Weapons, Means and Methods of Warfare, and New and Emerging Technologies

A Strategic Mapping for the Convention on Certain Conventional Weapons

United Nations Office for Disarmament Affairs

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Introduction

The 1980 Convention on Certain Conventional Weapons (the CCW) is a treaty of international humanitarian law (IHL) derived from, and with intrinsic links to, the 1977 Additional Protocols to the 1949 Geneva Conventions.[1] During the negotiations of the Additional Protocols, the inclusion of specific prohibitions or restrictions on the use of certain conventional weapon systems had been considered, based on reports of government expert meetings on "conventional weapons that may cause unnecessary suffering or have indiscriminate effects".[2] However, States decided not to include regulation of specific conventional weapons in the Additional Protocols, and instead recommended a separate diplomatic track within the framework of the United Nations (UN) "with a view to reaching agreements on prohibitions or restrictions on the use of specific conventional weapons", including landmines, booby-traps, incendiary weapons such as napalm, small-calibre projectiles, and certain blast and fragmentation weapons.[3] The resulting UN Diplomatic Conference adopted the CCW in 1980.[4]

As appears from its full title – the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May be Deemed to be Excessively Injurious or to have Indiscriminate Effects – the CCW builds upon long-established principles and rules of customary IHL regulating the conduct of hostilities, which are codified in the 1977 Additional Protocols and recalled in the CCW's preamble: the principle that the right of the parties to an armed conflict to choose methods or means of warfare is not unlimited; the prohibition on the use of means and methods of warfare of a nature to cause superfluous injury or unnecessary suffering; and the prohibitions on indiscriminate attacks and the use of indiscriminate weapons, derived from the principles of distinction and of the protection of the civilian population against the effects of hostilities. Echoing the "Martens Clause", the preamble of the CCW also confirms that civilians and combatants remain at all times "under the protection and authority of the principles of international law derived from… the principles of humanity and the dictates of public conscience".

While these general principles and rules of IHL – which are inherently underpinned by a balance between humanitarian considerations and military necessity[5] – govern the use of all weapons, means and methods of combat in armed conflict, the CCW's role is to impose specific prohibitions or restrictions on the use of certain

1 See UNODA, *Implementation Guide for the Convention on Certain Conventional Weapons (CCW)* (Geneva: UNODA, 2025), section 1.2.1, pp. 23-24, and R. J. Mathews, "The 1980 Convention on Certain Conventional Weapons: A useful framework despite earlier disappointments", *International Review of the Red Cross* (2001), vol. 83, no. 844, pp. 992-996.

2 These expert meetings had been convened by the International Committee of the Red Cross (the ICRC) at the request of the Diplomatic Conference on the Reaffirmation and Development of International Humanitarian Law Applicable in Armed Conflict, the body in which States were negotiating the Additional Protocols. See ICRC, Conference of Government Experts on the Reaffirmation and Development of International Humanitarian Law Applicable in Armed Conflict (Second Session 3 May – 3 June 1972): Report of the Work of the Conference Volume II (Geneva: ICRC, 1972), Proposal CE/SPF/2, p. 115.

3 Resolution 22 (IV) Follow-up regarding prohibition or restriction of use of certain conventional weapons, Fifty-seventh plenary meeting, 9 June 1977, in *Official Records of the Diplomatic Conference on the Reaffirmation and Development of International Humanitarian Law Applicable in Armed Conflict (1974-1977)* (Bern: Federal Political Department, 1978) vol. I, part 2, pp. 215-216.

4 The United Nations Conference on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May be Deemed to be Excessively Injurious or to have Indiscriminate Effects was mandated by UN General Assembly (UNGA) resolutions 32/152 (19 December 1977) and 33/70 (14 December 1978). See also Report of the Preparatory Conference, A/CONF.95/3 (25 May 1979) and Report of the Conference to the General Assembly, A/CONF.95/8 (8 October 1979). The Conference adopted the CCW on 10 October 1980: see Final Act of the Conference in Annex I, Final Report of the Conference to the General Assembly, A/CONF.95/15 (27 October 1980).

5 ICRC, *The Principles of Humanity and Necessity* (Geneva: ICRC, 2023).

4

conventional weapons about which there is widespread humanitarian concern.[6] Designed as a framework convention – that is, a treaty that sets out principles, objectives and general provisions for its operation, and leaves the regulation of specific weapons to its protocols – the CCW is intended as "a dynamic instrument that can respond to advancements in weapons technology and take into account developments in the nature and conduct of armed conflict",[7] bearing in mind, in the words of its preamble, "the need to continue the codification and progressive development of the rules of international law applicable in armed conflict".

The CCW has demonstrated its dynamism through the addition of new protocols and amendments that have strengthened the Convention. When it was adopted in 1980, the CCW contained three protocols, respectively prohibiting the use of any weapon the primary effect of which is to injure by fragments not detectable by X-ray (1980 Protocol I), regulating the use of mines, booby-traps and other explosive devices (1980 Protocol II), and restricting the use of incendiary weapons (1980 Protocol III). Fifteen years later, at the CCW's First Review Conference, High Contracting Parties (HCPs) adopted a new protocol prohibiting the use and transfer of blinding laser weapons, in anticipation of the development and deployment of these inhumane weapons (1995 Protocol IV). They also amended Protocol II to strengthen its rules on landmines, booby-traps and other devices in response to their increasingly devastating impacts on civilians (1996 Amended Protocol II). In 2001, the Second Review Conference amended the Convention to extend its application to non-international armed conflicts, recognising that most conflicts were of this nature. Two years later, HCPs adopted a new protocol to deal with the threats to civilians posed by explosive remnants of war (2003 Protocol V).

Alongside these successful efforts to strengthen the CCW, HCPs have continued to debate a number of issues that had been raised at the CCW's conception but had not resulted in specific restrictions or prohibitions under the CCW. They have also regularly raised new concerns about developments in weapons, means or methods of warfare of relevance to the CCW, including new military applications of science and technology. The present study maps these key weapons issues raised by HCPs in the context of the CCW, as well as new weapon systems, technologies and emerging issues with relevance to the CCW that have featured in the UN Secretary-General's annual reports on developments in science and technology.[8] The study provides a comprehensive but not exhaustive overview of the most salient issues.

Outside the scope of this mapping study are weapon systems falling within the scope of the CCW's five Protocols (referred to above), weapons initially raised in the CCW and later addressed by other treaties, such as anti-personnel mines and cluster munitions,[9] and weapons currently being addressed in a dedicated process within the CCW, such as lethal autonomous weapon systems (LAWS).

6 ICRC, *Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May be Deemed to be Excessively Injurious or to have Indiscriminate Effects, Text with amendments and Protocols adopted through 28 November 2003* (Geneva: ICRC, 2004), Foreword of President Jakob Kellenberger, p. 6.

7 Ibid., p.7.

8 UN Secretary-General has submitted a report on *Current developments in science and technology and their potential impact on international security and disarmament efforts* to the General Assembly every year since 2018, with the exception of 2021. The 2026 report was issued on 21 July 2026 (A/81/246).

9 Both anti-personnel landmines and cluster munitions have been comprehensively prohibited by, respectively, the 1997 Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction and the 2008 Convention on Cluster Munitions.

This mapping study seeks to inform HCPs' deliberations in the lead-up to and beyond the Seventh Review Conference in November 2026, by providing a factual overview of relevant developments. As such, it is intended to support the consideration of emerging issues relating to "the continued relevance, integrity and adequacy" of the CCW, acknowledging its key role "in monitoring ongoing and new developments in weapons, means and methods of war that may be deemed to be excessively injurious or to have indiscriminate effects, and in related science and technology".[10]

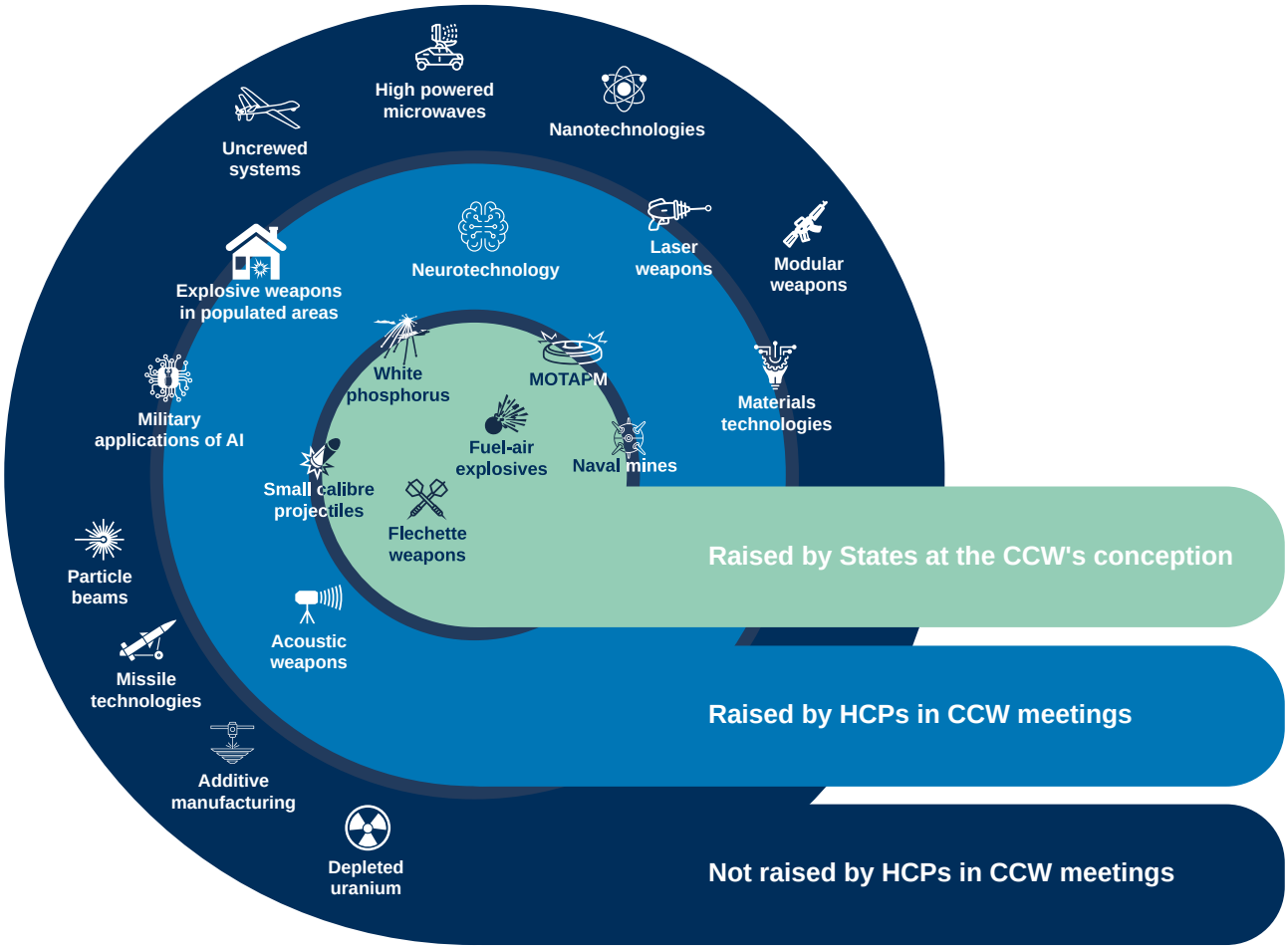
Note on methodology: Applying the parameters set out above, the conventional weapons, means or methods of warfare, and new and emerging technologies, included in this study were identified by reviewing the reports and records of the meetings and conferences related to the negotiation and adoption of the CCW and those of the CCW Review Conferences and Meetings of HCPs. The annual reports of the UN Secretary-General on developments in science and technology and other relevant reports of the Secretary-General were also reviewed. Authoritative secondary sources were also consulted.

