

Security hazards of nuclear installations

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1 The Terror Threat

- There are numerous potential targets for terrorist attacks (Industrial plants, city centres or filled sports stadiums...)
 - But an attack on a NPP could be attractive for a terrorist group because of
 - its immediate effect on power generation,
 - its symbolic character (nuclear energy has a civilian/military character,)
 - and the global attention it would receive.
 - A successful attack in one country is at the same time an attack on all NPPs around the world.
 - Countries that are highly dependent on nuclear power could face a real dilemma.
 - 422 nuclear reactors in operation in 30 countries. 85% of them were built before the 9/11 attacks and were not designed with sabotage in mind.
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1 The Terror Threat

- The public debate tends to concentrate on suicide attacks with a commercial airliner since 9 /11 2001. In fact, the threat is much more diverse and complex.
 - New possible means to support attacks emerge: Drones, can – like in military application – be used for the preparation of terror attacks.
 - Drones, which have flown over French nuclear facilities in autumn 2014 more than 30 times without uncovering their originators, are also a security threat to nuclear installations.
 - Furthermore, additional attack scenarios take attention: cyberattacks
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2 Targets and their vulnerability

- Old NPPs are particularly vulnerable to external hazards. Their reactor cores are surrounded by a relatively thin-walled building (less than 1 m).
 - If reactor building is destroyed, probably the containment fails too.
 - Furthermore, it has to be assumed that the reactor's cooling circuit will be damaged and that safety systems will also suffer major damage.
 - If the pipelines of the cooling system are damaged, it would be irrelevant if the emergency cooling system still functioned, since it would no longer be able to be effectively fed in.
 - Such a case would thus in a short time – within few hours – lead to the meltdown of the reactor core.
 - Radioactive substances will be released from the melted fuel and, since the containment will have been destroyed, they can get into the open with practically no delay or retention inside the building.
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2 Targets and their vulnerability

- The spent fuel pool is another vulnerable component with considerable radioactive inventory.
 - In some plants, it can contain several times the amount of fuel than the reactor itself.
 - If a terror attack causes a breach of the concrete walls of a spent fuel pool, the cooling water will pour out.
 - This causes the fuel to heat up due to the decay heat.
 - Once the fuel reaches the temperatures of 900 °C, the zirconium cladding starts to burn in air.
 - Resulting fire is very hot and cannot be extinguished with water.
 - Fire could spread to older fuel assemblies
 - High radioactive releases of about 75 % of caesium inventory possible
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3 Conceivable Attack Scenarios

- Different attack scenarios are possible:
 - Attack from the air
 - Firing on plant from a distance
 - Intrusion of attackers onto plant area
 - Not all nuclear power plants are vulnerable to the same extent. Generally, older ones are more vulnerable.
 - It is not the intention to provide “useful” information to terrorists, which could be used for the planning of attacks. However, to assess the risk related to terrorist attacks, we need to describe some scenarios in greater detail. The public also has a right to this information.
 - Three possible attack scenarios are discussed in some more detail.
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3 Conceivable Attack Scenarios

3.1 Explosives attack by insiders with the aid of drones

- Insiders are at least as much of a threat to NPPs as terrorist attacks from outside.
 - *"The insider threat is one of the most difficult to deal with, as this hinges on the ability to screen employees and figure out the nature of their intentions,"* said Page Stoutland at the U.S.-based Nuclear Threat Initiative (NTI).
 - His assessment reflects growing anxiety about the risk of radicalized individuals gaining access to sensitive energy infrastructure, including nuclear sites.
 - There are diverse “effective” scenarios involving inside perpetrators, but the most feasible appear to be attacks with explosives.
 - It is conceivable that several drones could “deliver” the explosives. Estimations show that knowledgeable insiders would need less than 10 kilos of explosives to trigger a core meltdown.
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3 Conceivable Attack Scenarios

3.2 Terror attack by an antitank guided weapon

- AT-14 is a third-generation portable antitank guided weapon – a weapon system developed by the Russian company
- Standard warhead is a tandem shaped charge: can pierce 1.2 m of steel armor or about 3 m of steel reinforced concrete.
- thermobaric warhead: primary effect achieved through the shock wave. temperature could reach 2,500 to 3,000 degrees Celsius. Other damage is done by the vacuum effect.
- After an attacks: a core meltdown with an open containment is possible.



