ENGINEERING METHODS TO MENTAIN IN SERVICE HIGH VOLTAGE DISCONNECTING SWITCHES AND PREVENT THEIR ACCIDENTAL DAMAGE

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Abstract: During years of exploitation in the electric fields, some of these Ceramic Post Insulators are affected by cracks, of different types. Besides, other defects like pores, lack of material, thermic points etc could be at the origin of Ceramic Post Insulators Damage. It is, of course, more convenient and economic to prevent their breaking in current exploitation. Doing this, we can avoid some very dangerous accidents and save o lot of money and troubles.

1. 110KV HIGH VOLTAGE SWITCHES CONSTRUCTION.

Ceramic Post Insulators which are studied in this scientific research, take part in the 110KV High Voltage Switches Construction. These Switches enable the horizontal blades opening, having a 110KV nominal Voltage and nominal currents of 1250 – 1600 – 2000 A. These Switches present only a monopole construction. Engineering schema of such a Rotative Switch is presented in Fig.1.1 and its connecting pole is enclosed.



Fig. 1.1. - Schema of an 110 kV Rotative High Switch

Ceramic Insulators 1, 2 can swivel, turning round with 90° under the action of a mechanic or an electrical device 3. On the rods 4 and 5, are set electrical contacts 6,7 and 8, as they are presented in fig. 1.2..



Fig. 1.2. – Electrical contacts of the switch.

They are mounted in a vertical position, on a metallic frame, on which are also set up all mechanic action devices. Manufacturer " Electroputere S.A " – provides all required needs

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conncerning setting up, adjusting and probation. It also provides a 12 -18 months guarantee period.

Ceramic materials used in the Cylindric Post Insulators processing are presented in the state normativ, STAS 3471-85,

Group	Sub- group	Engineering process	Properties	Utilisation field
100 China type materials,	110	-lathing -extrusion -casting	Good electrical and mechanical properties	Ceramic Insulators for High and Low Voltage

The usual material is: CER 110 - STAS 3471 - 85.

2. REPORTED ACCIDENTS TO THE BENEFICIARY

Electrical field events collected during a long period, 01.01.2005 - 01.06. 2006 showed that, some of these Ceramic Post Insulators have been broken in exploitation, both at the upper metallic cup and at the bottom metallic support of the ceramic rotating insulators. These accidents were traced out like follows:

- 4,3% through direct examination under electric voltage;
- 30,4 % direct examination without voltage ;
- 39,1% brakings with no other circuits damage;
- 26,1% brakings with other circuits damage.

The brakes were located at the upper metallic cup, most of them and also at the bottom metallic support.



Fig. 2.1. Cracks and boundary cement distruction:



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3. THE MAIN CAUSES OF CERAMIC POST INSULATORS BREAKING

According to electrical fields events, reported by the beneficiary, these kind of accidents happened to the old 110KV High Voltage Switches, having more then 10-15 years length of service.Geographic areas into which these accidents have been located are: Harghita, Bihor, Salaj, Cluj, Baia Mare, Satu Mare.

Reported Breakings of the Ceramic Post Insulators, used in 110KV High Voltage Switches, are the action result of one or more of the following causes:

Metallic Parts craking during the winter time, when the protection coat of paint falls and the water is absorbed by the bounding cement. Freeze of the condensed/ rainfall water sliped between Ceramic Insulators and its metallic parts, the upper cup and the bottom support, or absorbed by the bounding cement, involves an important volume increasing of iced water. Consequently, microscopic cracks appears both into the metallic parts and to Ceramic Post Insulator. In time, these cracks become larger and larger . There were cases when such fissured metallic cups fell themself from the Ceramic Insulator.

During winter time, due to the hoar frost and water frost, the weight of electric bounding conductor, may increase very much, exceeding the maximum load of 4000 N, which may result in Bending Moment overtaking.

Rigid electric rod conductors, inadequate used in exploitation, may become stiff and lead to loads increasing;

Bounding paste of the metallic parts on the Ceramic Insulators (Sulph paste, and Portland cement now) was many times unsuitable, because of economic reasons.

Metallic parts of the Ceramic Insulators, the upper cup and the bottom support, were made of cast iron Fgn-250, thermic treated in 1970 -1980 years. Afterwards, their quality has been changed in cast iron Fc 200, which is less suitable;

Metallic Parts supplier "Armătura Cluj" during 1970-1989, has been changed afterwards with other less serious producers, so that, is to expect more damages in future.

Armed operation of the Ceramic Insulators with their metallic parts, were made unsuitable, sometimes. Bounding cement layer, in some cases, were not symmetrical distributed, and there were found important excentricities. This fault is called "running core".

