Measures needed to ensure compliance with International Humanitarian Law and the identification of potential additional measures

I. Introduction

1. This background paper is submitted by the Chair of the Group of Governmental Experts (GGE) on emerging technologies in the area of lethal autonomous weapons systems (LAWs), under his sole authority, with the intention of facilitating and stimulating discussions of the Group. It aims to respond to requests from delegations made during the 2024 first session of the Group, whereby it was suggested that the Group might benefit from considering in future discussions the measures required to ensure LAWS’ compliance with International Humanitarian Law (IHL) and, based on those analyses, identify which additional measures may be needed. Delegations also referred to the need to rely on language already agreed by the Group, such as the Guiding Principles and conclusions adopted by the Group in past reports.¹

2. The paper also aims to contribute towards the mandate of the Group which states, inter alia, that “the Group is to further consider and formulate, by consensus, a set of elements of an instrument, without prejudging its nature, and other possible measures to address emerging technologies in the area of lethal autonomous weapon systems, taking into account the example of existing Protocols within the Convention, proposals presented by High Contracting Parties and other options related to the normative and operational framework on emerging technologies in the area of lethal autonomous weapon systems, building upon the recommendations and conclusions of the Group, and bringing in expertise on legal, military, and technological aspects.”²

3. The paper first provides the context for the topic and the rationale for its consideration by the GGE, together with possible focus areas for discussion. It then offers a concise overview of the Group’s conclusions and recommendations on measures needed to ensure compliance with IHL, organized under the thematic categories of weapon reviews, control, limits related to the conduct of hostilities, risk mitigation, and responsibility and accountability (section III). The paper then presents areas for further consideration on this topic as identified by the Group in its conclusions and recommendations (section IV). In section V, a summary is offered on possible additional measures, derived from proposals

presented by High Contracting Parties (HCPs) from 2019 to 2024. Finally, an Annex compiles an unabridged list of the conclusions and recommendations of the Group summarized in sections III and IV.

II. Context for the topic and possible focus areas for discussion by the Group

4. The Group has concluded that IHL continues to apply fully to the potential development and use of LAWS and that weapons systems based on emerging technologies in the area of LAWS must not be used if they are incapable of being used in compliance with IHL. It has also concluded that such a weapons system must not be used if it is of a nature to cause superfluous injury or unnecessary suffering, or if it is inherently indiscriminate, or is otherwise incapable of being used in accordance with the requirements and principles of IHL.

5. The Group has further concluded that certain measures could be taken to ensure that LAWS use is compliant with IHL. Such conclusions could be visualized in the following thematic categories: weapon reviews; control; risk mitigation; responsibility and accountability; limits related to the conduct of hostilities (see section III). The Group has also identified a number of areas where further work or additional review/clarification is needed in relation to several aspects of LAWS (see section IV).

6. In the context of this topic, the Group may wish to discuss the additional measures needed in order to ensure that LAWS can be used in compliance with IHL, other than those already identified by the Group in its conclusions and recommendations. In doing so, the Group could consider 1) the areas identified by the Group as requiring further work or additional review/clarification (see section IV), as well as 2) proposals that have been put forward by HCPs on the themes under discussion (see section V).

7. The Group might also find it helpful to consider questions that have arisen during recent discussions, including:

- What are the novel issues/questions that arise specifically in the context of LAWS that should be considered in relation to IHL?
- Are there types of LAWS the use of which would be inherently problematic or prohibited under IHL?
- What functions or effects would render a LAWS to be of a nature to cause superfluous injury or unnecessary suffering, or to be inherently indiscriminate?
- Are there any gaps in existing IHL when it comes to ensuring that LAWS are used in accordance with the principles of distinction, proportionality, and precautions in attack?
- What measures are needed to prevent an accountability gap under IHL in the context of LAWS?
- Is human control needed to ensure that LAWS use is predictable, explainable, and reliable?

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3 The paper considers proposals submitted from 2019 onwards, to reflect the more recent discussions and in view of the adoption of the Guiding Principles in 2019. The summarized proposals included in the paper are not exhaustive and therefore the paper does not include all proposals that have been submitted by States; the sole aim of the summary of proposals included in this paper is to aid discussions of the GGE regarding potential additional measures.


