THE CROSS-BORDER DETECTION OF RADIOLOGICAL, BIOLOGICAL AND CHEMICAL ACTIVE AND HARMFUL TERRORIST DEVICES

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Abstract

The cross-border detection of radiological, biological and chemical substances by border authorities is a task of tremendous importance because it prevents terrorists from smuggling 'dirty bombs' into a country in order to perpetrate attacks on world trade. Although it is easy to detect radiological devices by measuring radiation levels, biological and chemical devices pose a much greater challenge. This paper investigates the problems confronting the detection of biological and chemical weapons as well as alternative methods of detection. It also calls for a greater awareness of radiological threats by the border inspection agencies. The paper concludes with a proposal for a World Customs Organization (WCO) recommendation on improving customs authorities' awareness of radiological substances.

1. Introduction

Nuclear, biological and chemical (NBC[2]) terrorist weapons or related devices smuggled into a country by terrorists or hostile governments pose a significant and growing threat to civil societies. Covert attack is hard to deter or prevent and NBC weapons suitable for covert attacks are available to a growing range of states and groups hostile to the United States (US), European Union (EU), Australia, Canada and other countries such as Japan, Russia or India. At the same time, constraints on their use appear to be eroding (Falkenrath, Newman & Thayer 1998). Many agencies are involved in the cross-border detection of NBC devices, including customs authorities. This paper focuses on customs authorities' awareness of NBC weapons at the international level and highlights the problems inherent in their detection.

2. The dirty bomb

2.1 Function of the dirty bomb

A dirty bomb (that is, a Radiological Dispersal Device, [RDD]) disperses harmful radiological substances by means of an explosive device. The device triggers an explosion which serves to dissipate the radioactive particles within a wall of fire (King 2004, p. 35). An RDD can also be used to disperse harmful biological and chemical (B/C) substances. Accordingly, this paper defines the term 'dirty bomb' widely, to include B/C substances.

From the view of border agencies, the greatest challenge in detecting a dirty bomb is that it is very simple to construct: most of the necessary substances can be obtained within the target country itself. This means that terrorists do not necessarily have to smuggle NBC substances into the country in the first place. Customs authorities should nevertheless be aware of dangerous NBC substances because some can be detected easily (see section 4. of this paper).

2.2 Types of dirty bomb

A dirty bomb can be an active explosive device which serves to dissipate harmful NBC substances. However, they can also be non-explosive devices which are concealed in the surroundings and release harmful NBC substances into the atmosphere gradually. Both types of dirty bomb represent a 'terrorist threat' to federal and state authorities (despite the fact that the device in isolation may not be explosive or harmful).

2.3 Weapons of mass disruption

Although dirty bombs contain very harmful substances, they are not as dangerous as genuine weapons of mass destruction (WMD). These devices are also termed 'weapons of mass *disruption*' because they, most likely, will cause only minor casualties but trigger widespread panic and fear in civil societies.

2.4 Possible harmful substances carried by dirty bombs

What NBC substances are lethal and most likely to be smuggled into a country for use in a dirty bomb? There have been some educated guesses in this respect which are listed below in Table 1. However, this list should not be considered exhaustive. Some lethal new viruses have been discovered that could be used in a bio-weapon. These include the Ebola or Marburg Viruses, which have been listed by the US Center for Disease Control and Prevention (CDC).[3] The fact that both viruses have featured in the science-fiction TV series 'Re-Genesis' testifies to their widely-acknowledged ability to cause death.[4]

The following table provides an overview of known substances that could be used in the manufacture of WMD/dirty bombs.