Each of the sections in this mapping study focuses on a specific weapon, means or method of warfare and examines three elements in particular:

- A succinct **summary description** of the weapon system, including its development, damage and injury mechanisms, and intended purposes. The descriptions are not meant to provide extensive technical specifications or operational characteristics.
- The **humanitarian and IHL concerns** raised by the effects of the weapon, and their relevance to the CCW, in particular concerns regarding the protection of civilians from the potential indiscriminate effects of the weapon, and/or the protection of combatants from potential excessive injury caused by the weapon.
- The **context** in which concerns about the weapon were raised by States – be it at the conception of the CCW, in the CCW meetings, and/or in other relevant fora – including any proposals made by States to regulate the weapon system through restrictions or prohibitions on its use.

[10] Final Document of the Fifth Review Conference of the High Contracting Parties to the CCW, CCW/CONF.V/10 (23 December 2016), Final Declaration, p. 5.

Weapons, Means and Methods of Warfare, and New and Emerging Technologies: A Strategic Mapping for the Convention on Certain Conventional Weapons (CCW)



1. Small-calibre projectiles

Summary description

As of the 1960s, military requirements for lighter personal weapons for infantry drove the development of new technologies in small-calibre weapon systems, and in particular in small-calibre ammunition – generally understood as bullets of 12.7 mm and less in diameter. This led to the appearance of rifle bullets of smaller calibre and higher velocity that were said to have a tendency "to tumble and become deformed in the body" and to cause wounds that "may resemble dum-dum bullets", although experts disagreed on the factors accounting for the severity of the wounds.[11]

Separately, in the 1980s, a 12.7 mm multipurpose bullet containing explosive and incendiary material was designed for "increased effectiveness" against materiel targets such as helicopters, aircraft, and light armoured vehicles. It could be fired from a wide range of platforms, including a new generation of sniper rifles, which could increase the risk of its use against personnel (human targets). The bullet was said to explode on impact with both hard and soft (human) targets.[12]

HUMANITARIAN AND IHL CONCERNS

☐ Protection of civilians from indiscriminate effects

☑ Protection of combatants from excessive injury

States that expressed concerns in the CCW about small-calibre projectiles causing excessively large wounds referred to the IHL prohibition on weapons, means or methods of warfare of a nature to cause superfluous injury or unnecessary suffering. There were different views on whether the small-calibre projectiles under consideration fell under the specific prohibitions on expanding (or "dum-dum") bullets or of the anti-personnel use of exploding bullets. These projectiles are prohibited by, respectively, the 1899 Hague Declaration and the 1868 St. Petersburg Declaration, as well as by customary IHL.[13]

11 *Weapons that may Cause Unnecessary Suffering or have Indiscriminate Effects: Report on the Work of Experts* (Geneva: ICRC, 1973) (hereafter *Report of the Work of Experts 1973*), pp. 30-38, and in particular para. 112.

12 "Ensuring respect for the 1868 St. Petersburg Declaration prohibiting the use of certain explosive projectiles – International Committee of the Red Cross", CCW/CONFII/PC.3/WP.6 (18 September 2001), pp. 3-4.

13 Declaration Renouncing the Use, in Time of War, of Certain Explosive Projectiles (St. Petersburg, 11 December 1868) and Declaration (IV,3) concerning Expanding Bullets (The Hague, 29 July 1899). On the customary nature of these prohibitions, see J.-M. Henckaerts and L. Doswald-Beck, *Customary International Humanitarian Law - Volume I* (Cambridge University Press, 2005), pp. 244-250, Rules 77 and 78. Customary international law is described in the Statute of the International Court of Justice, Article 38(1)(b) as a general practice of States accepted as law, and is legally binding on all States.

CONTEXT

- ● Raised by States at the CCW's conception
- ● Raised by HCPs in CCW meetings
- ○ Not raised by HCPs in CCW meetings

Small calibre projectiles were extensively discussed during the governmental expert meetings at the at the conception of the CCW.[14] During the UN Diplomatic Conference that led to the adoption of the CCW, a group of States proposed a draft protocol that would have prohibited certain bullets that deform, break easily or tumble rapidly in the human body.[15] Instead, the Diplomatic Conference adopted a resolution inviting governments to carry out further research and testing of small-calibre weapon systems.[16] At the First Review Conference (1995-1996), a HCP put forward a new proposal for a Draft Protocol on Small Calibre Weapon Systems,[17] based on the understanding that "bullet construction is only one of the factors which lead to large wounds" and "the legality of a bullet should be determined by its pattern of energy deposit and not necessarily by its construction".[18] A decision on the proposed new Protocol was deferred to the Second Review Conference (2001), which invited "interested States Parties to consider possible issues related to small calibre weapons and ammunition" and report on their work.[19] In 2002, the Meeting of the HCPs invited States to continue informal meetings at expert level.[20]

Regarding exploding bullets, the Second Review Conference invited States to consider the report of the ICRC on "Ensuring respect for the 1868 St. Petersburg Declaration prohibiting the use of certain explosive projectiles" and to "take appropriate action".[21]

14 See e.g. *Conference of Government Experts on the Use of Certain Conventional Weapons (Lugano 28 January– 26 February 1976): Report* (Geneva: ICRC, 1976) (hereafter *Lugano Conference Report 1976*), pp. 13-16, 61-69, 116-118.

15 *Conference of Government Experts on the Use of Certain Conventional Weapons (Lucerne 24 September – 18 October 1974): Report* (Geneva: ICRC, 1975) (hereafter *Lucerne Conference Report 1975*), p. 46, para. 149. The proposed draft protocol was resubmitted by 16 States at the Lugano Conference in 1976: see E. Prokosch, "The Swiss draft Protocol on Small-Calibre Weapon Systems - Bringing the dumdum ban (1899) up to date", *International Review of the Red Cross* (1995), vol. 35, no. 307, p. 416.

16 Resolution on Small Calibre Weapon Systems, adopted by the Conference at its seventh plenary meeting on 23 September 1979, in Final Report of the Conference to the General Assembly, A/CONF.95/15 (27 October 1980), Annex I, Appendix E, p. 18.

17 CCW/CONF.I/GE/16 (11 August 1994).

18 R. Coupland and D. Loye, "The 1899 Hague Declaration concerning Expanding Bullets A treaty effective for more than 100 years faces complex contemporary issues", *International Review of the Red Cross* (2003), vol. 85, no. 849, pp. 138-139.

19 Final Document of the Second Review Conference of the States Parties to the CCW, CCW/CONF.II/2 (Geneva, 2001), p. 13.

20 Report of the Meeting of the States Parties to the CCW, CCW/MSP/2002/2 (20 December 2002), p. 2.

21 Final Document of the Second Review Conference of the States Parties to the CCW, Final Declaration, p. 9. The ICRC report had expressed concerns and made recommendations regarding "the proliferation in parallel of 12.7 mm multipurpose bullets (projectiles) which explode in human soft tissue simulants and of 12.7 mm sniper rifles capable of firing such bullets": "Ensuring respect for the 1868 St. Petersburg Declaration", p. 1.

2. Delayed-action weapons

At the time of the CCW's conception in the 1970s, extensive discussions were held in the governmental expert meetings on "delayed-action weapons", described as "time-fused or target-activated explosive devices",[22] and also referred to as "time-delay" or "treacherous" weapons. They encompassed landmines, booby-traps, and **naval mines** (addressed in subsection 2.1). Discussions referred to the "indiscriminate tendencies" of these weapons and measures to mitigate them.

At the UN Diplomatic Conference negotiating the CCW (1979-1980), deliberations focused on mines and booby-traps. It adopted Protocol II, later amended in 1996, which restricted the use of anti-personnel mines without prohibiting them and contained basic restrictions on the use of **mines other than anti-personnel mines**, which later became a major area of work in the CCW (addressed in subsection 2.2). Anti-personnel mines were comprehensively prohibited outside the CCW by the 1997 Anti-personnel Mine Ban Convention.

Two decades prior to the conception of the CCW, "delayed-action weapons" had been described in the ICRC's Draft Rules for the Limitation of the Dangers incurred by the Civilian Population in Time of War (1956), as weapons whose harmful effects "could spread to an unforeseen degree or escape, either in space or in time, from the control of those who employ them, thus endangering the civilian population".[23]

2.1 Naval mines

Summary description

Naval mine technology has undergone considerable advances over the last century. Also referred to as "sea-mines", naval mines have been defined as "an explosive device laid in the water, on the seabed, or in the subsoil thereof, with the intention of damaging or sinking ships or deterring shipping from entering a sea area".[24] They are typically "target-activated", either by direct contact with a vessel, or when magnetic, acoustic, or pressure sensors, or a combination thereof, are triggered.

Naval mines include: moored mines which are anchored to the sea bed and detonate on contact with a vessel; drifting or floating mines, that move with currents or prevailing weather conditions; "bottom mines", described as "technologically advanced mines that rest on the sea bed and operate on the basis of magnetic, electric, acoustic or pressure signatures of passing vessels" and which "are designed to be armed or disarmed remotely and can be programmed to self-destruct"; and "rising or rocket mines", described as "high-technology mines moored to the bottom of the sea bed", which can be employed at

22 *Report of the Work of Experts 1973*, p. 49, para. 153.

