

Research Activities and Academic Exchanges in State Key Laboratory of Electrical Insulation of Power Equipment, China

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The electric power industry in China has already stepped into an era characterized by large power unit, huge power grid and high voltage. Under this background, State Key Laboratory of Electrical Insulation for Power Equipment (SKLEI) was established in 1991, and approved by the State Council. SKLEI, being located in Xi'an Jiaotong university, is the unique state laboratory undertaking research on power equipment in China.

The research direction of SKLEI is decided by its academic board, whose members are from famous universities, research institutes, electric power companies and power equipment manufactures. Its academic board members, such as GAO Jingde, ZHENG Jianchao, WANG Gen and Teruyoshi Mizutani, are prestigious in the field of electrical engineering. GAO is member of the Chinese Academy of Sciences, and ZHENG and WANG are members of the Chinese Academy of Engineering. Professor XIE Hengkun was appointed to the position of director for the SKLEI. More than 70 staffs, including 19 professors, and more than 60 graduates and doctoral students, work in this laboratory. It should be pointed out that new generation of young scientists are very active and play a important role in research works. The research fields of SKLEI are covering dielectric theories, high voltage engineering, electrical insulation techniques, electrical insulating and functional materials, and electrical engineering information techniques. Recently the investigation has focused mainly on the following subjects:

1. Electrical insulation measuring and on-line monitoring techniques, and insulation diagnosis for power equipments.
2. Dielectric theories and the techniques to enhance the breakdown strength of electrical insulating system.
3. Research and development of new electrical insulating and functional materials.
4. Characteristics of gaseous insulation, in particular SF₆ and its mixture gases, and electric arc theory.
5. New techniques for power equipments.

With the raise of voltage grade and the application of large capacity power equipments, the reliability in service, mostly depending on the insulation system, becomes greatly important. SKLEI pay more attention to on-line monitoring and insulation diagnosis techniques for power equipments. A number of new detecting technique, such as ultra-wideband partial discharge detecting technique, ultrasonic system for detecting the microscopic defects in insulation, ultrasonic flow-meter for measuring the flow of circulatory cooling water in turbine generator, and several kinds of on-line partial discharge monitors and dielectric parameter detectors for different power equipment such as generator, transformer, cable and ZnO arrester have been developed. In SKLEI multi-stresses aging test bases were set up, with which the aging investigations of generator winding insulation and transformer insulation have been performed under



Attendants to ICPADM 2000 held

single stress or multi-stresses such as electric, mechanical and thermal stresses simultaneously. On the basis of aging experimental results, a certain of new characteristic parameters representing the aged state of insulation were found, which have been employed for insulation diagnosis and residual lifetime estimation of power equipments. These research items are the key projects supported by National Natural Science Foundation and National Power Foundation.

So far the highest voltage of transmission in China is 500kV. In order to meet the requirements of rapid development of electric power industry, even higher voltage for transmission, for example 750kV in Northwest and 1000kV in other area, is going under planning and construction in China. SKLEI is making efforts to investigate the insulation theories of power equipments with even higher voltage grade, involving discharge characteristics of outdoor insulation, unusual discharge phenomena, optimal insulation design, and electric-magnetic effects, etc. Some of the preliminary studies for even higher voltage grade of electric power transmission are being undertaken in cooperation with relative research institutes. SKLEI has investigated the corona suppression technique and theory for the insulation systems of even higher voltage grade for many years, and made considerable headway.

The interest in SF_6 gas mixtures has been re-ignited in recent years by the issue of the greenhouse effect of the SF_6 gas. The research activity in SKLEI is now focused on SF_6/N_2 and SF_6/CO_2 gas mixtures, which is suitable for application in electrical apparatus with slightly non-uniform fields. The application of SF_6/N_2 and SF_6/CO_2 to transformer, where both highly non-uniform field problems and partial discharge in gas/film insulation are inevitable, is also investigated.