Table 1: Lethal NBC agents that could be used in a dirty bomb

Device	**Type**[5]	**Harmful substance (Smuggling)**
Nuclear Bomb	N	Plutonium-239, Uranium-233, Uranium-235, Uranium-238
RDD Dirty Bomb	N	Americium-241, Caesium-137, Cobalt-60, Iridium-192, Polonium-210, Strontium-90
Anthrax[6]	B	Bacterium, *Bacillus anthracis*, Zoonosis[7]
Plague[8]	B	Bacterium, *Yersinia pestis*
Tularemia	B	Bacterium, pneumococcic, septic
Q-Fever	B	Bacteria, *Coxiella burnetii*, Zoonosis
Smallpox	B	Virus, *Variola major* and *Variola minor*
Botulism[9]	B	Toxin, protein produced by the bacterium *Clostridium botulinum*
Brucellosis[10]	B	Bacteria, Genus *Brucella*
Ricin	B	Toxin, extracted from the castor bean (*Ricinus communis*)
Viral Hemoragic Fever	B	Viruses, includes the *Filoviridae* (containing the Marburg and Ebola genera), and the *Arenaviridae* (for example, Lassa or Machupo)
Tabun	C	Nerve agent, a clear, colourless, and tasteless liquid with a faint fruity odour
Sarin	C	Nerve agent, a colourless, odourless liquid
VX	C	Nerve agent, an odourless and tasteless liquid with high viscosity and low volatility; VX has the texture and feel of motor oil, like motor oil

Device	Type[5]	Harmful substance (Smuggling)
Mustard gas	C	Blister agent HN1: Bis (2-chloroethyl) ethylamine HN2: Bis (2-chloroethyl) methylamine HN3: Tris (2-chloroethyl) amine Bis (2-chloroethyl) sulfide
Hydrogen cyanide	C	Blood agent, HCN, a colourless, extremely poisonous, and highly volatile liquid that has a faint, bitter, almond-like odour
Phosgene	C	Choking agent, $COCl_2$, a colourless gas, in low concentrations its odour resembles freshly cut hay or grass

Source: Simons 2002, pp. 22-23 (updated); King 2004; and www.wikipedia.org.

A related question that arises is whether these harmful substances are likely to be smuggled into countries as part of cross-border transactions between a seller and buyer.

Most sources of radiological substances suitable for use in a RDD can be found in medical institutions worldwide which often store radioactive substances for the treatment of cancer (so-called 'radiotherapy'). Even within the medical profession, there is little awareness about the dangers presented by such radiological substances (Correia et al. 2005; Picano et al. 2007). Farms, pharmaceutical companies, scientific laboratories and food processing plants also use radiological devices. The major problem presented by these users is that some of them have poor safety standards and carelessly dispose of old equipment (for example, an irrigation machine or old radiological therapy equipment) despite the fact that they may still contain radiological substances.

Since 9/11, the US has spent large sums of money in tracking down missing radioactive materials (for example, in 2002, it spent $US25 million alone). The secret services are concentrating their efforts mainly on Russia and the former states of the USSR. The International Atomic Energy Agency (IAEA) has also published data on the illicit trafficking of nuclear and radioactive material (IAEA 2006) and in 2007, held an international conference on this topic in Edinburgh, Scotland (IAEA 2008). This illicit cross-border trade in radioactive substances is highly covert and dangerous, involving terrorist groups and organised criminal networks. It demands the expertise of specialist crime-fighting agencies.

3. The dangers presented by NBC material

3.1 Dangers presented by nuclear devices

Nuclear weapons were developed at the end of the Second World War (WWII, 1939-1945) and used by the US against the Japanese cities of Hiroshima and Nagasaki. Nuclear devices emit three types of radiation (that is, α, β or γ radiation), all of which can be lethal. Depending on the dosage, radioactive substances cause radiation sickness which can quickly lead to a most painful death.

3.2 Dangers presented by biological agents

The dangers of infectious biological agents are manifold, depending on the type of germ released (for example, bacteria, fungi, worms, viruses, neurotoxins, etc.). Most germs used as bioweapons or dispersed by means of a dirty bomb will have a highly lethal effect on humans.

3.3 Dangers presented by chemical toxins

Chemical toxins are mostly gaseous substances that can cause harmful lung conditions and kill instantly. Chemical weapons were widely used during the Great War (WWI, 1914-1918) and WWII. There are

many varieties of chemical toxins and the type selected by terrorists will depend on the aim they wish to achieve. They usually take the form of liquids or gaseous substances that are both colourless and odourless.

4. A brief history of NBC smuggling and attempts by terrorists to use NBC substances

4.1 Which countries have NBC programs?

One expert puts it plain and simple: 'Nobody really knows what's out there' (Simons 2002, p. 19) and over the years there have been numerous attempts to smuggle and acquire NBC substances. In particular, those found in the former USSR are distributed over the great expanse of new states and barren landscapes which makes them difficult to detect. It has been reported that radioactive waste and even weapons of mass destruction have simply vanished from their known sources.

