

Lightning, Surge Arresters, and Insulation Co-ordination for High Voltage Power Systems

IEEJ Surge Arresters Investigating R&D Committee

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1. Introduction

Surge arresters have contributed to supply of electric power suppressing lightning surge on transmission lines in case of lightning phenomena. Metal (Zinc) Oxide Surge Arresters using zinc oxide (ZnO) elements⁽¹⁾⁻⁽¹⁸⁰⁾ are suitable for insulation co-ordination, and are enable to reduce LIWV (Lightning Impulse Withstand Voltage) and construction cost of power systems.

This IEEJ R&D Technical Report “**Lightning, Surge Arresters, and Insulation Co-ordination for High Voltage Power Systems**” describes the transition of the technology of surge arresters born in Japan for high voltage 66-1100kV power systems.

Chapter 1: Introduction

This chapter describes the introduction of main contents of this IEEJ R&D Technical Report.

Chapter 2: Surge Arresters for 66-550kV Power Systems in Japan under Social Conditions⁽⁸⁶⁾

Surge arresters have contributed to supply of electric power suppressing lightning surge on transmission lines in case of lightning phenomena. This chapter introduces an outline of lightning phenomena, surge arresters, demands of electric power, main power systems, failure time of an annual power supply, and an invested capital et al. through the about 35 years engineering experiences under social conditions in Japan.

Chapter 2.1: Application Tendency of Surge Arresters for 66-550kV Substations⁽¹⁵⁷⁾

Metal (Zinc) Oxide Surge Arresters using zinc oxide (ZnO) elements are suitable for insulation co-ordination, and are enable to reduce LIWV (Lightning Impulse Withstand Voltage) and construction cost, especially, on 550kV power systems. This chapter describes an application tendency of surge arresters for 66-550kV power systems in Japan to verify the validity of effects of surge protection.

Chapter 2.2: Surge Arresters and JEC Standard⁽⁸⁵⁾

In the developments and applications of surge arresters, the standards of surge arresters are very important. In the age of lightning arresters with multi-series gaps, JEC (the Japanese Electrotechnical Committee) standard JEC-203-1978 was established. At present, in 2009, JEC standards have “Metal Oxide Surge Arresters” JEC-217-1984 (for 3.3-500kV Systems), “Gas-Insulated Metal-Enclosed Surge Arresters”

JEC-2372 -1995 (for 187-550kV Systems), and “Gas-Insulated Metal -Enclosed Surge Arresters” JEC-2373-1998 (for 3.3-154kV Systems), “Porcelain-housed Arresters” JEC -2371-2003 (for 3.3-500kV Systems), “Polymer-housed Arresters” JEC-TR-23002 -2008 technical report (for 3.3-500kV Systems) in Japan harmonizing with IEC 60099-4 (2009).

The JEC standardization works on the IEEJ special committee has been performed along with the progress of the hardware technique of surge arresters in Japan. These committees are consisted by engineers of manufacturers, electric power company, CRIEPI (Central Research Institute of Electric Power Industry), University et al. The standard of Metal Oxide Surge Arresters JEC-217-1984 is the first standard of Metal Oxide Surge Arresters in the world. These standard have contributed to standardize IEC60099-4 (1991) “Metal -oxide surge arrester without gaps for a. c. systems”. This chapter reviews surge arresters for 66-1100kV substation equipments and JEC standards in Japan.

Chapter 2.3: Developments of ZnO Elements for Surge Arresters⁽¹⁹⁾⁽²¹⁾⁽³⁸⁾⁽⁵⁴⁾⁽⁹⁹⁾⁽¹⁰⁰⁾⁽¹⁰¹⁾⁽¹⁴¹⁾⁽¹⁴²⁾⁽¹⁵¹⁾⁽¹⁵²⁾

The starting point of the realization of gapless metal oxide surge arresters (MOSA) is the initial viewpoint of non-ohm resistive characteristics of low voltage ceramics varistors using grain boundary that developed in Japan and used in Televisions using Brown tube etc. around 1970. These initial zinc oxide varistors for low voltage circuit have poor characteristics on discharge capability, V(Voltage)-I(Current) characteristics, life and others in order to apply to surge arresters for high voltage power systems. Surge arresters manufacturers have improved these basic characteristics of zinc oxide (ZnO) elements. At present, ZnO elements have been applied to many surge arresters for low and high voltage power systems .

Chapter 2.4: Maintenance Methods of Surge Arresters⁽¹²¹⁾

Maintenance of surge arresters is important to operate soundly in the fields. These works have been performed periodically on measurements of leakage current or insulation resistance of surge arresters etc. In case of deteriorations of metal oxide surge arresters, resistive leakage current increases abruptly. Methods of measuring arresters leakage current have been used an ammeter or a clamp type CT (current transformer).

Chapter 2.5: Developments and Applications of 800kV Surge Arresters (Overseas Use)⁽²³⁾⁽⁶⁷⁾⁽¹⁴³⁾

High performance ZnO elements and high voltage gradient ZnO elements have been developed. These ZnO