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भारत सरकार GOVERNMENT OF INDIA
रेल मंत्रालय MINISTRY OF RAILWAYS



CONDITION MONITORING OF LIGHTNING ARRESTOR (LA) BY LCM III

End User : TrD Maintenance Staff

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महाराजपुर, ग्वालियर & 474 005
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**CONDITION
MONITORING
OF
LIGHTNING ARRESTOR
(LA) BY LCM III**

QUALITY POLICY

“To develop safe, modern and cost effective Railway Technology complying with Statutory and Regulatory requirements, through excellence in Research, Designs and Standards and Continual improvements in Quality Management System to cater to growing demand of passenger and freight traffic on the railways”.

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1. INTRODUCTION

Lightning Arrester (LA)/surge arrester is a protective device used for limiting the affect of surge voltages on the equipment / power distribution system. This arrester helps in discharging the surge current, thus protecting the system and equipment from dangerous over voltages and also disturbances.

These lightning arrestors, age out during its period of services due to,

- moisture ingress due to sealing problem
- ageing of Zink Oxide variations
- dust particles on external surface
- cracks on porcelain surface
- internal partial discharges

To avoid the failure of LA, it is necessary to monitor its health because if a lightning arrester fails, it explodes with porcelain splinters and apart from creating a short circuit, it also mechanically damages the other

surrounding equipments like CTs, PTs, transformer bushing etc. Thus it creates a total disruption of power circuit.

2. WHY MONITOR THE RESISTIVE LEAKAGE CURRENT OF LIGHTNING ARRESTERS.

- In normal service a metal oxide surge arrester is carrying a continuous, but small leakage current, typically in the range of 0.1 -2 mA. The leakage current is dominated by a capacitive current component whereas the resistive component may be in the range of 5 - 25% of the capacitive component.
- Metal Oxide Surge Arresters (MOSAs) are normally operated at a continuous voltage ranging 60% to 80% of the rated voltage.
- The non linear characteristic of ZnO blocks entails that even a large increase in the Resistive leakage current I_r is barely noticeable in the total leakage current.

- The 3rd harmonic component of leakage current is measured health of LA
- Measurement of the resistive current component by the LCM III is therefore the best way to obtain sensitive and reliable information about the arrester condition.

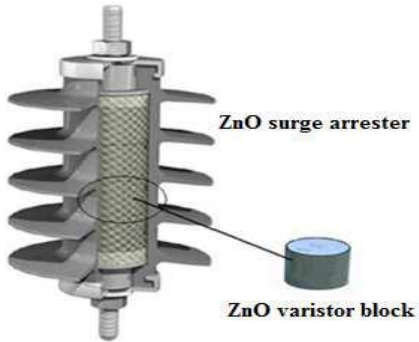
As per TI directorate maintenance instruction no. RDSO/TI/MI/0041, (Rev-1) dated 08.04.2010

- One cycle of measurement of leakage current of lightning arrester should be completed prior to onset of monsoon.
- The lightning arresters with resistive leakage currents in between **350-500 μA** should be closely monitored and beyond **500 μA** should be replaced & jointly checked with manufacturer.

3. CONSTRUCTIONAL DETAILS OF ZINC OXIDE (ZnO) LA

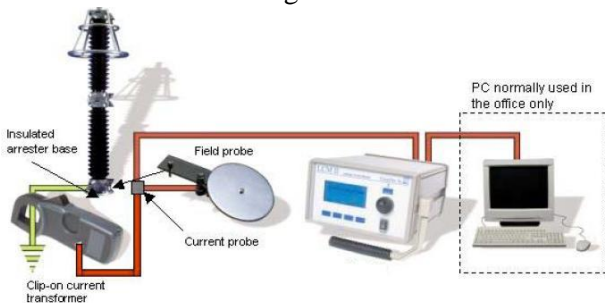
Gapless zinc oxide (ZnO) lightning arresters are widely used. These are usually connected between the phase and ground terminals. LA limit the voltage level below the withstand voltage in power equipment such as transformers etc.

LA consists of an insulating housing which is made of porcelain material, and the inner active column, composed of the ZnO varistors as shown in figure below:



4. CONDITION MONITORING OF LA BY LCM III

- Leakage Current Monitor as per RDSO spec no.TI/SPC/PSI/LCMLA/00030 and TI/MI/0041Rev.1 dated 08.04.2010 may be used by the Railways for measuring the third harmonic resistive components (THRC) leakage current of lightning arrester.
- LCM III is a complete portable system for condition monitoring of live lightning arrester. The system is suitable for measurement and analysis of resistive leakage current of LAs in live



switch yard conditions without any need for shut down. The system is based on the measurement of 3rd harmonic resistive current with compensation for harmonic in the system voltage.

- It provides quick and reliable information about the health of the lightning arrester and allows for storing of all the measurement data in the field.

5. PRINCIPLE OF LCM-III

- The non linear resistance of the ZnO blocks will introduce a 3rd harmonic resistive component in the leakage current when it is stressed by a sinusoidal voltage.
- This current component is the best indicator for detection of changes in the non-linear characteristics of the surge arrester over time.
- Harmonic content in the operating voltage will increase the harmonic content in the leakage current.