Table 2 below lists the countries that are known to pursue programs to manufacture weapons of mass destruction using NBC substances. There is a risk that terrorist groups will seek to obtain NBC material and disperse it by means of a dirty bomb or other device. The table does not include countries which had atomic ambitions in the past. These are: Egypt, Algeria, Argentina, Australia, Brazil, Germany (West), Iraq, Yugoslavia, Libya, Poland, Romania, Taiwan, Sweden, Switzerland, South Africa, Belarus, Kazakhstan, Ukraine. However, their programs are no longer considered a threat to world security.

Table 2: Countries with NBC capability

Country	Atomic Weapons	Biological Weapons	Chemical Weapons
US	*	-	-
Russia	*	*	*
UK	*	-	-
France	*	-	-
Israel	*	#	#
China	*	#	#
North Korea	*	?	*
India	*	-	#
Pakistan	*	-	?
Libya	-	?	*
Sudan	-	?	?
Egypt	-	?	*
Syria	-	?	*
Iran	#	#	#
Saudi Arabia	?	-	-
Brazil	?	-	-
Terrorists	#	#	#

Key: * Known, # possible, ? possible offensive research programs

Source: Simons 2002, pp. 18-19 (updated); www.wikipedia.org.

4.2 Reported use of NBC material by terrorists

The secret services of many countries may or may not know the reality of the situation in this respect. However, this research paper takes account only of reported events or attempted attacks which are listed below.[11]

1985 *Salmonella* was used by followers of Bhagwan Shree Rajneesh in The Dalles, US

1987 Possible use of X-Fever against British post offices by Ōmu Shinrikyō (so-called 'Aum' sect)

1995 Tokyo, subway attack with Sarin by Ōmu Shinrikyō (so-called 'Aum' sect)

1996 Russian separatists/terrorists in Chechenya planted a working RDD in a park in Moscow

1997 It was reported that over 1,500 radioactive devices have been stolen, lost or abandoned in the US alone. The US federal government can only account for 660 of these devices.[12]

2001 Many anthrax attacks carried out in the US on official departments and the White House by a worker of the biodefence lab, resulting in five casualties

2001 One anthrax attack in Kenya

2008 In Bangor, Maine, US an RDD was found in a dead man's home with four small containers of chemicals and uranium (Griffin 2009)

Note: It is suspected that many more incidents have occurred around the globe which have not been publicised by the authorities.

In addition, King (2004) draws attention to two reports which are a cause for concern:

- there are rumoured to be 20 missing Russian nuclear (fission) suitcase bombs
- 38 Alazan warheads are reported missing. These have been modified to carry radioactive material by the Russian government, effectively creating the world's first 'dirty bombs'.

5. Detection of NBC materials

The detection of NBC substances ranges from easy to near-impossible. The challenges facing the detection of each substance are examined below.

5.1 Detection of nuclear substances

It is relatively easy to detect radiation using active measuring devices (so-called 'Geiger counters'[13]). Passive detection devices (for example, so-called 'dosimeter' devices[14]) can measure the radiation emitted over a certain period at a certain location and are regularly worn by workers at atomic reactors.

5.2 Detection of biological substances

Controlling the cross-border importation of active biological substances by customs authorities has always formed a major part of their efforts to prevent viruses (for example, H5N1, avian influenza [H1N1], swine influenza), harmful insects (for example, *Anoplophora glabripennis*) or harmful plants from entering the customs territory. This is particularly crucial with regard to island territories (for example, Australia, New Zealand, Cuba) where the introduction of *neophytes* or *neozooes* (that is, non-native, exotic plants or animals) can have disastrous consequences for carefully balanced eco-systems. It can lead to the mass reproduction of invasive organisms and the extinction of native species.

Many invasive species have been transported to foreign territories in the ballast tanks of merchant ships. For example, water pumped into ballast tanks in the coastal areas of North America and later released

into the coastal waters of Europe or Asia. This problem has been compounded by humans, who have often introduced foreign animals in order to control unwanted biological species (for example, sheep in Australia, fish to eat other fish) thereby often doing more harm than good. The detection and control of biological organisms also has an important economic dimension since the introduction of harmful animals/plants/diseases may harm important produce (such as bananas, apples, grapes) and livestock (such as cattle, pigs, sheep). Detection of such threats is, however, far easier than the detection of relatively unknown substances: they could be any of a million possible substances. As a result, customs authorities are not in a position to easily detect harmful biological substances such as bacteria, viruses or fungi.

