CANADA'S SAFETY FRAMEWORK
for Automated and Connected Vehicles

Transport Canada

Transports Canada

Canada

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MESSAGE FROM THE MINISTER OF TRANSPORT

I am pleased to introduce *Canada's Safety Framework for Automated and Connected Vehicles* (the Safety Framework), a collaborative document that sets out Transport Canada's approach to maintaining the safety of our roadways and road users with current and future levels of vehicle automation and connectivity.

Automated and connected vehicles (AV/CVs) are at the forefront of a rapid technological evolution within the automotive and transportation sectors. These technologies could bring Canadians unprecedented opportunities for safety, innovation, investment and growth. However, with these exciting possibilities come new challenges, such as ensuring road user and pedestrian safety, cyber security, data protection and privacy.

Transport Canada's horizontal approach to AV/CV technologies focuses on: safely deploying AV/CVs on Canadian roads; improving road safety; increasing transportation efficiency and the free flow of goods and people; facilitating opportunities for innovation and growth among Canadian businesses; and ensuring privacy and cyber security. To support these objectives, Budget 2018 committed funding to strengthen motor vehicle safety in Canada, which includes addressing emerging technologies such as AV/CVs.

As all levels of government, industry and other stakeholders come together to realize the full potential of AV/CVs in Canada, we must work towards a national approach that incorporates safety and security. The Safety Framework and *Safety Assessment for Automated Driving Systems* are key documents that inform this national vision. These documents complement existing, foundational AV/CV resources in Canada, such as *Testing Highly Automated Vehicles in Canada: Guidelines for Trial Organizations and Canadian Jurisdictional Guidelines for Safe Testing and Deployment of Highly Automated Vehicles*.

We must also ensure our national vision for AV/CVs aligns with other countries, and we need to share information, resources and expertise on common safety priorities. With that in mind, the Government of Canada is working closely with international partners. Notably, Canada and the United States have a continued partnership to advance and align AV/CV technologies in the context of our respective regulatory regimes. Transport Canada is also actively involved in international forums to discuss international standards and regulations for AV/CVs.

Together, we are all responsible for the safety of Canadians on our roads. I would like to extend my gratitude to the many stakeholders across Canada who have reviewed the Safety Framework and provided their feedback and support. I look forward to continuing our strong partnerships and collaborative work, which will allow us to leverage the potential of these technologies in Canada.

The Honourable Marc Garneau, P.C., M.P.
Minister of Transport

EXECUTIVE SUMMARY

Canada's Safety Framework for Automated and Connected Vehicles (the Safety Framework) informs stakeholders of Transport Canada (TC)'s safety-focused approach to automated and connected vehicles (AV/CVs). It sets a stable policy direction for safely deploying AV/CVs on Canada's public roads.

The Safety Framework sets out the following guiding principles for a national approach to AV/CVs:

> Enhanced safety and security

> Clear and consistent oversight, within a modernized, innovative approach

> Strengthened engagement and collaboration

> Continuous improvement

The Safety Framework provides an overview of Canada's current legislative and regulatory regimes and standards. Recognizing the challenges in keeping pace with rapid AV/CV technological advancements, the document also describes a new, flexible approach that uses non-regulatory tools to support the safe testing and deployment of AV/CV technologies, including guidance for governments and industry stakeholders.

Research, testing and data collection are the cornerstones of AV/CV technological development. The Safety Framework gives examples of research projects underway in several jurisdictions across Canada, and describes some of the research and testing being undertaken by TC to promote the continued safety of AV/CVs. Going forward, there is a need to continue AV/CV research and testing, and to translate that knowledge to Canadians through public awareness and education initiatives.

The Safety Framework identifies Canadian and international forums, along with other information sharing mechanisms, which TC participates in to align federal work with international partners, and points to proposed future activities in areas such as AV/CV policy, research and testing.

INTRODUCTION

The automotive and transportation sectors are in a period of significant transformation. New trends and technologies, including vehicles with automated and connected features, are emerging at a rapid pace. These technologies could bring fundamental changes to the way we view and use transportation in Canada. While it is expected that AV/CVs will offer safety, economic, and environmental benefits, they also present potential challenges. For instance, ensuring the continued safety of our roadways as new technology is deployed, managing the transition period when traditional vehicles, and other road users, share the road with AV/CVs, and cyber security vulnerabilities are some of the issues that must be taken into consideration as we move forward in this space.

In order to harness the full potential of AV/CVs, governments around the world must encourage responsible innovation in a way that prioritizes safety. That is why TC is working to manage the safety of AV/CVs by developing flexible policy frameworks and non-regulatory guidance and tools. This modernized approach aligns with that of our global partners, such as the United States. It ensures that Canadians can benefit from this important technological change, while also knowing their well-being is protected. As more highly automated vehicles are deployed in Canada, additional regulatory measures may be required. New regulations would be informed by data collected through AV/CV trials, testing and research, non-regulatory tools, and engagement with stakeholders.

PURPOSE

Safety is paramount to successfully designing and deploying AV/CVs. This Safety Framework provides an in-depth analysis of the current state of AV/CV work in Canada. It is a first step in creating a stable policy environment that ensures all stakeholders (different levels of government, industry, and members of the Canadian public) are informed of TC's vision for the safety of AV/CVs. This Safety Framework supports the "safety" pillar of the broader National Policy Framework. It charts out TC's approach to maintaining the safety of roadways and passengers with current and future levels of vehicle automation and connectivity, and will continue to evolve as new developments and findings emerge.

More specifically, the Safety Framework gives an overview of current legislation, and existing and emerging policy tools, which TC will use to support AV/CV safety and security while also encouraging innovation. The tools outlined range from non-regulatory interventions (guidelines) to more formal means (legislation, regulations and standards).

CONTEXT

For over 100 years, motor vehicles have played a vital role in Canada's transportation system. Vehicles connect Canadian communities, businesses and families across one of the world's largest roadway networks.