5 Ibid., para. 21 (b).


7 Terminology in the Group’s conclusions relating to this concept includes “human judgement”, “control”, “control and judgement”, among others. See section III.
III. Overview of conclusions and recommendations of the Group relating to measures needed to ensure compliance with IHL

8. The Group has already identified several measures required to ensure that the use of LAWS is compliant with IHL, which can be visualized under the thematic categories of weapon reviews, control, risk mitigation, responsibility and accountability, and limits related to the conduct of hostilities. Below is a summary of the Group’s conclusions and recommendations across these thematic categories.⁸

A. Weapon reviews

• In accordance with their obligations under international law, States must determine whether the employment of new weapons, means, or methods of warfare would be prohibited by international law.⁹

• National legal reviews are a useful tool to evaluate compliance of LAWS with international law, in all or some circumstances.¹⁰

• The voluntary exchange of best practices between States is encouraged in the context of weapon reviews.¹¹

• Weapons systems under development, or modification which significantly changes the use of existing weapons systems, must undergo review as applicable to ensure adherence to IHL.¹²

B. Control

• Control over LAWS is needed to ensure compliance with international law, particularly with the IHL principles of distinction, proportionality, and precautions in attack.¹³

• Human judgement is essential to ensure that the potential use of LAWS complies with international law and IHL.¹⁴

• IHL requirements, including inter alia distinction, proportionality, and precautions in attack, must be applied by human operators and commanders through a chain of responsible command and control.¹⁵

• Compliance with IHL principles requires human beings to make judgements in good faith based on their assessment of available information.¹⁶

• Human-machine interaction should ensure that the use of LAWS complies with international law, considering factors such as operational context and system capabilities.¹⁷

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⁸ See the Annex for the unabridged list of these conclusions and recommendations, organized by year.


¹⁰ Final GGE Report of 2019, para. 17 (i).


¹² Final GGE Report of 2018, para. 23 (c). No.9 supra.

¹³ Final GGE Report of 2023, para. 21 (c).

¹⁴ Final GGE Report of 2019, para. 17 (e).

¹⁵ Ibid., para. 17 (d).


• Human responsibility for the use of force must be retained. To the extent possible or feasible, this could extend to intervention in the operation of a weapon if necessary to ensure compliance with IHL. 18

C. Limits related to the conduct of hostilities

• When necessary, States should, inter alia, impose limitations on the types of targets that LAWS can engage and, on the duration, geographical scope, and scale of their operation. 19

D. Risk mitigation

• States must ensure compliance with international law, particularly IHL, throughout the lifecycle of LAWS, and should provide appropriate training and instructions for human operators when necessary. 20

• During the design, development, testing, and deployment of LAWS, States must consider risks such as civilian casualties and take precautions to minimize the risk of harm to civilians and civilian objects, as well as other risks including but not limited to unintended engagements, loss of control, proliferation, and acquisition by terrorist groups. 21

• Risk mitigation measures can include rigorous testing, legal reviews, readily understandable human-machine interfaces and controls, training personnel, establishing doctrine and procedures, and circumscribing weapons use through rules of engagement. 22

• In developing or acquiring LAWS, States should consider physical security, appropriate non-physical safeguards, and risks of proliferation and acquisition by terrorist groups. 23

• Risk assessments and mitigation measures should be part of the design, development, testing and deployment cycle of LAWS. 24

• When feasible and appropriate, interdisciplinary perspectives must be integrated into research and development, including through independent ethics reviews. 25

• When feasible and appropriate, verifiability and certification procedures covering all likely or intended use scenarios must be developed and the experience should be shared. 26

E. Responsibility and accountability

• Every internationally wrongful act involving weapons systems, including LAWS, triggers international responsibility of the State under international law. 27

• IHL imposes obligations on States, parties to armed conflict, and individuals, not machines. 28

18 Final GGE Report of 2018, para. 23 (f).
19 Final GGE Report of 2023, paras. 22 (a) and (b).
20 Ibid., para. 22 (c).
21 Final GGE Report of 2019, para. 23 (a).
22 Ibid., para. 23 (b).
24 Ibid., Guiding Principle (g).
26 Ibid., para. 23 (d).
28 Final GGE Report of 2019, para. 17 (b).
• States must ensure individual responsibility for the employment of means or methods of warfare involving potential use of LAWS in accordance with IHL.  

