



Continuous Road Testing Ltd brings innovative solutions to the problem of vehicle skidding collisions caused by ice, slush and snow. Skidding collisions cause substantial losses to the society in regions where high numbers of these collisions occur. For many years an illusion, a false sense of security, has been created that skidding collisions are no longer a concern, yet the opposite is true. At the time of writing this brochure, the websites of automakers were specifying that the hands-free driving mode on autos and trucks should not be used on “slippery roads”. These warnings would indicate that a solution to measure road surface friction while driving was not available as a factory-installed technology. While continuous friction measuring equipment (CFME) may not be suitable for use on cars due to fairly large dimensions as seen in the above photo, it can be installed on trucks. CFME measures friction with competence while driving at the speeds of streets or highways.

Why are there so many multi-vehicle collisions at times when highways are icy? It is because the driver’s perception of ice, frost and related slippery conditions becomes very unreliable as driving speed increases. Hands-free modes, semi-autonomous vehicles, and technology for truck platooning are primarily for highway driving, not for cities, and therefore the automated driving technologies would be used at higher speed. The urgency to make driving on icy highways safe has never been more pronounced.

Continuous Road Testing Ltd has been building and innovating continuous friction measuring equipment for more than a decade. Until other solutions are found for the problem, why not measure friction while driving with Ice-Check CFME and avoid skidding collisions? There is no plausible reason that skidding incidents on ice cannot be avoided in this modern age by keeping apprised of the road surface friction at the location where you are driving.

Without CFME, winter ice control operations performed by sand spreaders, salt spreaders, or brine trucks, have major deficiencies. Temperatures below minus 9°C negate or diminish the effectiveness of salt or chemical brine. Conventional ice control is not a reliable solution to prevent skidding collisions on highways unless the surface is checked in a follow-up inspection measuring the friction.

Our CFME was originally designed to be used to assist winter maintenance operations with follow-up inspection, to ensure coverage during ice control operations. As elaborated in official government specifications, the purpose for spreading materials such as abrasives, salt, or brine is to improve friction. To check the effectiveness of ice control it is necessary to measure friction.

Knowing the coefficient of friction as measured by CFME will allow spreader operators who spread materials on the highway to optimize ice control. Knowing the coefficient of friction will also allow drivers to tailor their driving speed, following distance, and preparedness to avoid other vehicles that may skid out of control in adjacent lanes.

Companies that operate fleets of vehicles delivering goods and services are impacted by the costs of highway collisions as well as the ensuing traffic delays. In Canadian provinces, slippery winter contaminant has been a factor in 5% to 25% of all serious injury collisions for over twenty years. The rate of fatality collisions on slush, snow or ice is alarming. The traffic collision statistics justify an investment in friction measuring programs.

The Ice-Check CFME has gone through extensive field trials over more than a decade. To assure that friction measurements produced by this technology are representative of the grip for tires to perform the necessary steering and braking actions, we did two things: We drove close to 80,000 kilometers using the CFME in winter, and we developed special procedures to study the plus/minus tolerance for accuracy in a variety of road conditions. These performance evaluation procedures were published in a technical paper in 2022 to help others understand the potential as well as the limitations of CFME technology. The operating mechanisms of the Ice-Check are described in the patents listed on the last page of this brochure.

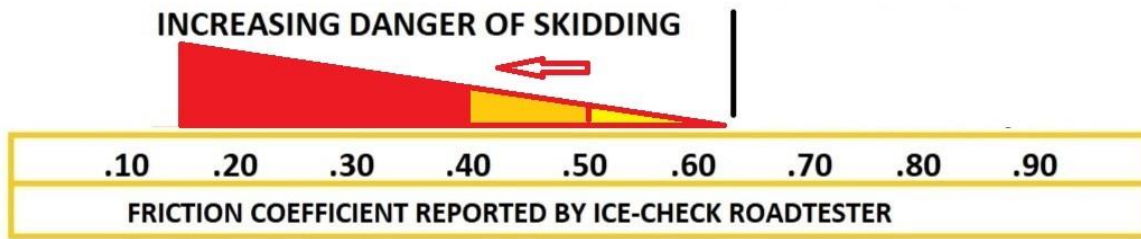


Illustration showing how risk of skidding is related to coefficient of friction μ

Continuous Road Testing Ltd has been a long-time advocate of *friction measuring programs in winter*. Either privately-funded or publicly-funded friction measuring programs would reduce the numbers of skidding collisions amongst vehicles that are not equipped with CFME and that includes the majority of vehicles. Vehicles equipped with CFME have real-time friction data and therefore would not rely upon road condition reports, but for the rest of the vehicles that use highways, road condition reports are the “life-line”.

