

Pugwash Briefing Paper

Hypersonic Weapon Series

#5

What are the roles and missions
of Hypersonic Weapons?

Background

The Pugwash Foundation supported an international Pugwash workshop on hypersonic weapons, which took place in Geneva on 9 and 10 December 2019. The meeting brought together 30 international participants from various continents, including current and former government officials, scientists, engineers, academics and experts from think tanks and other non-governmental organisations.

The workshop aimed at fostering a constructive exchange of views on hypersonic weapons. Participants discussed factors driving the development, roles and purposes of hypersonic weapons, as well as the risks associated with their deployment and use.

Based on the workshop's discussions, the Pugwash Foundation produced a series of briefing papers on hypersonic weapons. The series covers the following themes:

- What is a hypersonic weapon?
- What technical challenges do hypersonic weapons raise?
- What are the current hypersonic weapon development programmes?
- Why do States develop hypersonic weapons?
- What are the roles and missions of hypersonic weapons?
- What are the risks associated with hypersonic weapons?
- How to mitigate the risks associated with hypersonic weapons?
- How to counter hypersonic weapons?

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What are the roles and missions of hypersonic weapons?

Most HCM and HGV programmes are still in their design and experimental phases and will not be operational for some time. Building an understanding of their potential roles and missions ahead of their deployment could give policymakers and practitioners a head-start in dealing with possible future problems.

More than their speed and manoeuvrability, it is actually their range and payload that define what HCMs and HGVs might be used for and what their consequences may be. In that sense, they are no different from traditional ballistic and cruise missiles.

At the moment, it seems that HCMs and HGVs are not being built to take on new missions. Rather they seem to be integrated into the existing operational framework to support pre-existing missions. Some countries may believe that HCMs and HGVs can support more effectively than traditional missiles the following missions:

- Strategic level
 - Defensive missions
 - Offensive missions
- Tactical level
 - Defensive missions
 - Offensive missions

Hypersonic Glide Vehicles (HGVs)

Strategic defensive missions

Enhancing second-strike capability

Provided that they are deployed on survivable platforms, the late detection time and greater manoeuvrability (see *Box.1*) of nuclear HGVs could boost confidence in the effectiveness of one's second-strike capability, thereby enhancing their nuclear deterrent capability and contributing to strategic balance.

Box.1 HGV characteristics

HGVs are not faster than traditional ballistic missiles, both travel at a maximum speed of Mach 20+.

The main differences between ballistic missiles and HGVs reside in their detection time and manoeuvrability:

- HGVs fly at lower altitudes than ballistic missiles. Thus HGVs will enter a ground-based radars' field of view later than ballistic missile re-entry vehicles because of the earth's curvature.
- Space-based sensors can detect both ballistic missile and HGV launches equally well in their boost phase, because both emit identical rocket plumes. However, it is unclear whether space-based sensors can track HGVs throughout the mid-course phase.
- Provided that the approach of interceptors is detected in time, HGVs' manoeuvrability enables them to evade missile defence systems more effectively than ballistic missiles.

A HGV carrying a conventional payload would not be considered as contributing to second-strike capability.

Strategic offensive missions

Enhancing first-strike capability

For essentially the same reasons (late detection time and greater manoeuvrability), HGVs could be considered as weapons of choice to conduct a decapitating first strike.

Many factors would determine the success of such a strike, including:

- undetected preparations
- accuracy
- number and payload of HGVs

For conventional HGVs to be used in a first strike, their accuracy must be extremely high. Whereas nuclear HGVs would not need to be as accurate.

Enhancing pre-emptive strike capability

Some countries might also consider them in a more selective manner to take out targets that represent a major risk to national security and located deep into other countries' territory:

- Territory of nuclear weapon States – The use of both conventional or nuclear HGVs would risk triggering a nuclear war.
- Territory of non-nuclear-weapon States – It is hard to imagine what reasons could lead to the use of a nuclear HGV.

- Territory of non-nuclear-weapon States – Although conventional HGVs could be used, their cost and the fact that non-hypersonic systems have proven their effectiveness makes their use very unlikely.

Tactical defensive missions

Enhancing anti-access / area-denial capability

Over shorter distances, the difference in detection time between short- and intermediate-range ballistic missiles and HGVs tends to be reduced.

However, some countries may still consider the deployment of short- and intermediate-HGVs as enhancing their anti-access/area denial capabilities.

The use of nuclear HGVs for anti-access/area denial mission would immediately escalate the conflict to a nuclear one.

Unless there is an overwhelming attack that can only be stopped with nuclear weapons, conventional HGVs are more likely to be used for anti-access/area-denial missions.

Tactical offensive missions

Enhancing pre-emptive strike capability

Some countries might use short- and intermediate-HGVs to take out protected high-value targets or “fleeting targets” visible for only a short amount of time at the beginning or during a conflict, in an attempt to gain the upper hand in a given theatre of operations:

- Territory of nuclear weapon States – The use of both conventional or nuclear HGVs would risk triggering a nuclear war.
- Territory of non-nuclear-weapon States – It is hard to imagine what reasons could lead to the use of a nuclear HGV.
- Territory of non-nuclear-weapon States – Although conventional HGVs could be used, their cost and the fact that non-hypersonic systems have proven their effectiveness makes their use very unlikely.

Hypersonic Cruise Missiles (HCMs)

Strategic defensive missions

Enhancing second-strike capability

Provided that they are deployed on survivable forward-based platforms, the late detection time and high manoeuvrability (see *Box.2*) of nuclear HCMs could boost confidence in the effectiveness of one's second-strike capability, thereby enhancing their nuclear deterrent capability and contributing to strategic balance.

A HCM carrying a conventional payload would not be considered as contributing to second-strike capability.