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• Human responsibility for decisions on the use of weapons systems must be retained and should be considered across their entire life cycle, since accountability cannot be transferred to machines.  

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• Accountability for developing, deploying and using of weapons systems must remain with humans across the entire lifecycle, with a responsible chain of human command and control.  

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• Humans must at all times remain accountable in accordance with applicable international law for decisions on the use of force. Such accountability must be ensured including through operation of LAWS within a responsible chain of command and control.  

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• In the context of CCW, a focus is necessary on characteristics related to the human element in the use of force and its interface with machines to address accountability and responsibility.  

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• Necessary investments in human resources and training should be made to comply with IHL and maintain human accountability and responsibility throughout the development and deployment cycle of emerging technologies.  

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• Responsibility for deploying any weapons system in armed conflict remains with States, which must ensure accountability for lethal actions in accordance with applicable international law, particularly IHL.  

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IV. Areas for further consideration as identified by the Group in its conclusions and recommendations

9. As part of its conclusions and recommendations, the Group has identified areas for further consideration or where greater clarity or review may be needed. Below is the list of areas for further consideration, arranged thematically and summarized.

A. Weapon reviews

• Clarification of good practices for national-level legal reviews of potential weapons systems, particularly LAWS, to ensure compliance with IHL may be beneficial.  

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• The need for identification of the practical measures, best practices, and information sharing to improve compliance with international law, including legal weapon reviews as mandated by Article 36 of Additional Protocol I to the Geneva Conventions was underlined.  

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29 Ibid., para. 17 (c).
32 Final GGE Report of 2018, para. 23 (a).
33 Ibid., para. 23 (c).
34 Final GGE Report of 2018, para. 22 (f).
35 Ibid., para. 23 (g).
37 The unabridged compilation of these identified areas is included in the Annex.
38 Final GGE Report of 2019, para. 18 (c).
B. Control

- Further work would be needed to develop shared understandings of the concept of human element and its application.\(^{40}\)
- Clarification is needed on the type and degree of human-machine interaction, including elements of control and judgment, required for compliance with IHL at different stages of a weapon’s life cycle.\(^{41}\)
- It would be useful to continue discussions to establish shared understandings of and clarify accountability for human-machine interaction throughout a weapon’s life cycle.\(^{42}\)
- The human element in using lethal force should be further considered.\(^{43}\)
- There is a need to further assess the aspects of human-machine interaction in developing, deploying, and using emerging technologies, especially LAWS.\(^{44}\)

C. Limits related to the conduct of hostilities

- Further work is needed to build a shared understanding of how operational constraints, such as tasks, target profiles, timeframe of operation, and operating environment.\(^{45}\)

D. Responsibility and accountability

- It would be useful to continue discussions on reaching shared understandings of the extent and quality of human-machine interaction throughout the various phases of a weapon system’s life cycle, along with clarifying the accountability threads during these phases.\(^{46}\)

E. Other aspects that may benefit from additional clarification or review

- Possible bias in data sets used in algorithm-based programming for LAWS may benefit from additional clarification or review.\(^{47}\)
- Different potential characteristics of LAWS, including self-adaption, predictability, explainability, reliability, intervention ability, adaptability to the environment, and ability to self-initiate may benefit from additional clarification or review.\(^{48}\)
- Technical characteristics related to self-learning and self-evolution have to be further studied.\(^{49}\)
- Autonomy in the military targeting and engagement cycle has to be further studied, considering its presence throughout or during parts of the targeting cycle and its potential application in other contexts such as close combat.\(^{50}\)

\(^{40}\) Final GGE Report of 2019, para. 22 (a).
\(^{41}\) Ibid., para. 22 (b).
\(^{42}\) Final GGE Report of 2018, para. 23 (b).
\(^{43}\) Final GGE Report of 2017, para. 16 (c). No.36 supra.
\(^{44}\) Ibid., para. 16 (g).
\(^{45}\) Final GGE Report of 2019, para. 18 (b).
\(^{46}\) Final GGE Report of 2018, para. 23 (b).
\(^{47}\) Final GGE Report of 2019, para. 20 (a).
\(^{48}\) Ibid., para. 20 (b).
\(^{49}\) Final GGE Report of 2018, para. 22 (c).
\(^{50}\) Ibid., para. 22 (c).
V. Possible additional measures as contained in proposals presented by High Contacting Parties

10. Over the years, HCPs have submitted diverse proposals containing possible measures to ensure that the use of LAWS is compliant with IHL, beyond those already agreed upon by the Group and those identified by the Group as requiring further consideration. Such proposals are summarized and presented in this section. Proposals discussed in this section correspond to the period from 2019 to the present, which are considered to reflect the more recent discussions and positions of States. This summarized compilation of possible additional measures needed as proposed by States should not be considered as exhaustive and is included here solely with the purpose of aiding and stimulating the discussions of the Group.