What data is needed by drivers to avoid skidding collisions?

When the road surface has very low friction the road surface will often look much better in terms of slipperiness than the *true* or *actual* condition. Deceptive appearance of an icy road surface will add further to the risk. Black ice and freezing rain are difficult to see. With the **Ice-Check** we measure the resistance-to-skidding force parallel to the road surface. The resistance-to-skidding force will be representative of the steering, handling and braking efficiency of a vehicle on road surfaces.

Drivers require a warning of slipperiness i.e. low friction, that could allow their vehicle to slip when the force on tires pushing parallel to the road surface exceeds the resistance-to-skidding. The **Ice-Check** will provide drivers with a live display of friction coefficient that is updated at least once per second while driving. The quicker that the warning arrives, the better. It is necessary to watch our videos to see how quickly the measurements of friction respond when we drive from bare pavement onto a patch of ice. At slower driving speeds, the line trace responds and updates instantly. At higher driving speeds, there will be a slight delay before the line trace responds and updates.

Real-time displays on tablet or laptop computers used in conjunction with small warning lights keep the driver informed. Friction values above .65 μ correspond to bare pavement free of any ice. When ice is present and is reducing friction, the displayed value will be below .60 μ . When contaminated by frost or ice the range of friction is between .20 μ to .60 μ . The values reported by Ice-Check correspond proportionally to the resistance-to-skidding force as measured using a representative rubber compound testing tire.

The following examples are a guide to maintain a margin of safety. If the coefficient of friction is reported to be less than .30 μ by the **Ice-Check** then our advice is to drive no faster than 30 miles per hour (48 KPH). This will depend on traffic conditions and visibility so it is a guide only. If the coefficient of friction is .45 μ , our advice is to drive no faster than 45 miles per hour (72 KPH). This recommendation comes from seeing the frequent slide-off vehicles in the ditches. Although there may be no injuries these slide-off incidents could have had serious consequences. We take notes on the coefficient of friction at the location of skidding incidents and this gives us an idea of a safe driving speed and also an idea of where to set the thresholds that activate the warning lights.

A program to measure friction on a highway would involve the following steps

1 – A truck carrying **Ice-Check** tests the highway driving in the lane that would be used by slower traffic and by large transport trucks. When safe to do so, occasionally check the passing lane. If the passing lane is very slippery then that information should be noted on the report. Any condition that could cause a skidding incident should be noted.

2 - The patrol truck that we will call Vehicle A, carries **Ice-Check** friction measuring equipment. The recipient of a friction file, Vehicle B, also has a laptop computing device with our proprietary GPS software. The driver of B intends to use the file of data received from A. It is necessary for B to drive in the same highway lane where the friction was measured. If B leaves that lane or turns off the highway, for example when stopping to get gas, the displayed measurements will turn off. The measurements will come back on the screen when B returns to the highway.

3 – The friction data files may be shared by cellular communication with other drivers and with a central dispatch or operation office. Data-sharing could be called “pitch and catch” because one vehicle pitches the data and the other one

catches it. The vehicle catching the data is not sending any data back to the first vehicle.

4 – Warning lights are available to help the driver maintain a safe speed. The green light indicates no added risk. An amber light is triggered by a threshold set at .60 Mu. Amber means to take added caution because ice is likely to be on the road. A red warning light will be triggered by a threshold set at some level below .60 Mu as decided by the user of the equipment.