Most of research activities on dielectric theory were concerned with treeing and space charge effects. With extensive international cooperation, the installations

for measuring the space charge in solid or liquid dielectrics were set up, by using which a number of space charge effects in insulating system have been investigated in SKLEI. Also, the electric treeing phenomena was one of the important projects in this laboratory. According to the experimental results and theoretical analyses, the researchers of SKLEI put forward a low density region theory for the pre-breakdown of solid dielectrics, and proposed a series of approaches to treeing suppression and breakdown strength enhancement for XLPE cable insulation. Combining space charge effect with dielectric properties, interfacial effects in filled and reinforced polymeric composites have been studied in SKLEI, and a model for the dynamic process of interfacial space charge accumulation is put forward.

The functional materials and new insulating materials are of vital importance for developing high and new techniques. A part of researchers are engaged in the investigations on high permittivity-high voltage ceramic capacitors, linear and nonlinear ZnO resitors, power electronic device insulation, and insulation for unusual and extreme environment. These researchers developed a number of new products such as ceramic capacitors for the uniform of voltage distribution in high voltage circuit-breaker and arrester, different types of ZnO resister for power apparatus and electronics, self-regulating heating cable, fire-retardant cable insulation, etc, which are employed yet extensively in China.

Owing to the concerted efforts of staffs, SKLEI has received many awards such as national natural science awards, national science and technique progress awards and national invention awards.

SKLEI has persistently been attaching importance to international academic exchanges. In recent years, it has sponsored several international conferences including ICPADM (International Conference on Properties and Applications of Dielectric Materials),



at Xi'an Jiaotong University in June 21-26, 2000

Electrical Insulation in Vacuum), AICGD (Asian International Conference on Gaseous Discharge) and AICDEI&J-CEID (Asian International Conference on Dielectrics & Electrical Insulation and Japan-China Conference on Electrical Insulation Diagnosis), and established research cooperation with a number of universities and research institutes of Canada, UK, Germany and Japan, etc. It is worthy of special mention that SKLEI has close education and research cooperation with Nagoya University, Musashi Institute of Technology and Waseda University in Japan. SKLEI is open to the insulation researchers all over the world, and offers financial support to more

than 10 Chinese and foreign visiting scholars per annum to do research work in this laboratory.

EINA (Electrical Insulation News in Asia) has provided an opportunity for scientists and engineers in Asia to exchange research and development information, and is of great benefit to the people engaged in the field of electrical insulation. SKLEI would like to express its sincere gratitude to the editors of EINA for their great efforts, and hope that EINA will play an even more important role in creation of brilliant future of electrical insulation in Asia.

The Research on High Voltage and Insulation Technology in Tsinghua University

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I am very glad to receive the E-mail from Professor Tatsuo Takada asking me to submit a manuscript to the 7th EINA for introducing the research activities on high voltage and insulation technology in Tsinghua University. It is a good opportunity for our research institute to make close links and active cooperation with other research institutes in Asia.

It is necessary to establish Future Communication Network for High Voltage, Electrical Insulation and Dielectrics in Asia based on world wide web site for scientists and engineers among Asia countries to exchange the latest information. Our research institute would like to joint the network actively.

High voltage and insulation technology research institute is one of six research institutes in the Department of electrical engineering and applied electronic technology of Tsinghua University. The other five research institutes are:

- Power Systems and its Automation
- Electrical Machines and its Control
- Power Electronic Techniques
- Theoretical Electrotechnics
- Biomedical Engineering and Instruments.

In the high voltage and insulation technology research institute there are 9 full professors, 8 associate professors, 7 lectures, 3 assistant teaches 3 technicians and 5 postdoctor research fellows. In 1999 in the high voltage and insulation research institute there are 24 doctor candidates, 67 master degree candidates and 18 part time master degree candidates. Each year 30 undergraduate students choice this research institute to do research projects for graduate theses.

In this research institute there are 6 research groups.

The name and research direction of each group is as follows:

1. Gas Discharge, Plasma and High power Pulsed Technology
 - Low temperature plasma
 - High power pulse technology
 - High temperature plasma and Z-pinch
 - Techniques and applications of photoelectronics