Box.2 HCM characteristics

Speed:

- HCMs are faster than traditional cruise missiles. They can thus hit a target faster regardless of distance.

Manoeuvrability:

- Due to their hypersonic speed, HCMs are slightly less manoeuvrable than traditional cruise missiles.

Flightpath:

- HCMs fly at slightly higher altitude than traditional cruise missiles which makes them more visible to radars. But the plasma layer may absorb or deflect radars' electromagnetic waves (depending on the radar frequency).

Range:

- HCMs have a shorter range than traditional ballistic missiles and HGVs. But the deployment of HCMs on mobile sea- / air- / land-platforms could offset the initial lack of range.

Strategic Offensive missions

Enhancing pre-emptive strike capability

There are limits to where forward-based mobile platforms can go. It means that HCMs cannot cover a wide territory. They cannot hit as deep into other countries' territory as ballistic missiles and HGVs. This makes the use of HCMs for decapitating first strike unlikely, unless used in conjunction with other weapon systems such as HGVs.

But, due to their high manoeuvrability and low altitude, some countries might also consider them to take out targets within range that represent a risk to national security:

- Territory of nuclear weapon States – The use of both conventional or nuclear HCMs would risk triggering a nuclear war.
- Territory of non-nuclear-weapon States – It is hard to imagine what reasons could lead to the use of a nuclear HCM.
- Territory of non-nuclear-weapon States – Although conventional HCMs could be used, their cost and the fact that non-hypersonic systems have proven their effectiveness makes their use very unlikely.

Tactical defensive missions

Enhancing anti-access / area-denial capability

Some countries may consider the deployment of short-/intermediate-HCMs as enhancing their anti-access/area denial capabilities.

The use of nuclear HCMs for anti-access/area denial mission would immediately escalate the conflict to a nuclear one.

Unless there is an overwhelming attack that can only be stopped with nuclear weapons, conventional HCMs are more likely to be used for anti-access/area-denial missions.

Tactical offensive missions

Enhancing pre-emptive strike capability

Some countries might use HCMs to take out protected high-value targets or “fleeting targets” in an attempt to gain the upper hand in a given theatre of operations:

- Territory of nuclear weapon States – The use of both conventional or nuclear HGVs would risk triggering a nuclear war.
- Territory of non-nuclear-weapon States – It is hard to imagine what reasons could lead to the use of a nuclear HGV.
- Territory of non-nuclear-weapon States – Although conventional HCMs could be used, their cost and the fact that non-hypersonic systems have proven their effectiveness makes their use very unlikely.

HGVs and HCMs are more likely to be used in a conflict involving two or more countries with advanced missile defence systems and missile programmes. The use of HGVs and HCMs in conflicts involving countries with less technologically advanced missile and anti-missile programmes would represent a waste of resources.

However, as long as countries do not lay open in their military doctrines the intended use of HCMs and HGVs, uncertainty will remain as to their true defensive and offensive purposes in strategic and tactical contexts.

Many questions will still have to be answered before countries feel confident in using hypersonic weapons. For example, the impact of physical phenomena on their navigation, communication, guidance and other supporting sub-systems represents an array of challenges.

It is also unclear to which extent HCMs and HGVs are compatible with existing sub-systems, such as launch-platforms, satellites and C4ISTAREW (Command, Control, Communication, Computer, Intelligence, Surveillance, Target Acquisition, Reconnaissance and Electronic Warfare).

For all these reasons, HCMs and HGVs are unlikely to replace traditional cruise or ballistic missiles very soon. Traditional missiles will, in all likelihood, remain the preferred military choice in the near to medium term.

Hypersonic technology could also be used for Intelligence, Surveillance and Reconnaissance (ISR) missions. However, speed, aerodynamic forces and high temperatures were seen as significant challenges to the gathering of accurate and exploitable information. While hypersonic vehicles hold an important future potential for ISR missions, conventional aircrafts and satellites are currently still more effective.

Conclusion

At the moment, it seems that HCMs and HGVs are not being built to take on new missions. Rather they seem to be integrated into the existing operational framework to support pre-existing missions.

Hypersonic Glide Vehicles (HGVs) and Hypersonic Cruise Missiles (HCMs)			
Strategic Missions		Tactical Missions	
Defensive	Offensive	Defensive	Offensive
Enhancing second-strike capability	<p>Enhancing first-strike capability</p> <p>Enhancing ability to eliminate targets that are perceived to pose a threat to national security wherever their geographic location.</p>	Enhancing anti-access/area-denial capability.	Enhancing ability to eliminate targets, in an attempt to gain operational superiority in a given context.

However, as long as countries do not lay open in their military doctrine the intended use of HCMs and HGVs, uncertainty will remain as to their true defensive and offensive purposes in strategic and tactical contexts.

Many questions will still have to be answered before countries feel confident in using hypersonic weapons. For example, the impact of physical phenomena on their navigation, communication, guidance and other supporting sub-systems represents an array of challenges. It is still unclear whether HCMs and HGVs are compatible with existing sub-systems, or whether they require an upgrade of existing or the development of new sub-systems.

Thus, HCMs and HGVs are unlikely to replace traditional cruise or ballistic missiles very soon. Traditional missiles will, in all likelihood, remain the preferred military choice in the near to medium term.

Acknowledgements

The Pugwash Foundation and the Pugwash Conferences on Science and World Affairs would like to express their gratitude to the Ministry of Foreign Affairs of the Kingdom of the Netherlands for its generous financial support, which made this workshop possible. They are also grateful to the Federal Department of Foreign Affairs of Switzerland, the Permanent Mission of Canada to the United Nations in Geneva, and the British Pugwash Group for their assistance in the realisation of this workshop.