The trucking industry is suffering substantial losses from winter collisions

In a short span of time, between November 2023 and February 2024 several hundred semi-trailer and heavy truck collisions and “slide-offs” have occurred in Canada. In January 2024 alone, over 400 heavy truck or CMV incidents requiring towing and often involving extensive damage, were reported in Ontario. The majority of those incidents were ice-related. Every province had its share of heavy truck and Commercial Motor Vehicle skidding collisions. A large number of the ice-related collisions across Canada have been on the TransCanada Highway and other major highways. These highways are critical to the movement of goods and services. The trucking industry could benefit substantially from CFME. Installation of CFME on heavy trucks (trucks with standard 22.5-inch tire size) has potential to reduce the numbers of skidding incidents. The frame of the truck and the clearance height between road surface and bottom of the truck are to be considered. At the time of writing, the **Ice-Check** has been used extensively on ½, ¾ and 1-ton trucks. The equipment is installed at the beginning of the winter and removed in the spring. In a city environment we use a towed trailer equipped with CFME. A pickup truck or SUV can tow the trailer.

The well-known friction formula ($F_f = \mu N$) is largely responsible for repeatability of friction measurements and reproducibility of friction graphs

A major difference between the **Ice-Check** and other friction testing equipment is as follows: The **Ice-Check** testing tires do not cause frictional melting of ice or packed snow. Whenever tires slip on ice, the ice melts under the tires creating a lubricating layer of water. Our CFME **do not** heat up the surface of ice enough to melt the ice and create that lubricating film of water.

A formula ensures repeatability. The friction formula ($F_f = \mu N$) will apply, it will hold true and ensure repeatability, if frictional melting caused by tire slippage does not change the surface from its solid state. If on the other hand, frictional melting creates a lubricating layer of water, the formula will no longer ensure repeatability. That is the fundamental difference between the **Ice-Check** and the rest of the CFME that have been advertised as capable of measuring on ice.

Using CFME to improve winter maintenance services provided by highways contractors

If equipment measures resistance-to-skidding, then that equipment can likely measure and report reliable measurements representing the safeness after an application of sand, salt or brine. A rubber tire in contact with the road surface is the only way to measure resistance-to-skidding. Therefore the most economical and practical way to perform a follow-up inspection is to measure resistance-to-skidding and it is necessary to use CFME with testing tires.

After measuring friction on a highway there are several methods of alerting the public or informing the public of conditions that pose a high risk. Changeable signage along the highway can temporarily lower the speed limit. On-line road reports are another alternative.

CFME provide information that no RWIS system can provide. Road Weather Information System (RWIS) technology does not determine the efficiency of applications of sand, salt or brine. Fixed RWIS weather stations along a highway, even if spaced at 10-kilometer intervals, don't offer much information on road conditions between stations. The RWIS stations are expensive, reportedly some are priced in the range of \$100,000. Mobile RWIS trucks do not determine the efficiency of applications of sand, salt or brine because they do not have a representative testing tire in contact with the surface.

CFME provide an economical solution for winter maintenance on highways in remote regions where highways are hundreds of kilometers in length. Friction measuring patrols could be very cost-effective as compared to attempting to spread abrasives, salt or brine. Essential routes in rural areas such as school bus and emergency vehicle routes could be monitored by local organizations or municipal governments. Routes with high AADT (average annual daily traffic) such as circumferential roads around cities would be candidates for friction measuring programs. Bridge decks that are prone to ice have caused huge numbers of

skidding collisions. These decks could be monitored at reasonable cost. It is important to minimize the use of salt or calcium chloride on bridges due to corrosion of reinforcing steel and other infrastructure damage.

Canadians use over 5 million tonnes of salt annually on roads to reduce skidding collision numbers. Continuous friction measuring equipment (CFME) provide a solution to reduce the harmful effects on the environment of salt use. Using CFME in a well-managed program will provide a solution to reduce the numbers of skidding incidents and, at the same time, reduce the damage to the environment.

Between 2003 and 2014 governments funded eight Canadian research studies involving CFME equipment sourced from US and European companies. An early prototype of the Canadian-made Ice-Check was evaluated in two of the projects.