5.3 Detection of chemical substances

Another important task of customs authorities and other border agencies is to intercept the cross-border transport of active chemical substances in order to prevent their dispersal into the atmosphere by means of explosive devices. As with biological substances, however, detection is challenged by difficulties in identifying the target substance since there are many structurally related and equally effective chemicals (that is, the possibilities are practically endless). As a result, customs authorities are poorly positioned to intercept harmful chemical substances. However, unlike biological substances, chemical substances do contain some easily measurable indicators, for example, their acidity can be measured using a pH-meter or mass spectrometers (the latter are more important in practice).

5.4 Detection technology used by customs authorities

A most successful method used by customs authorities in order to detect illegal substances is the sniffer dog that can detect either actively or passively the presence of certain substances in luggage (for example, explosives, drugs, living or dead animals). Sniffer dogs have been trained to detect a variety of substances and could also be trained to detect others. In fact, this technique has recently been proclaimed as the 'most efficient form of "customs technology" ' by WCO Secretary General Kunio Mikuriya (WCO 2009a). However, the broad range of possible hazardous NBC substances limits the overall idea of training sniffer dogs for such substances because many of them are odourless, colourless and life threatening.

Geiger counters and wipe tests for the detection of special drugs are also widely used. However, although the latter might be effective in detecting many biological or chemical agents, there are simply too many variants to cope with. Moreover, there are no easy-to-use wipe tests available for customs authorities.

Many experts are aware of the fact that the major threat does not lie in the smuggling of relatively small NBC devices but rather in the use of ocean containers which are big enough to contain a dirty bomb and larger NBC devices. The greater dimensions of these devices present a real threat to national security. The Container Security Initiative of the US Department of Homeland Security is a measure specifically designed to prevent dirty bombs being smuggled into a country by means of ocean containers. In this regard, many US customs officers are currently working abroad in Europe and Asia to inspect container ships prior to their departure for the US.

6. NBC awareness of customs authorities

Steps should be taken at the international level to raise customs authorities' awareness of the threats presented by NBC substances. Of course, there has always been an awareness of the dangers presented by invasive species or chemical substances. However, the new variety of NBC threats presented by terrorists makes it all the more important to ensure that customs officers have in-depth knowledge of NBC threats and are provided with the necessary training and equipment to carry out their inspection activities properly.

In addition to the need to prevent terrorist attacks, international trade presents a number of hazards that demand an awareness of NBC substances. The following provides four examples of such hazards.

- Containers that have been treated with chemical wood products (in order to prevent infestation with bugs such as the Asian beetle *Anoplophora glabripennis*). Such containers can emit toxic gaseous substances which may cause severe illnesses if opened by customs officers unaware that the container emits toxic fumes.
- Radiation-emitting steel was discovered throughout Germany in 2008 during the course of random inspections. The steel was reported to have been imported from India and its radioactivity stems from the use of Cobalt-60 (Co-60). The steel industry is aware of the dangers of radiation contamination and steel producers have therefore installed Geiger counters at the entrances to their plants (*Der Spiegel* 2009; Schwägerl 2009).
- In 1987, an incident occurred in the Brazilian city of Goiânia (the so-called 'Goiânia-accident') when radioactive material was stolen from an unused hospital (the Instituto Goiano de Radioterapia). A scrap-monger extracted radioactive material from an old radiotherapy device which was then handled by members of his family and friends. Parts of the city are still radioactively polluted (IAEA 1988).
- In 2000, a radiological accident occurred in Samut Prakarn, Thailand. Here, a disused Cobalt-60 teletherapy source was stored, apparently without knowledge or permission of the regulatory authority, at an insecure outdoor premises normally used for storing new cars. Two local scrap collectors bought some scrap that included the source and took it home to dismantle and sell; the incident resulted in death, injury and widespread concern (Mac Kenzie 2006).