Today, AV/CVs are causing a transformative shift in the transportation sector. While vehicles can include both automated and connected features, these features can also be distinct, and are not dependent on one another. Automated vehicles (AVs) have technology that allows the vehicle to perform real-time operational and tactical functions required to operate a vehicle in on-road traffic. Low levels of automation (SAE levels 0-2) are already available to Canadian consumers, in the form of automatic emergency braking, lane keeping assist and adaptive cruise control. Connected vehicles (CVs) use radio, cellular and internet connectivity to communicate with other vehicles (V2V), transportation infrastructure (V2I) and other elements of the modern surface transportation system. Although AV/CV technologies can operate independently of one another, and may develop at different rates, an approach that considers vehicles equipped with both automated and connected features will maximize the full safety benefits and promises of these technologies.

It is expected that AV/CVs will bring significant new benefits for Canadians. These technologies could lead to a significant reduction in traffic collisions, and a corresponding reduction in fatalities and injuries.

ALTHOUGH MOTOR VEHICLE COLLISIONS INVOLVING FATALITIES HAVE DECREASED BY 38% OVER THE LAST TWO DECADES, THE DATA SHOWS THAT APPROXIMATELY 85% OF CASUALTY COLLISIONS HAD DRIVER ERROR AS A CONTRIBUTING FACTOR.

Speeding was a factor in 23% of fatal collisions, distracted driving in 22%, and impaired driving in 19%[1]. According to the Conference Board of Canada, the estimated total economic benefit of AV/CVs may be over $65 billion, from fewer collisions, less traffic congestion, and lower fuel costs. Current automation features on conventional vehicles have already been shown to warn and assist drivers.

For example, there has been a 38% reduction of rear-end injury crashes in vehicles with automatic emergency braking compared to those without.

It is anticipated that more advanced AV/CV technologies will be available in the near future. Active on-road trials are taking place or are planned in various jurisdictions in Canada. Although predictions vary regarding when highly automated and connected vehicles will be deployed, it is clear they are on the horizon. This underlines the importance of creating flexible policy tools and guidance documents in short order, to ensure that AV/CVs are tested and deployed in the safest way possible.

The Standing Senate Committee on Transport and Communications report "_**Driving Change: Technology and the Future of the Automated Vehicle**_", released in January 2018, highlights the regulatory, policy, and technical issues that need to be addressed to successfully deploy AV/CVs in Canada. The report makes 16 recommendations to the Government of Canada, which focus on: policy and regulation; safety standards and guidelines; cyber security; privacy; and innovation, skills and employment. Notable progress has been made in each of these areas, including measures to safely test and deploy AV/CVs outlined in this Safety Framework. On July 27, 2018, the Government of Canada tabled its _**Response to the Senate Report**_ after carefully considering the recommendations and any actions required to further strengthen the safety, efficiency, and competitiveness of Canada's transportation system. The Response addresses each of the 16 recommendations by highlighting the Government's policy, program and safety initiatives and objectives for AV/CVs. This includes creating an interdepartmental task team, jointly led by TC and Innovation, Science and Economic Development (ISED) to develop a whole-of-government AV/CV strategy. Through this task team and other inter-jurisdictional efforts, the Government of Canada will continue to explore ways to address the Senate Report's recommendations.

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1   Source: Transport Canada, National Collision Database (motor vehicles)

ROLES AND RESPONSIBILITIES

In Canada, motor vehicle transportation is a shared responsibility between federal, provincial and territorial governments. Under the *Motor Vehicle Safety Act* (MVSA), TC establishes safety regulations that apply to the importation of motor vehicles and designated motor vehicle equipment, and the shipment of newly manufactured motor vehicles and designated equipment across provincial/territorial boundaries. The objective of these regulations is to reduce the risk of death, injury, and damage to property and the environment. In addition to conducting motor vehicle safety research, investigations and managing recalls of safety-related motor vehicle defects, TC also has a responsibility to exercise leadership and offer guidance on new and emerging technologies to promote motor vehicle safety in this rapidly changing environment.

With respect to vehicle connectivity, ISED is the lead federal government that sets and enforces compliance with technical standards and licencing requirements for wireless technologies integrated in vehicles and roadside infrastructure.

Provincial and territorial governments oversee many of the laws and regulations governing the safe operation of vehicles on public roads. For instance, they are responsible for driver licensing; vehicle registration; motor vehicle insurance and liability; vehicle maintenance standards; and traffic laws. Municipalities' responsibilities for roadways vary to some degree across the country, but generally they can include creating and enforcing by-laws for vehicle movement and managing public transportation in their respective jurisdictions, among other responsibilities. Municipalities, provinces and territories share responsibility for traffic laws, and for adapting infrastructure to support the use of AV/CVs.

Notwithstanding these distinct roles and responsibilities, all levels of government are working together with national stakeholders to advance a cohesive approach for safely testing and deploying AV/CVs on Canadian roads.

GUIDING PRINCIPLES

The following principles guide TC's approach to supporting the ongoing safety of AV/CVs, and each has influenced the development of this Safety Framework. These principles reflect the mission, vision and objectives of TC, and are also consistent with principles in the "Safer Transportation" theme of *Transportation 2030: A Strategic Plan for the Future of Transportation in Canada*: to build a safer, more secure transportation system that Canadians trust.

1. ENHANCED SAFETY AND SECURITY:

Maintaining and enhancing the safety of people on Canada's roads is a shared responsibility between federal, provincial, and territorial governments, who work closely together with national stakeholders. As such, Canada's vision for road safety, as defined in the Canadian Council of Motor Transport Administrators' (CCMTA) Road Safety Strategy 2025, is to have the safest roads in the world. This goal is based on the international best practice, "Vision Zero", which strives for zero fatalities and serious injuries on roadways. In support of Vision Zero and the responsibilities of all levels of government, the main objective of this Safety Framework is to promote a safe and secure future for the use of AV/CVs in Canada.

