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# Introduction to a Counter UAS Testing and Evaluation Methodology and its Application to Nuclear Facilities

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## 1. Introduction

Recently, drones are becoming a hot topic throughout the world as many industries are using drones for filming, transportation, cargo, etc. As the drone industry is revitalized, access to drones increased and is considered as a new threat to be defended by important national facilities. Nuclear power plants, which are important national facilities, are also considering drones as a new threat apart from the main threat measures previously considered and research for nuclear security is actively in progress. KINAC (Korea Institute of Nuclear Nonproliferation and Control) is conducting research on the development of regulatory standards such as performance requirements for nuclear facilities against drones as new threat. SNL (Sandia National Laboratory) introduces a testing and evaluation methodology for CUAS (Counter Unmanned Aerial Systems) referring to the process for evaluating the performance of the existing protection system. In this paper, we will cover the CUAS testing and evaluation methodology and its application to nuclear facilities.

## 2. CUAS Testing & Evaluation Methodology

Currently, research is in progress to enact international standards for CUAS worldwide. However, the quantitative evaluation of the performance is still insignificant. SNL’s methodology evaluates CUAS in a quantitative way and compared the performance of each system based on the evaluation results. It follows a similar flow of the methodology for performance evaluation of various detection systems used in nuclear power plants.

### *2.1 Performance Indicators*

There are 4 indicators that can be considered when evaluating the performance of CUAS, which are as follows. Detection, tracking, identification and neutralization.

Detection literally means detection of flying objects such as drones around a target point(area). Assessment means specifying information about the detected aircraft (manufacturer, altitude, speed, etc.) and information about the pilot who is controlling the drone (pilot's location, communication environment, etc.) within the detection range. Neutralization means to incapacitate the aircraft, out of the target area by taking control of the illegal flying vehicle from the pilot after the drone is identified. Tracking means continuously tracking the location, speed, altitude, etc. of an aircraft in the entire process of detection, identification, and neutralization.

In order to quantitatively measure the performance of each indicator, it is necessary to fix the environment in which the test is performed and the type of vehicle used for evaluation. Additionally, the route must be set constant for each test flight. The fixed variables should be thoroughly reviewed and set when performing the initial test. Among the four indicators, the first to be considered is detection. There are three indices for detection: detection probability, detection point, and detection range. Assuming that the test is performed 10 times, the detection probability is an index that shows how many times it is detected (if 5 out of 10 succeeds, the mathematical probability has a 50% success probability). The detection point is literally the number of detection points. Coordinates and detection range are ranges made up of a set of detection points. The indicators considered in assessment include assessment probability, assessment point, assessment time, and assessment range. The assessment probability, point, and range are the same as the detection probability, point, and range, and the assessment time refers to the time it takes for assessment to be completed. The neutralization index considers the neutralization probability, neutralization point, neutralization time, and neutralization range, which has the same meaning as the detection and assessment described above. Tracking records the number of failures or interruptions in tracking during detection, assessment, neutralization and evaluates tracking accuracy by comparing the difference between the actual location of the vehicle and the recorded location.

### *2.2 NAR/FAR Testing*

Since the CUAS facility basically are classified as detection equipment, NAR/FAR tests are required to evaluate the detection accuracy. NAR and FAR to nuisance alarm rate and false alarm rate, respectively. A nuisance alarm is a case in which an alarm is triggered by an object (bird, leaf, etc.) or environment (wind, rain, etc.) other than the object to be detected and identified and a false alarm is a case in which the device malfunctions and triggers an alarm. If the NAR/FAR level is high, the alarm monitoring staff may be vigilant without identifying the cause of each alarm [1]. In the maintenance of the system, necessary information may be missed. As a result, the detection probability of actual intrusion behavior and the effectiveness of system introduction can drop. The tests for NAR/FAR values are sometimes carried out at a separate test site, but since environmental factors play a big role, it is effective to carry out the test at the installation site of the system. There are cases where the evaluation is conducted after introduction. Another method is to measure the frequency for a certain period and then compare it by each period.

### *2.3 Performance Evaluation*

After the test for each indicator is performed, the efficiency value according to the reliability is calculated for each indicator. The value according to the reliability is calculated by the following formula [2].

$$\mathrm{CL} = 1 - \sum_{i=n}^{N} \binom{N}{n} {P_D}^{i} (1 - P_D)^{N-i}$$

CL is the confidence level, N is the number of tests, n is the number of successes and $P_D$ is the probability of detection. For example, if a performance target is set to have a reliability of 95%, the $P_D$ value becomes 90% according to the test results of 30 successes out of 30 tests. It is necessary to set up a test plan by adjusting the number of tests before and after performing the test in order to satisfy the pre-set performance goal.

## 3. Conclusion

After the drone strike in 2019 at an oil refinery in Saudi Arabia, drone terror on national facilities emerged as a new threat raising interest in drone protection for important national facilities like nuclear power plants [3]. As a result, anti-drone equipment has been deployed at the nuclear power plant site in late 2021. As quantitative performance standards for CUAS have not yet been established, performance evaluation of the currently introduced CUAS can be performed using the final results of the evaluation. Currently, the physical protection standard suggests an authorized performance certification or quantitative performance goals for devices that perform functions similar to CUAS. The methodology introduced in this thesis can be used as an option for evaluating CUAS.

## REFERENCES

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