, so that insulation deterioration diagnosis is properly carried out.

In addition, with the development of ICT and sensing technologies, online diagnosis in Japan and abroad have been utilized for the insulation deterioration diagnosis of electric power apparatus and equipment. Based on the requirements for early detection of insulation deterioration and labor saving in insulation deterioration diagnosis, the importance of online diagnosis is expected to increase in future. Considering the effective use of online diagnosis, it is important to develop sensing technologies to detect the precursor phenomena of electrical breakdown and ascertain the lead time to electrical breakdown.

Against this background, the objective of this committee is to investigate the precursor phenomena of electrical breakdown and the process through which deterioration leads to electrical breakdown, according to changes in the insulation design of electric power apparatus and equipment and usage environments and the latest sensing technologies to detect such changes.

## 2. Background and internal and external research activities

Countries other than Japan have shown significant interest in how the management of electric power apparatus and equipment can prevent power outage accidents in advance. In Asia, several activities have been initiated toward the implementation of periodic deterioration diagnosis and the introduction of online diagnostic equipment. Online diagnosis is being pursued more outside Japan, and judgment criteria for deterioration diagnosis have been discussed in detail.

International conferences on this topic in Asia include the China–Japan Conference on Electrical Insulation Diagnosis (CEID), which is convened roughly every two years and has been held in Xi'an, China, in 1990, Shanghai in 1992, Japan in 1994, and Xi'an again in 1996. The Asian Conference on Electrical Insulation Diagnosis (ACEID), led by China, South Korea, and Japan, was held in South Korea in 1999, jointly with ISEIM2001 in Japan in 2001, and jointly with ICMEP in China in 2003. Furthermore, ACEID was extended to the International Conference on Condition Monitoring and Diagnosis (CMD) held in South Korea in 2006, China in 2008, Japan in 2010, Indonesia in 2012, South Korea in 2014, China in 2016, and Australia in 2018. In 2020, it was held in a hybrid live and online format in Thailand.

## 3. Investigative matters

The committee will investigate the following items for 3.3–77-kV cables, transformers, rotating machines, gas-insulated switchgears, circuit breakers, and disconnectors:

- (1) Changes in insulation design and usage environments
- (2) Precursor phenomena of electrical breakdown and process through which deterioration leads to electrical breakdown
- (3) Latest sensing technologies to detect the precursor phenomena of electrical breakdown

## 4. Expected effects

Investigating the aforementioned items will help identify the precursor phenomena of electrical breakdown and the process through which deterioration leads to electrical breakdown in electric power apparatus and equipment, e.g., cables, transformers, rotating machines, gas-insulated switchgears, circuit breakers, and disconnectors operated in various environments; accordingly, electric power apparatus and equipment suitable for online diagnosis can be determined. In addition, it is believed that investigating these sensing technologies will contribute to the development of online diagnosis technology and early detection of insulation deterioration.

## 5. Term of investigation

April 2021 to March 2024

## 6. Committee members

Position	Name	Affiliation	Member/Non-member category of IEEEJ
Chairperson	Takashi Kurihara	Central Research Institute of Electric Power Industry	Member
Member	Ryuji Ikeda	Toshiba Mitsubishi-Electric Industrial Systems Corporation	Non-member
"	Seiichi Inoue	Fuji Electric Co., Ltd.	Member

<b>Position</b>	<b>Name</b>	<b>Affiliation</b>	<b>Member/Non-member category of IEEJ</b>
Member	Hideki Ueno	University of Hyogo	Member
"	Keisuke Eto	Idemitsu Kosan Co., Ltd.	Member
"	Yoshiyasu Ehara	Tokyo City University	Member
Member	Yasumitsu Ebinuma	He used to be a professor at Shonan Institute of Technology.	Member
"	Hiroaki Kamohara	Dyden Corporation	Member
"	Masahiro Kozako	Kyushu Institute of Technology	Member
"	Tatsuya Sakoda	University of Miyazaki	Member
"	Kiyoka Suenaga	Electric Science Technical Academy	Member
"	Makoto Takanezawa	Toshiba Energy Systems & Solutions Corporation	Member
"	Hiroki Tamura	Tokyo Electric Power Company Holdings, Inc.	Member
"	Moritaka Higashi	SE Technology, Ltd.	Member
"	Kazunori Hayashi	Kitamachi Kikaku Office	Member
"	Masayuki Hirai	Kuwahara Electric Corporation	Non-member
"	Jun Fujiki	Nitto Shinko Corporation	Member
"	Takayuki Furukawa	East Japan Railway Company	Member
"	Tai Yokoyama	Sumitomo Electric Industries, Ltd.	Member
"	Yasuhiro Yoshioka	Meidensha Corporation	Member
"	Masanobu Yoshida	Chubu Electric Power Co., Inc.	Member
Secretary	Hiroaki Cho	Toshiba Infrastructure Systems & Solutions Corporation	Member
Assistant secretary	Naoto Shigemori	Furukawa Electric Co., Ltd.	Member

## 7. Activity schedule

Committee meetings: 5 times/year; Secretariat: 2 times/year; Visit once a year

## 8. Reporting format

A technical report shall be prepared to present the results.