3 Conceivable Attack Scenarios

3.3 Terror attacks by helicopter

- An attack by helicopter is one of several conceivable aerial attack scenarios.
 - For such an attack a terrorist group would have to
 - a) get a helicopter,
 - b) load it with a large quantity of explosives,
 - c) fly the loaded helicopter to the NPP and there
 - d) detonate a large quantity of explosives.
 - In light of all the steps required, a terrorist attack using a helicopter is a relatively simple attack scenario to execute with a high probability of causing catastrophic consequences.
 - Overflights by drones have made it clear that existing security measures cannot prevent such an attack.
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4 Consequences of an attack on a nuclear facility

- A crash of a commercial airline or another terror attack that causes a major damage of the **reactor building** would lead to accident of the most severe category: **core melt accident with open containment**.
 - The release would be especially **high**. e. g. cesium-137 between 50 and 90 % of the core inventory.
 - Radioactive substances would thus be released especially **early** (within a few hours)
 - If an evacuation should go wrong, then, depending upon the weather, hundreds of thousands of people could receive life-threatening doses.
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5 Countermeasure and their limitation

Short term shutdown of the reactor

- A problem for reactor safety lies in the fact that although a quick interruption of the nuclear chain reaction can be achieved by a fast shutdown, that does nothing to stop heat developing through the radioactive decay of the fuel.
 - Thus, if the cooling fails, a meltdown of the core can occur within a short period of time.
 - The vulnerability of a NPP to attacks can be generally reduced by shut down the plant. A shutdown done as a short-term measure against increased danger, however, does not accomplish very much.
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5 Countermeasure and their limitation

Strengthening protection of the facility

- One option for defending against terrorist attacks is to strengthen the facility's protection. This includes measures such as increasing the number and weapons of security personnel, extending fencing, erecting barriers on approaches, etc..
 - Protection against attacks by land are doubtless improved by such measures. But insiders are a problem
 - As the drone overflights in France, for example, show they are of less help against attacks from the air.
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6 Sabotage in Belgien

- In the internal safety area at the Belgian Doel 4 NPP, an act of sabotage on 5 August 2014 influenced reactor operation; an emergency shutdown occurred after lubricant leaked from the high-pressure turbine through an open valve.
 - Further investigations revealed that the oil tank had emptied completely after the drain valve, which allows oil to be quickly fed into an auxiliary tank in the event of a fire, had been opened manually. As there were numerous indications that this valve had been opened intentionally without any instructions, it was quickly suspected that sabotage had taken place.
 - Electrabel filed a complaint against unknown persons.
 - The Federal Public Prosecutor's Office opened an investigation. This procedure has not yet led to the identification of the perpetrator(s).
 - At the end of 2015, it emerged that the home of a high-ranking official in the Belgian nuclear sector had been spied on by people linked to the perpetrators of the Paris attacks in November 2015.
 - Although there was no concrete evidence of a terrorist threat specifically directed against a nuclear company, the entire Belgian nuclear sector was henceforth on heightened alert.
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7 Cyber Attack of Bushehr

- Hacker attacked on Iranian NPP in Bushehr (23.10.2022).
 - Hackers have gained access to the Bushehr nuclear power plant's email server, Iran's nuclear authority says.
 - They apparently support the regime-critical protests. Tehran, on the other hand, blames "a specific country".
 - On Twitter, a group called "Black Reward" claimed responsibility for the attack. It is calling for the release of people detained during the anti-regime protests over the past weeks because of the death of Mahsa Amini. In a statement it said, "In the name of and for women, life and liberty.""
 - Cases have come to light in which computer viruses have been introduced from outside into industrial and even into computer systems of nuclear facilities. Through targeted program changes, it is in principle possible to alter the control and regulating equipment in NPPs in such a way that sufficient cooling of the reactor core is prevented.
 - Stuxnet is a powerful and malicious computer worm that first surfaced in 2010. The virus primarily targeted the centrifuges of Iran's uranium enrichment facilities. However, cyber attackers modified it over time and adapted it to target other facilities such as power plants.
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5 Countermeasure and their limitation

No-fly zones and anti-aircraft weapons

- In European countries flying over nuclear power plants within a radius of 5 km and at a height below 1000 m is prohibited.
 - Although no-fly zones around nuclear power plants reduce the risk of accidental crashes, this measure has no effect against a targeted attack.
 - Likewise, air force interceptors can contribute only marginally to the protection of NPPs. Theoretically it would be possible for scrambled interceptors to shoot down a helicopter that had been recognized in time as having a terrorist intent. However, it is hardly to be expected that the interceptors could get there in time.
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