23 ICRC, *Draft Rules for the Limitation of the Dangers incurred by the Civilian Population in Time of War* (Geneva: ICRC, 1956), Article 14. At the same time, Article 15 proposed that if landmines were to be used, measures to minimize their impact on civilians must be taken, such as "charting the minefields" and equipping landmines "with a safety device which renders them harmless when they escape from the control of those who employ them". The Draft Rules were submitted to the XIXth International Conference of the Red Cross and Red Crescent in New Delhi in 1957, which took note of them.

24 Article 2 of the Draft Protocol on Naval Mines, document CCW/CONF.I/GE/12 (9 August 1994) submitted to the First Review Conference of the States Parties to the CCW. See also Chatham House, *International Law Applicable to Naval Mines - International Security Department Workshop Summary* (October 2014), p. 3.

great depths and are usually designed for use against submarines.[25] Naval mines have long formed part of naval operations and continue to be employed in contemporary armed conflicts.

HUMANITARIAN AND IHL CONCERNS

- ☑ Protection of civilians from indiscriminate effects
- ☐ Protection of combatants from excessive injury

There have long been concerns about the indiscriminate effects of naval mines, notably on civilian shipping. The 1907 Hague Convention, which contains basic restrictions on the use of automatic contact mines, especially those that are unanchored, is the only treaty applying specifically to naval mines.[26] It does not apply to more technologically-advanced mines, the use of which remains regulated by the principles and rules of customary IHL, including the prohibitions on indiscriminate attacks and indiscriminate weapons.

CONTEXT

- ● Raised by States at the CCW's conception
- ● Raised by HCPs in CCW meetings
- ○ Not raised by HCPs in CCW meetings

In the governmental expert meetings at the conception of the CCW, naval mines were dealt with cursorily compared to other "delayed-action" weapons,[27] then excluded altogether from the work of the final meeting, which focused on landmines and booby-traps. At the First Review Conference (1995-1996), a HCP submitted a proposal for a new protocol on naval mines,[28] which was meant to update the 1907 Hague Convention, also to take into account technological developments such as sensor-fusing. The restrictions on the use of naval mines proposed in the draft protocol included the prohibition on drifting mines which do not become harmless after one hour and the introduction of a compulsory neutralisation mechanism. However, some criticized the draft for being weaker than existing international law, notably with regard to clearance responsibilities after active hostilities.[29] The First Review Conference deferred consideration of "the question of eventual further measures in relation to naval mines" to the next review conference,[30] which did not address it.

25 Chatham House, *International Law Applicable to Naval Mines*, p. 3.

26 Convention (VIII) relative to the Laying of Automatic Submarine Contact Mines (The Hague, 18 October 1907) is considered to have acquired the status of customary international law: see Chatham House, *International Law Applicable to Naval Mines*, p. 5. For a restatement of international law applicable to armed conflicts at sea, including the relevant rules of customary IHL, see *San Remo Manual on International Law Applicable to Armed Conflicts at Sea* (International Institute of Humanitarian Law, 12 June 1994). On naval mines and international law, see also D. Letts, "Naval mines: Legal considerations in armed conflict and peacetime", *International Review of the Red Cross* (2016), vol. 98, no. 2, pp. 543-565.

27 *Lucerne Conference Report 1975*, pp. 64-65.

28 CCW/CONF.I/GE/12. Another HCP had also made a proposal for a new protocol on naval mines: CCW/CONF.I/GE/CRP.30 (not accessible at time of writing).

29 As reported in ICRC, "The rationale for considering other proposals relating to the Convention and to its existing or future Protocols", p.19.

30 Final Document of the First Review Conference of the States Parties to the CCW (Part I), CCW/CONF.I/16, Annex C, Final Declaration, p. 38.

2.2 Mines other than anti-personnel mines

Summary description

The term "mines other than anti-personnel mines" (MOTAPM) is employed in the context of Amended Protocol II (1996) to refer to anti-vehicle mines. Unlike anti-personnel mines, which are specifically defined in Article 2(3), the Protocol does not contain a definition of anti-vehicle mines. Instead, they are encompassed by the general definition of a "mine" in Article 2(1), meaning "a munition placed under, on or near the ground or other surface area and designed to be exploded by the presence, proximity or contact of a person or vehicle".

Under Amended Protocol II, anti-vehicle mines must comply with the restrictions applying to all mines, including the requirements related to remotely-delivered mines, recording of information concerning minefields and mined areas, and clearance of minefields and mined areas. However, unlike anti-personnel mines, the Protocol does not prohibit the use of non-detectable anti-vehicle mines nor does it require anti-vehicle mines to have self-destruct or self-deactivating mechanisms when used outside perimeter-marked and monitored areas. Key developments in anti-vehicle systems have included the use of sensor technologies which may contribute to reducing their indiscriminate effects.

HUMANITARIAN AND IHL CONCERNS

- ☑ Protection of civilians from indiscriminate effects
- ☐ Protection of combatants from excessive injury

The adverse impacts of anti-vehicle mines on civilians are well-documented. Data on anti-vehicle mines indicates a majority of casualties are civilians, and their presence hinders the ability of humanitarian organisations to deliver assistance, the return of displaced civilians, the cultivation of lands, and post-conflict reconstruction.[31] Some but not all of the indiscriminate effects of anti-vehicle mines can be mitigated by applying the restrictions of Amended Protocol II, but these have long been considered insufficient to address the risks they pose to civilians.

CONTEXT

- ● Raised by States at the CCW's conception
- ● Raised by HCPs in CCW meetings
- ○ Not raised by HCPs in CCW meetings

From early on in the CCW through recent years, there have been consistent calls from HCPs to strengthen the rules on anti-vehicle mines to better protect civilians. At the Second Review Conference (2001), two HCPs proposed a new protocol that would have prohibited the use of non-detectable MOTAPM and of remotely-delivered MOTAPM without self-destruct or self-deactivation mechanisms. While this proposal did not achieve consensus, HCPs agreed to establish a Group of Governmental Experts to further explore the

[31] See e.g. GICHD and SIPRI, *Global Mapping and Analysis of Anti-Vehicle Mine Incidents in 2018* (Geneva and Stockholm: 2019), and ICRC, "Views and Recommendations for the Sixth Review Conference of the CCW", CCW/CONF.VI/WP.1 (20 December 2021), para. 15.

issue of MOTAPM, with the support of a Group of Military and Technical Experts. Substantive work on MOTAPM was carried out in the context of the GGE in 2002-2006.[32]

At the Third Review Conference (2006), the Coordinator on MOTAPM submitted a report that included a "Compilation of Provisions" on MOTAPM that "could command consensus" as well as Technical Annexes, while indicating that the two "most controversial issues" on which there was no agreement remained "detectability" and "active life".[33] Groups of HCPs made four separate "Declarations on Anti-Vehicle Mines", including one by 26 States which committed each of their governments to take steps to adopt "as a matter of national policy" practices on detectability, active life (self-destruct and self-neutralization mechanisms), and transfer restrictions.[34]

HCPs continued to exchange views under dedicated agenda items on MOTAPM at every Meetings of the HCPs from 2007 to 2017, including in 2012 at a three-day open-ended meeting of experts on IHL implementation in relation to MOTAPM. In 2018, the Chairperson of the Meeting of the HCPs held informal consultations on the modalities and format of future discussions on MOTAPM, but differences in views could not be resolved. Further consultations were later undertaken "on possibilities to include discussions on good practices in the implementation of" Amended Protocol II with regard to MOTAPM "in particular with regard to the protection of civilians". The Sixth Review Conference (2021) noted that that divergences in views remained.[35]

32 See background paper "Mines other than anti-personnel mines (MOTAPM) – Submitted by the CCW Implementation Support Unit at the request of the President", CCW/CONF.IV/MC.I/INF.1 (16 November 2011).

33 "Report of the Work in 2006 on Mines Other than Anti-personnel Mines", prepared by the Coordinator on MOTAPM and the Chairperson of the Meetings of Military Experts, CCW/CONF.III/7/Add.2 (13 October 2006), para. 4. A HCP proposed an alternative draft to the Coordinator's Compilation of Provisions, in a working paper entitled "An integrated approach to efforts to ensure a more effective protection of civilians from MOTAPM", CCW/CONF.III/WP.6 (9 November 2006).

34 Final Document of the Third Review Conference of the High Contracting Parties to the CCW (Part III) (Geneva, 7-17 November 2026), CCW/CONF.III/11, pp. 36-37.

35 Final Document of the Sixth Review Conference of the High Contracting Parties to the CCW, CCW/CONF.VI/11 (27 April 2022), Final Declaration, p. 13, para. 83.

3. Blast and fragmentation weapons

Blast and fragmentation weapons – another term for explosive weapons – were extensively discussed in the governmental expert meetings at the conception of the CCW, including their military applications – both antimateriel and anti-personnel – and their medical effects. The weapon systems under scrutiny ranged from general purpose bombs, rocket and missile warheads and mortar and artillery shells, to **flechettes** (subsection 3.1) and **fuel-air explosives** (subsection 3.2), as well as cluster bombs.[36] It was noted that blast and fragmentation effects are displayed to varying degrees by all explosive munitions, which can be envisaged on a spectrum "between weapons that maximize blast, such as the fuel-air explosive devices, and weapons that maximize fragmentation, such as the multiple-fléchette projectiles". In the middle of the spectrum are weapons such as general-purpose bombs, which damage both through blast and fragmentation.[37] The governmental expert meetings also discussed "area weapons" and the area effects of blast and fragmentation weapons in terms of their "indiscriminateness", foreshadowing the CCW's future discussions on **explosive weapons in populated areas** (subsection 3.3).

3.1 Flechette weapons

Summary description

A flechette is defined as "a small dart-shaped projectile that is clustered in an explosive warhead, dropped as a missile from an airplane, or fired from a handheld gun".[38] Flechette weapons are designed for maximum fragmentation and primarily for anti-personnel use. Flechettes are most commonly used in lieu of fragments in explosive munitions. The munition ejects at high velocity several thousand (depending on the calibre of the projectile) three- to four-centimetre-long metal arrows or needles, dispersing the flechettes over an area. Dispersal patterns are of conical shape and can reach several hundred meters long. They are thus useful for targeting infantry units or small groups of combatants, but not for precisely targeting individuals. They were first employed in World War I, and later in the Vietnam War. Their use in contemporary armed conflicts continues to be reported, although not as frequently as before.[39]

HUMANITARIAN AND IHL CONCERNS	☐ Protection of civilians from indiscriminate effects	☑ Protection of combatants from excessive injury

Anti-personnel flechette weapons have long been controversial. During the governmental expert meetings at the conception of the CCW, concerns were raised mainly in terms of superfluous injury and unnecessary suffering to combatants. For example, it was said that the "victims suffer multiple injuries with the high degree of pain and suffering characteristic of such injuries", increasing "the difficulty of medical treatment".