2. MODERNIZED AND INNOVATIVE APPROACH:

TC will continue to exercise national leadership on road safety issues by promoting and supporting consistent, transformative, Canada-wide approaches to policy and regulation for AV/CV safety, in partnership with Canadian stakeholders, and with global partners. Every effort has been made to ensure this Safety Framework meets the needs of a modernized approach to government oversight, while also enhancing safety.

3. STRENGTHEN ENGAGEMENT AND COLLABORATION:

Timely, thorough and transparent engagement with a variety of stakeholders is key to ensure effective decision making. A strengthened relationship among all levels of government and key stakeholders is required to increase understanding of objectives and processes around AV/CV development. This Safety Framework outlines various ways to share information and best practices, which will facilitate collaboration.

4. CLEAR AND CONSISTENT OVERSIGHT:

This Safety Framework provides industry and stakeholders with a clear, organized, and central repository of existing and planned policy approaches for safely testing and deploying AV/CVs on public roads in Canada. It provides tools to help stakeholders and manufacturers understand TC's motor vehicle safety policies and regulations, so they are aware of compliance and conformity requirements for AV/CVs (legislation, regulation, standards, oversight). It also clarifies the various roles and responsibilities of federal, provincial, territorial, and municipal governments.

5. CONTINUOUS IMPROVEMENT:

TC is committed to regularly reviewing and improving its policies, frameworks and non-regulatory tools to ensure the continued safety of AV/CVs in Canada. The Safety Framework will continue to be updated as new information emerges and processes are developed, which will support the broader Government of Canada approach to AV/CVs.

TERMINOLOGY (SAE LEVELS OF AUTOMATION)

SAE International (formerly the Society of Automotive Engineers) has identified 6 levels of automation (0 through 5). The following table is based on SAE International's *Surface Vehicle Recommended Practice: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles*, J3016 (2018), which can be accessed for free from the SAE International website at: *https://www.sae.org/*

LEVELS OF DRIVING
AUTOMATION

LEVEL 0

NO AUTOMATION
The human driver performs all aspects of the dynamic driving task.

LEVEL 1

DRIVER ASSISTANCE
The vehicle's driver assistance features support the driver with **either** steering **or** acceleration/deceleration **under specific conditions**. The human driver is expected to perform all remaining aspects of the dynamic driving task, including monitoring and responding to the driving environment.

LEVEL 2

PARTIAL AUTOMATION
The vehicle's driver assistance features support the driver with **both** steering **and** acceleration/deceleration **under specific conditions**. The human driver is still expected to perform all remaining aspects of the dynamic driving task, including monitoring and responding to the driving environment.

LEVEL 3

CONDITIONAL AUTOMATION
The vehicle's automated driving system (ADS) features perform all aspects of the dynamic driving task, including monitoring and responding to the driving environment, **under specific conditions**. The human driver must **be alert and ready** to perform the dynamic driving task when the system requests the human driver to intervene.

LEVEL 4

HIGH AUTOMATION
The ADS-equipped vehicle performs all aspects of the dynamic driving task, including monitoring and responding to the driving environment, **under specific conditions**. The vehicle is designed to respond safely without human action to all situations, including when it reaches the limits of its operating environment.

LEVEL 5

FULL AUTOMATION
The ADS-equipped vehicle performs all aspects of the dynamic driving task, including monitoring and responding to the driving environment, **in all conditions**.

SECTION 1: CURRENT CANADIAN STATUTORY REGIME

This section of the Safety Framework outlines how Canadian legislation and regulations accommodate the low levels of automation currently on the market (SAE levels 0-2). It also provides an overview of provisions in the _Motor Vehicle Safety Act_ (MVSA) that can be leveraged to address vehicles that may not be compatible with existing legislation and regulations, including vehicles equipped with automated features[2].

1.1 LEGISLATION

The MVSA sets safety regulations and standards for the importation of motor vehicles and designated motor vehicle equipment, and the shipment of newly manufactured motor vehicles and designated equipment across provincial/territorial boundaries with the aim to reduce the risk of death, injury, and damage to property and the environment. Vehicles with automated and connected features must continue to comply with applicable legislation at the federal and provincial/territorial levels, including the MVSA. The MVSA doesn't currently include standards for advanced automation technologies, but as vehicles with higher degrees of automation emerge on the market, there may be a need to amend regulatory requirements on a permanent or a temporary basis so these vehicles may be manufactured, shipped inter-provincially or imported into Canada.

The Strengthening Motor Vehicle Safety for Canadians Act came into force on March 1, 2018, introducing substantive amendments to the MVSA. In particular, it strengthened the Minister of Transport's enforcement and compliance authorities in the area of road safety, and afforded greater flexibility for addressing emerging technologies, such as AV/CVs. These authorities include provisions for exempting, modifying or suspending vehicle safety standards and regulations; an Administrative Monetary Penalty (AMP) regime; and, new powers to order recalls at no cost to the consumer.

IMPORTATION FOR TESTS OR TRIALS

The MVSA's section 7(1)(a) importation exception allows people or companies to temporarily import a vehicle that does not comply with the Canadian Motor Vehicle Safety Standards, if the vehicle is being imported only for exhibition, demonstration, evaluation or testing. This clause can be used for vehicles with automated and connected features that may not comply with existing motor vehicle standards, such as those not equipped with human driver controls.

To import a vehicle for one of these purposes, the applicant must complete and submit a _Schedule VII declaration_ form to TC for approval. If the information is accurate and complete, TC will authorize the vehicle to enter Canada for the reason stated by the applicant. The Schedule VII process allows for temporary importations for periods up to one year, or other periods specified by the Minister.

In addition to the Schedule VII permit, if the person or company intends to use the temporarily imported vehicle on public roads, they must complete a _Vehicle Import Form 1_, which will be presented to the Canada Border Services Agency and the relevant provincial/territorial department responsible for vehicle licensing and registration.

