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The future of nuclear terrorism in individual terrorist tactics
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THE FUTURE OF NUCLEAR TERRORISM IN INDIVIDUAL TERRORIST TACTICS

Abstract

Could nuclear terrorism spread to the realm of individual terrorism and 'lone wolves' in the coming years? Although the threat has never materialised, the possibility has been raised in recent decades by a number of terrorism theorists, including Anders Breivik, one of the most lethal lone wolves in the history of terrorism. In this paper, we will examine terrorist literature that addresses the issue of nuclear terrorism and look at ways a lone wolf or individual terrorist could carry out a nuclear or radiological attack, either using a Radiological Dispersal Device (RDD) or by attacking a nuclear power facility. The originality and relevance of the arguments put forward in this paper lie in the fact that very few studies address this threat specifically and that the primary documentary sources have barely been explored by academia.

Keywords

Nuclear terrorism, individual players, lone wolves, individual terrorists, insiders.

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INTRODUCTION

At its 4956th meeting on 28 April 2004, the UN Security Council adopted Resolution 1540 (2004), which states that 'proliferation of nuclear, chemical and biological weapons, as well as their means of delivery, constitutes a threat to international peace and security'[1]. Gravely concerned by the threat of terrorism and the risk that non-State actors 'may acquire, develop, traffic in or use nuclear, chemical and biological weapons and their means of delivery'[2], the Council called for enhanced coordination of efforts on international levels in order to strengthen a global response to this serious challenge and threat to international security.

In view of the terrorist strategy and tactics of individual players that have emerged since then, particularly right-wing extremists and Islamic fundamentalists, it seems logical to ask ourselves about the role of individual terrorists in the future of nuclear terrorism.

Accordingly, the objective of this paper is to analyse the future of nuclear terrorism in individual terrorist strategy and tactics, hypothesising that, over the coming years, nuclear terrorism will spread to the realm of individual terrorism more easily than to conventional organised terrorism.

POSSIBLE RISKS AND CASES

Definition and magnitude of the threat

a) A lone wolf is a self-radicalised individual that operates as a terrorist outside of an organisation and has no connection whatsoever with any organisation. In other words, someone whose actions are not influenced by a leader, who does not follow a plan, who devises their own agenda and, occasionally, their own ideology. And who, moreover, feeling rejected by society and even by terrorist organisations themselves, decides to operate completely on their own. They are therefore capable of self-activating at any time and in any place in order to achieve their political, social or religious goals and their terrorist activities focus on threats, violence and sabotage[3].

b) In contrast, the individual terrorist operates alone and in isolation. Unlike the lone wolf, however, they may also act together with another individual or in small cells or terrorist networks. They belong, or claim to belong, to a terrorist group or network;

1 Resolution 1540 (2004), United Nations Security Council, 28 April 2004, 4 pp.

2 *Ibid.*

3 The author's definition.

they always have a leader behind them who influences them and, occasionally, someone else directs their attack[4].

Both figures, as we can see, have a similar modus operandi but differ in one major aspect: the lone wolf's total independence in devising a terrorist agenda and executing the attack. Furthermore, they have three characteristics in common that make this type of independent terrorism such a lethal form of political violence:

1) They are more difficult to detect; because they act completely alone, there is a possibility that any self-radicalised individual can become a lone wolf or individual terrorist, thus making it difficult for State security forces and law-enforcement agencies to detect them.

2) Lone wolves and individual terrorists, due to psychological disorders and socio-economic difficulties, are less concerned about the risk they run in perpetrating an attack.

3) Lone wolves and individual terrorists are more dangerous than conventional terrorists because they are less predictable. According to Jeffrey D. Simon, this is so in part because the lone wolf is not bound to group decision-making processes and is therefore free to create and implement their own scenarios. Another reason is that lone wolves tend to be more creative and innovative and more likely to carry out 'black swan' and unexpected large-scale attacks[5].

To date, there have been five cases of lone wolves and individual terrorists plotting attacks using radiological or nuclear weapons[6]:

- 2002, United States: José Padilla (Abdullah al-Muhajir) was arrested on 8 May 2002 for allegedly trying to manufacture a 'dirty bomb'[7]. According to U.S. officials, Mujahir was in the early stages of the plan and, had he managed to implement it, could have caused more casualties than the 9/11 attacks (the plans have been corroborated by numerous independent sources).
- 2004, United States: Neo-Nazi Demetrius "Van" Crocker, 41, was arrested and sentenced to 30 years in prison for attempting to acquire nerve gas, explosives and material to make a dirty bomb which he planned to use to destroy the U.S. Congress, government buildings and kill members of the Afro-American community in Jackson.

4 GARRIGA, David. El Lobo Solitario, Criminología y Criminalística, 01/2014, at http://criminologiaycriminalisticafb.blogspot.com.es/2014/01/el-lobo-solitario.html (accessed on 23 February 2017).

5 SIMON, Jeffrey. Lone Wolf Terrorism: Understanding the Growing Threat. New York: Prometheus Books, pp. 37-39.

6 The case of Dhiren Barot (2004) is not included in the list as this British terrorist was the leader of a dormant cell and not a lone wolf or individual terrorist as such.

7 'Dirty bomb' is the term used in academia and counterterrorism for a conventional explosive designed to spread radioactive material over a wide area. Although sometimes called a Radiological Dispersal Device (RDD), it should be borne in mind that not all RDDs are dirty bombs, given that there are other non-explosive means of dispersing radioactive particles through air and water.

- 2008, United States: After reports of several shots being fired in a house in Belfast, Maine (USA), police found neo-Nazi James G. Cummings, 29, dead, allegedly shot to death by his wife. Radioactive material and instructions on how to build a dirty bomb were found in his home, in addition to abundant white supremacist propaganda. According to the FBI report, Cummings already had the ingredients needed to make a dirty bomb (albeit a low-level radiation one): hydrogen peroxide, uranium, thorium, lithium, termite reaction, boron, black iron oxide and magnesium tape.
- 2009, France: Dr Adlène Hicheur, 32, with dual Algerian and French citizenship and specialised in particle physics and antimatter, was arrested on 8 October 2009 for allegedly attempting to acquire radioactive material, taking advantage of his work with the European Organisation for Nuclear Research (CERN)[8], and for virtual correspondence with Al Qaeda in the Islamic Maghreb (AQIM) terrorist organisation. On 4 May 2012, Hicheur was sentenced to five years in prison for plotting terrorist attacks on behalf of Al Qaeda's North African branch.
- 2015, United States: Self-proclaimed white supremacist and U.S. navy veteran Glendon Scott Crawford was arrested for attempting to produce a radiological dispersal device (RDD) with the assistance of another individual. The aim was to kill members of the Muslim community and the then U.S. President, Barack Obama. Crawford was sentenced to 30 years in prison on 19 December 2016 in Albany, State of New York.

