A Study on the Possibility of Unmanned Aerial Vehicles (UAV)' Threat in Nuclear Facilities

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1. Introduction

Threats targeted at nuclear facilities have evolved in many ways. Therefore, countries regularly evaluate threats targeted at nuclear facilities, set the elements that constitute the assessed threat criteria as design basis threats (DBT). And then they ensure that the physical protection system is improved.

As time goes by, threats have become more diverse and materialized. And new forms of threats have also emerged that have not been considered in the past. One of them is a small Unmanned Aerial Vehicle (UAV) threat (more commonly termed small drones) at nuclear facilities. Drones are rapidly evolving and being utilized in various fields; industrial, agricultural, and etc.

In this paper, those factors are analyzed such as the cases of threat attempts using small and medium-sized UAV, legal regulations of domestic and foreign countries, and possible impacts of small UAV threat.

Based on these analyses, it is derived countermeasures and implications that should be considered in the future.

2. Threat Cases of Small UAVs (Drones)

In the past few years, drone overflights at nuclear facilities in around the world have triggered big interest in the field of physical protection.

The cases of small UAV threat are as follows;

Date	Case Description
October, 2014	In France, UAV appeared at seven nuclear power plants on October 5th to 20th, mainly at night or early morning hours. Under French aviation law, no objects should fly within a 5 km radius of the power plant and one kilometer above the ground. But EDF, the operator could not immediately respond to the UAVs.
January 2015	In Washington D.C., a civilian UAV flew over the White House fence and crash-landed on the lawn.
January 2015	In the UAE, all air traffic at the Dubai Airport was brought to a stop for 55 minutes by a recreational UAV.
June, 2016	UAV flights were observed over the Savannah River Site (SRS; site for processing nuclear materials) in South Carolina, US
August, 2016	A small UAV crashed into a nuclear power plant in Koberg, South Africa and hit the exterior wall of the building.
October, 2016	In northern Iraq, a small drone carrying an IED was used by Islamic extremist militants.

It has very low possibility that the threat through drones will directly strike the nuclear facilities and have a major radiological impact. However, this can cause a major panic among the personnel of the nuclear facilities if explosives are loaded on the drone and detonated close to the main building of the nuclear facilities. Also it can generate the public impacts over the UAV's presence at the national security facilities.

3. Legal Regulation of UAVs in Domestic and Foreign Countries

3.1 Domestic Legal Regulation

Under the current law (Aviation Safety Act), drones are unmanned power-driven vehicles such as unmanned aircraft, unmanned helicopters or unmanned aerial vehicles with a mass of less than 150 kilograms' self-weight.

In addition, unmanned power-driven vehicles is obliged to report the device in accordance with its own weight (including battery weight). When reporting the device, the type, purpose and owner's name should be reported. It also stipulates that the issued report number should be marked on the relevant ultralight aircraft (article 122). And if any changes are occurred in purpose of the ultra-light aircraft, the owner's name, etc. it should be also reported.

	Regulations Since October 2018	
UAV reporting declaration / cancellation	for business or non-business	· Not required to report below 250g · Owner registration for 250g~7kg * Declaration, register over 1,400J · Required to report more than 7kg
Flight approval	not more than 250g	· Flight approval is required around the airport (3 km)
	250g~25kg	· Flight approval

		is required for Air control zone (9.3km), airspace prohibited area (No-fly zone)
	Over the 25kg	· Flight approval is required.
	Overflight over 150 m altitude	· Flight approval is required
Safety certification		· Safety certification is required over 25 kg
Pilot qualification	for business or non-business	· No qualification required below 250g · online education is required between 250g to 7kg *Written test + flying experience is needed over 1,400J · Written test + flying experience is needed between 7kg to 25kg · Written test + practical test is needed between 25kg to 150kg

Meanwhile, a 19-kilometer radius of the nuclear power plant is designated as a no-fly zone.