[36] Cluster munitions would later become an area of work in the CCW, notably in the Group of Governmental Experts established by the Third Review Conference (2006). As explained in the Introduction, cluster munitions are not included in this mapping study, having been comprehensively banned in 2008 by the Convention on Cluster Munitions.

[37] *Report of the Work of Experts 1973*, p. 39, para. 113.

[38] Merriam-Webster Dictionary (online edition), "flechette".

[39] See I. Kinder and M. Čolić, "On (Im)Permissibility of Flechette Anti-Personnel Weapons – A Historical Overview", *Review of International, European and Comparative Law*, vol. XXII (2024), pp. 15-16 and 20-22.

It was also noted that when "the fléchettes hit a person at high velocity they bend or break at impact and the wounds resulting are aggravated by the high velocity effect." [40] Although some experts noted that "from the point of view of medical effects, fléchettes could be regarded as producing wounds similar, in general, to other fragmentation wounds",[41] other studies found that "the use of flechette weapons is more likely to result in permanent disability or death for the victim compared to other types of conventional anti-personnel weapons that cause fragmentation."[42] The risk of indiscriminate effects of flechette weapons has also been expressed in view of its area effects, as when they are used against a target located in a populated area.[43]

CONTEXT

- ● Raised by States at the CCW's conception
- ○ Raised by HCPs in CCW meetings
- ○ Not raised by HCPs in CCW meetings

Flechettes were singled out for discussion at the conception of the CCW during the governmental expert meetings. At the 1976 Lugano Conference, a group of thirteen States called for a prohibition on the use of munitions "which act through the release of a number of projectiles in the form of fléchettes, needles and similar" projectiles,[44] and this call was again made during the CCW negotiation conference, however agreement could not be reached.[45]

3.2 Fuel-air explosives

Summary description

Fuel-air explosives, alongside thermobaric and enhanced blast explosives, are part of a class of weapon called "volumetric weapons", sometimes referred to as "vacuum bombs", which operate on similar technical principles.[46] Weapons in this class use oxygen from the air to create a high-temperature explosion. They are the "purest blast munitions", designed to maximize blast effects, and generating more destruction than conventional explosives.[47] They generally consist of a munition filled with fuel that is dispersed into the air across the target area by an initiating charge, creating a cloud of aerosolized fuel that detonates moments later. "The result is a massive fireball that produces an especially powerful blast wave" that includes a pronounced negative pressure phase during which all of the oxygen in the blast area is consumed by the

40 *Lugano Conference Report 1976*, pp. 70, 72, and 204-205.

41 *Lucerne Conference Report 1975*, p. 59, para. 209.

42 I. Kinder and M. Čolić, "On (Im)Permissibility of Flechette Anti-Personnel Weapons", at p. 25.

43 Ibid., at pp. 15-16 and 33.

44 *Lugano Conference Report 1976*, pp. 199 & 205.

45 See Report of the Preparatory Conference for the United Nations Conference on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May be Deemed to be Excessively Injurious or to Have Indiscriminate Effects, A/CONF.95/3 (25 May 1979), Annex I, p. 6, and Final Report of the Conference to the General Assembly, A/CONF.95/15 (27 October 1980), p. 7, para. 23.

46 L. Türker, "Thermobaric and Enhanced Blast Explosives (TBX and EBX)", *Defence Technology*, vol. 12, no. 6 (2016), pp. 1. Since the technical differences between fuel-air explosives, thermobaric weapons, and enhanced blast munitions are small, they are often used interchangeably: see ibid., p. 2, and T. R. DeGhett, "A New Kind of Bomb is Being Used in Syria and It's A Humanitarian Nightmare", *Vice* (August 18, 2015).

47 *Report of the Work of Experts 1973*, p. 39, para. 113.

explosion, creating the vacuum effect.[48] Fuel-air explosives have been used to clear minefields containing pressure-sensitive mines, and "for use against military objectives located in buildings and hard or deeply buried subterranean structures", as well as for anti-personnel purposes.[49]

Due to their significant thermal effects, fuel-air explosives and thermobaric weapons have been described as "analogous to incendiary weapons".[50] However, their primary damage mechanism is enhanced blast, and as such, they are not considered incendiary weapons within the meaning of CCW Protocol III.[51]

HUMANITARIAN AND IHL CONCERNS

- ☑ Protection of civilians from indiscriminate effects
- ☑ Protection of combatants from excessive injury

Concerns about the effects of fuel-air explosives and other types of volumetric weapons have been expressed in terms of protecting combatants from excessive suffering and civilians from indiscriminate harm. During the governmental expert meetings at the conception of the CCW, it was noted that these weapons could produce "extremely severe" injuries that are difficult to treat "and, indeed, utterly inhumane effects".[52] Contemporary literature observes that thermobaric weapons are "highly destructive to human bodies, and their use increases the quantity and severity of injuries to which humans are normally exposed with conventional explosive weapons". Their lethal effects "are often related to the bronchial trauma caused by the negative pressure."[53] Personnel close to the ignition point are likely to be crushed or obliterated, while those further away will potentially suffer ruptured organs due to the blast pressure. Fuel-air explosives can generate casualties that overwhelm military medical systems, and can inflict devastating civilian harm when used against targets in populated areas.[54]

CONTEXT

- ● Raised by States at the CCW's conception
- ○ Raised by HCPs in CCW meetings
- ○ Not raised by HCPs in CCW meetings

Fuel-air explosives were singled out for discussion during the governmental expert meetings at the conception of the CCW. At the 1976 Lugano Conference, two proposals called for prohibiting, respectively, the "anti-

48 Maj. M. Montazolli, "Are Thermobaric Weapons Lawful?", *Articles of War* (online journal), (West Point: Lieber Institute, March 23, 2022).

49 A. van Coller, "Detonating the air: The legality of the use of thermobaric weapons under international humanitarian law", *International Review of the Red Cross* (2023), vol. 105, no. 923, p. 1124.

50 UNODA, *The Regulation of Incendiary Weapons under International Humanitarian Law* (Geneva: UNODA, 2024), pp. 8 and 21.

51 Article 1(b)(ii) of CCW Protocol III on Prohibitions or Restrictions on the Use of Incendiary Weapons excludes from the Protocol's scope "combined-effect munitions in which the incendiary effect is not specifically designed to cause burn injury to persons, but to be used against military objectives…".

52 *Lugano Conference Report 1976*, p. 19, para. 51.

53 A. van Coller, "Detonating the air", pp. 1132 and 1126.

54 Maj. M. Montazolli, "Are Thermobaric Weapons Lawful?". At the Lugano Conference, one expert stated that "if used over wide areas where civilians might be found, fuel-air explosives might well become weapons of mass destruction": *Lugano Conference Report 1976*, Ninth Meeting, General Debate on Blast and Fragmentation Weapons, p. 75, para. 10. See also in the same report: Report of Plenary Meeting Proceedings, p. 19, para. 51.

personnel use of weapons which for their effects rely exclusively on shock waves in the air" and the detonation for military purposes of "gas-air and dust-air mixtures which release gas pressure".[55] Similar proposals were made during the CCW negotiation conference, however agreement could not be reached.[56] While there have not been discussions dedicated specifically to fuel-air explosives in the CCW, fuel-air explosives have appeared in CCW discussions on incendiary weapons and on explosive weapons in populated areas.

3.3 Explosive weapons in populated areas

Summary description

Weapon systems deliver explosive munitions through a range of different platforms and mechanisms, including: indirect fire weapons, such as artillery, rockets and mortars; weapons designed to fire multiple munitions in salvos, such as multiple-launch rocket systems; large air-dropped bombs; and surface-to-surface ballistic missiles. Such systems variously involve munitions with a large blast and fragmentation radius, inaccurate delivery mechanisms, or the delivery of multiple munitions over a wide area. Many of the weapon systems in question were originally designed for use in open battlefields, but due to the growing urbanisation of armed conflict, they have increasingly been used in populated areas (also referred to as areas where there are concentrations of civilians).[57]

HUMANITARIAN AND IHL CONCERNS

- ☑ Protection of civilians from indiscriminate effects
- ☐ Protection of combatants from excessive injury

In considering blast and fragmentation weapons with a wide "area coverage", the governmental expert meetings at the CCW's conception noted that "area weapons have an obvious and uncontrollable tendency towards indiscriminateness, although in this regard much, but not all, depends upon the manner and circumstances in which the weapons are used."[58] In particular, on the question of "indiscriminateness", it was reported that "in circumstances where combatants and noncombatants are sufficiently close to one another, area weapons will inevitably be less discriminate than point weapons, regardless either of the accuracy with which they are delivered or of the diligence of the user in attempting to avoid injury to noncombatants."[59] In the CCW, the HCPs that have raised concerns about the use of explosive weapons in populated areas have referred to the propensity of these weapons to cause significant civilian casualties and other humanitarian impacts, including their reverberating effects on civilian infrastructure and essential

55 *Lugano Conference Report 1976*, pp. 167 and 182.

56 Report of the Preparatory Conference for the United Nations Conference on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May be Deemed to be Excessively Injurious or to Have Indiscriminate Effects, A/CONF.95/3 (25 May 1979), Annex I, pp. 1-2. See also Final Report of the Conference to the General Assembly, A/CONF.95/15 (27 October 1980), p. 7, para. 23.

57 See UNODA, Explosive Weapons in Populated Areas. A populated area is generally understood as a permanent or temporary concentration of civilians and/or civilian objects.

58 *Report of the Work of Experts 1973*, p. 48, para. 150. In the discussions on blast and fragmentation weapons, the size of the explosive charge or the firing of a large number of (even small) projectiles in rapid succession were seen as relevant to characterising the weapon as an area weapon: ibid., p. 39, para. 114.