Although there have only been five cases of nuclear terrorism by individual actors (four North Americans and three far-right lone wolves), we should ask ourselves whether nuclear terrorism by individual terrorists and lone wolves is likely to increase in the coming years; a question we shall attempt to answer later in this paper.

The first problem we encounter when attempting to define nuclear terrorism is that, despite numerous attempts by terrorist organisations and individual actors to engage in it, an attack has never actually been carried out. As Vicente Garrido Rebolledo has pointed out, 'in reality, no one fully understands the relationship between terrorism and weapons of mass destruction (WMD) and particularly what is known as nuclear terrorism'[9]. Although such weapons (like 'dirty bombs') are not (normally) regarded as a WMD (based on the number of deaths), they are considered a weapon of mass panic (WMP 'because of the level of panic they can cause')[10] [11]. According to Xavier Bohigas, the term 'nuclear terrorism' 'is the intentional use or threat to use

8 TOBOSO BUEZO, Mario. Lobos de Occidente: El Terrorismo Individual como Elemento Emergente y Evolución Táctica de Al-Qa'ida. Madrid: Instituto Universitario General Gutiérrez Mellado, 2014, p. 196.

9 GARRIDO, Vicente. Terrorismo nuclear: ¿desafío a la seguridad?, Política Exterior, no. 148 (julio/agosto), Madrid, 2012, p.3.

10 *Ibid.*

11 FERGUSON, Charles D. and POTTER, William C. The Four Faces of Nuclear Terrorism. California, USA: Center for Nonproliferation Studies, 2004, p. 193.

radioactive materials or devices made from radioactive material in terrorist acts, including conventional attacks on nuclear facilities'[12]. Cristian Martín Corrales defines nuclear terrorism as 'the use of nuclear or radiological weapons or an attack on nuclear facilities to instil terror in the population'[13].

Therefore, based on these definitions, there is obvious concern that terrorist organisations or individual players will use nuclear or radiological weapons to achieve their political goals and spread terror in society. And even more so when the international arena is faced, as Garrido has pointed out, with 'terrorist groups that have announced their intention to acquire, steal or obtain nuclear materials by any means for the purpose of manufacturing nuclear devices'[14]. Therefore, if we accept the premise that the aim of individual terrorism has always been to launch surprise attacks without being detected by the State beforehand, using, as mentioned previously, innovative methods, we can conclude that a nuclear or radiological attack by a lone wolf would meet this definition.

Nuclear terrorism in the writings of individual players

Up until now, the greatest theoretical advocate for nuclear terrorism in individual terrorist tactics has precisely been a lone wolf: Anders Behring Breivik, the perpetrator of the double attack on 22 July 2011 in Norway which claimed 77 lives. In his 1518-page manifesto and terrorist manual *2083: A European Declaration of Independence* (2011; under the pseudonym Andrew Berwick), he wrote about how 'European Resistance Movements' could acquire or manufacture in the future nuclear arms[15], attack nuclear facilities[16] or create and detonate a radiological dispersal device[17]. The Norwegian lone wolf believed that a terrorist attack of these characteristics would create favourable conditions for the Europeans to support far-right armed movements, given that:

'The Chernobyl disaster broke the back of the Soviet Union. A new Chernobyl disaster in the heart of Western Europe will break the back of the EUSSR, have no doubt. Causing a new Chernobyl disaster on a multiculturalist regime would completely cripple them and might eventually lead to the collapse of the EU altogether (...) The resettlement of millions, mass building of new housing units, financial compensation for up to several millions will bankrupt any multiculturalist European country and will force them to halt all Muslim immigration. Furthermore, it will cause the regime

12 BOHIGAS, Xavier. Una Ojeada al terrorismo nuclear, revista *Mientras Tanto*, n.º 120, Barcelona, 2013, p. 35

13 MARTÍN CORRALES, Cristian. Terrorismo Nuclear, CESEDEN, no. 16, Madrid, 2007, 16.

14 See Garrido, *op. cit.*, p.5.

15 BREIVIK, Anders. 2083*:* A European Declaration of Independence. Norway: self-published, 2011, pp. 955-959.

16 *Ibid.*, pp. 1025-1057.

17 *Ibid.*, pp. 1058-1064.

to cut all funding of minority groups and foreign aid and instead focus on rebuilding (...) The regime will have no choice but to drastically reduce their over-inflated public sector resulting in hundreds of thousands of unemployed. All Western European countries will be forced to immediately halt all Muslim immigration as they are forced to help the internally driven European "refugees".

(...) However, at this point the suffering is already prevalent so they will have nothing to lose. These conditions will be favourable for further consolidation and for the creation (of) patriotic armed militias. Eventually, the conditions will be there for a military coup and we will fully take advantage of this window of opportunity'[18].

Another prominent nuclear theorist was Dr William Luther Pierce III who, under the pseudonym Andrew Macdonald, published two novels that became very popular in the North American far-right subculture: *The Turner Diaries* (1978) and *Hunter* (1989). Both novels not only seek to indoctrinate 'white American trash' but are also terrorist manuals that aim to educate potential far-right lone wolves. *The Turner Diaries*, for instance, teaches fighting tactics and guerrilla warfare, as well as explaining how to bring a nuclear power plant to a halt using radioactive material. The book suggests two ways to accomplish this: the first entails a suicide mission[19] and the second involves the use of a 4.2-inch mortar to launch radioactive material via three modified projectiles, which requires the assistance of a third individual (an insider from another plant) to supply the radioactive material to the far-right terrorists[20].

Like Breivik, Pierce also believed that nuclear terrorism would play a key role in white supremacist agenda by polarising society and causing chaos, until winning over a share of the affected population. In *The Turner Diaries*, after the white supremacists launch a nuclear missile at the city of Baltimore, Pierce points out that 'The holocaust through which the people up there had passed had clearly convinced them quite thoroughly of one thing: the System could no longer guarantee their security. They no longer had even a trace of confidence in the old order; they merely wanted to survive now, and they would turn to anyone who could help them stay alive a while longer.'[21] Later on we will analyse the nuclear terrorism channels that these two extremists developed.

Nuclear terrorism as an emerging global risk

According to the Fissile Materials Working Group (FMWG), there are approximately 20,000 nuclear weapons in the world today distributed among nine countries

18 *Ibid.*, pp. 955-1027.

19 MACDONALD, A. [LUTHER PIERCE III, W] (1978), Los Diarios de Turner. Colombia: Editorial Ojeda, p. 173. (Originally published in English with the title: The Turner Diaries).

20 *Ibid.*, p. 177.