According to two *New Scientist* reports, there are approximately 30,000 old devices containing NBC substances stored in Europe alone, of which almost 70 go missing each year (Edwards 2002, 2004a, 2004b). Since 1993, the IAEA Illicit Tracking Database has recorded 827 confirmed cases of incidents reported by 81 IAEA Member states of either illicit trafficking or other unauthorised activities involving nuclear (224 cases) or other radioactive materials (516 cases) (IAEA 2006).

Customs officers and border control agencies should bear in mind that nuclear and radiation materials are transported in lead-shielded containers of various sizes so that suitcases or other containers which are unexpectedly heavy should indicate the need to carry out an inspection using a Geiger counter. Furthermore, the use of passive dosimeters should form a standard part of the personal safety precautions of security officers and should be regarded as essential to carry out safety and security inspections at all borders throughout the world.

7. Call for NBC awareness within the WCO

The WCO should promote NBC awareness amongst its Member states by issuing and circulating a declaration to this effect. Further, national customs authorities as well as other competent authorities, such as the IAEA, should exchange information regarding techniques and detection devices in order to develop a common standard and joint approach to combat the proliferation of NBC devices.

Some national governments are well prepared and their measures can be used as a blueprint for strategies and training programs, for example, the US CDC has a very useful homepage, 'Bioterror emergency preparedness and response.[15] The IAEA[16] has also issued the so-called 'Sealed radioactivity sources toolkit' that focuses on the long-term issues in safely and securely managing radioactive sealed sources (Mac Kenzie 2006). At a supranational level, the EU has initiated a program of radiological and bioterror awareness.[17]

The WCO and the IAEA have been cooperating to combat the illicit trafficking of radiological sources or nuclear fuel/material since May 1988 when they signed a Memorandum of Understanding (WCO

2009b). However, it is also important that the WCO Member states upgrade their detection equipment and personnel training regimes in order to appropriately protect their border control officers and combat cross-border smuggling.

8. Conclusions

It has often been the case that terrorists have successfully carried out attacks without the use of NBC substances, for example, car bombings, backpack bombings, the airplane attacks on September 11, 2001. Such threats are very real and still quite likely to occur. It is also possible to construct NBC devices using simple, everyday objects. For example, all that terrorists need to carry out an anthrax attack is an ordinary envelope. It is simply not possible to control all means of cross-border transport, for example, scanning all letters and parcels sent internationally.

It is also difficult for border control agencies to effectively monitor large frontier areas, such as the long coastlines along the US, US-Canada or Russian border. Drug traffickers use the vast stretches of these 'green' or 'blue' borders to smuggle their goods into the target country. Indeed, it has been reported that drug cartels use submarines or speedboats to transport cocaine from South America into the US. That said, the fight against drugs cannot automatically be compared with the fight against NBC trafficking (Kleimann, Reuter & Caulkins 2002). The WCO and its Member states should therefore focus their efforts on the likely means of delivery as well as the large amounts of cargo transported, for example, bulk shipments or cargo transported in containers.

UNICRI (United Nations Interregional Crime and Justice Research Institute), EUROPOL (the EU Police Agency) and the SECI Center (Southeast European Cooperative Initiative Regional Center for Combating Trans-Border Crime[18] also play an important role in combating the smuggling of NBC substances. It is widely accepted that enhancing cooperation among law enforcement authorities at national and regional level is a fundamental pre-condition of preventing the illicit use of NBC agents; broad expertise is required to effectively address these issues (WCO 2004). As such, law enforcement authorities and international organisations must establish permanent, comprehensive and efficient channels of communication, as recommended by the UN Security Council Resolutions 1373 (2001), 1456 (2003), 1540 (2004), upgrade equipment and offer sufficient training for all enforcement officers.

The US Container Security Initiative (CSI) focuses on the analysis of data 24 hours prior to the departure of a vessel. So far, this approach has proved very successful.

The US is planning to introduce 100 per cent scanning of all containers bound for the US. This proposal has sparked international controversy mainly because it promises to incur a great deal of expense owing to the cost of acquisition of new detection devices, improved harbour facilities and better trained cross-border authorities. However, it must be pointed out that Geiger counters are only capable of detecting radiological or nuclear material. It is not apparent how biological and chemical materials which may also be very harmful and hazardous are to be detected. Another important consideration regarding 100 per cent scanning is that whereas industrial countries may be in a position to upgrade their harbour facilities without too much difficulty and within a relatively short period, this is unlikely to be the case with the numerous small harbours in the third world.

