Performance Test of a Magnetic Change Detection Sensorin a Test Field

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1. Introduction

The fast development of technologies regarding detection sensors and access control systems allows the equipment designed by using those technologies to account for a greater part in facilities' physical protection system than ever before. The popular area for the equipment is an exterior intrusion detection system. The selection of intrusion detection equipment involves identifying the equipment and methods of installation that best meet the overall system objectives. The system objectives, including the purpose of the intrusion detection equipment and the types of assumed threats, should indicate the desired requirements of the exterior intrusion detection system in three primary areas:

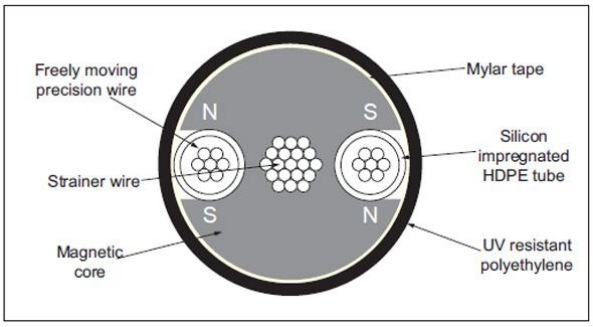
• Probability of detection of the intruder
• Nuisance alarm rate and causes of the nuisance alarms
• Vulnerability of the equipment to defeat

These three areas are intimately interrelated with the characteristics of the particular equipment, the methods of installation and adjustment, the manner in which the equipment is interconnected, and the environment to which the equipment is exposed.

While there are twenty nuclear power plants operating with various types of detection equipment deployed in Korea as of now, few studies have been conducted as to actual performance of deployed equipment and guidelines in both installing and operating those equipment.

In order to tackle this lack of studies, KINAC established the test field and conducted some field tests on several sensors. This paper aims at describing the procedures and results of the tests on a magnetic change detection sensor (herein called the "MCDS") and sharing experiences earned through the actual test.

2. Description of MCDS



MCDS attached to fence fabric uses precision wires moving freely in a fixed magnetic field to generate a voltage. This movement is caused by an intruder's physical impact. These kind of magnetic sensors differ from most other detectors in that they do not directly measure the physical property of interest. Devices that monitor properties such as temperature, pressure, strain, or flow provide an output that directly reports the desired parameter. Magnetic sensors, on the other hand, detect changes, or disturbances, in magnetic fields that have been created or modified, and from them derive information on properties such as direction, presence, rotation, angle, or electrical currents. The output signal of these sensors requires some signal processing for translation into the desired parameter.

3. Probability of detection (Pd)

The Pd for a sensor is a statistical determination of probable sensor performance in detecting an intruder.

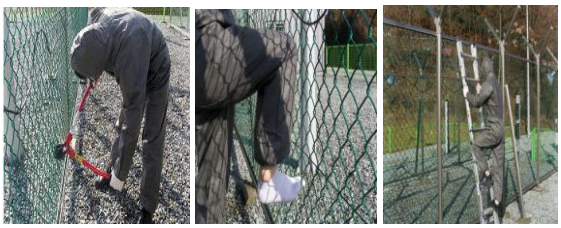
▪ **Design of tests:** the following factors could affect Pd in MCDS system.

1. the height of installation of the sensor line : the recommended height of installation is 1m from the ground. Nevertheless, various circumstances in actual fields make it hard to meet the recommendation so that some MCDS were installed either significantly higher or lower that 1m height. In this sense, it is fair to consider it worthwhile to test the performance of MCDS in accordance of its install location.
2. the location of intrusion : Given that the sensor line is attached to fence fabric, the radius of movement is subject to the tension of the fence fabric. So the assumption that states the location of intrusion would affect Pd of MCDS was taken into account.
3. the type of intrusion : intruders would try various types of intrusion such as climbing a fence, cutting fence fabric in order not to be detected. They might cut the fabric with hand-carried wire cutter or run and make a quick jump or slowly crawl over the fence. In terms of the intrusion type of cutting the fence fabric, the test was conducted under the condition that states 'to make 40cm radius hall(allowing an adult intruder to invade without making other physical impact on the system) at least 18cuts needed'. While conducting the intrusion simulation of crawling over the fence, another version of crawling was included in the test, which is crawling very slowly with bare feet. Looking at the result, this intrusion type caused considerable change in Pd of the MCDS at certain fixed sensitivity of the system which

was appropriate to successfully detect other types of intrusion.

<the location of intrusion>

<the height of installation of the sensor line
0.6m, 1m, 1.4m, 1.8m >



<cutting, crawling (bare foot), bypass (ladder)>

4. Vulnerability to defeat

Vulnerability to defeat is another measure of the performance of a sensor. A sensor that is desirable with respect to Pd would not necessarily be a suitable choice if it is easy to defeat. There are two basic defeat modes:

1. Spoof refers to defeat modes that employ equipment and actions to either mask the intruder's signal or inhibit the electronics from producing an alarm during an intrusion through the detection zone of the intrusion detection sensor.

2. Bypass is a defeat mode in which the intruder defeats the intrusion detection sensor by avoiding its detection zone.

Bypass defeat mode was simulated in the test.

- **Design of the test:** One of the easiest and most feasible ways of defeating MCDS is bypassing the sensor by climbing a ladder as showed above.

5. Operation guide for MCDS

All the nuclear power plant sites in Korea use the same model of MCDS which is called 'Defensor'. The 'Defensor' model provides so-called 'event function' which has two adjustable sensitivity factors; the number of event (1~9) and the duration of event (30~270sec). For example, if the number of event is set at 3 and the duration is set 60sec, the alarm would go off only provided that more than 3 intrusion attempts were detected within 60sec. This function was designed in order to reduce false or nuisance alarms. Nevertheless, it has to be operated very carefully in order to function appropriate as a detection sensor. '2event within 30sec' was tested in order to verify whether it is possible to break into at the second most sensitive mode.

6. Summary of the result

1. The height of installation of the sensor line is negligible when it comes to the detection of climbing. But the height of installation is no longer negligible when trying to detect the intrusion by cutting the fence fabric. The installation of sensor lines over 1.4m from the ground should be prohibited for robust MCDSs.
2. MCDS is extremely vulnerable to bypass using a ladder as the sensor line is attached to fence fabric in order to sense physical impact. This vulnerability give it a reason to encourage nuclear facilities to have at least dual system of sensors composed of different type of sensors.
3. Two sensitivity adjusters of 'Defensor', cutting detection sensitivity and climbing detection sensitivity, don't function respectively. The verified adjustment level of two sensitivities is 11 and 11 respectively. (The level rages from 1 to 18)
4. The intrusion without causing any alarm was possible at the second most sensitive mode of event function when two intruders who have enough information about the function cooperated. The event function should be kept at the most sensitive mode.

REFERENCES

[1] Technology Transfer Manual 'Exterior Intrusion Detection, Sandia National Laboratories, 1999