59 Ibid., p. 24, para. 57.

services. They have also invoked the need to strengthen respect for IHL rules aimed at protecting civilians against the indiscriminate effects of weapons, means and methods of warfare.[60]

CONTEXT

- Raised by States at the CCW's conception
- Raised by HCPs in CCW meetings
- Not raised by HCPs in CCW meetings

During the governmental expert meetings at the conception of the CCW, the potential "indiscriminateness" of "area weapons" was discussed *inter alia* in the context of debates on blast and fragmentation weapons.[61] The Fourth Review Conference (2011) of the CCW acknowledged "the foreseeable effects of… explosive weapons on civilian populations as a factor to be considered in applying" IHL rules.[62] From 2012 onwards, the annual Meetings of the HCPs, and at the Fifth (2016) and Sixth (2021) Review Conferences, HCPs raised concerns about the use of explosive weapons in populated areas or "in areas where there are concentrations of civilians".[63] At the 2017, 2018 and 2019 Meetings of the HCPs in particular, the use of explosive weapons in populated areas was raised by HCPs in discussions on "other matters" and "emerging issues" and in working papers.[64]

Outside the CCW, the *Political Declaration on Strengthening the Protection of Civilians from the Humanitarian Consequences Arising from the Use of Explosive Weapons in Populated Areas* was negotiated in a process outside the CCW from 2019 to 2021 and adopted in Dublin on 18 November 2022, with over 90 States having endorsed it since.[65] The *Pact for the Future*, adopted by consensus by the General Assembly on 22 September 2024 , committed Member States to "restrict or refrain from, as appropriate, the use of explosive weapons in populated areas when their use may be expected to cause harm to civilians or civilian objects, including essential civilian infrastructure, schools, medical facilities and places of worship, in accordance with international law".[66]

60 See Final Reports of the 2012, 2013, 2014 and 2015 Meetings of the High Contracting Parties, at respectively CCW/MSP/2012/9, para. 25, CCW/MSP/2013/10, para. 17 CCW/MSP/2014/9, para 22, and CCW/MSP/2015/9, para. 21, which "noted the concerns raised by some [HCPs] regarding the implementation of existing [IHL], in particular the use of explosive weapons in populated areas". See also the working papers related to explosive weapons in populated areas submitted by HCPs at the 2017, 2018 and 2019 Meetings of the High Contracting Parties.

61 *Report of the Work of Experts 1973*, p. 48, para. 150. See also *Lucerne Conference Report 1975*, p. 62, para. 215.

62 Final Document of the Fourth Review Conference of the High Contracting Parties to the CCW (Part II) (Geneva, 14-25 November 2011) (Advance Version), Final Declaration, tenth preambular paragraph. In his opening remarks to the Review Conference, the Secretary-General "noted with increasing alarm the use of explosive weapons in populated areas, leading to profound suffering among civilian populations": CCW/CONF.IV/SR.1 (18 June 2012), p. 5, para. 28.

63 See Final Document of the Fifth Review Conference of the High Contracting Parties to the CCW (2016), Final Declaration, p. 7, para. 10, and p. 10, Decision 5, and Final Document of the Sixth Review Conference of the High Contracting Parties to the CCW (2021), Final Declaration, p. 7, para. 11.

64 Final Report of the 2017 Meeting of the High Contracting Parties, CCW/MSP/2017/8 (11 December 2017), paras. 16 & 25, Final Report of the 2018 Meeting of the High Contracting Parties, CCW/MSP/2018/11 (28 December 2018), paras. 21, and Final Report of the 2019 Meeting of the High Contracting Parties, CCW/MSP/2019/9 (13 December 2019), paras. 20 & 21.

65 The text of the Political Declaration and list of endorsing States can be found at UNODA, The Political Declaration.

66 Action 14 of the Pact for the Future, adopted by UNGA resolution A/RES/79/1 (22 September 2024).

4. Missile technologies

Summary description

Missiles can be differentiated by their launch location (i.e. land, sea, and air platforms), their target (e.g. air, ground, ship etc.), their payload (e.g. conventional or nuclear-armed) and their propulsion or flight mode (e.g. ballistic or cruise missiles).[67] Missile technologies singled out by the UN Secretary-General in his annual reports on developments in science and technology include ballistic missiles and artillery rockets, hypersonic missiles (hypersonic glide vehicles or powered hypersonic vehicles), and anti-missile and terrestrial anti-satellite systems. Technological innovations, notably in the area of precision guidance, have increased the accuracy of ballistic missiles and artillery rocket systems, leading to their increased use as long-range strike weapons in ongoing armed conflicts. Developments in science and technology have also enabled the development and testing of large-calibre artillery rocket systems.[68]

HUMANITARIAN AND IHL CONCERNS

- ☑ Protection of civilians from indiscriminate effects
- ☐ Protection of combatants from excessive injury

Concerns about missile technologies have traditionally been framed mainly, but not exclusively, in terms of the challenges they pose to "strategic stability" or their role as means of delivering weapons of mass destruction (WMD). In terms of humanitarian and IHL concerns, missiles in general are noted as having a historical record of indiscriminate use, and ballistic missiles in particular are being used more frequently in contemporary armed conflicts.[69] Ballistic missiles, artillery rockets, and hypersonic vehicles delivering conventional munitions give rise to concerns due to the risk of indiscriminate effects in populated areas (see subsection 3.3). As for anti-satellite missile systems, they may also lead to indiscriminate effects if used, for example, to disable or destroy satellites that have civilian functions supporting essential services on Earth.[70]

67 UNODA, Missiles.

68 See Current developments in science and technology and their potential impact on international security and disarmament efforts – Report of the Secretary-General, A/80/237 (22 July 2025), paras. 39-46, and A/81/246 (21 July 2026). The Secretary-General has issued such report annually since 2018. Hereafter, each such report will be referred to as "Report of the Secretary-General on developments in science and technology", preceded by the year of issue.

69 UNODA, Missiles.

70 See e.g. ICRC, "The Potential Human Cost of the Use of Weapons in Outer Space and the Protection Afforded by International Humanitarian Law - Position paper submitted to the Secretary-General of the United Nations on the issues outlined in General Assembly Resolution 75/36" (8 April 2021).

CONTEXT

○ Raised by States at the CCW's conception

● Raised by HCPs in CCW meetings

○ Not raised by HCPs in CCW meetings

At the 2018 Meeting of the HCPs, "advanced missile and missile-defence technologies" were referred to in a working paper submitted by HCPs[71] by reference to the 2018 Report of the Secretary-General on developments in science and technology.

Outside the CCW, at the General Assembly, three panels of governmental experts on missile technologies were established between 2001 and 2008, and it remains on the agenda of the First Committee, though focused on concerns related to "strategic stability" and non-proliferation of WMD-related technologies. Non-proliferation concerns also underpin two non-binding intergovernmental arrangements: the 1987 Missile Technology Control Regime, and the 2002 Hague Code of Conduct against Ballistic Missile Proliferation. As for the issue of terrestrial anti-satellite weapons, it has been raised in various UN bodies on outer space security, including the Open-Ended Working Group on the Prevention of an Arms Race in Outer Space. In 2022, the General Assembly called upon all States to commit not to conduct destructive direct-ascent anti-satellite missile tests.[72]

71 CCW/MSP/2018/WP.2 (20 November 2018).

72 2025 and 2026 Reports of the Secretary-General on developments in science and technology, at respectively, paras. 47-49 and 58-61.

5. White phosphorus

Summary description

White phosphorus is waxy solid substance that ignites spontaneously upon contact with oxygen and "continues to burn until it is fully oxidized or until deprived of oxygen", producing "a dense, white, irritating smoke containing mixed phosphorus oxides".[73] It has been used since World War I both as an incendiary agent and for creating smoke screens and smoke signals.[74] Munitions used to deliver white phosphorus include grenades and artillery and mortar shells. While white phosphorus is commonly used as an illuminant or obscurant, it is also employed by armed forces for its incendiary properties, both against personnel and objects.[75] However, it is considered to be excluded from the scope of CCW Protocol III "because its primary design is not to set fire to objects or to cause burn injury to persons, but rather to serve as an illuminant, smoke or signalling system".[76]

HUMANITARIAN AND IHL CONCERNS

- ☑ Protection of civilians from indiscriminate effects
- ☑ Protection of combatants from excessive injury

Concerns with the nature and severity of the wounds caused by exposure to white phosphorus were expressed during the government expert meetings at the conception of the CCW.[77] More recently, the World Health Organisation has stated that white phosphorus is "harmful to humans by all routes of exposure". Dermal exposure can cause severe deep burns which result from a combination of thermal and chemical injuries, and which can penetrate even through bone and are extremely painful and slow to heal. White phosphorus sticks to surfaces like skin and clothing and is difficult to extinguish once ignited. Furthermore, particles of white phosphorus that have penetrated the skin, for example as shrapnel, can re-ignite during or after initial treatment when in contact with oxygen. In addition, the smoke from burning phosphorus is harmful to the eyes and respiratory tract as phosphorus oxides dissolve in moisture to form phosphoric acids, among other toxic effects.[78]

Due to the particular severity of the wounds it causes and the difficulty in treating them, white phosphorus has raised concerns under the prohibition on weapons of a nature to cause superfluous injury or unnecessary suffering, with at least one State having instructed its armed forces not to use it directly against personnel.[79]

73 WHO, White phosphorus (15 January 2024).

74 *Report of the Work of Experts 1973*, p. 56, paras. 188 and 201.

75 UNODA, *The Regulation of Incendiary Weapons under International Humanitarian Law*, p. 6.

76 Ibid., p.21. Article 1 of CCW Protocol III defines "incendiary weapons" as "any weapon or munition which is primarily designed to set fire to objects or to cause burn injury to persons through the action of flame, heat, or combination thereof, produced by a chemical reaction of a substance delivered on the target." Specific examples given in Article 1, paragraph (a) include flame throwers, shells, rockets, grenades and bombs as containers of incendiary substances (e.g. napalm). Article 1, paragraph (b)(i) excludes from the scope of the definition "munitions which may have incidental incendiary effects, such as illuminants, tracers, smoke or signalling systems".

