FIELD EXPERIENCE OF DIAGNOSIS TECHNIQUES FOR DETECTING DAMAGED INSULATORS OF OVERHEAD DISTRIBUTION LINE

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ABSTRACT

Because of increasing dependence of electricity in economic growth, it is important to reduce the number of interruption in distribution line. KEPCO have more inspection on distribution line and have chosen to utilize diagnostic tools such as infrared thermography, ultrasonic and UV camera now than before. Patrol or simple visual inspections consists of walking, driving by equipment to identify obvious structural problems and hazards such as leaning poles, damaged equipment, contact something. It is necessary to use handhold detectors for correctly detecting insulation defect during a patrol. The aim of this paper is to identify electromagnetic signal emitted from defected and damaged insulations on 22.9 kV distribution overhead line. The results obtained during the field inspections are compared with that of verification test carried out at high voltage laboratory. From the comparisons of these results the effectiveness of each technology applied to the field inspection could be obtained.

INTRODUCTION

Distribution network operators are today faced with the difficult task of keeping networks up despite reduced revenue while at the same time guaranteeing appropriate and generally accepted reliability of networks. Because of increasing dependence of electricity in economic growth, it has become important to reduce the number of interruption in distribution line. Typical distribution line inspection consists of walking, driving by equipment to identify obvious structural problems and hazards such as leaning poles, damaged equipment, contact something. It is necessary to use handhold detectors for correctly detecting insulation defects during routine line patrol. KEPCO have conducted more inspection and have chosen to utilize diagnostic tools such as infrared thermography, ultrasonic and UV camera now than before. In this paper, the property of diagnosis equipments is investigated based on field experience whether it can identify electromagnetic signal emitted from defected and damaged insulators on KEPCO distribution overhead line. The results obtained during the field inspections are compared with that of verification test carried out at high voltage laboratory. From the comparisons of these results the effectiveness of each detector applied to the field inspection could be obtained.

Overhead line inspection

Figure 1 shows the result of cause analysis on distribution line interruption. The number of line faults can considerably reduce in scheduling line inspection. Patrol or simple visual inspection consists of walking, driving by equipment to identify obvious structural problems and hazards such as leaning poles, damaged equipments and broken insulators.

Table 1 shows inspection and maintenance plan intervals
of KEPCO’s distribution network. Distribution lines have been inspected by ground patrol a minimum of once every 1-2 years. For economic reasons, the use of diagnosis methods is not considered for distribution network in the past. Using of diagnosis equipments is become more economical and convenient to conduct field inspection at present. Remote inspection devices which are used for ground patrol in KEPCO are infrared thermal imaging, ultraviolet imaging and ultrasonic discharge detector. Inspection of distribution overhead lines has been performed with a qualified person from KEPCO academy.

Detection of defective components

KEPCO is applying an optical telescope, thermal camera, High frequency corona & ultrasonic detector and UV detector to overhead distribution network inspection. At the first step, High frequency corona & ultrasonic detectors are used for roughly detection to network components that have highly possibility of faults. These detectors are reproduced as audible sounds for practical usage and portable convenience. Secondly, its detailed inspection is performed with an optical telescope, thermal camera. If it is found to damaged or estimated bad components, those are dismounted and sent to a research centre to experimentally evaluate its properties. Finally, it is improved the method and criteria to identify detected equipments in overhead distribution line.

FIELD DETECTION

Inspection equipments

Ultrasonic detector

Because it is the critical factor of detection results, ultrasonic detection equipment which has center frequency adjustable from 35 kHz to 45 kHz is selected with a serious consideration. Ultrasonic detector is extremely useful conducting nondestructive examination of porcelain insulators.

Figure 2: Ultrasonic detector and waveforms (upper-normal insulator, under-defected insulator)

Especially, it detects well flaws in outdoor porcelain insulators such as line post, switchgear bushing, cut-out insulator. In KEPCO, it’s generally accepted the most economical solution because ultrasonic sensor can detect a damaged insulators at speeds up to 30-40 km/h for overhead distribution line inspection.

Figure 2 shows the ultrasonic detector and an example of ultrasonic wave. We have found out flaws with the criteria a expressed in decibel (dB). Waveforms which are collected with high resolution transducer have used to reference data for the higher probability of correct decision. We could build well foundation of ultrasonic detection if we can choose good equipments, detectors, and correct detection parameters based on long field experience. And also, the sensitivity and frequency of the detector should be adjusted in the same set value for correct decision.