A. Weapon reviews

- Exploring mechanisms for HCPs to exchange views, information, and best practices on domestic implementations, including weapon reviews under the Martens Clause.
- Compiling of a compendium of good national practices concerning legal weapon reviews to increase standardization.
- Introducing reporting obligations to detail how States adhere to Article 36 of Additional Protocol I to the Geneva Conventions, via the annual reporting mechanism under CCW, as one option.
- Conducting legal reviews with an appropriate understanding of the weapons’ capabilities and limitations, its planned uses, and its anticipated effects in those circumstances.
- During legal reviews, examining weapons systems against biases, as comprehensive testing goes into assuring a system works as intended.
- Conducting properly executed legal reviews that need to be critical, wide-scoped, multidisciplinary and detailed to the intended use cases.

B. Control

- Meaningful human control ensures that human operator retains the ultimate decision-making power over the critical functions of LAWS, particularly in targeting decisions and especially before the actual use of force.

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51 Acknowledging at times the different preferences in terminology among States, the paper only uses the term “LAWS” to facilitate reading and to focus on the consideration of the topic at hand.
52 Joint Working Paper Submitted by the Argentine Republic, the Republic of Costa Rica, the Republic of Ecuador, the Republic of El Salvador, the Republic of Panama, the State of Palestine, the Republic of Peru, the Republic of the Philippines, the Republic of Sierra Leone and the Eastern Republic of Uruguay. CCW/GGE.1/2021/WP.7. 27 September 2021, para. 11 (d).
55 Principles and Good Practices on Emerging Technologies in the Area of Lethal Autonomous Weapons Systems Proposed by Australia, Canada, Japan, the Republic of Korea, the United Kingdom and the United States. CCW/GGE.1/2022/WP.2. 8 August 2022, para. 30 (c).
56 Answer by Bulgaria in Compilation of replies received to the Chair’s guiding questions, CCW/GGE.1/2024/CRP.1. 1 March 2024, p. 16.
57 Answer by Finland to the Chair’s guiding questions 2024, p. 27. No.56 supra.
58 Answer by Brazil to the Chair’s guiding questions 2024, p. 13.
A human operator or upper-level control system should be able to intervene to change the mode of operation of such systems, including partial or complete deactivation.59

Developers, commanders and operators - depending on their role and level of responsibility - must have a sufficient understanding of the weapons systems’ way of operating, effect and likely interaction with its environment. This would enable the commanders and operators to predict (prospective focus) and explain (retrospective) the behavior of the weapons systems.60

Meaningful human control includes the ability to redefine or modify the weapon system’s objectives or missions or otherwise adapt it to the environment; to deactivate, abort, terminate, or interrupt its operation and use as needed; and to constrain its function to self-initiate.61

LAWS should be restricted from changing targeting parameters autonomously without approval by a human user.62

Human operator must be able to take the necessary precautions during the conduct of operations to ensure that a weapons system is not able to change mission parameters without human validation.63

Meaningful human control must ensure that a human can make moral and legal judgement over the acceptability of the effects of an attack.64

Integration of the monitoring process into a comprehensive international regulatory framework to ensure consistent preservation of meaningful human control through regular reviews.65

C. Limits related to the conduct of hostilities

LAWS should not be used in dynamic, congested or complex civilian environments such as cities or towns.66

Feasible precautions in attack may include warnings that enable steps to reduce the danger to civilians, such as avoiding locations where the system is operating.67

Commanders and operators must have the intention of striking specific or potential targets that constitute military objectives or of operating the system within specific locations constituting military objectives.68