77 See e.g. *Report of the Work of Experts 1973*, p. 63, para. 218.

78 See WHO, White phosphorus, 15 January 2024.

79 UNODA, *The Regulation of Incendiary Weapons under International Humanitarian Law*, p. 10.

Concerns have also been raised in terms of its potential indiscriminate effects when used in populated areas, as when fires are caused by burning white phosphorus and spread.[80]

CONTEXT

- ● Raised by States at the CCW's conception
- ● Raised by HCPs in CCW meetings
- ○ Not raised by HCPs in CCW meetings

In the context of discussions on incendiary weapons during the governmental expert meetings at the CCW's conception, concerns were expressed about the effects of white phosphorus munitions, whether used specifically for incendiary purposes or as smoke or signalling systems.[81] At the Fourth Review Conference (2011) and the 2012 Meeting of the HCPs, some HCPs raised concerns "about the offensive use of white phosphorus against civilians", but there was no agreement to pursue further discussions on this matter.[82] White phosphorus has subsequently continued to arise in CCW discussions on incendiary weapons, primarily in the context of debates on the scope and application of Protocol III. Outside the CCW, there have been calls to ban the use of white phosphorus as an obscurant or smokescreen, due to the severe burns that it causes and its toxic properties.[83]

80 See e.g. "Views and Recommendations for the Sixth Review Conference of the Convention on Certain Conventional Weapons - Submitted by the International Committee of the Red Cross", CCW/CONF.VI/WP.1 (20 December 2021), paras. 19-20.

81 *Report of the Work of Experts 1973*, pp. 56-58, and *Lucerne Conference Report 1975*, pp. 16-17.

82 Final Document of the Fourth Review Conference (Part II) (Advance Version), p. 10, Final Report of the Meeting of the High Contracting Parties to the CCW, CCW/MSP/2012/9 (30 November 2012), para. 24. The issue was raised again at the Fifth and Sixth Review Conferences, and at the 2017, 2018, and 2019 Meetings of the High Contracting Parties in similar terms. See e.g. Final Report of the 2019 Meeting of the High Contracting Parties, para. 24, noting that "a number of delegations raised concerns over the recent growing number of reports of the use of incendiary weapons against civilians and condemned any use of incendiary weapons against civilians or civilian objects, and any other use incompatible with the relevant rules of [IHL], including the provisions of Protocol III where applicable. While some delegations called for the reinstatement of a specific agenda item on Protocol III, some other delegations were of the view that there is no need to include the item on Protocol III on the agenda."

83 UNODA, *The Regulation of Incendiary Weapons under International Humanitarian Law*, p. 7.

6. Uncrewed systems

Summary description

Uncrewed systems – commonly referred to as "drones" - are employed in the aerial, ground, maritime and space domains. They can be armed or unarmed. Armed systems are typically fitted with explosive munitions. They can be piloted remotely, semi-autonomously or autonomously. The use of uncrewed aerial systems in and outside armed conflicts is widespread. Applications include military surveillance and reconnaissance, target acquisition and strike operations. The use of electronic warfare as a countermeasure against uncrewed aerial systems is driving the increased integration of AI into these systems in order to reduce reliance on potentially vulnerable communication links. There is a trend towards creating improvised uncrewed aerial systems by modifying commercial systems or by manufacturing certain components, including through additive manufacturing (see section 11.2). There is also a trend towards converting uncrewed aerial systems into loitering munitions, that is, systems that combine the characteristics of uncrewed aerial systems and missiles, whereby the system itself is used as the weapon. The development and use of uncrewed maritime systems are increasing. They can be operated on the surface of or underwater, to conduct surveillance and reconnaissance, as well as mine countermeasures and offensive actions.[84]

HUMANITARIAN AND IHL CONCERNS

- ☑ Protection of civilians from indiscriminate effects
- ☐ Protection of combatants from excessive injury

While questions about armed uncrewed systems have been framed mainly in terms of the need to increase transparency, accountability and oversight and to prevent their proliferation to unauthorised recipients,[85] the use of these systems in armed conflict to direct attacks against civilians and critical infrastructure, or otherwise to strike targets in populated areas, "continues to raise concerns regarding the protection of civilians and compliance with" IHL.[86] In addition, semi-autonomous and autonomous armed uncrewed systems, and AI-enabled armed uncrewed systems, raise similar ethical and legal challenges (see also section 7).

[84] The description of uncrewed systems is based on the 2025 Report of the Secretary-General on developments in science and technology, paras. 12-15. See also the 2026 Report of the Secretary-General on developments in science and technology, paras. 13-15.

[85] See ibid. and UNODA, *Securing our Common Future, An Agenda for Disarmament* (New York: UNODA, 2018), pp. 38 & 40.

[86] 2025 and 2026 Reports of the Secretary-General on developments in science and technology, paras. 12 and 13, respectively.

CONTEXT

○ Raised by States at the CCW's conception

● Raised by HCPs in CCW meetings

○ Not raised by HCPs in CCW meetings

Uncrewed systems have featured in every annual report of the UN Secretary-General on developments in science and technology, as well as in the Secretary-General's Agenda for Disarmament (2018)[87] and New Agenda for Peace (2023).[88] Uncrewed systems with autonomy in critical functions have been discussed in meetings of the CCW Group of Governmental Experts on Lethal Autonomous Weapon Systems.

Outside the CCW, work on uncrewed systems has focused on preventing their proliferation to unauthorised recipients, and on transparency and responsible transfers.[89] Other efforts have included a joint statement in 2024 on increasing multilateral exchanges of views regarding armed UAVs, endorsed by 21 States.[90]

87 UNODA, *Securing our Common Future*, pp. 38 & 40.

88 United Nations, *A New Agenda for Peace, Our Common Agenda Policy Brief 9* (July 2023), p. 5.

89 See 2025 and 2026 Reports of the Secretary-General on developments in science and technology, paras. 16-17, and UNODA, Armed uncrewed systems.

90 Joint Statement on increasing multilateral exchanges of views regarding armed Uncrewed Aerial Vehicles (22 March 2024). In addition, the UN Disarmament Commission discussed UAVs in 2024 in the context of deliberations under the agenda item "Recommendations on common understandings related to emerging technologies in the context of international security": see UN Disarmament Commission, Working Group II Chair's summary (18 April 2024), para. 12.

7. Artificial intelligence

Summary description

Artificial intelligence (AI) can be applied in a broad range of weapon systems and weapon-related functions. Some States have already tested or fielded AI-enabled systems such as "uncrewed systems capable of autonomous navigation; coordinated mobility and swarming systems;" and "systems that collect, sort and analyse intelligence, surveillance and reconnaissance data".[91] The incorporation of AI into a weapon system could also enable its autonomy.[92] AI and autonomy are related but distinct concepts: AI may enable autonomous functions, while not all autonomous systems incorporate AI to execute particular tasks.[93]

HUMANITARIAN AND IHL CONCERNS

- ☑ Protection of civilians from indiscriminate effects
- ☐ Protection of combatants from excessive injury

Based on the views of Member States, the Secretary-General, in his 2025 report on AI in the military domain, noted that "the use of AI could lead to indiscriminate use of force", and raised issues regarding "the protection of civilians and civilian infrastructure", "the potential to increase the intensity and lethality of conflicts for combatants", and "responsibility and accountability in the case of illegal or wrongful acts".[94] Moreover, as noted by HCPs, military applications of AI in weapon systems can lead to the loss of human control over weapon systems and the use of force, raising ethical and legal concerns, notably in terms of compliance with IHL and the prevention of indiscriminate effects.

CONTEXT

- ○ Raised by States at the CCW's conception
- ● Raised by HCPs in CCW meetings
- ○ Not raised by HCPs in CCW meetings

In the CCW, the Group of Governmental Experts on Lethal Autonomous Weapons Systems (GGE on LAWS) has discussed autonomy in weapon systems, including systems enabled by AI. Outside the GGE on LAWS, legal and ethical concerns about the military applications of AI, including the potential application of machine learning and generative AI in weapon systems, have been raised in working papers submitted by HCPs at the Sixth Review Conference (2021) and at the 2022 and 2024 Meetings of the HCPs.[95]

91 2025 Report of the Secretary-General on developments in science and technology, para. 6.

92 2024 Report of the Secretary-General on developments in science and technology, A/79/224 (23 July 2024), para. 74.

93 UNODA, Lethal Autonomous Weapon Systems.

94 Artificial intelligence in the military domain and its implications for international peace and security - Report of the Secretary-General, A/80/78 (5 June 2025), para. 21.

95 CCW/CONF.VI/WP.2 (20 December 2021), CCW/MSP/2022/WP.1 (16 November 2022), CCW/MSP/2024/WP.10 (15 November 2024), CCW/MSP/2024/WP.38 (20 November 2024), CCW/MSP/2024/WP.28 (20 November 2024).

Outside the CCW, in 2024 and 2025, the General Assembly adopted resolutions on *Artificial intelligence in the military domain and its implications for international peace and security*,[96] which establish a broad framework covering the application of AI throughout its life cycle, including weapons, means and methods of warfare and systems supporting military operations. They also affirm that international law, including the UN Charter, IHL and international human rights law, applies throughout that life cycle, and recognise the humanitarian, legal, security, technological and ethical dimensions of military AI, including its implications for the protection of civilians and civilian objects.[97] Outside the United Nations, States and other stakeholders met at three summits on Responsible AI in the Military Domain (REAIM) in 2023, 2024 and 2026, each of which concluded with a political declarations.[98]

96 A/RES/79/239 (31 December 2024) and A/RES/80/58 (5 December 2025), respectively.

97 The militarization of AI was also discussed in the Disarmament Commission in 2024 and 2025, under agenda item "Recommendations on common understandings related to emerging technologies in the context of international security": see UN Disarmament Commission, Working Group II Chair's summary (18 April 2024), para. 12.

98 At each of the three REAIM summits, political declarations were opened for endorsement by States: a Political Declaration on Responsible Military Use of Artificial Intelligence (AI) and Autonomy (2023), a Blueprint for Action (2024), and a Declaration on Pathways to Action (2026).

8. Directed energy weapons

Directed energy weapons are a specific category of electromagnetic technologies, which are defined as weapon technologies "that use electromagnetic energy to achieve their primary mode of effect or to propel projectiles". Directed energy weapons "are electromagnetic systems capable of focusing radiated energy on a target, resulting in physical damage".[99] "Directed energy" was identified as a possible area of work in a working paper submitted by a HCP to the 2024 and 2025 Meetings of the HCPs.[100]

Three main types of weapon systems fall in the category of directed energy weapons, each of which is at a different level of technological maturity: weapon systems that direct laser beams at a target, including low- and high-power lasers; weapon systems that direct microwaves and millimetre-waves at a target; and weapon systems that direct particle beams at a target.[101]

8.1 Laser systems

Summary description

There are different types of laser systems, of which low-powered laser systems have been in use for decades, notably for range finding or target designation. They can also be used to "dazzle" or blind the optical sensors of surveillance satellites,[102] and in an anti-personnel capacity to dazzle or "temporarily" blind human targets. Anti-personnel laser systems designed to cause permanent blindness to unenhanced vision were studied and developed in the 1980s, before being prohibited in 1995 by Protocol IV on Blinding Laser Weapons.[103]

High-power laser systems, which are beginning to reach technological maturity, are of interest for their disruptive or destructive physical effects on equipment, notably in air and missile defence applications, and for their low "cost per shot".[104] In particular, the UN Secretary-General has reported that "States have successfully tested terrestrial-based lasers against aerial targets and are developing such systems for use against uncrewed aerial vehicles, rockets, missiles and incoming munitions."[105] In addition, space-based lasers are being studied and tested, including for communications purposes.[106]

99 2025 Report of the Secretary-General on developments in science and technology, para. 59. In addition to directed energy weapons, electromagnetic technologies include electronic warfare and electromagnetically-propelled weapons, which are not covered by this mapping study.