3.2 Status of Legal Regulations in Foreign Countries

Country	US	China	Japan
UAV reporting declaration	Business purpose or over 250g (airframe weight)	Over 250g	Submit relevant documents if flight approval is required
Pilot qualification	Business purpose	Over 7kg	Submit relevant documents if flight approval is required
Altitude limit	120m	120m	150m
Flight restricted area	Around Washington D.C.(24km), Airport (9.3km radius), Washington Airport(28km), Nuclear power plant (5.6km radius), Stadium (5.6km radius)	Around the Beijing, airport, nuclear power plants, etc.	Around the Tokyo (residential area with a population of more than 4,000/km2), Airport (9km radius, around the NPP, etc.
Velocity limit	161km/h	100km/h	Unlimited
Night flight, non-visual, flying over the crowd.	Not allowed in principle, but allowed exceptions	Not allowed in principle, but allowed exceptions	Not allowed in principle, but allowed exceptions. Maintain a distance of not less than 30 meters from people, vehicles, buildings, etc.
Project scope for using drones	Unlimited	Unlimited	Unlimited

UAV flight regulation in major countries is as follows, and most of the areas around nuclear facilities have flight restricted area (no-fly zone). In EU member countries, flying over nuclear power plants within a radius of 5 km and at a height below 1000 m is prohibited.

In addition, the owners of all drones in EU member countries should be registered and an electronic identification system for drones should be established by 2019. The plan also includes the application of Geo-fencing technology so that drones can be avoided in the presence of no-fly zones. In UK, drones weighing more than 250g must be registered with the government, wherever they are used, and must prove that users have mastered all relevant regulations on the use of unmanned aircraft (drone's safety tests, relevant regulation test, etc.).

4. Physical Protection Concerns for Nuclear Facilities

In nuclear facilities, the threat posed by small-scale UAV may be direct facility strikes, distributed attacks, paralysis of the access control system, and attacks linked to cyber security, etc.

Potential threats refer to how either current realities or foreseeable advances in UAV capability would challenge the current emphasis in nuclear facility security on detection, delay and response. At the same time, UAV capabilities may also provide non-traditional mechanisms for stopping a potential security incident or identifying those persons responsible for such incidents. [1]

Given the various considerations of small-scaled UAV threats, nuclear facilities need to take practical measures to protect them at the facility level based on the established threat criteria for UAV.

To do this, firstly, detection and identification measures should be made in a timely manner.

Early detection and identification is the key factors to effective neutralization of the UAV threat in nuclear facilities. For example, Radar, electro-optical technology, acoustical sensors, Magnetic detection systems, and human visual detection can be used for timely detection and identification.

Second, appropriate response and disablement measures are needed at the level of nuclear facilities. If UAVs emerge in nuclear facilities, which is possible to pose a realistic threat, the facility will need to consolidate its cooperative system with related agencies like military or police, as well as seek the possible physical measures to response them, realistically.

5. Conclusion

If these small unmanned aerial vehicles (UAVs) are used for terrorist purposes, they could be equipped with various detection instruments (optical, infrared, radar sensor, etc.) to carry out surveillance, reconnaissance, precision attack guidance, etc. and could be developed into precision weapons by loading explosives.

Whether it is an unmanned aircraft with power or a non-powered aircraft that does not need power, direct or indirect attacks could pose a major threat to nuclear facilities. With the rapid increase in the field of using small-sized UAVs for commercial and personal purpose, the possibility of abuse cannot be ruled out, now. So, it is time that specific and practical responses in nuclear facilities itself will be needed. The commonly known anti-drone procedure is carried out in three stages: detection-identification-neutralization. As rapid detection and identification is the cornerstone for early response and disablement, there should be realistic detection and identification enhancement activities at the nuclear facility level. Therefore, it is time to establish practical response measures that is considering the advantages and limitations of the current disabling method.

REFERENCES

[1] Alexander Solodov, Analyzing the Threat of Unmanned Aerial Vehicles (UAV) to Nuclear Facilities, 2017