- If we ignore the harmonic content in the leakage current, we will not be able to know if an apparent increase in the resistive current is really due to the faulty arrester or if it is a false increase due to varying harmonic content over time.
- Thus it is necessary to take the effect of harmonics into account and compensate for it in the final measurement.

6. ACCESSORIES OF LCM- III

The accessories are given below:

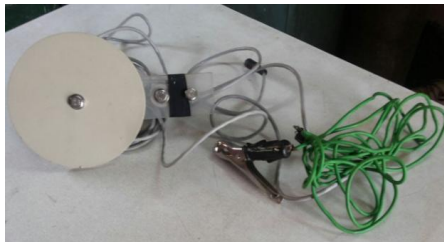
a) Leakage Current Transformer (LCT)

The Leakage Current Transformer (LCT) is connected across the earthing strip of the lightning arrester to measure the total leakage current flowing through the lightning arrester



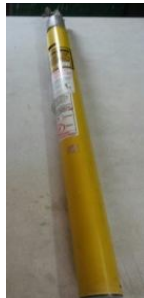
b) Dish Antenna Probe (DAP)

The Dish Antenna Probe (DAP) is placed at the base of the lightning arrester to pick up the harmonics in the system voltage, thereby giving the capacitive component of the leakage current.



c) Telescopic Hot Stick (THS)

The Telescopic Hot Stick (THS) is used to place the DAP at the base of the lightning arrester.



d) **Signal Conditioning & Measuring Unit (SCU)**

The Signal Conditioning & Measuring Unit (SCU) is provided with the signals from the LCT & DAP as inputs to determine the resistive component of the leakage current.



e) **Signal Processing & Data Management Unit, Model (SPU)**

SPU contains Data Management System where the features Related to the hardware like self test & signal simulation are provided. It has also got the features of defining & storing the information pertaining to the various LA's in the network, saving the corresponding



leakage current values over a period of time. The waveforms of the various components of leakage current can also be viewed in SPU, without the need to connect an external oscilloscope.

7. HOW TO USE LCM III

- (i) Connect LCT across the earthing strip of the lightning arrester to measure the total leakage current flowing through the lightning arrester.



- (ii) Place the Dish Antenna Probe (DAP) with the help of Telescopic Hot Stick (THS) at the base of the lightning arrester to pick up the harmonics in the system voltage,



thereby giving the capacitive component of the leakage current.

- (iii) Connect the Signal Conditioning & Measuring Unit (SCU) with the leads from the LCT & DAP as inputs to determine the resistive component of the leakage Current.
- (iv) Connect the SCU and SPU. The waveforms of the various components of leakage current can be viewed in SPU, without the need to connect an external oscilloscope.



8. MEASURED PARAMETERS

The LCM III measure and displays the following parameters in a live switchyards

- It (mA): This field indicates the Peak values of the total leakage current in mA.
- Ic (mA): This field indicates the peak values of the Capacitive current.
- I3t (mA): This field indicates the third order harmonic current measured.
- Ir (mA): This field indicates the resistive current of the lightning arrester. This is the un- corrected value and must be corrected for voltage and temperature variations.
- Ir (corr): This field indicates the corrected value of the resistive current referenced to 70% rated voltage and 20 deg.C.

9. BENEFITS WITH THE LCM-III

The LCM can monitor the condition of high voltage Surge Arresters in service. The LCM measures the resistive component of the leakage current of the Arresters. Increased resistive current indicates a higher risk of breakdown of the Arresters. The LCM offers the following benefits.

- Confident knowledge to replace surge arresters in due time before an arrester failure occurs. The LCM is the most reliable system for diagnosis of metal oxide surge arresters (MOSA).
- Capability to prevent costly arrester failure and possible damages to other major equipment in the neighborhoods. An important achievement is an increased safety for the maintenance staff.
- No disturbance for the normal operation of the system. The condition of surge arresters is checked without any influence on the operation of the power system.

- Assured knowledge of the condition of the surge arresters. This experience is even more important as the age of the arrester increases. It is very satisfactory also to know whether the condition of the components in the supply system is “perfect”, or not.
- Systematic information about all measured surge arrester. It is included a comprehensive data base to give all necessary information like the status of each arrester, key data of each item, numbers of measurements, time for next measurement etc.
- The instrument should be used as a part of the regular maintenance program to increase the reliability of the supply.
- The LCM is a very reliable system for field measurements. The instrument is portable and gives fast results. The method for measurements is well accepted internationally. The LCM is based on harmonic analysis of the

leakage current using a principle called third harmonic with compensation. System for measurements of third harmonic resistive leakage current only, is considered very unreliable.

REFERENCES

1. RDSO Specification No. TI/SPC/PSI/LCMLA/00030
2. RDSO SMI No. TI/MI/0041 (Rev.-1) dated 08.04.2010.
3. Manual of Leakage Current Monitor (LCM)

OUR OBJECTIVE

To upgrade maintenance technologies and methodologies and achieve improvement in productivity, performance of all Railway assets and manpower which inter-alia would cover reliability, availability, utilisation and efficiency.

CAMTECH is continuing its efforts in the documentation and up-gradation of information on maintenance practices of electrical assets. Over the years a large number of publications on electrical assets have been prepared in the form of handbooks, pocket books, pamphlets & video films etc. These publications have been uploaded on the internet as well as rail net.

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