59 Answer by the Russian Federation to the Chair’s guiding questions 2024, pp. 21-22.
60 Working paper Submitted by Finland, France, Germany, the Netherlands, Norway, Spain and Sweden. CCW/GGE.1/2022/WP.7. 9 August 2022, p. 2.
63 Answer by Brazil to the Chair’s guiding questions 2024, p. 13. See also Elements for a Legally Binding Instrument to Address the Challenges Posed by Autonomy in Weapon Systems Submitted by Chile and Mexico. CCW/GGE.1/2022/WP.5. 8 August 2022, para. 18(b).
64 Roadmap Towards a New Protocol on Autonomous Weapons Systems Submitted by the delegations of Argentina, Costa Rica, Guatemala, Kazakhstan, Nigeria, Panama, Philippines, Sierra Leone, State of Palestine and Uruguay. CCW/GGE.1/2022/WP.3. 8 August 2022, para. 15.
65 Revised working paper Submitted by Austria. CCW/GGE.1/2023/WP.1/Rev.1. 3 March 2023, para. 4.
67 Draft articles on autonomous weapon systems – prohibitions and other regulatory measures on the basis of international humanitarian law (“IHL”) Submitted by Australia, Canada, Japan, the Republic of Korea, the United Kingdom, and the United States. CCW/GGE.1/2023/WP.4/Rev.2. 15 May 2023, Article 5 (1) (b).
68 Ibid., Article 3 (1).
States should provide appropriate rules of engagement or other directives or orders circumscribing the use of LAWS in military operations, consistent with applicable IHL.  

During the deployment, a precise mission framework in terms of targets and objectives and temporal and spatial limits should be set.

It should be ensured that weapon systems do not cause lasting environmental damage.

D. Risk mitigation

- Practical measures to implement IHL requirements include establishing doctrine, training, and procedures to ensure that weapons are used in accordance with how they have been designed, tested, and reviewed.
- Personnel who develop and use such weapons systems must receive comprehensive and systematic training and observe ethics and relevant laws.
- States should implement measures to increase resilience of partially autonomous weapons systems against cyber-attacks.
- Access by non-state actors who could use LAWS for illegal purposes should be prevented.
- Self-destruct, self-deactivation or self-neutralization mechanisms should be incorporated into munitions or the system.
- A committee of technical experts should be established within the CCW to monitor technological evolutions related to emerging technologies in the area of LAWS.
- Tailored risk mitigation measures, including technical safeguards, during the design, development, testing, and deployment of weapons systems should be put in place that should aim to prevent and mitigate risks related to the safety and security of such systems, including risks of unintended bias (e.g., gender aspects), unintended engagements, loss of control, and diversion to unauthorized users.
- Continuous operator monitoring of the actions of such systems, ensuring emergency termination of a combat mission by operator's command is an effective risk mitigating measure.

Ibid., Article 6 (2) (d).
Answer by Luxembourg to the Chair’s guiding questions 2024, p. 31.
Draft Protocol VI Submitted by Argentina, Ecuador, Costa Rica, El Salvador, Guatemala, Kazakhstan, Nigeria, Panama, the Philippines, Sierra Leone and Uruguay. CCW/GGE.1/2022/WP.8. 9 August 2022, Article 3, sec. 4.
Answer by France to the Chair’s guiding questions 2024, p. 28.
Answer by the Russian Federation to the Chair’s guiding questions 2024, p. 32.
Answers by Australia and the United States of America to the Chair’s guiding questions 2024, pp. 25 and 33 respectively.
Outline for a normative and operational framework on emerging technologies in the area of LAWS Submitted by France and Germany. CCW/GGE.1/2021/WP.5. 27 September 2021, para. 2 (e).
Working paper Submitted by Bulgaria, Denmark, France, Germany, Italy, Luxembourg and Norway. CCW/GGE.1/2024/WP.3. 4 March 2024, para.15.
Answer by the Russian Federation to the Chair’s guiding questions 2024, p. 32.
A training certification should be introduced for the operators by relevant authorities to ensure they have been trained to operate the weapon system in accordance with applicable rules.\textsuperscript{80}

Obligations and commitments on LAWS may include, rigorous documentation of the data sets used in autonomous weapons, in order to enhance traceability and transparency, and provide information regarding motivation, the collection process and recommended use.\textsuperscript{81}