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2   It should be noted that in the event that the information within this document differs from the MVSA and associated regulations, the information contained within the legislation and regulations prevails.

PROCESS FOR SEEKING EXEMPTIONS

TC aims to create an environment that encourages the development and use of transformative technologies. Where existing standards and newly manufactured or imported vehicles that are planned for temporary or permanent use in Canada are not compatible, a company[3] may apply for an exemption from a prescribed standard.

Section 9 of the MVSA provides the Minister of Transport with authority and discretion to grant exemptions from current standards to promote the development of new safety features or new kinds of vehicles, technologies, vehicle systems, or components, including vehicles with automated and connected features. A company seeking an exemption must provide all information and documentation in sections 13 and 14 of the _Motor Vehicle Safety Regulations_, demonstrating that the exemption would not greatly diminish the overall safety performance of the model. Conformity with this process and provision of the necessary information doesn't guarantee that the exemption will be granted.

Companies can use this exemption to manufacture or import the vehicle model specified in the exemption order for as long as the exemption is valid. An exemption will only apply to the model of vehicle specified in the exemption order. Even with an exemption, companies are still responsible for all requirements in the MVSA and its accompanying regulations throughout the lifecycle of the vehicle, including notices of defect/non-compliance requirements.

Per subsection 9(3) of the MVSA, the exemption would be made public, which will also ensure a transparent and level playing field across industry.

ADDITIONAL MINISTERIAL ORDER PROVISIONS TO SUSPEND OR MODIFY REGULATIONS

In order to keep pace with emerging technologies, the _Strengthening Motor Vehicle Safety for Canadians Act_ provides more flexibility to ensure that Canada can build on these advances, while keeping Canadians safe. As such, subsections 13(1) and 13.1 of the MVSA allow for the adoption of regulations already available in another country, and to create short-term regulatory changes in advance of the full regulation being available:

> **Interim orders** allow for the suspension or modification of a Canadian regulation that corresponds to a foreign regulation if there is a change by that foreign government. The _Strengthening Motor Vehicle Safety for Canadians Act_ extended the period of an interim order from one to three years to reflect the typical length of time required to complete the full regulatory process.

> **Suspension orders** allow for the adaptation of existing Canadian regulations. In particular, section 13.1 of the MVSA allows for the temporary suspension, modification, or adaptation of an existing regulation. Suspension orders also have a maximum three year period. They are intended to provide a temporary solution while a permanent regulatory change is being developed. Introduced as a new provision under the _Strengthening Motor Vehicle Safety for Canadians Act_, this new Ministerial power allows Canada to adopt newer technologies more quickly than would be possible under the traditional regulatory process.

With these conditions, Canada can lead the way in regulatory development to address new and emerging technologies.

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3 The _Motor Vehicle Safety Act_ defines a company as a person: a) who is engaged in the business of manufacturing vehicles or equipment in Canada, b) who is engaged in the business of selling to other persons, for the purpose of resale by those persons, vehicles or equipment obtained directly from a person described in (a) or the agent of such a person, or c) who imports a vehicle or article of equipment into Canada for the purpose of sale.
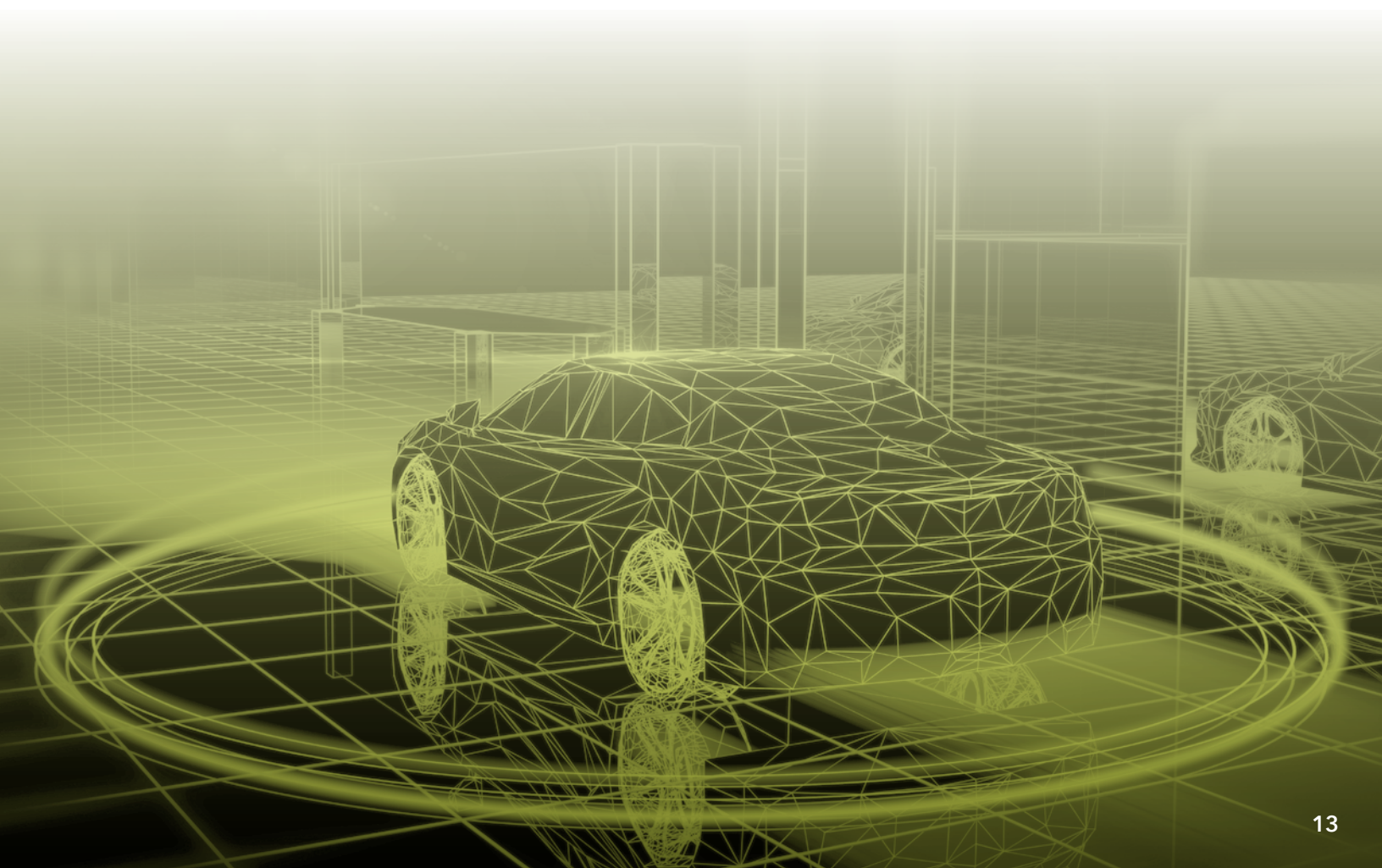
1.2 REGULATIONS AND STANDARDS