21 *Ibid.*, p. 276.

(United States, France, United Kingdom, Israel, Russia, China, North Korea, India and Pakistan). There is enough fissile material (enriched uranium and plutonium) spread throughout hundreds of locations in dozens of countries around the world to build more than 100 000 nuclear weapons and there have been 19 confirmed cases of lost or stolen fissile material to date in countries such as the United States, France, Belgium, Germany, the Czech Republic, Lithuania, Moldova, Bulgaria, Japan, Georgia, Russia and South Africa[22]. In addition, more than 150 cases of trafficking in radiological and nuclear materials are reported annually to the International Atomic Energy Agency's (IAEA) Incident and Trafficking Database (ITDB)[23].

If, in addition, we consider that global terrorist groups such as Daesh, Al-Qaeda[24], the Taliban and Chechen terrorists[25] have in the past expressed a willingness to use nuclear weapons in terrorist attacks[26], the real threat of an attack of this magnitude occurring increases considerably. Of the terrorist groups mentioned, the case of the self-proclaimed Islamic State deserves special mention; in May 2015 it announced in issue number 9 of its magazine *Dabiq* (since replaced by *Rumiyah*) that it was seeking to acquire a nuclear bomb in the near future. British journalist John Cantlie (who was being held hostage by the jihadists since November 2012) wrote an article in the magazine entitled *The Perfect Storm*[27] about the hypothetical possibility of Daesh using its millions of dollars to purchase a nuclear weapon with the aid of corrupt officials in Pakistan. According to Cantlie, the device would be transported to the United States along routes passing through countries such as Libya, Nigeria, South America and Mexico. John Cantlie points out that: 'From there (the Mexico-U.S. border) it's just a quick hop through a smuggling tunnel and hey presto, they're mingling (the

22 FISSILE MATERIALS WORKING GROUP (FMWG). Map, at http://www.fmwg.org/map.cfm (accessed on 8 March 2017).

23 EUROPEAN COMMISSION. Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and The Committee of the Regions on a New EU Approach to the Detection and Mitigation of CBRN-E Risks, Brussels, 05/05/2014.

24 BUNN, Matthew and BIELEFELD, Tom. Reducing Nuclear and Radiological Terrorism Threats, Institute for Nuclear Materials Management 48th Annual Meeting, Tucson, Arizona, 8-12 July 2007, at https://www.belfercenter.org/publication/reducing-nuclear-and-radiological-terrorism-threats (accessed on 14 March 2018).

25 The first terrorists in history to plant a dirty bomb when, in 1995, they placed a small quantity of cesium-137 in Moscow's Izmaylovsky Park, though it did not explode. In 1998 the Chechen separatists made a second attempt after attaching a cesium device to a land mine.

FORBES. The Biggest Threat Dirty Bombs Pose is Panic, 11/09/2014, at https://www.forbes.com/sites/stratfor/2014/09/11/the-biggest-threat-dirty-bombs-pose-is-panic/2/#22dea12644f4 (accessed on 30 January 2018).

26 TOBEY, William and ZOLOTAREV, Pavel. The Nuclear Terrorism Threat, Belfer Center for Science and International Affairs (2014), at https://www.belfercenter.org/sites/default/files/legacy/files/nuclearterrorismthreatthailand2014.pdf (accessed on 19 January 2018).

27 CANTLIE, John. The Perfect Storm, Dabiq, 2015, pp. 74-77

mujāhidīn) with another 12 million "illegal" aliens in America with a nuclear bomb in the trunk of their car'[28]. Cantlie concludes his article by stating that 'Perhaps such a scenario is far-fetched but it's the sum of all fears for Western intelligence agencies and it's infinitely more possible today than it was just one year ago'[29].

MEANS BY WHICH A LONE WOLF OR INDIVIDUAL TERRORIST WOULD SEEK TO CARRY OUT A NUCLEAR OR RADIOLOGICAL ATTACK

According to Dr Garrido Rebolledo, there are essentially three nuclear terrorism scenarios: firstly, 'the theft and dispersal of fissile material suitable for the manufacture of a rudimentary nuclear device and its detonation in a densely populated city'. Secondly, 'the theft of a radioactive source for medical or industrial use and its dispersal by explosion or by or any other means'. And thirdly, 'an attack or sabotage using conventional explosives (or any other means)' on a nuclear power plant in order to cause enough damage to trigger an uncontrolled radiation emission[30].

Radiological Dispersal Devices (RDDs)

Radiological Dispersal Devices (RDDs) would undoubtedly be the most viable method for both a terrorist organisation and lone wolf to use. An RDD is a device used to disperse radioactive material with the intention of causing as much physical, psychological and economic damage as possible. The best known method is the dirty bomb, 'comprised of radioactive material that is dispersed (through a conventional explosive) over a more or less large area (for example, a city)'[31] [32] [33]. The second method is the dispersion of radioactive material over a specific area by another means (from the air, drinking water sources, etc.).

It should be pointed out that the isotopes that pose the greatest health risk because of their potential use in an RDD can be found in widely-used commercial radioactive sources: cancer treatments, food sterilisation and industrial and scientific research

28 *Ibid.*, p. 77.

29 *Ibid.*, p. 77.

30 See Garrido, *op. cit.*, p. 5.

31 See Corrales, *op. cit.*, p. 27.

32 See Ferguson and Potter, *op. cit.*, pp. 259-283.

33 COLELLA, Mike, THOMSON, Stuart, MACINTOSH, Steven and LOGAN, Mike. An introduction to radiological terrorism, The Australian Journal of Emergency Management, Vol. 20 No, 2 (May), Australia, 2005, pp. 9-12 and 14.

radiography. These include amercium-241, californium-252, cesium-137, cobalt-60, iridium-192, plutonium-238, strontium-90 and radium-226. Indeed, cesium-137 is the greatest radiological safety hazard contained in spent nuclear fuel, and radium-226 is a naturally-occurring radioactive metal[34] [35]. Another radioactive source is the orphan source which is not under 'regulatory control, either because it has never been under regulatory control, or because it has been abandoned, lost, misplaced, stolen or transferred without proper authorisation'[36]. In addition, a study by the U.S. Department of Defense suggests that the following conditions are conducive to trafficking in radioactive materials in a region: **1)** A strong black market **2)** High unemployment **3)** A degree of industrial development **4)** Sources of Chemical, Biological, Radiological, and Nuclear (CBRN) material and **5)** Ethnic/religious factionalism[37].