E. Responsibility and accountability

- The following practices, amongst others, help ensure accountability: conducting operations under a clear operational chain of command, subjecting members of the armed forces to a system of military law and disciplinary and punitive measures as appropriate.\textsuperscript{82}
- States shall develop regulations for due register, tracking and analysis of LAWS, thus allowing for accountability for full chain of command as well as fabrication and development.\textsuperscript{83}
- Mechanisms to report violations and launch investigations on credible allegations of IHL violations by States’ armed forces, their nationals or on their territory should be implemented.\textsuperscript{84}
- The disciplinary procedures and prosecution of suspected perpetrators of grave breaches of IHL as appropriate should be implemented.\textsuperscript{85}

\textsuperscript{80} U.S. Proposals on Aspects of the Normative and Operational Framework Submitted by the United States of America. CCW/GGE.1/2021/WP.3. 27 September 2021, para. 10 (b).
\textsuperscript{81} Addressing Bias in Autonomous Weapons Submitted by Austria, Belgium, Canada, Costa Rica, Germany, Ireland, Luxembourg, Mexico, Panama and Uruguay. CCW/GGE.1/2024/WP.5. 8 March 2024, para. 11 (b).
\textsuperscript{82} U.S. Proposals on Aspects of the Normative and Operational Framework, para. 8. No.80 supra.
\textsuperscript{83} Draft Protocol VI Submitted by Argentina, Ecuador, Costa Rica, El Salvador, Guatemala, Kazakhstan, Nigeria, Panama, the Philippines, Sierra Leone and Uruguay, Article 3, sec. 5. No.71 supra.
\textsuperscript{84} Working paper Submitted by Finland, France, Germany, the Netherlands, Norway, Spain and Sweden, p. 3. No.60 supra.
\textsuperscript{85} Ibid.
Annex

Conclusions and recommendations of the GGE regarding additional measures needed and areas for further consideration (2023 -2017) (organized in reverse chronological order)

Weapon reviews

In accordance with States’ obligations under international law, in the study, development, acquisition, or adoption of a new weapon, means or method of warfare, determination must be made whether its employment would, in some or all circumstances, be prohibited by international law. In this context, the voluntary exchange of relevant best practices between States is encouraged, bearing in mind national security considerations or commercial restrictions on proprietary information (2023 Report, para. 23).

In accordance with States’ obligations under international law, in the study, development, acquisition, or adoption of a new weapon, means or method of warfare, determination must be made whether its employment would, in some or all circumstances, be prohibited by international law (2019 Guiding principle (e)).

Legal reviews, at the national level, in the study, development, acquisition or adoption of a new weapon, means or method of warfare are a useful tool to assess nationally whether potential weapons systems based on emerging technologies in the area of lethal autonomous weapons systems would be prohibited by any rule of international law applicable to that State in all or some circumstances. States are free to independently determine the means to conduct legal reviews although the voluntary exchange of best practices could be beneficial, bearing in mind national security considerations or commercial restrictions on proprietary information (2019 Report, para. 17 (i)).

In accordance with States’ obligations under international law, in the study, development, acquisition, or adoption of a new weapon, means or method of warfare, determination must be made whether its employment would, in some or all circumstances, be prohibited by international law (2018 Report, para. 21 (d)).

Weapons systems under development, or modification which significantly changes the use of existing weapons systems, must be reviewed as applicable to ensure compliance with IHL (2018 Report, para. 23 (c)).

The following aspects may benefit from additional clarification or review, as identified by the Group:

Possible good practices in the conduct of legal reviews, at the national level, of a potential weapons system based on emerging technologies in the area of lethal autonomous weapons systems to determine if its employment, in light of its intended or expected use, would be prohibited by the requirements and principles of IHL, in all or some circumstances (2019 Report, para. 18 (c)).

The need to identify practical measures, best practices and information sharing for improving compliance with international law, including legal weapons reviews required by Article 36 of the Additional Protocol I to the Geneva Conventions, was underlined (2018 Report, para. 28).

Control

Control with regard to weapon systems based on emerging technologies in the area of LAWS is needed to uphold compliance with international law, in particular IHL, including the principles and requirements of distinction, proportionality and precautions in attack (2023 Report, para. 21 (c)).
Human judgement is essential in order to ensure that the potential use of weapons systems based on emerging technologies in the area of lethal autonomous weapons systems is in compliance with international law, and in particular IHL (2019 Report, para. 17 (e)).