Under the MVSA, the _Motor Vehicle Safety Regulations_ sets out requirements for the importation of motor vehicles and designated motor vehicle equipment, and the shipment of newly manufactured motor vehicles and designated equipment across provincial/territorial boundaries, including AV/CVs.

The _Canadian Motor Vehicle Safety Standards (CMVSS)_, included within Schedule III of the regulations, set out the minimum performance levels vehicles and equipment must meet. Each standard includes, either directly or by reference to other documents, the performance requirements against which regulated vehicles and equipment are to be measured to determine compliance. Companies must self-certify that all new vehicles and equipment manufactured, shipped inter-provincially or imported in Canada comply with the applicable safety standards as of the date they are manufactured.

While TC regulates some advanced safety features, such as advanced lighting technologies, mandatory back-up cameras and electronic stability control systems, there are no standards at this time that deal specifically with automation features, such as automatic emergency braking, automated steering systems and adaptive cruise control. A number of the standards in the CMVSS reference user interfaces that must be available to a human driver, such as driver control features and requirements. Therefore the main challenge of future AV/CVs complying with today's regulations and standards is likely to happen if these vehicles are not equipped with human driver control features, such as the requirement for a brake pedal.

It is anticipated that several standards will need to be temporarily or permanently amended to permit these highly automated vehicles to be imported or sold in Canada; therefore, TC will continue to explore opportunities to incorporate AV/CV technologies into existing regulations or standards, or to create new ones, as required. Taking part in international forums focused on AV/CV standards development will help facilitate this work, as will research and analysis.

1.3 COMPLIANCE AND ENFORCEMENT (MOTOR VEHICLE SAFETY OVERSIGHT PROGRAM)

Manufacturers of vehicles or equipment are responsible for certifying that they comply with applicable standards and regulations, as per Canada's "self-certification". New vehicles manufactured in Canada and shipped inter-provincially must bear a National Safety Mark (NSM), as defined in sections 2 and 3 of the MVSA. This mark shows that a vehicle or equipment complies with the MVSA and its associated regulations and safety standards. TC authorizes its use and any company that intends to use an NSM must apply for one.

TC monitors and enforces compliance with the MVSA's regulations and standards in three main ways:

> *Compliance testing*: inspection and testing of regulated vehicles, tires and equipment for use in the restraint of children and disabled persons.

> *Compliance audits*: auditing companies, which includes reviewing certification documents, quality-control procedures, production capabilities and line operations, as well as examination of products.

> *Defect investigations and recalls*: documenting, analyzing, and investigating public complaints alleging safety-related defects and reviewing companies' Notice of Defect procedures and specific corrective measures (recalls).

As new technology is emerging at such a rapid rate, the *Strengthening Motor Vehicle Safety for Canadians Act* has also provided the Minister with more authority via a suite of enforcement tools that will encourage industry compliance with safety standards. Although they do not only apply to AV/CVs, they can be used to support new safety features or new kinds of vehicles or technologies. They include a new Administrative Monetary Penalties (AMPs) regime and information gathering requirements (Ministerial authority to get more information to analyze and identify defect or non-compliance), neither of which is in force yet, as well as "consent agreements", which offer enforceable terms and conditions as an alternative to AMPs.

The new AMPs regime will be subject to a rigorous regulatory development process (e.g. policy analysis and development, guidelines for the use of consent agreements, regulatory development and appeals process, training of enforcement officers) involving extensive and ongoing consultation, and will eventually be published in the Canada Gazette, Part II.

A range of new instruments will be established in support of the changes coming into force with the *Strengthening Motor Vehicle Safety for Canadians Act*. Specifically, there is a need to develop a process for designating companies that must provide a contact person to TC for communication and compliance purposes, and required to provide information to the Minister where notices of defect or non-compliance have been issued under the MVSA. In addition, TC is drafting a way to ensure government officials have the appropriate authorities under the MVSA to quickly remedy a safety defect or address non-compliance.

SECTION 2: CANADIAN NON-REGULATORY GUIDANCE

This section provides a non-exhaustive list of guidance documents, for both governments and manufacturers, to support and promote the safe testing and deployment of highly automated vehicles (SAE levels 3-5). Given the interconnectedness of safety and security, and the need to ensure AV/CVs will be cyber-safe, preliminary considerations for cyber security of AV/CVs is included. As more guidelines are developed, they will be included within this section to ensure that stakeholders are provided with the necessary tools to effectively and safely test and deploy this technology.

2.1 TESTING HIGHLY AUTOMATED VEHICLES: GUIDELINES FOR TRIAL ORGANIZATIONS (PUBLISHED HERE)

TC's Testing Highly Automated Vehicles: Guidelines for Trial Organizations seeks to clarify the various roles and responsibilities of federal, provincial and territorial levels of government involved in facilitating trials and establish a set of recommended minimum safety requirements that trial organizations are expected to follow when operating in Canada. Provincial and territorial jurisdictions are responsible for approving requests from trial organizations, based on their respective laws and regulations, and building upon these minimum requirements as they deem necessary.