In relation to dirty bombs, Breivik has pointed out that their use in the future 'will cause minimal to no civilian casualties but will create devastating ideological, physiological and economical damage'[38]. The Norwegian lone wolf highlights six aspects in relation to the possible use of dirty bombs, which should be taken into consideration for counterterrorism:

g) Breivik states that 'The source should be "sufficiently" radioactive to create direct radiological damage at the explosion or at least to perform societal damage or disruption.'
h) He recommends the use of fertilisers for making explosives and the most suitable means of building dirty bombs, given that, according to Breivik, this material is easy to acquire and a lethal and relatively easy explosive to produce.
i) He goes on to add that 'The source should be transportable with enough shielding to protect the carrier, but not so much that it will be too heavy to manoeuvre'.
j) Breivik also believes that 'The radiological material must be sufficiently dispersed during detonation to effectively contaminate the area around the explosion'.
k) In addition, he recommends the inclusion of hollow or soaked projectiles, adding that 'If you cover the bomb with thousands of these metal carrier shrapnel/balls, depending on detonation site, it may contaminate an area up to 3 square kilometres (...) (resulting in) a scenario where it will literally "rain radioactive balls"'.

34 See Corrales, *op. cit.*, p. 27.

35 See Colella, Thomson, Macintosh and Logan, *op. cit.*, pp. 9-12.

36 See Toboso Buezo, *op. cit.*, p. 252.

37 KUZNAR, Larry; ASAL, Victor; RETHEMEYER, Karl; PATTIPATI, Krishna; POPP, Robert; SHELLMAN, Steven. Anticipating Rare Events: Can Acts of Terror, Use of Weapons of Mass Destruction or Other High Profile Acts Be Anticipated? A Scientific Perspective on Problems, Pitfalls and Prospective Solutions, United States: Department of Defense [DoD] (White Paper), 2008, p. 85.

38 See Breivik, *op. cit.*, p. 1059.

l) As suitable locations for attacks, Breivik cites Western European capitals, particularly inner city tourist attractions and popular locations of symbolic value to 'cause maximum ideological, psychological and economical damage'[39].

The radiological or nuclear route would undoubtedly be the most likely way an individual terrorist would attempt an attack because it requires only basic knowledge of bomb-making, or none at all if the terrorist looks for other methods of dispersal. It would also be an economical attack for the terrorist and the only difficulty they would encounter would be the acquisition of radioactive material, where an insider, opportunism or illegal trafficking would undoubtedly play a key role. If, in addition, we consider the narcissistic personality of most lone wolves, not unlike that of mass murderers and school killers, it becomes apparent that an attack of these characteristics would be a perfect means of attaining the public and media attention that most individuals who pursue terrorist tactics and strategies crave.

Attack on a nuclear facility

Nuclear facilities are an attractive target for terrorists because of their potential to strike fear into the public, a fear they would always be tempted to exploit[40]. In the event of an attempted attack on a nuclear facility, terrorists could choose as a target a nuclear power plant, reprocessing plant, research reactor, radioactive waste storage facility[41] or a fuel assembly plant. However, Spanish army operations analyst Julio Ortega García believes it would not make sense for a terrorist group to attack a nuclear facility unless it were a nuclear power plant, because terrorists would not pursue such a 'limited target'[42].

As Martín Corrales has pointed out, an attack on a nuclear power plant could cause a radioactive leak, 'leading to a large-scale nuclear disaster with devastating environmental, human and economic consequences'. If the spent fuel pools were destroyed, radioactive substances could be released into the atmosphere and if, in addition, the terrorists were able to sabotage the reactor core and cause it to overheat, it could melt. Nevertheless, to achieve this, 'the terrorists would not only have to be able to successfully attack certain systems (....), but also destroy (at least in part) the containment building in order to disperse some of the reactor fuel'. The most vulnerable facilities, adds Corrales, would be 'nuclear reactors that do not have a containment building, such as the Soviet-designed RBMK and VVER reactors and those designed

39 *Ibid.*, pp. 1062-1063.

40 See Corrales, *op. cit.*, p. 28.

41 *Ibid.*, p. 19.

42 Ortega García, Julio. Medidas de Defensa en España frente al terrorismo nuclear. Documento Marco IEEE, no. 05/2013., p. 14.

using Magnox technology in the United Kingdom'[43] [44]. Today, there are a total of 446 nuclear reactors operating in 30 countries[45], therefore the possibility of an attempted attack on a nuclear power plant is considerably high.

In his manifesto *2083: A European Declaration of Independence*, Anders Behring Breivik calls upon his followers to use nuclear power plants as a weapon of mass destruction, urging them to attack them to cause nuclear disasters like that of Chernobyl. In addition, Breivik recognises the role insiders would play in a terrorist attack, pointing out that: 'All committed individuals (to his far-right cause) will have ample time to take a relevant education granting them access to W. European Nuclear facilities'[46]. We will now look at the different types of attacks that an individual terrorist could carry out on a nuclear power plant:

a) Suicide attack with a commercial aircraft. Crashing a commercial aircraft into a nuclear power plant would have a devastating effect and could even destroy the site of the impact, including the containment building. However, the destruction wreaked would be even greater if the aircraft's fuel tanks were full, thus possibly causing further damage to auxiliary systems and resulting in the uncontrolled emission of radioactive material. And even if the containment building were not seriously damaged, Martín Corrales claims that 'an impact of this magnitude would render so many systems unusable that short- and medium-term operation of the plant would be impossible and could even lead to it being shut down permanently'[47] [48]. Nowadays, while most nuclear power plants would be able to withstand the impact of an aircraft, the impact of a commercial aircraft with its fuel tanks full would cause far greater controversy[49] [50]. Most nuclear power plants were designed (special mention for the first and second-generation nuclear reactors) to withstand the damage caused by earthquakes, hurricanes and other meteorological phenomena[51]. However, deliberate attacks with commercial aircraft loaded with fuel were not taken into account, such as the 9/11 attacks on the Twin Towers. Accordingly, months after the Fukushima nuclear disaster and following

43 See Corrales, *op. cit.*, p. 29.

44 See Ferguson and Potter, *op. cit.*, p. 202.

45 BHATIA, Vandana. The US-India Nuclear Agreement: Accommodating the Anomaly? London: Lexington Books, 2017, p. VIII.

46 See Breivik, *op. cit.*, p. 1027.

47 See Corrales, *op. cit.*, p. 30.

48 See Ferguson and Potter, *op. cit.*, pp. 194 and 212-217.

49 See Ortega García, *op. cit.*, p. 14.

50 ESCARTÍ, Francisco. Los análisis del impacto de un avión comercial en una central nuclear, 16/09/2015, at https://elsecretodelospajaros.net/2015/09/16/los-analisis-del-impacto-de-un-avion-comercial-en-una-central-nuclear/ (accessed on 29 March 2017).