The IHL requirements and principles including inter alia distinction, proportionality and precautions in attack must be applied through a chain of responsible command and control by the human operators and commanders who use weapons systems based on emerging technologies in the area of lethal autonomous weapons systems (2019 Report, para. 17 (d)).

Compliance with the IHL requirements and principles, including inter alia distinction, proportionality and precautions in attack, in the potential use of weapons systems based on emerging technologies in the area of lethal autonomous weapons systems requires inter alia that human beings make certain judgements in good faith based on their assessment of the information available to them at the time (2019 Report, para. 17 (f)).

Human-machine interaction, which may take various forms and be implemented at various stages of the life cycle of a weapon, should ensure that the potential use of weapons systems based on emerging technologies in the area of lethal autonomous weapons systems is in compliance with applicable international law, in particular IHL. In determining the quality and extent of human-machine interaction, a range of factors should be considered including the operational context, and the characteristics and capabilities of the weapons system as a whole (2019 Guiding Principle (c)).

Human responsibility for the use of force must be retained. To the extent possible or feasible, this could extend to intervention in the operation of a weapon if necessary to ensure compliance with IHL (2018 Report, para. 23 (f))

The following aspects may benefit from additional clarification or review:

Although there is agreement on the importance of the human element in the use of weapons systems based on emerging technologies in the area of lethal autonomous weapons systems, further work would be needed to develop shared understandings of this concept and its application (2019 Report, para. 22 (a)).

Further clarification is needed on the type and degree of human-machine interaction required, including elements of control and judgement, in different stages of a weapon’s life cycle, in order to ensure compliance with IHL in relation to the use of weapons systems based on emerging technologies in the area of lethal autonomous weapons systems (2019 Report, para. 22 (b)).

It would be useful to continue discussions on reaching shared understandings on the extent and quality of the human-machine interaction in the various phases of the weapons system’s life cycle as well as clarifying the accountability threads throughout these phases (2018 Report, para. 23 (h)).

The human element in the use of lethal force should be further considered (2017 Report, para. 16 (c)).

There is a need to further assess the aspects of human-machine interaction in the development, deployment and use of emerging technologies in the area of lethal autonomous weapons systems in the next stage of the Group’s work (2017 Report, para. 16 (g)).

Limits related to conduct of hostilities

When necessary, States should, inter alia: limit the types of targets that the system can engage and limit the duration, geographical scope, and scale of the operation of the weapon system (2023 Report, para. 22 (a) and (b)).

The following aspects may benefit from additional clarification or review:

Further work is needed to build shared understanding on the role of operational constraints regarding tasks, target profiles, timeframe of operation, and scope of movement over an area and operating environment. There was not shared understanding on how constraints and
capabilities could reduce the likelihood of causing civilian casualties or damage to civilian objects and thereby assist with implementation of IHL by parties to an armed conflict (2019 Report, para. 18 (b)).

**Risk mitigation**

States must ensure compliance with their obligations under international law, in particular IHL, throughout the lifecycle of weapon systems based on emerging technologies in the area of LAWS. When necessary, States should, *inter alia*: provide appropriate training and instructions for human operators (2023 Report, para. 22 (c)).

During the design, development, testing and deployment of weapons systems based on emerging technologies in the area of lethal autonomous weapons systems, the risks *inter alia* of civilian casualties, as well as precautions to help minimize the risk of incidental loss of life, injuries to civilians and damage to civilian objects must be considered. Other types of risks should be considered, as appropriate, including but not limited to the risk of unintended engagements, risk of loss of control of the system, risk of proliferation, and risk of acquisition by terrorist groups (2019 Report, para. 23 (a)).

Risk mitigation measures can include: rigorous testing and evaluation of systems, legal reviews, readily understandable human-machine interfaces and controls, training personnel, establishing doctrine and procedures, and circumscribing weapons use through appropriate rules of engagement (2019 Report, para. 23 (b)).

The dual use nature of the underlying technologies in the area of lethal autonomous weapons systems, it is important to promote responsible innovation and use of such technologies (2019 Report, para. 23 (c)).

When developing or acquiring new weapons systems based on emerging technologies in the area of lethal autonomous weapons systems, physical security, appropriate non-physical safeguards (including cyber-security against hacking or data spoofing), the risk of acquisition by terrorist groups and the risk of proliferation should be considered (2019 Guiding Principle (f)).