Recognizing that highly automated vehicle technologies continue to evolve, these guidelines will be updated as needed, together with the Canadian Council of Motor Transport Administrators (CCMTA) member jurisdictions. This will ensure alignment with safety needs, as well as international trends and best practices. Provisions of these guidelines may also be further clarified as experience is gained through implementation.

2.2 CANADIAN JURISDICTIONAL GUIDELINES FOR SAFE TESTING AND DEPLOYMENT OF HIGHLY AUTOMATED VEHICLES-CCMTA LEAD (PUBLISHED HERE)

To advance a consistent, national approach to AV/CV policy, the CCMTA, in partnership with TC and Canada's provinces and territories, published the *Canadian Jurisdictional Guidelines for Safe Testing and Deployment of Highly Automated Vehicles*. This document is intended to provide guidance to provinces and territories on the various policy, legislative and regulatory issues they may need to consider to facilitate both the testing and deployment of AV/CVs, such as vehicle registration, driver training, testing and licensing programs, enforcement of traffic laws, and first response to traffic related incidents.

These guidelines will be updated as needed by the CCMTA member jurisdictions to ensure that stakeholders continue to receive relevant guidance on the safe testing and deployment of highly automated vehicles.
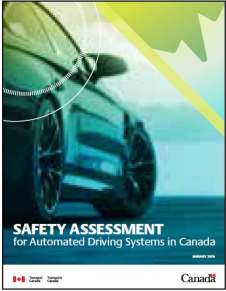
2.3 SAFETY ASSESSMENT FOR AUTOMATED DRIVING SYSTEMS IN CANADA

TC's Safety Assessment is a tool developed to support manufacturers as they review and manage the safety of SAE levels 3 to 5 vehicles before they are deployed on Canadian roads. The Safety Assessment is focused on vehicle safety issues that are not addressed in existing regulations, at a time when technologies are rapidly evolving and it is not yet appropriate to consider conventional regulatory approaches. This policy approach is aligned with other international partners, including the United States.

2.4 CYBER SECURITY

Cyber systems are an increasingly integral part of Canada's transportation network. They form the backbone of new and emerging technologies, including AV/CVs. As vehicles and transportation infrastructure become more automated and connected, there is an increasing need to protect and mitigate potential cyber security threats to their underlying cyber systems.

Cyber security is a shared priority amongst several lead federal departments and agencies, such as the Communications Security Establishment, Public Safety Canada (PS), Defence Research and Development Canada and the Royal Canadian Mounted Police (RCMP). Given the shared responsibility of road transportation with provinces and territories, TC is working together with all levels of government, industry stakeholders, and international counterparts, to better understand the range of cyber security issues. This will in turn inform the development of policies, directives and tools to guide stakeholders in using cyber security best practices as they design and deploy AV/CVs.

There is already important guidance in place both domestically and internationally, such as *Canada's National Cyber Security Strategy* and the *United States National Institute of Standards and Technology's Framework for Improving Critical Infrastructure Cyber Security*, both of which provide overarching cyber security vision and direction. Recognizing the need to equip stakeholders with targeted cyber security guidance, TC is working to develop key principles and best practices for resilient cyber security of AV/CVs, building on experience from other lead federal departments. Canadian guidance will align with international best practices, such as the United States Department of Transportation *Cyber Security Best Practices for Modern Vehicles*. Guidance will also be positioned around recognized key principles, namely collaboration and information sharing; secure digital infrastructure; intrusion detection, risk management; incident management; education and awareness; and privacy.

SECTION 3: AVAILABLE RESOURCES

3.1 RESEARCH AND TESTING

Developing AV/CV technologies requires extensive testing in a variety of environments, including on public roads and in closed test facilities. This is important as it allows industry to continue to develop, and for regulators to understand, what these technologies can do, along with their limitations. In addition, practical methods are needed to systematically, objectively and reliably assess the safety of road user interactions with AV/CV technologies.

TC is conducting driving simulator research to develop methods for evaluating the safety of driver interactions with automation. This "human factors" research explores how drivers interact with automation, test methods, interface design and the importance of appropriate trust in automation. This research is being done in coordination with other international research groups. In addition to the driving simulator research, TC has an eye-tracking system that shows how interacting with AV/CV technologies affects drivers' monitoring behaviour and patterns. The combination of driving simulator and eye tracker data will help TC in supporting and developing standards and guidelines for optimizing safety practices.

TC also has ongoing field operational tests that look at how advanced collision avoidance systems in heavy vehicles can help detect and possibly prevent collisions with vulnerable road users. These field operational tests are occurring at multiple cities across Canada to cover a wide range of weather and road conditions.

Lastly, TC is conducting research and testing on cyber security of AV/CVs in an effort to better understand and identify vulnerabilities and threats. This includes conducting vehicle vulnerability assessments on light, medium and heavy duty vehicles, in partnership with DRDC and the United States Department of Transportation, and working with academia and industry on vehicle cyber security research.

In Canada, a number of state-of-the-art facilities and test-beds, some of which are supported by various levels of government, test, evaluate and characterize the safety and environmental performance of AV/CV technologies. Although not an exhaustive list, the following are examples of some of these research and testing programs.

MOTOR VEHICLE TEST CENTRE

To support research and development related to AV/CVs, TC has already made significant investments in its Motor Vehicle Test Centre (MVTC), located in Blainville, Quebec. Additionally, the department conducts an array of AV/CV test activities at the MVTC to evaluate the performance of advanced driver assistance systems (e.g., automatic emergency braking, lane-keeping assist, pedestrian detection and avoidance systems), cooperative truck platooning, and vehicle-to-vehicle communications technologies, among others – technologies that are paving the way towards full automation.