100 CCW/MSP/2024/WP.35 (25 November 2024) and CCW/MSP/2025/WP.4 (21 November 2025).

101 2025 Report of the Secretary-General on developments in science and technology, para. 62. See also S. Grand-Clément, Directed Energy Weapons: A New Look at an 'Old' Technology, UNIDIR (12 May 2022), and Article 36, "Directed Energy Weapons, Discussion paper for the CCW" (Geneva, November 2017).

102 2020 Report of the Secretary-General on developments in science and technology, A/75/221 (23 July 2020), para. 61.

103 Article 1 of Protocol IV of the CCW prohibits the use of "laser weapons specifically designed, as their sole combat function or a one of their combat functions, to cause permanent blindness to unenhanced vision, that is to the naked eye or to the eye with corrective eyesight devices."

104 See S. Grand-Clément, Directed Energy Weapons: A New Look at an 'Old' Technology, and Article 36, "Directed Energy Weapons", p. 2.

105 2024 Report of the Secretary-General on developments in science and technology, para. 63.

106 2025 Report of the Secretary-General on developments in science and technology, para. 53, and 2026 Report of the Secretary-General on developments in science and technology, paras. 53 & 56.

HUMANITARIAN AND IHL CONCERNS

- ☑ Protection of civilians from indiscriminate effects
- ☑ Protection of combatants from excessive injury

The blinding effects of dazzling lasers could raise concerns under the IHL prohibition on superfluous injury or unnecessary suffering to combatants. Anti-materiel high-power laser systems used to disrupt or destroy satellites that have civilian functions may lead to indiscriminate effects.[107]

CONTEXT

- ● Raised by States at the CCW's conception
- ● Raised by HCPs in CCW meetings
- ○ Not raised by HCPs in CCW meetings

In the governmental expert meetings at the CCW's conception, laser weapons were characterised as "future weapons". Concerns focused mainly on lasers used "in an anti-personnel capacity", especially those causing ocular injury that could lead to partial or total blindness, foreshadowing the adoption of Protocol IV on Blinding Laser Weapons at the CCW's First Review Conference in 1995. Concerns were also expressed about the incidental anti-personnel effects of low-powered lasers that have primarily anti-materiel purposes, due to their capacity to damage the human eye at long range.[108] The Second Review Conference (2001) recognised "the importance of keeping the blinding effects related to the use of laser systems under consideration, taking into account scientific and technological developments".[109] At the Third Review Conference (2006), working papers submitted by HCPs proposed a mandate to study feasible precautions that could be taken to improve the design of military laser systems in order to avoid the incidence of permanent blindness to unenhanced vision.[110] The Fifth (2016) and Sixth Review Conferences (2021) reminded parties to CCW Protocol IV of their obligation under Article 2 to take all feasible precautions in the use of laser systems to avoid the incidence of permanent blindness to unenhanced vision.[111]

Outside the CCW, the implications of space lasers and other directed energy weapons have been discussed in the context of various UN processes on outer space, such as the Open-Ended Working Group on Further Practical Measures for the Prevention of an Arms Race in Outer Space.[112]

107 See e.g. ICRC, "The Potential Human Cost of the Use of Weapons in Outer Space and the Protection Afforded by International Humanitarian Law".

108 See *Report of the Work of Experts 1973*, pp. 67-69, paras. 235-242, *Lucerne Conference Report 1975*, pp. 73-74, para. 261-262, and *Lugano Conference Report 1976*, pp. 19 & 81.

109 Final Document of the Second Review Conference of the States Parties to the CCW, p. 11.

110 CCW/CONF.III/WP.2 (25 October 2006).

111 Final Document of the Fifth Review Conference, para. 73, and Final Document of the Sixth Review Conference, para. 91.

112 2026 Report of the Secretary-General on developments in science and technology, para. 68.

8.2 High-power microwave and millimetre wave systems

Summary description

Sometimes described as "radio-frequency systems", high-power microwave and millimetre-wave systems are already in operational use. Attacks using high-power microwaves directed at equipment can degrade and damage electronics, from smartphones and motors to command posts, and as such can be used to counter threats from uncrewed aerial systems. Such attacks can be difficult to attribute. High-power millimetre waves beamed at human targets produce a burning sensation on the skin. Also called "active denial systems", they can be used as "less-lethal" anti-personnel weapons for perimeter security and crowd control.[113]

HUMANITARIAN AND IHL CONCERNS

- ☐ Protection of civilians from indiscriminate effects
- ☑ Protection of combatants from excessive injury

Millimetre waves used as anti-personnel "active denial" (or area denial) systems in combat could raise concerns mainly under the prohibition on superfluous injury or unnecessary suffering to combatants. They also raise questions under international human rights law restrictions on the use of weapons in law enforcement, e.g. when used for civilian crowd control.

CONTEXT

- ● Raised by States at the CCW's conception
- ○ Raised by HCPs in CCW meetings
- ○ Not raised by HCPs in CCW meetings

The governmental expert meetings at the CCW's conception discussed "microwave devices", including those using "high frequency microwave radiation", singled out for concern due to their ability to "burn the skin" and damage the eye "resulting in impairment or loss of vision".[114] In his annual reports on developments in science and technology, the UN Secretary-General has mentioned high-power microwave and millimetre-wave systems as a type of directed energy weapon of military interest.[115]

[113] See S. Grand-Clément, Directed Energy Weapons: A New Look at an 'Old' Technology, and Article 36, "Directed Energy Weapons", pp. 2-3.

[114] *Lucerne Conference Report 1975*, p. 74, paras. 263-264.

[115] See e.g. 2025 Report of the Secretary-General on developments in science and technology, para.62.

8.3 Particle beam systems

Summary description

Particle beam systems "fire atomic or sub-atomic particles at a target with the aim of disrupting or destroying that target's molecular or atomic structure".[116] They would emit either charged or neutral particles, the latter being of particular interest as they could be used outside the atmosphere. Particle beam systems are the least mature of the three types of directed energy systems.[117]

HUMANITARIAN AND IHL CONCERNS

- ☑ Protection of civilians from indiscriminate effects
- ☐ Protection of combatants from excessive injury

As with high-power laser systems, particle beam systems used to disrupt or destroy satellites would raise concerns about their potential indiscriminate effects.

CONTEXT

- ○ Raised by States at the CCW's conception
- ○ Raised by HCPs in CCW meetings
- ● Not raised by HCPs in CCW meetings

In his annual reports on developments in science and technology, the UN Secretary-General has mentioned particle beams as a type of directed energy weapon of military interest, without elaborating further.[118]

[116] Article 36, *Directed Energy Weapons, Discussion paper for the CCW*, supra, p.3.

[117] See S. Grand-Clément, Directed Energy Weapons: A New Look at an 'Old' Technology, supra.

[118] See e.g. 2026 Report of the Secretary-General on developments in science and technology, para. 65.

9. Acoustic weapons

Summary description

Acoustic weapons aim to use the propagation of sound to affect a target. Most are based on either ultrasound, low frequencies or infrasound.[119] Acoustic devices are often branded as "non-lethal" or "less-lethal" and designed primarily for law enforcement operations. Those in use include:

- Acoustic hailing devices (AHD) or 'sound cannons', the best-known of which is the Long-Range Acoustic Device (LRAD). AHDs are used in both military and law enforcement settings, primarily for crowd and border control. They can reportedly produce "pain-inducing tones", and "can damage the human ear and even cause permanent hearing loss over short distances."
- Flash-bang devices, such as "stun grenades", "sound bombs" and "flash-bang grenades", which "are in widespread use by military and law enforcement and are designed to temporarily blind, disorient and cause dizziness."[120]

HUMANITARIAN AND IHL CONCERNS

- ☑ Protection of civilians from indiscriminate effects
- ☑ Protection of combatants from excessive injury

The harmful effects produced by acoustic devices include, most notably, "temporary and permanent hearing loss, as well as pain, disorientation, sensations of discomfort and nausea".[121] Used as a means or method of warfare against combatants, acoustic weapons could raise concerns under the IHL prohibition on superfluous injury or unnecessary suffering. In addition, there may be challenges in limiting the effects of acoustic weapons to the target, especially at long ranges or in built-up areas, thereby exposing civilians to potential indiscriminate effects and raising concerns under the IHL prohibition one indiscriminate attacks.[122]

CONTEXT

- ● Raised by States at the CCW's conception
- ● Raised by HCPs in CCW meetings
- ○ Not raised by HCPs in CCW meetings

The governmental expert meetings at the CCW's conception discussed "infrasound devices". It was noted at the time "that the military application of infrasound would be impeded by the size of the necessary generators and by the difficulties of directing the sound discriminately at an enemy in an area occupied by other people as well".[123] At the 2024 and 2025 Meetings of the HCPs, working papers on emerging issues submitted by a HCP identified "acoustics" among the areas that may be relevant to the work of the CCW.[124]

119 Ultrasound refers to frequencies above 20 kilohertz, low frequencies to those below 100 hertz, and infrasound to those below 20 hertz. See Article 36, "Acoustic Weapons, Discussion paper for the CCW" (Geneva, November 2018), p. 1.

120 Ibid., p. 2.

121 It is important to note that "the physiological and psychological effects of sound on humans depend not only on frequency, but also on sound pressure levels, duration and number of exposures and recovery time between exposures": Article 36, "Acoustic Weapons", p. 3.

122 Ibid., pp. 3-4.

123 *Lucerne Conference Report 1975*, pp. 74-75, paras. 265-266.