51 CONSEJO DE SEGURIDAD NACIONAL [CSN]. Pruebas de resistencia realizadas a las centrales nucleares españolas. Informe final. Reino de España, 2011.

the presentation of a preliminary report by the Spanish Nuclear Safety Council (CSN) that same year, Greenpeace released an alarmist document entitled *Consecuencias en las centrales nucleares españolas tras la colisión de un avión de pasajeros* (Consequences for Spanish nuclear power plants following the collision of a commercial aircraft, 2011) in which it suggested that stress tests had revealed that no Spanish nuclear power plant would be able to withstand a collision with a commercial aircraft[52].

According to the report published by Greenpeace and the Union of Concerned Scientists (UCS), for decades, European and U.S. nuclear power plants have been inadequately designed to withstand external impacts, despite the existence of studies which claim the opposite in their stress tests[53] and, in the case of all Spanish nuclear power plants up to 2011, none of them, according to Greenpeace, except Trillo 1 (Guadalajara, third-generation), would be able to withstand the impact of even a light military aircraft[54]. Therefore, in the event of an air attack with a commercial aircraft, the condition of nuclear power plants could result in the melting of the core in the reactor building, serious damage to the spent fuel pool and the other buildings needed for the proper and safe functioning of the plant[55]. Based on data from the Swiss Federal Nuclear Safety Inspectorate, Greenpeace also claimed that the most vulnerable reactor at the time was the one at the nuclear power plant in Santa María de Garoña, Burgos, a first-generation plant with the same type of reactor as Fukushima 1. According to Greenpeace, the thickness of the walls of the reactor building at the Burgos plant was only 0.60 metres and the minimum thickness of the dome was 0.15 metres[56] [57]. In July that year, the then chairperson of the

52 GREENPEACE ESPAÑA Y BECKER, Oda. Consecuencias en las centrales nucleares españolas tras la colisión de un avión de pasajeros, Greenpeace España, 2011, p. 6.

53 ELECTRONIC POWER RESEARCH INSTITUTE [EPRI]. Deterring Terrorism: Aircraft Crash Impact Analyses Demonstrate Nuclear Power Plant's Structural Strength, California (USA): EPRI, 2002.

54 See Greenpace España y Becker, *op. cit.*, pp. 13-14.

55 *Ibid.*, p. 10-12.

56 *Ibid.*, p. 21.

57 The data provided by Greenpeace in the *Consequences for Spanish nuclear power plants following the collision of a commercial aircraft* (2011) document contradicts data from Nuclenor, which claims that the reinforced concrete walls of the reactor building in the Burgos plant is more than one metre thick, and Basque newspaper El Correo claims it is 1.5 metres thick. In addition, sources at CCOO have pointed out that Greenpeace would not have taken account of the improvements made to the design of Garoña after it was commissioned, and other sources claim that the material comprising the containment building dome is superior to that of the walls. In addition, the Greenpeace report overlooked the additional protection provided by the dry well and pressure suppression chamber. In any event, since 2011 certain data on Spanish nuclear power plants are no long being published, as they relate to the plants' physical safety, and the more reliable studies are classified. It should also be pointed out that nuclear physicist Ignacio Araluce (former director of the World Association of Nuclear Operators (WANO) and current chairman of *Foro Nuclear*, the Spanish Nuclear Industry Forum) has stated that, in addition to the natural disaster stress tests provided for in the *Pruebas de resistencia realizadas a las centrales nucleares españolas. Informe Final* (Final report on the stress tests

CSN, Carmen Martínez Ten, announced that Spain was going to strengthen safety at its nuclear plants, given the possibility of a terrorist attack or major fire. Since then, the findings of commercial aircraft crash impact analyses in relation to containment structures at Spanish nuclear power plants have ceased to be published, as they contain information on their physical safety, and the more reliable studies are classified[58].

Furthermore, as announced by the CSN in 2011 and according to data from the Spanish Nuclear Industry Forum, the safety of nuclear power plants has been improved to ensure their robustness and thus avoid a similar situation to that of the Fukushima plant in Japan (2011). Meanwhile, after completing stress tests at all of Europe's nuclear power plants, the European Nuclear Safety Regulators Group (ENSREG) issued an Action Plan in July 2012, where it called for the implementation of standardised actions in countries of the eurozone. Later on that year, the Spanish Nuclear Safety Council (CSN) approved the National Action Plan for 2012 and its review in 2014. The Forum has stated that:

'In Spain, the conclusions of these tests proved the safety measures with which nuclear plants are operating, the solidity of their designs and their high safety levels' which include 'protection actions and measures against extreme natural phenomena (...) reinforcement of the prevention and mitigation systems, improving the existing ones and adding portable equipment and additional cooling systems (...) that can operate in the event of an electric isolation of the site (...) (in addition to the implementation of) a common external support center for emergencies (CAE) and a support center for emergency management at each site (CAGE)'[59].

As to whether the containment buildings of Spanish reactors would be able to withstand the impact of a large commercial aircraft, the Spanish Nuclear Industry Forum has this to say: 'secondary containments would be able to withstand major impacts as they are robustly built and, although they would be damaged by a strong impact, the reactors would not be affected because they are protected by the primary containments which prevent damage to the reactor vessel'. Indeed, 'aircraft impact simulations have been conducted in the United Kingdom' and it has been demonstrated that an impact of this type would not affect 'the reactor vessel' as the 'various safety barriers' would protect it from 'any type of impact or damage'[60].

performed on Spanish nuclear power plants 2011), regulatory bodies, operators and governments do study potential terrorist attacks, although these are not included in the stress test methodology, which is the only public information available.

58 See Corrales, *op. cit.*, p. 30.

59 FORO NUCLEAR (Foro de la Industria Nuclear Española). Las centrales nucleares españolas 5 años después de Fukushima, 03/03/2016, at http://www.foronuclear.org/es/sala-de-prensa/notas-de-prensa/122110-las-centrales-nucleares-espanolas-5-anos-despues-de-fukushima (accessed on 2 April 2017).

60 FORO NUCLEAR (Foro de la Industria Nuclear Española). Edificios de contención de las centrales nucleares, 24/06/2015, at http://www.foronuclear.org/es/consultas-al-experto/121631-edificios-de-contencion-de-las-centrales-nucleares (accessed on 2 April 2017).