Getting stuck / blocking of the Mechanic Systems which rotate the High Voltage Switch, concerning following aspects: blocking of the Levers System which rotate the Switch

Cylindric Insulators; unsuitable maintenance of the Switch Electric Contacts, which require a thoroughly half-yearly regulation, axial bearings lubrication.

Accidental Switch Rods collision, in the Electric Contacts Junction, setting up by a Contact Cylinder and a Contact Muff.

Contact Pressure of the Slides Pack envolved in Electric Contacts, adjustable by Spring Sets, is not propely checked out. Regulation and checking of Electric Contact Resistance should be done at least once a year.

Incorrect operation of the mechanical systems which rotate High Voltage Disconnecting Switch , by the staff on duty. They used to knock with a hammer the blocked levers of the mechanic system.

4. MAINTENANCE ENGINEERING PROGRAM

Considering the main causes of Ceramic Post Insulators Breaking in service, presented before, we may set up an useful maintenance program, capable to extend the exploatation of 110KV High Voltage Disconnecting Switches period, as it follows:

1. First, there have to eliminate incorrect operation of the mechanical systems that rotate High Voltage Disconnecting Switches, by knocking with a hammer the blocked levers of the mechanic system. They have to check up thoroughly, twice a year, the Levers System which rotate the Switch Cylindrical Insulators and control axial bearings lubrication.

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2. Checking Contact Pressure of the Slides Pack evolved in Electric Contacts, adjustable by Spring Sets, is not properly checked out. Regulation and checking of the Electric Contact Resistance should be done at least once a year.

3. Staff on duty should avoid accidental Switch Rods collision, in the Electric Contact Junctions, checking up the good state of function of Contact Cylinder and its Contact Muff.

4. At the Ceramic Post Insulators' producer, the armed operation of the Ceramic Insulators with their metallic parts, should be mechanized. In such a way, the defect called "running core" could be eliminated.

5. It is desirable to avoid rigid electric rod conductors, as they may become stiff and lead to loads increasing;

6. Twice a year, especially before the winter time, staff on duty must to verify the perfect state of the paint which protects he boundary cement introduced between Cement Insulators and their metallic cups.

5. LABORATORY INVESTIGATION PROCEEDINGS.

The usual laboratory proceedings to investigate functional state of Ceramics Cylindrical Insulators are:

- Thermograph in infra-red Methods: The Active Method and The Passive Method.
- Penetrating Liquids Methods.
- Ultrasonic Investigating System

Thermography in infra-red by impulses, the Active Method, involves an adequate system of thermography apparatus, containing a ThermoCAM PM 350, a Warm System by Electric Lamps, an appropriate computer, able to create a thermic image which can be disply into a spectral range. So that, this method is suitable for a laboratory study.

The Passive Method has only a Thermocamera THERMOCAM SC 640 that uses the inner warm of the ceramic material. This method is appropriate to put in evidence the Ceramic Post Insulators Damages, by Direct Control, without taking off the use of Disconnecting Switches, Fig.5.1. In fact this Passive method does complete examination performed through the Active Method.



"The Penetrating Liquides Method" is applicable to detect superficial defects like pores, cracks, lack of material, pierces, stratifications and deep cracks, on the body of different pieces. This method is a very practical one as it may offer a first image about presence of cracks in the Ceramic Post Insulators and its metallic Cups, directly at the Electric Fields, where they are mounted on the Disconnecting Switches.

The ultrasonic pulse-echo testing system is also applicable, to detect all kind of defects like those presented above and more, like hidden defects. Laboratory equipment consist of a Deprecator scope KRÄUTKRAMER, USM 35 X and different types of palpitates.

Only a very qualified and experienced staff is required.

5. CONCLUSION.

Examination of the Running State of the Ceramic Cylindrical Post Insulators, selected before from the Electric Fields, with the professional laboratory methods called "Nondestructive Control Methods", presented above, led to the following conclusions:

- Some of the investigated Ceramics Insulators presents original defects like: cracks, pores, lack of material, thermo points ;
- Thermo Points localized at the base of some Insulators, may generate a " V " small slit, which in time, during exploitation, may penetrate through the material, to the surface ;
- During Investigation of the Ceramics Post Insulators, the Disconnecting Switcher must be put off the function.
- Taking off from the electric power the disconnecting switches, is possible to examine the Ceramics Insulators integrity, at the place, were they are mounted in a structure, by applying Thermograph in infra-red Methods, Penetrating Liquids Methods, Ultra Sonic Control Methods to put in evidence cracks, holes, pores, lack of materials and so on, which may have correspondence with deep inner defects.
- Every one of these methods is complimentary to each other, so is desirable to set up an engineering maintenance program, capable to extend the exploatation of 110KV High Voltage Disconnecting Switches service.

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