2. High Voltage Insulation and Composite Insulator
 - Discharge along polluted insulator
 - Composite insulators
 - Compact EHV transmission lines
 - Contaminated outdoor insulation in high altitude area
 - Application of discharge in environment engineering and biology technology
3. Insulation Detection and Diagnosis
 - Digital monitoring system for on-line partial discharge detection of power apparatus
 - Acoustic measuring system for partial discharge detection of power apparatus
 - Optical measuring technology for pressure and temperature of power apparatus
 - Signal processing methods applied to the measurements of partial discharge in power apparatus
4. High Voltage Measurement and Test
 - Dynamic performance of digital measuring system for high voltage transient signal acquisition
 - Impulse waveform recording and data processing system
 - Standard voltage divider for high voltage impulse measurement
 - Study on ozone generator and its application
5. Overvoltage in Power System and Insulation Coordination
 - Insulation coordination of gas insulated substations
 - Insulation coordination of ultra-high voltage systems and optimal design of transmission lines
 - Corona modeling for the calculation of transients on transmission lines
 - Study on substation grounding system
 - Lightning overvoltage protection

6. High Voltage Apparatus and Condition Monitoring
 - Inner fault detection of gas insulated switchgear
 - Mechano-electronic integrative detecting and diagnosing techniques for high voltage switchgear
 - DC and AC arc interruption
 - Study on switching characteristics of large capacity GTO

In 1999 there are 45 research projects are being studied and 98 papers are published in our research institute. We have received several research awards from central government. Now some international cooperation projects are being studied with overseas universities and companies. Welcome professors, scientists and engineers from foreign countries to visit our research institute to make close links and collaboration.



Guan Zhicheng

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Stay in Xi'an Jiaotong University, China

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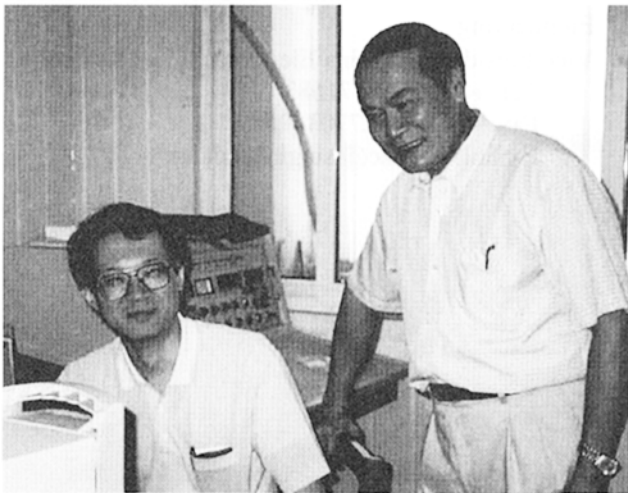
Staying in China had been my dream for a long time since I first time visited this country ten years ago. The dream has come true when Prof. Hengkun Xie kindly invited me as a visiting scholar at State Key Laboratory of Electrical Insulation Power Equipment in Xi'an Jiaotong University. I stayed there during this August and worked for partial discharge measurement of generator coils and simulation of partial discharge pattern considering discharge time-lag. Some of the achievement will be published soon.

This university, where two ICPADM meetings were held, is well known as one of the most advanced university in China on insulation field. Researches are carried out on "breakdown strength and discharge", "dielectric properties, measurement and insulation diagnostics", "insulating and functional materials" and "gaseous insulation". Most advanced facilities in the world are available at this lab. Around the campus was flooded with electronics and software shops so that students could purchase whatever component they want. Students I worked with worked very hard from early morning to late at night. It was impressive that they were so enthusiastic to learn something from me.

We often talked for a long time on measurement technique and analysis.

Although Xi'an is one of the major positions for the development of west China, there are very new and very old things at the same time. This circumstance was close to my hometown Kyoto, so I was very happy to go downtown by bicycle to enjoy both shopping for software and visiting historical places.

Chinese people were open minded and very friendly to me. It looked that they were proud of Chinese history and culture. I studied a lot about China when taking a rest at the lab. They like to teach something. In addition, I had a chance to take a lesson on Chinese language every day. Being able to speak some Chinese language is good for enjoying the life outside the campus. Some people became so friendly when they had known that I made a big effort in learning their language. Prof. Xie says he welcomes outstanding researchers from outside China. I strongly recommend young researchers to stay there and exchange technical information and friendship as well. You sure will be fun of China and Chinese people.



Prof. H.K.Xie (right) checks if the visiting scholar is working earnestly.



Doctor candidates Zh.D.Jia, X.W.Jiang and the author (center) talk about the research at the lab.