Since the September 11 terrorist attacks, more and more proposals have been put forward on how to improve the physical safety of nuclear power plants against the impact of a commercial aircraft. In fact, specific nuclear safety procedures were introduced in many countries several years ago in a bid to avoid such an occurrence. The most recent nuclear power plant built in Spain, in Trillo to be precise, is equipped with reinforced concrete walls with a thickness of up to two metres and is capable of withstanding the impact of a Boeing 747. It is also equipped with an additional control room in case the main one is destroyed. To give you an idea of its ability to withstand an impact, according to a study conducted by engineers Alexander Siefert and Fritz-Otto Henkel, in order to avoid significant damage, the thickness of the wall would have to be 1.8 metres to withstand a Boeing 747, while a thickness of 1.2 metres would suffice for an Airbus A320[61] [62]. There is also a no-fly zone for the nuclear plant at Trillo which allows the Madrid-Barcelona flight route to be varied to improve the plant's safety. Finally, it should be pointed out that, according to CSN experts, Spain's nuclear power plants are protected with anti-missile slabs capable of withstanding the impact of a commercial aircraft. The slabs are placed on the reactor head to provide additional steel protection to the plant's most sensitive area.

Furthermore, in May 2016 the Interior Ministry announced that it would deploy 185 members of the Civil Guard to nuclear power plants that year to strengthen surveillance against the threat of a terrorist attack, and 305 guards in 2017. Since June 2016 a Civil Guard protection and immediate response unit has been permanently on duty inside the Trillo plant to strengthen security against a jihadist attack.

Nevertheless, in relation to the question as to whether it would be possible for an aircraft to crash into a nuclear power plant, we must highlight the following:

1) In the 1970s alone, there were more than 150 cases of successful or attempted airliner hijackings[63].

2) One of the initial targets of the masterminds behind the September 11 attacks was to crash commercial aircraft into two U.S. nuclear power plants.

3) With regard to individual players, there have been several cases of aerial terrorism. One of the most prominent cases was that of Andrew Joseph Stack III, a far-right lone wolf, who deliberately crashed his light aircraft into the IRS building in Austin, Texas on 18 February 2010, killing one worker, injuring thirteen other workers and partially destroying the government building. Other cases of aerial terrorism committed by lone wolves and individual terrorists were those of Viktor Widera (1972, Air Canada hijacking), an anonymous Tunisian terrorist (1980, Alitalia hijacking), Hus-

61 See Escartí, *op. cit.*

62 SIEFERT, Alexander and HENKEL, Fritz-Otto. Computation of load functions for different types of aircraft, Varna (Bulgaria): Conference, 5 and 7 June 2013.

63 AVIATION SAFETY NETWORK, Airliner hijackings, 21/12/2012, at https://aviation-safety.net/statistics/period/stats.php?cat=H2 (accessed on 12 April 2017).

sein Shey Kholya (1983, Rio Airways hijacking), an anonymous Libyan terrorist (1985, Lufthansa hijacking), an anonymous Algerian terrorist (1993, Paris-Nice flight hijacking), Richard Reid (2001, American Airlines, failed bombing attempt) and Umar Farouk Abdulmutallab (2009, Northwest Airlines failed bombing attempt). Crashing a commercial aircraft into a nuclear power plant is a terrorist tactic that far-right lone wolf Anders Breivik spoke of in his manifesto and manual, with the idea of making it a 'weapon of mass destruction'. Nevertheless, aware of the security measures in place and the difficulty of attacking a Western nuclear power plant, Breivik pointed out that to destroy the containment building and release radioactivity, you would have to load the aircraft with explosives and take into account the possibility of anti-aircraft devices in the security perimeter around the plant:

'A civilian aircraft with enough carrying capacity to hold 2-5 ton of (explosive) cargo may be used. The detonation has to be timed perfectly as the blast radius has to be able to destroy the containment building. Testing shows that many containment buildings can withstand a direct hit by both fighter jets and even civilian airliners. However, it is uncertain how (much damage) a civilian aircraft loaded with explosives would cause. There is a no-fly-zone surrounding the facility. Any ground to air missile devices (if any) placed close to the facility may pose a threat to the aircraft'.[64].

b) Aerial attack with missiles or the planting of explosives. In his manifesto, Breivik also speaks of the possibility, which he considers unlikely, of insiders working in the air force of a country taking control of a jet fighter and using it to destroy the containment building of a nuclear power plant. Thus, the Norwegian lone wolf would consider this possibility if there were 'any jet fighter missiles which has the potency to penetrate a containment building (they are sometimes constructed to withstand missile attacks)'[65].

Another possibility would be for a terrorist group to use a helicopter, such as a fire-fighting helicopter, to plant explosives in a nuclear power plant before fleeing and destroying the containment building. According to Corrales, 'the costs and staff required to carry out such an attack would be low and within the reach of any terrorist organisation' and it could destroy the containment building and secondary systems, possibly leading to leakage of radioactive material[66]. However, an attack of this kind would be more difficult than a suicide attack with a commercial aircraft given that, as explained previously, nuclear power plants are sufficiently protected against external explosions, have no-fly zones and very often anti-aircraft systems.

c) Ground attack. The aim of such an attack might not only be to destroy the power plant or release radiation, but also to hijack it or shut it down; indeed, as Martín Corrales has pointed out, 'terrorists might try to build an RDD using spent nuclear

64 See Breivik, *op. cit.*, p. 1029.

65 See Breivik, *op. cit.*, p. 1029.

66 See Corrales, *op. cit.*, p. 33.

fuel'[67] and then detonate it in the plant[68]. Along the lines of the scenario described by Corrales, we already mentioned the possibility of terrorists using mortar to launch radioactive material in an attempt to bring the plant to a standstill[69], which would be an easier tactic for an individual player. In any event, in order to carry out a ground attack, you would need 'detailed information on the layout of the buildings, their interior plans, security systems and staff', etc. Therefore, the terrorists would need the assistance of a worker or insider[70], which was what happened in the Pelindaba nuclear research centre in South Africa in 2007 when armed individuals managed to enter the facility with the help of an insider.

Breivik speaks of four strategies for attacking a nuclear power plant by ground:

- Strategy 1 (no insiders): using a team of at least three terrorists posing as representatives of the authorities or firemen and detonating a truck bomb.
- Strategy 2 (no insiders): using a team of at least three terrorists that force the plant workers to deactivate the nuclear power plant systems before detonating explosives and releasing radiation.
- Strategy 3 (1 insider and 2 outsiders): the two strategies described above, but with the assistance of an insider to help the other terrorists enter the power plant.
- Strategy 4 (2 insiders and 1 outsider): according to Breivik, a team of two insiders might be enough to sabotage the reactor protection system (RPS), the emergency diesel generators and coolant pipes while an outsider places explosives close to the containment building in order for leakage of radioactive material to reach the atmosphere[71].