124 CCW/MSP/2024/WP.35 (25 November 2024) and CCW/MSP/2025/WP.4 (21 November 2025).

10. Neurotechnology

Summary description

Neurotechnology "includes tools that measure, infer and influence nervous system activity, as well as mental states, whether through direct interaction with the nervous system (both invasive and non-invasive) or by interfacing it with devices and systems."[125] It encompasses technologies that are being applied in the medical field (e.g. brain-computer interfaces that allow people with paralysis to control prosthetics)[126] and in commercial applications (e.g. smartwatches that track heart rate, sleep or activity levels and immersive entertainment). Although military research in neurotechnology is in very early stages, "it is a rapidly evolving domain that is attracting growing attention and investment".[127] Military research is currently "exploring ways to enhance soldiers' cognitive, sensory and physical capabilities, including through direct brain-machine interfacing with uncrewed systems".[128]

HUMANITARIAN AND IHL CONCERNS

- ☐ Protection of civilians from indiscriminate effects
- ☑ Protection of combatants from excessive injury

The potential military uses of neurotechnology raises complex ethical and legal challenges, some of which are similar to those posed by the militarisation of AI (see section 7). They include the risk of losing human control over weapon systems due to the integration of humans and machines, which blurs the distinction "between human judgment and machine input in military decision-making" and accelerates the time for decision-making, thereby reducing "space for cognitive human input and control".[129] This loss or alteration of human judgment puts IHL compliance into question and complicates the attribution of responsibility, among other legal challenges. Another concern relates to the long-term psychological and physical effects of neurotechnologies on soldiers,[130] which may raise significant legal and ethical concerns, particularly in relation to their human rights.

CONTEXT

- ○ Raised by States at the CCW's conception
- ● Raised by HCPs in CCW meetings
- ○ Not raised by HCPs in CCW meetings

125 UNESCO, *Recommendation on the Ethics of Neurotechnology – Adopted on 11 November 2025* (Paris: UNESCO, 2026), Section I, paras. 2-3.

126 Opening statement of UNIDIR Director to Innovations Dialogue 2025: Neurotechnologies and their implications for international peace and security (November 2025).

127 F. Mantellassi & E. Madziwa, *Neurotechnology in the Military Domain: a Primer* (Geneva: UNIDIR, 2025), pp. 6-7 and 11-12.

128 UNIDIR, Innovations Dialogue 2025: Neurotechnologies and their implications for international peace and security.

129 F. Mantellassi & E. Madziwa, *Neurotechnology in the Military Domain: a Primer*, p. 18.

130 Ibid, pp. 18, 22-23.

At the Fifth Review Conference (2016) and the 2024 and 2025 Meetings of the HCPs, working papers submitted by HCPs identified neurotechnology as a possible area of work for CCW HCPs in the medium to long term.[131]

Outside the CCW, in his New Agenda for Peace, the UN Secretary-General recommended that States develop "measures to address the risks involved in biotechnology and human enhancement technologies applied in the military domain".[132] In November 2025, at the 43rd Session of its General Conference, UNESCO adopted Recommendations on the Ethics of Neurotechnology, described as a "standard-setting instrument" and focused on civilian applications.[133]

131 CCW/CONF.V/WP.4 (5 December 2016), CCW/MSP/2024/WP.35 (25 November 2024), and CCW/MSP/2025/WP.4 (21 November 2025).

132 *A New Agenda for Peace - Our Common Agenda Policy Brief 9*, p. 29. In particular, for States party to the Biological Weapons Convention and the Chemical Weapons Convention, the Secretary-General recommended that they "explore the potential implications of advances in neurobiology and related converging technologies for the respective governance regimes."

133 UNESCO, *Recommendation on the Ethics of Neurotechnology – Adopted on 11 November 2025*.

11. Materials technologies

Materials technologies encompass new and novel design and production methods, including those using non-traditional materials. They are "enabling" technologies that can be used in a broad range of contexts, including for weapon systems and weapon-related functions.

At the Fifth Review Conference (2016) and the 2018 and 2025 Meetings of the HCPs, working papers submitted by HCPs on the consideration of developments in science and technology referred generally to "materials technologies" among the areas that may be relevant to the work of the CCW, without indicating a specific materials technology.[134]

11.1 Depleted uranium

Summary description

Depleted uranium (DU) is uranium metal with relatively low concentrations of radioactive isotopes, and considered a toxic heavy metal. Due to its high density, DU has been used in munitions to enhance their penetrative and destructive effects against hard targets like armour plate. Munitions containing DU explode upon impact and release uranium oxide dust, giving rise to concerns over possible health and environmental effects.[135]

HUMANITARIAN AND IHL CONCERNS	☑ Protection of civilians from indiscriminate effects	☑ Protection of combatants from excessive injury

The potential radiological and toxicological effects of munitions containing DU on human health, as well as the potential persistence of environmental contamination following their use, elicit questions under the IHL prohibition on weapons of a nature to cause superfluous injury or unnecessary suffering, and the IHL rules protecting civilians and the natural environment from the effects of hostilities. However, UN monitoring of the health effects of radiation exposure has not found any clinically significant pathology related to exposure to DU. Separately, studies involving the IAEA have concluded that the potential risk of radiation effects for individuals who come into direct contact with fragments or ammunition containing DU can be mitigated through simple countermeasures.[136]

134 CCW/CONF.V/WP.4 (5 December 2016), CCW/MSP/2018/WP.2 (20 November 2018), CCW/MSP/2024/WP.35 (25 November 2024), and CCW/MSP/2025/WP.4 (21 November 2025).

135 UNODA, Depleted uranium.

136 Ibid.

CONTEXT

○ Raised by States at the CCW's conception

○ Raised by HCPs in CCW meetings

● Not raised by HCPs in CCW meetings

The General Assembly first addressed DU in 2007 and has taken up the issue in biennial resolutions since 2008.[137] The Secretary General has submitted biennial reports since 2008 on *Effects of the use of armaments and ammunitions containing depleted uranium*, which compile the views of Member States submitted on a voluntary basis, as well as those of the WHO, the UNEP and the IAEA.[138]

11.2 Other materials technologies

Summary description

Three materials technologies have been singled out in discussions on developments in science and technology.

- **Additive manufacturing**, also known as "3D printing", which refers to an automated process that can be used to build three-dimensional objects of virtually any shape or form, based on a digital file, by depositing and fusing layers of material. This technology has enabled the decentralised production of a wide range of complex parts and components, ranging from small arms and light weapons to uncrewed aerial systems and missile components, as well as ammunition.
- **Modular weapons**, which consist of "multiple components that can be reconfigured either by the manufacturer, at an armoury workshop, or in the field by a user", resulting in "a variable configuration" that may challenge the ability to ensure that a unique marking is preserved for the weapon as a whole."[139]
- **Nanotechnology**, which refers to the design, manipulation, manufacture and application of materials at a scale of between one and 100 nanometres.[140] Engineering nanomaterials can increase their electrical conductivity, hardness and strength and reduce their weight,[141] and present opportunities for advancements in sensing, computing and communication technologies.[142] Military applications being researched include cloaking, camouflage and smart armour, and the use of nanomaterials to increase the energy released by explosives. Nanotechnologies can also make it easier to produce, transport and deliver chemical and biological weapons.[143]

137 See e.g. *Effects of the use of armaments and ammunitions containing depleted uranium*, A/RES/79/49 (9 December 2024).

138 See e.g. *Effects of the use of armaments and ammunitions containing depleted uranium*, Report of the Secretary-General, A/81/127 (1 July 2026).

139 See 2020 Report of the Secretary-General on developments in science and technology, para. 66, referring to studies of the International Atomic Energy Agency (IAEA), and to the findings of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), which continues to review scientific studies on the health effects of radiation exposure.

140 One nanometre is one billionth of a metre.

141 2018 Report of the Secretary-General on developments in science and technology, A/73/177 (17 July 2018), para. 63.

142 W. He, *Enabling Technologies and International Security: A Compendium - 2024 ed.*, (Geneva: UNIDIR, 2024), p. 11.

143 See e.g. 2018, 2022 and 2025 Reports of the Secretary-General on developments in science and technology, at paras. 63, 67 and 67, respectively.

HUMANITARIAN AND IHL CONCERNS

☑ Protection of civilians from indiscriminate effects

☑ Protection of combatants from excessive injury

Additive manufacturing and modular weapons raise concerns mainly in relation to the illicit proliferation of weapons. Additive manufacturing lowers the barriers for State and non-State actors to build a wide range of complex weapon parts and components, and therefore to access a broad range of weapons, including conventional weapons that raise humanitarian and IHL concerns, such as those prohibited or restricted by the CCW. Likewise, the variable configuration of modular weapons creates challenges for the enforcement of the prohibitions and restrictions on certain conventional weapons, as well as for the efficacy of export controls.[144]

While concerns about the military application of nanotechnologies have focused mainly on the risks of chemical and biological weapons proliferation,[145] the use of nanomaterials to increase the energy released by conventional explosive weapons could potentially raise humanitarian and IHL concerns.

CONTEXT

○ Raised by States at the CCW's conception

○ Raised by HCPs in CCW meetings

● Not raised by HCPs in CCW meetings

Since 2018, each of the UN Secretary-General's annual reports to the General Assembly on developments in science and technology have referred to additive manufacturing, modular weapons and nanotechnologies in sections dedicated to materials technologies. In 2024, the General Assembly established an open-ended technical expert group to address developments in small arms and light weapons manufacturing, technology and design, including additive manufacturing and modular weapons. It met for the first time in June 2026 during the Biennial Meeting of States under the Programme of Action and will meet again in 2028.[146] Working Group II of the UN Disarmament Commission discussed additive manufacturing in 2024.[147] Nanotechnologies have been discussed in chemical and biological weapons (CBW)-related fora.

144 Concerns about modular weapons have been framed essentially in terms of difficulties in marking and tracing, and notably the challenges this presents to the requirement in the International Tracing Instrument to Enable States to Identify and Trace, in a Timely and Reliable Manner, Illicit Small Arms and Light Weapons "that a unique marking be included on an essential or structural component of a weapon": 2025 Report of the Secretary-General on developments in science and technology, para. 68.

145 Ibid, para. 67.

146 See *The illicit trade in small arms and light weapons in all its aspects*, UNGA resolution A/RES/79/40 (9 December 2024), OP 33, and 2026 Report of the Secretary-General on developments in science and technology, paras. 73-74.

147 These discussions took place in the context of deliberations under agenda item entitled "Recommendations on common understandings related to emerging technologies in the context of international security": see UN Disarmament Commission, Working Group II Chair's summary (18 April 2024), para. 18.

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