PROGRAM TO ADVANCE CONNECTIVITY AND AUTOMATION IN THE TRANSPORTATION SYSTEM

TC's Program to Advance Connectivity and Automation in Transportation Systems (ACATS) was established to help Canadian jurisdictions address technical, regulatory and policy issues related to AV/CV. The program is providing $2.9 million in grant and contribution funding, over four years, for a variety of projects, including research aimed at identifying and mitigating AV/CV cyber security vulnerabilities.

ACTIVE-AURORA PROJECT

TC invested $1.3 million, under the Asia-Pacific Gateway and Corridor Initiative, toward the $3.7 million ACTIVE-AURORA project, Canada's first connected vehicle test-bed network. This project includes five on-road and in-lab test-beds at the Universities of Alberta and British Columbia. ACTIVE-AURORA is helping organizations test and evaluate new and emerging AV/CV systems, applications and services for both active traffic and demand management, and freight security and efficiency. https://www.stantec.com/en/projects/canada-projects/a/active-aurora-cv-testbed-network

AUTONOMOUS VEHICLE INNOVATION NETWORK

The Ontario Centres of Excellence (OCE) Autonomous Vehicle Innovation Network (AVIN) supports advancements in transformative automotive technologies, as well as transportation and infrastructure systems. This is accomplished in part through initiatives like the new AVIN demonstration zone in Stratford, Ontario, and through AV research and development partnership funds, which supports AV/CV technology projects in priority areas such as mass light vehicles, heavy vehicles, transportation infrastructure, intelligent transportation systems and transit-supportive systems and vehicles. AVIN will support the OCE in establishing six regional technology development sites across Ontario to harness regional capacity and support and enable small and medium sized enterprises to develop, prototype, test and validate new technologies. https://www.avinhub.ca/

3.2 PUBLIC AWARENESS

AV/CVs have the potential to bring positive impacts to Canadian society, including better safety and improved mobility. However for these benefits to be fully realized, drivers need to understand both the capabilities and limitations of the automation and connectivity features of their vehicles. Although numerous studies have been conducted on AV/CV technologies, including some that have touched on Canadian perspectives, there is limited information about public awareness of AV/CVs.

TC is currently exploring different facets of consumer awareness and public education needs as they relate to AV/CVs and will be looking at innovative approaches to address them moving forward. This work will include public opinion research to better understand how Canadians learn about emerging vehicle technologies, as well as their perception and confidence in AV/CVs. This research will help to support future programming to enhance public awareness, safe use, and safe interactions with these technologies.

The emergence of AV/CV technologies may also pose unique ethical questions, such as how an automated vehicle makes certain decisions when interacting with other road users and how intelligent transportation systems are designed and managed to maximize public benefits. TC continues to work with academic institutions to further scope and understand these and other issues, and how they may inform future policy development and public awareness.

3.3 INFORMATION SHARING FORUMS

Jurisdictions and organizations worldwide are working to develop regulatory frameworks, guidelines, and standards for AV/CVs that are informed by test results and best practices. Recognizing that collaboration and engagement with a variety of stakeholders is key to ensure effective decision making in this environment of rapid change, TC consults regularly and on a range of topics with industry experts, academia, international governments, and other key partners. TC will continue to engage with stakeholders to ensure a cohesive and collaborative safety approach for AV/CVs. In addition to informal consultation, TC will also continue to leverage existing forums to learn, inform, validate and share information and best practices.

The following non-exhaustive list of forums provides an overview of some of the mechanisms through which TC engages and collaborates with program partners:

CANADIAN COUNCIL OF MOTOR TRANSPORT ADMINISTRATORS (CCMTA)

The CCMTA is a federal-provincial-territorial organization that coordinates all matters dealing with the administration, regulation and control of motor vehicle transportation and highway safety. Membership includes representation from all provincial and territorial governments, and the federal government, where TC plays a key leadership role. TC actively participates in the CCMTA working group on AV/CVs, and has leveraged this forum to consult on multiple policy initiatives.

TRANSPORTATION ASSOCIATION OF CANADA (TAC)

The Transportation Association of Canada (TAC) is a national technical association focused on road and highway infrastructure, and urban transportation that provides a forum for members to share ideas and information, build knowledge, and work together to address transportation issues and challenges, including those associated with AV/CVs. Membership includes all levels of government, representatives from the private sector, academia and key associations. TC has been working with the TAC, and other key partners, to address AV/CV issues, like road signs, design and infrastructure readiness.

MEMORANDA OF UNDERSTANDING

To deliver a more responsive approach to emerging technologies, TC is engaging with other countries, international organizations, and vehicle manufacturers in order to enhance cooperation and encourage widespread deployment of features with clear safety benefits for Canadians (for example, automatic emergency braking and automatic lane-keeping). These engagements could include Memoranda of Understanding (MOUs) that strengthen collaboration between the parties and share best practices and lessons learned in this rapidly evolving field. MOUs also present opportunities to help us build on our respective resources and expertise, to ensure the safety of AV/CV technologies, and to tap into the economic opportunities these technologies present.

G7 WORKING GROUP ON AUTOMATED AND CONNECTED DRIVING

In 2017, G7 Ministers recognized the significant opportunity that advanced technologies for vehicles and infrastructure offer, not only in improving road safety and environmentally-friendly mobility, but also in providing new transportation solutions that can benefit the aging population, people with disabilities and low-income users. Ministers agreed there is a need to facilitate the development of AV/CVs, and to work together to share approaches and best practices. As such, the G7 Working Group on Automated and Connected Driving was established, with an objective to build on previous year's G7 Transport Ministers' Meetings and to share approaches to further the exchange of international best practices and public policy perspectives associated with the ongoing evolution of AV/CVs. TC provides significant support to advancing Canada's engagement on this Working Group.