While it is true that it would be very difficult to implement the strategies described by Breivik (security at nuclear power plants has improved considerably in recent years), let us not forget the incident involving Greenpeace on 15 February 2011 when around twenty Greenpeace activists managed to force their way into Cofrentes nuclear power plant to demand that the Nuclear Safety Council and the Government not renew the plant's operating licence. There was a similar incident at the Zorita nuclear power plant (Cáceres) in 2002, when activists managed to climb to the top of the dome. In the case of Cofrentes, the activists managed to get over the electric fence protecting the grounds, get past the private security staff (even jostling with some of the guards) and climb to the top of the plant's 125-metre-high cooling tower with the intention of writing an anti-nuclear message on it. With this violent act, the activists sought to demonstrate, to use their own words, 'the lack of security at Co-

67 See Corrales, *op. cit.*, p. 177.

68 See Ferguson and Potter, *op. cit.*, pp. 218-222.

69 See Macdonald, *op. cit.*, p. 177.

70 See Corrales, *op. cit.*, p. 31.

71 See Breivik, *op. cit.*, pp. 1028-1029.

frentes, which is why Greenpeace is requesting its closure'[72]. Following the incident, the owners of nuclear power plants and CSN requested that private security guards be allowed to carry weapons, as is the case with Spanish tuna trawlers fishing in conflict zones. The Civil Guard is still responsible for overseeing security at Spain's nuclear power plants with the assistance of private security companies. On the other hand, in April 2016, when asked about the possibility of terrorists managing to access the control towers of nuclear power plants, the spokesperson for *Sociedad Nuclear Española* (the Spanish Nuclear Society), Eugeni Vives, said that this would be impossible as the rooms are armoured, pointing out that the terrorists would have to overcome two barriers: an industrial and a security barrier, as well as entry points equipped with walk-through-metal-detectors for weapons and bomb detectors before they would be able to enter the premises[73].

d) Vehicle-bomb attack. This would involve the detonation of a vehicle-borne improvised explosive device within the security perimeter of a nuclear power plant or in the actual plant[74]. While it is true that this has been one of the most lethal tactics used by terrorists in the past, nowadays it would be very difficult to damage a nuclear power plant in this way and the maximum damage likely to be caused would be a technical stop. It should also be borne in mind that there are currently comprehensive security controls and measures in place to prevent such an attack in Spain.

Nevertheless, if a vehicle-borne bomb did manage to make it inside the security perimeter, we would have to consider the lethality of such a terrorist attack, bearing in mind the Oklahoma City bombing (1995, carried out by a lone wolf), which killed 168 people, injured 680 others, burnt 86 vehicles and destroyed or damaged 324 other buildings. Breivik also proposes this type of an attack on a nuclear power plant, getting the truck bombs into the premises under the guise of fire trucks[75]. Such an attack, however, would not be viable given the high security measures in Western nuclear power plants.

Nevertheless, if we take into account the evolution of structural safety at the nuclear power plants discussed above, there are studies that question the safety of several first- and second-generation plants, such as the U.S. study entitled *Calculating Nuclear Power Plant Vulnerability Using Integrated Geometry and Event/Fault Tree Models* (2004, VVAA), which goes so far as to claim that even an explosion outside a nuclear

72 ANTENA 3. Activistas de Greenpeace asaltan la central nuclear de Cofrentes, 15/02/2011, at http://www.antena3.com/especiales/noticias/ciencia/hazte-eco/-greenpeace/activistas-greenpeace-asaltan-central-nuclear-cofrentes_2011021500005.html (accessed on 5 May 2017).

73 TOBALINA, Belén. ¿Es difícil atacar las nucleares desde fuera? Y ¿desde dentro?, *La Razón*, 04/04/2016, at http://www.larazon.es/atusalud/medioambiente/es-dificil-atacar-las-nucleares-desde-fuera-y-desde-dentro-PD12337899 (accessed on 20 May 2017).

74 See Corrales, *op. cit.*, pp. 30-31.

75 See Breivik, *op. cit.*, p. 1028.

power plant could cause damage to the nuclear reactor core[76]. On the other hand, more recent studies, such as *Vulnerability Analysis of a Nuclear Power Plant Considering Detonations of Explosive Devices* (2012, VVAA), claim that an explosion, either inside or outside a nuclear power plant would not cause significant damage, although it does state that if certain conditions are met in which all systems are affected, there is a minimum probability that the core would be damaged[77].

e) Attack by water. If a terrorist group were to attack the cooling water system of a nuclear power plant, it would undoubtedly result in economic losses and raise public tension and perceptions of the vulnerability of power plants. However, it would be unlikely to cause significant damage[78] and Martín Corrales has pointed out that this method of attack is being treated as a potential threat in Spain[79].

f) Sabotage. Sabotage, with the consequent melting of the reactor core or leakage of radioactive material, could only be carried out by a complex ground attack necessitating two or more teams and the assistance of insiders to sabotage the plant. Nevertheless, if a nuclear power plant were to be completely sabotaged, it could lead to a variety of scenarios, ranging from slight to extreme situations, depending on the force and coordination used[80] [81].

An example of an act of sabotage carried out in *The Turner Diaries* involved, as William Luther Pierce explained, contaminating the plant with radioactive material by packing enough of it 'into a cane or a crutch, together with a small explosive charge for dispersing it, to make the entire Evanston Power Project uninhabitable. The plant won't be damaged physically, but they'll have to shut it down. Decontamination will be such an enormous task that the plant may very well stay closed permanently'[82]. The book points out that this will be a suicide mission because 'Whoever carries the radioactive material into the plant will already have been exposed to a lethal dose of radiation before he gets to the plant gate with it'[83]. And even then, Pierce points out that several nuclear power plants have radiation detectors in which case it would not be possible to carry out a terrorist attack of these characteristics. However, if there

76 PEPLOW, Douglas E; SULFREDGE, David C; SANDERS, Robert L; MORRIS, Robert H; HANN, Todd A. Calculating Nuclear Power Plant Vulnerability Using Integrated Geometry and Event/Fault Tree Models, Nuclear Science and Engineering, no. 146 (1), 2012, pp. 1258-1269.

77 ČEPIN, Marko; CIZELJ, Leon, LESKOVAR, Matjaž. Vulnerability Analysis of a Nuclear Power Plant Considering Detonations of Explosive Devices, Journal of Nuclear Science and Technology, no. 43 (10), pp. 1258-1269.