A great deal of technical research is now focusing on so-called 'smart containers'. These containers are able to transmit a message via satellite, signalling when a seal has been broken or the cargo tampered with. However, there do not seem to be sufficient precautions in place to prevent NBC smuggling or attacks. Reports should therefore focus on the contents of a container rather than the seals. Placing a smart seal on a container which contains a dirty bomb will simply ensure its safe and secure delivery and nothing more.

Proposal: Introduction of a GPS black box for containers/bulk ships

Black boxes are widely used in airplanes, ships and trucks. Their purpose is to record all the parameters of a journey in order to explain the causes of any accidents that may occur.

For safety and security reasons, a smart black box should be introduced for containers that would continuously measure certain values (temperature, pressure, acidity, radiation). When a reading fluctuates rapidly/dramatically, an alarm could be triggered to indicate an immediate safety/security threat, for example, a chemical or gas leakage, or imminent explosion.

By equipping vessels carrying bulk cargo and containers with a smart detection device, the wealthy industrial countries at risk of terrorist attacks could satisfy their need for security whilst meeting the costs themselves (that is, upgrading carrier vessels and their containers using all available technical means).

Furthermore, customs officers around the world must be made aware of the dangers that NBC devices present. They must also be adequately trained, equipped with state of the art detection devices (Geiger counters) and personal security equipment (dosimeters).

Annex 1: Important symbols for dangerous goods

Biohazard

Radioactivity

New radioactivity sign of IAEA

Toxic

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Endnotes

1 The author has studied biology and life sciences at the Universities of Bremen and Glasgow and holds a BSc in molecular and cellular biology. This is privately conducted and financed research and does not comprise the official opinion of either the European Commission or Germany's Customs Service if not otherwise stated. The author would like to thank learned friends for insightful discussions, including Professor Dr Björn Poppe (Institute of Physics, Medical Physics, Universität Oldenburg, Germany) for all radiological issues; Dr Martin Glodde (IBM, NY/US) for the input on chemical aspects; Dr Olaf Kniemeyer (Leibnitz-Institut für Naturstoff-Forschung und Infektionsbiologie e.V., Hans-Knöll-Institut, Jena, Germany) for all biological issues.

2 Another common abbreviation is BCNR for biological, chemical, nuclear and radiating devices; for the purpose of this paper both abbreviations are regarded as being similar.

3 See www.bt.cdc.gov/agent/agentlist.asp.

4 See www.regenesistv.com.

5 N (Nuclear), B (Biological), C (Chemical).

6 See US Department of Health and Human Services, Division of Foodborne, Bacterial and Myotic Diseases, viewed 26 July 2009, www.cdc.gov/nczved/dfbmd/disease_listing/anthrax_gi.html.

7 Zoonosis is an illness that can transfer from animals to human beings.

8 See CDC Plague Home Page, viewed 1 August 2009, www.cdc.gov/ncidod/dvbid/plague/index.htm.

9 See US Department of Health and Human Services, Division of Foodborne, Bacterial and Myotic Diseases, viewed 1 August 2009, www.cdc.gov/nczved/dfbmd/disease_listing/botulism_gi.html.

10 See US Department of Health and Human Services, Division of Foodborne, Bacterial and Myotic Diseases, viewed 1 August 2009, www.cdc.gov/ncidod/dbmd/diseaseinfo/brucellosis_g.htm.

11 Sources include public papers, public broadcastings, King 2004, and www.wikipedia.org.

12 King 2004, p. 69.

13 Viewed 1 August 2009, http://en.wikipedia.org/wiki/Geiger_counter; a suitable Geiger counter for security personnel is FRISKY, www.gammasonics.com/frisky.html.

14 See http://en.wikipedia.org/wiki/Dosimeter, and for more detail, the German Version, viewed 1 August 2009, http://de.wikipedia.org/wiki/Dosimeter.

15 See www.bt.cdc.gov.

16 Many technical and political publications on radioactive sources are available at www.iaea.org.

17 EU Commission 2001; EU Council 2004 and 2007; EurActive 2007.

18 The SECI Center is an operational regional organisation that brings together police and customs authorities from 13 member countries in Southeast Europe. See www.secicenter.org.

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