CANADA-UNITED STATES COLLABORATION

Canada and the United States share a deeply integrated automotive sector and very closely aligned regulatory regimes for motor vehicles, both of which are based on self-certification. Both countries also support a flexible, non-regulatory approach to AV/CV testing and deployment. Given these similarities, TC and the United States Department of Transportation regularly share best practices and lessons learned on AV/CV issues of mutual interest. Further dialogues are anticipated to identify bilateral areas for collaboration on AV/CV safety moving forward.

The Regulatory Cooperation Council (RCC) facilitates cooperation between Canada and the United States to reduce regulatory differences and streamline procedures with unnecessary requirements and costs for citizens, businesses and economies. Its goal is to make the Canadian and United States economies stronger and more competitive, while meeting the fundamental responsibilities to protect the safety and welfare of citizens. There are currently two work plans in place between TC and the United States Department of Transportation, through the RCC, to advance collaborative work on AV/CVs:

> The *Motor Vehicle Safety Standards Work Plan*, which facilitates alignment of motor vehicle safety standards, taking into account each country's safety risks and needs.

> The *Connected Vehicle Work Plan*, which includes work on cyber security research, Intelligent Transportation System (ITS) Architecture and Security Credential Management System development.

INTERNATIONAL STANDARDS ORGANIZATION COMMITTEES

Various international standards organizations, such as SAE International, the International Organization for Standardization, and the Institute of Electrical and Electronics Engineers, among others, are making significant developments in the AV/CV space. For current information on their publications, recommendations, standards and other resource information, please consult their websites:

> SAE International

> International Organization for Standardization

> Institute of Electrical and Electronics Engineers (IEEE)

International coordination will be required in order to safely harness the full potential of AV/CV, including consideration for interoperability and harmonized connectivity. As such, TC actively participates in international forums to assess and develop international standards and guidelines for driver assistance technologies, and in several committees on driver distraction and human machine interfaces.

UNITED NATIONS WORLD FORUMS

TC is the Government of Canada lead on the United Nations (UN) Global Forum for Road Traffic Safety (WP.1) along with the UN World Forum for Harmonization of Vehicle Regulations (WP.29) and its subsidiary sub-committees, which includes the recently announced Working Party of Automated/Autonomous and Connected Vehicles (GRVA). The GRVA will be responsible for developing international regulations and requirements for AV/CVs. WP.1 has adopted a Consolidated Resolution on highly and fully automated vehicles, and is considering issues that include the operation of a highly automated vehicle from outside the vehicle, and determining other activities a driver should or should not do in a highly automated vehicle.

AUTOMOTIVE INFORMATION SHARING AND ANALYSIS CENTER

The United States Automotive Information Sharing and Analysis Center (Auto-ISAC) is an industry-driven community to share and analyze intelligence about emerging cyber security risks to the vehicle, and to collectively enhance vehicle cyber security capabilities across the global automotive industry, including light- and heavy-duty vehicle original equipment manufacturers, suppliers and the commercial vehicle sector.

SECTION 4: WAY FORWARD

4.1 FUTURE DIRECTION

Moving forward, TC will use a multi-pronged approach to maintaining safety and fostering AV/CV innovation, including modernized legislation and regulations; flexible and responsive policy and regulatory frameworks, standards, and institutional partnerships; and guidance and tools for industry and jurisdictions. Taken together, this will inform a strategic pan-Canadian approach to the safe development, testing and integration of AV/CVs in Canada.

The Safety Framework will continue to be updated as more information is collected and these technologies mature, and will serve as a key resource to monitor new developments that may inform shifts in non-regulatory guidance and new regulatory measures that may be required. TC will continue to align Canada's safety approach with the United States and other key international partners, to ensure interoperability, continued safety and economic benefits for the Canadian economy.

4.2 AV/CV SAFETY INITIATIVES

The following table provides an overview of TC's planned future activities to ensure the continued safety of AV/CV development and deployment in Canada. Please note that due to the rapidly changing environment, advancements in the field, and shifting priorities, this is not an exhaustive list and activities are subject to change.

GUIDING PRINCIPLE	WAY FORWARD
ENHANCED SAFETY AND SECURITY	Working with all levels of government, and the automotive and transportation industries, to incorporate safety and security considerations into AV/CV testing and deployment. Activities include: > Developing regulations and policies to accompany new provisions under the *Strengthening Motor Vehicle Safety for Canadians Act* > Addressing data management, privacy, and cyber security concerns, including the development of guidance to ensure AV/CVs remain cyber-safe > Public awareness initiatives > Facilitating and coordinating research opportunities to inform future regulatory and non-regulatory development that promote AV/CV safety, ensuring alignment with international trends and best practices
MODERNIZED AND INNOVATIVE APPROACH	Exploring opportunities to reduce barriers to innovation in AV/CV research, testing, and deployment. Activities include: > Establishing formal and informal agreements with key partners to advance AV/CV innovation > Exploring the possibility of developing new classes of motor vehicles in the MVSR to accommodate AV/CV > Examining the current suite of regulations as part of the broader Treasury Board Secretariat-led Regulatory Modernization initiative, with a focus on AV/CV safety considerations
STRENGTHENED ENGAGEMENT AND COLLABORATION	Continuing to maintain strong partnerships with all levels of government, academia, and industry, and forging new ones, to ensure that all stakeholders have the latest information and data to inform effective decision-making. Activities include: > Establishing an online digital platform for collaboration with stakeholders within and outside government to share information, ideas and address key AV/CV issues > Leveraging existing information, resources, or capabilities of other jurisdictions, and other countries which have shared AV/CV priorities
CLEAR AND CONSISTENT OVERSIGHT	Continuing to undertake coordinated stakeholder engagement efforts to ensure transparency and awareness of AV/CV safety, and the continued alignment of Canada's shared vision for AV/CV safety with key international partners.
CONTINUOUS IMPROVEMENT	Reviewing and updating policies, frameworks and regulatory processes in consideration of new information and developments.