Risk assessments and mitigation measures should be part of the design, development, testing and deployment cycle of emerging technologies in any weapons systems (2019 Guiding Principle (g)).

Where feasible and appropriate, inter-disciplinary perspectives must be integrated in research and development, including through independent ethics reviews bearing in mind national security considerations and restrictions on commercial proprietary information (2018 Report, para. 23 (b)).

Where feasible and appropriate, verifiability and certification procedures covering all likely or intended use scenarios must be developed, the experience of applying such procedures should be shared bearing in mind national security considerations or commercial restrictions on proprietary information (2018 Report, para. 23 (d)).

**Responsibility and accountability**

For the purposes of its work, the Group recognized that every internationally wrongful act of a State, including those potentially involving weapons systems based on emerging technologies in the area of LAWS entails international responsibility of that State, in accordance with international law. In addition, States must comply with international humanitarian law. Humans responsible for the planning and conducting of attacks must comply with international humanitarian law (2022 Report, para. 19).

IHL imposes obligations on States, parties to armed conflict and individuals, not machines (2019 Report, para. 17 (b)).

States, parties to armed conflict and individuals remain at all times responsible for adhering to their obligations under applicable international law, including IHL. States must also ensure
individual responsibility for the employment of means or methods of warfare involving the potential use of weapons systems based on emerging technologies in the area of lethal autonomous weapons systems in accordance with their obligations under IHL (2019 Report, para. 17 (c)).

Human responsibility for decisions on the use of weapons systems must be retained since accountability cannot be transferred to machines. This should be considered across the entire life cycle of the weapons system (2019 Guiding Principle (b)).

Accountability for developing, deploying and using any emerging weapons system in the framework of the CCW must be ensured in accordance with applicable international law, including through the operation of such systems within a responsible chain of human command and control (2019 Guiding Principle (d)).

Human responsibility for decisions on the use of weapons systems must be retained since accountability cannot be transferred to machines. This should be considered across the entire life cycle of the weapons system (2018 Report, para. 21 (b)).

In the context of the CCW, a focus on characteristics related to the human element in the use of force and its interface with machines is necessary in addressing accountability and responsibility (2018 Report, para. 22 (f)).

Humans must at all times remain accountable in accordance with applicable international law for decisions on the use of force (2018 Report, para. 23 (a)).

Accountability for the use of force in armed conflict must be ensured in accordance with applicable international law, including through the operation of any emerging weapons systems within a responsible chain of command and control (2018 Report, para. 23 (e)).

Necessary investments in human resources and training should be made in order to comply with IHL and retain human accountability and responsibility throughout the development and deployment cycle of emerging technologies (2018 Report, para. 23 (g)).

Responsibility for the deployment of any weapons system in armed conflict remains with States. States must ensure accountability for lethal action by any weapon system used by the State’s forces in armed conflict in accordance with applicable international law, in particular international humanitarian law (2017 Report, para. 16 (c)).

The following aspects may benefit from additional clarification or review:

It would be useful to continue discussions on reaching shared understandings on the extent and quality of the human-machine interaction in the various phases of the weapons system’s life cycle as well as clarifying the accountability threads throughout these phases (2018 Report, para. 23 (h)).

Other aspects that may benefit from additional clarification or review

The following aspects that may benefit from additional clarification or review: possible bias in the data sets used in algorithm-based programming relevant to emerging technologies in the area of lethal autonomous weapons systems (2019 Report, para. 20 (a)).

Different potential characteristics of emerging technologies in the area of lethal autonomous weapons systems, including: self-adaption; predictability; explainability; reliability; ability to be subject to intervention; ability to redefine or modify objectives or goals or otherwise adapt to the environment; and ability to self-initiate (2019 Report, para. 20 (b)).

Technical characteristics related to self-learning (without externally-fed training data) and self-evolution (without human design inputs) have to be further studied. Similarly, attempting to define a general threshold level of autonomy based on technical criteria alone could pose difficulty as autonomy is a spectrum, its understanding changes with shifts in the technology frontier, and different functions of a weapons system could have different degrees of autonomy (2018 Report, para. 22 (c)).
Autonomy in the military targeting and engagement cycle has to be studied further keeping in view that autonomy can exist throughout or during parts of the targeting cycle and could start to be applied increasingly in other contexts such as close combat (2018 Report, para. 22 (e)).