The data in figure 3 shows that the ultrasonic properties of defective ceramic insulator have been changed with the temperature. It shows the higher rate of detection during the summer season rather than winter season. Although sound energy become generally known that is absorbed by humidity, the ultrasonic detector is used to inspect distribution line didn’t have direct influence.

Figure 3: Temperature dependence of the amplitude of ultrasonic signals transmitted through the air

Figure 4 shows that amplitude of signal detected by ultrasonic detector was inversely proportional to sensing distance. If low-level discharges are emitted from defected insulators in distribution line, it is very difficult to detect that by the ultrasonic detection.

Figure 4: Amplitude of ultrasonic signal detected versus sensing distance

Thermal image

The infrared imaging technique is effective and simpler technique.
chnique for detecting the defect insulators. We have used to locate overheating joints, increased leakage and poor lightning arrester with the rise in temperature. Thermal image camera mounted on vehicle or carried by hand can be a squired more feature values at night than in the daytime, but visual image in the daytime. We have avoided shiny surfaces in daylight to reduce the probability of misdetection.

UV detector
The MultiCAM System provides a simultaneous video image of an infrared spot and corona in distribution equipment. This information assists the user in determining the location of the hot spot and/or corona and also, by a close examination, it’s possible cause. Since the video provides a moving image, it is possible to determine the seriousness of the hotspot. UV detector is insufficiency for verifying correctly defective insulators on KEPCO distribution line up to now. We need to have more field experience and technical information.

Inspection process
The first step is to conduct a rough detection with high frequency corona and ultrasonic detectors that are hand carried or vehicle mounted. As the second step, a qualified person is to perform a detailed inspection with an optical telescope and thermal camera. Defective insulators are dismounted from a pole and sent to research laboratory for experimental evaluation. Finally, it is the most important work to document the field data and to modify the detection criteria. As these data of line inspection and monitoring are key activities in ensuring asset integrity, we are especially pay attention to analyze, judge and make correct evaluation.

Figure 6: Field inspection with ultrasonic detector

Documentation and System input
The person performing distribution line inspection could move to one and another pole 30~40 km/h of speed with high frequency corona and ultrasonic detectors. The images and signal from the detectors were saved in its hard disc, and at the same time, some information is transmitted to the server by wireless access point. Two types of documents are using for statistical analysis of resultant that has performed inspection in the field. One thing is general information such as detecting value, weather condition and geographical locations. The other is analyzing the historical data and detailed information about the equipment’s condition obtained from inspection, monitoring and maintenance record.

Limitation of detection
The conventional examination of overhead lines is mainly checking the internal and surface deficiencies of porcelain insulators and porcelain shells. The common internal nondestructive examination is ultrasonic and high frequency examination. The other detection methods such as thermal imaging and UV detection are not suitable for low leakage current condition. Ultrasonic examination can detect the cracks buried inside porcelain insulators and porcelain shells. The other methods could not do this due to be detected only the weak signal on the ground. Through field inspection with an ultrasonic detector and an optical telescope we can find out over 90% crack position located in ceramic line post. Table 2 shows factors such as field condition and inspector to affect the detecting efficiency. The fact or affecting on diagnosis precision has been recorded and utilized to correct each criteria.

Table 2: Factors to affect efficiency of the fault detection in field inspection

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<tr>
<th>Affection factors</th>
<th>Field conditions</th>
<th>Inspector</th>
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<tr>
<td>sun light, temperature, humidity, rainfall, wind speed and direction construction of pole</td>
<td></td>
<td>distance and direction speed of vehicle state of equipment</td>
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CONCLUSIONS
The use of visible/infrared/ultraviolet imaging devices and ultrasonic detector for inspecting the health of distribution line is well known and widely accepted in KEPCO. We have detected abnormal signal emitted from insulators with local damage such as micro crack, void, tracking and surface contamination.

Thermal imaging display good detection property at night in good weather condition and avoid detection in direct sunlight. Ultrasonic is no correlation between detection value in dB and the degree of defect. If we detect the signal on ground level, there is a high possibility of defect. The magnitude of detected signal was affected by direction and distance from inspector. In some case, it was used to detect normal discharge from pole transformer or switchgear. Now, by combining above inspection techniques into one instrument significant savings in time and cost can be achieved to make predictive maintenance faster, safer and more efficient.
ore cost effective.

Because it emit a very weak signal on defective polymeric insulators in good weather condition, there are very difficult to detect. KEPCO is now making optimal inspection guidelines for polymeric insulators. Diagnosis equipment have the quite different sensitivity to identify the defective insulators with environmental condition and its types. Based on the available knowledge for detecting property and defective insulators it is much more economical carried out the distribution line inspection.

REFERENCES


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