78 See Ferguson and Potter, *op. cit.*, pp. 217-218.

79 See Corrales, *op. cit.*, p. 31.

80 See Tobey and Zolotarev, *op. cit.*

81 See Ferguson and Potter, *op. cit.*, pp. 192 and 232.

82 See Macdonald, *op. cit.*, p. 173.

83 *Ibid.*, p. 173.

are no radiation detectors and the terrorists can carry out the attack, Pierce says that: 'The whole plan is pretty scary, but it has one big advantage: the psychological impact on the public. People are almost superstitious in their fear of nuclear radiation'[84]. Breivik has pointed out that the target of a sabotage mission is not necessarily the loss of human lives, stating that '(Sabotage operations are) the most efficient ways to cripple the current Western European multiculturalist regime [85] and that 'The primary purpose of sabotage missions is to cause system disruptions or contribute to gradual but devastating economic losses to the cultural Marxist regime. The most potent and efficient way of doing this is to select targets and use means that will trigger secondary reactions and effects. These secondary reactions/effects can be for example pollution/oil spills (requiring extremely expensive cleanup operations), damage on the electricity or communications net'[86]. One example of this would be the sabotaging of the Doel 4 nuclear power plant (2014), where an unidentified individual drained 65,000 litres of lubricating oil from a turbine, resulting in repair costs of more than 100 million euros[87].

Furthermore, when speaking of sabotage, it is important to highlight the insider security gap, a threat that has emerged in the past, as evidenced by the following examples:

- The lone wolf Bruce Edwards Ivins, a microbiologist at the United States Army Medical Research Institute for Infectious Diseases, and key suspect in the 2001 anthrax attacks.
- A group of insiders, whether coordinated or not, who misuse information they are privy to within a company or institution.
- A coordinated group of insiders and outsiders where the latter are individuals unrelated to the company or institution that they wish to attack or steal material or information from.

Therefore, based on the above, insiders are one of the greatest challenges for nuclear safety systems. This is because insiders are the most effective means by which a lone wolf or individual terrorist can reach their targets in nuclear terrorism, whether the goal is to damage the power supply grid, thereby creating social panic, or the theft of radioactive material. Given this potential threat, we may therefore ask ourselves the following question: Could a terrorist end up working in a nuclear power plant? NucNet director Santiago San Antonio refutes this idea, pointing out that 'in addition to the various examinations candidates have to take before working in a nuclear power plant, they also have to sit psychological and technical tests and undergo annual me-

84 See Macdonald, *op. cit.*, p. 174.

85 See Breivik, *op. cit.*, p. 965.

86 *Ibid.*, p. 966.

87 BLANCO NAVARRO, José María y ESTEBAN MORENO, Estefanía. Barack Obama, seguridad nuclear y terrorismo», Documento de Opinión IEEE, Madrid no. 84/2016, p. 9.

dical check ups'[88]. Nevertheless, Spain has also experienced its share of insider cases; for example, there was the case in October 2007 of the security guard at Juzbado fuel assembly factory, owned by Empresa Nacional de Uranio ENUSA, who managed to steal 70 enriched uranium pellets that were later found outside the security zone of the factory simply to tarnish the company's reputation.

CONCLUSIONS

We can conclude that terrorists will – inevitably – attempt to adopt radiological and nuclear tactics for the following reasons:

Firstly, because of the considerable terrorist potential that possessing nuclear or radiological weapons and being able to attack a nuclear facility affords an organisation or individual player.

Secondly, because the fear of radiation and its consequences is an emotion that is deeply rooted in the collective unconscious, and exploiting this fear is a basic principle of terrorism, i.e. employing terror as a strategy and tactic to achieve political goals.

Thirdly, because right-wing extremists and Islamic fundamentalists intend to use nuclear and radiological weapons, as we have seen from terrorist literature.

However, whether or not nuclear terrorism will spread to the realm of individual terrorism and lone wolves in the coming years is a difficult question to answer. On the one hand, the construction, supply, sale or theft of a nuclear device has not been addressed in this analysis because it is an extremely complex process for which an individual player would require a tremendous amount of contacts, funds, networks and support groups. On the other hand, we encounter the same difficulty when considering scenarios such as terrorist attacks on nuclear facilities by lone wolves by ground, water or air, which, again, would require the coordinated action of one or more organised groups. External cyber-attacks or cyber-sabotage have also been excluded from our analysis because all control systems in Spain are currently isolated from management networks.

Nevertheless, there are other scenarios where an individual player would be able to carry out a radiological terrorist attack. One such scenario would be the theft of radioactive material from civilian facilities such as hospitals or clinics and the carrying out of a subsequent attack in an urban area using conventional explosives or other dispersal methods. To date there have been five cases of lone wolves or individual terrorists attempting such a tactic. The possibility of an isolated individual attempting to carry out an attack of this magnitude in the coming years should be considered, not just because of the relative ease with which a terrorist would be able to acquire radioactive material from civilian facilities, but also because it does not require any cooperation

88 See Tobalina, *op. cit.*

or planning whatsoever with other individuals and an attack of this scale would cause mass panic[89] in society.

Another way for a lone wolf or individual terrorist to carry out a nuclear or radiological attack would be with the collaboration of an insider, as discussed previously. The insider would know the facility, staff, working hours, security measures and the different procedures, etc. A malicious individual working in a delicate area would always find it easier to carry out an attack than someone who is not on the company payroll. Nevertheless, as we have seen, the various containment and security measures in place in nuclear facilities would prevent the damage from escalating in the event of sabotage; therefore, an insider would only manage to create social alarm and media impact, though these goals are also pursued by terrorists. The scenario might be different if the individual had the assistance of an outsider and attempted a coordinated attack, though we would no longer be looking at a lone wolf or individual terrorist, but a terrorist organisation or small autonomous cell. In addition, we must highlight the pivotal role an insider could play in the theft of nuclear or radiological material, in which case an RDD or 'dirty bomb' attack, as mentioned earlier, would be the most viable route for an individual player seeking to carry out a radiological attack.

Finally, it is worth pointing out that up until now nuclear and radiological terrorism tactics by individual terrorists have mainly been confined to the U.S., considering that four of the five cases discussed in this article happened in North American and that three involved right-wing extremists. This is something that should not be ignored and it is very representative, particularly if we consider that the U.S. is the country with the largest number of lone wolves and white supremacist terrorists in the world.

Although it would be difficult for an individual player to carry out an attack of this kind, it is a possibility that should not be overlooked. A basic premise in risk analysis is to reduce the uncertainty threshold and implement security measures and engage specialised analysts. If we carry out a historiographical analysis of terrorism, we can see that, just as anarchist terrorism in the 19th century employed individual terrorism and dynamite, Islamic terrorists in the 21st century use social media and give priority to soft attacks. Therefore, we must bear in mind that a terrorist attack of a radiological or nuclear nature in the 21st century is a possibility, and that an isolated individual is more likely to carry out such an attack because of the ease with which a lone wolf can go undetected compared to a wolf pack.

89 BARNETT, Daniel J., PARKER, Cindy L., BLODGETT, David W., WIERZBA, Rachel K. and LINKS, Jonathan M. Understanding Radiologic and Nuclear Terrorism as Public Health Threats: Preparedness and Response Perspectives, The Journal of Nuclear Medicine (JNM), no. 47 (October), 2016, pp. 1655-1658.

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