Many research studies centred around the use of CFME have been carried out in European countries and in the United States. During the studies the CFME were operated on ice-contaminated roads or airfield runways. Some studies involved braking tests and electronic decelerometers to compare CFME with braking tests. In Canada there have been eight of these friction measurement projects. As an example, a 2008 Canadian project was carried out by the Transportation Association of Canada. At the time we supplied a pickup truck equipped with CFME for a short evaluation period. The TAC project was entitled “Winter Maintenance Performance Measurement Using Friction Testing”. The executive summary of the project report states: **“The Transportation Association of Canada has a long-term vision to utilize the benefits of winter road surface friction testing in facilitating winter maintenance planning, evaluating the effectiveness of winter maintenance operations, minimizing environmental impacts, and enhancing road safety by communicating friction levels in a format that can be understood by motorists”.**

Continuous Road Testing Ltd built CFME for an MTQ project in 2007. The CFME that we provided were compared with other CFME sourced from Europe and the USA. The existence of the research studies and the fact that the World Road Association PIARC has organized a congress on winter roads every fourth year, and publishes the Snow and Ice Data Book at the time of those winter congresses, show that there is worldwide interest in prevention of skidding collisions on winter roads.

Continuous Road Testing Ltd participation in the 2010 World Winter Roads Congress and 2022 World Winter Service and Road Resilience Congress

At the 2010 PIARC World Winter Roads Congress we hosted a booth in the exhibition hall and in the outdoor exhibition, exhibited a Ford Ranger pickup truck carrying our CFME with testing tire. Twelve years later, in February 2022, *Continuous Road Testing* participated in the 2022 PIARC World Winter Roads Congress. The congress was called Calgary 2022 World Winter Service and Road Resilience Congress.

For the 2022 congress *Continuous Road Testing* submitted (accepted by the technical committee) a paper titled *“Using Road Surface Friction Reports in Winter Service – Designing performance tests for continuous friction measuring”* for inclusion in the session WS 3.1 Winter Indices and Friction.

The an excerpt from the introduction to the congress session reads: *“...New technologies in data collection, transfer and analysis enable new innovative technologies to support decision makers. Winter weather events can have very different impacts on a road network depending on the road. In addition each winter weather event is different in its own with countless combinations of precipitation type, rate and temperatures. To compare such events and winter service operations winter indices can be used and are presented in this session. Road friction is the main value to keep up to ensure traffic safety. How winter weather affects friction and how it can be measured is part of this session.”*

A PDF copy of our 14-page paper that was included in the Winter Indices and Friction session is available if you send us a request at the email address glenbrown@ice-check.com

Repeatability is the “must-have” requirement of winter CFME

With our GPS software it is a straightforward matter to check for repeatability. Repeatability is the foremost requirement of all instruments for measuring things like temperature, force, speed etc. To evaluate a CFME for repeatability drive around a loop of several miles of highway. Record a friction file while driving around the route. Save that file and then open it up again before driving around the loop a second time. Now you can compare the two displays of measurements. One screen shows the “first pass” and the other screen shows the “second pass” around the same route. This experiment takes less than an hour and proves 1) locational accuracy of measurements and 2) repeatability of measurements.

That repeatability evaluation is absolutely essential and it differentiates CFME from the technologies that do not utilize testing tires such as the “non-contacting” technologies and the “car wheel-slip” technologies. A repeatability evaluation may be carried out on bare pavement when there are changes from a pavement surface providing less friction to one providing more friction. Transitions from older polished pavement to newer asphalt or concrete will exhibit an increase in friction. The repeatability evaluation should also be performed on ice-contaminated pavement as the CFME will be used specifically to measure the roads when they are contaminated or to ensure that they are not contaminated. To ensure that the measurements are not influenced by the speed at which the testing is performed it is wise to repeat the evaluation at more than one speed although do not exceed a speed that is safe on slippery conditions.

While repeatability is important, CFME must also be practical to use. The tires on a Roadtester outlast tires on other CFME-type products by over ten times the distance. The **Ice-Check** can test pavement for 800 kilometers (500 miles) before it is recommended to replace the testing tire or check the tire tread depth.

GPS moving graphs of Coefficient of Friction show the recent trend, either descending or improving, of friction measurements.

A line graph provides a forecast of the conditions ahead on the road surface. Occasionally slippery conditions occur without advance warning, but in the majority of scenarios, the friction graph will show a trend of descending friction either at localized areas on the road or over several kilometers. **Ice-Check** friction measurements are displayed both as a moving line graph and as a number seen in the upper corner of the screen. The number representing Mu updates at a rate of once every ~ 40 meters or once per second. GPS software is used to record and save data as a spreadsheet file with each measurement traceable back to an exact location on the highway.

The photo below shows the testing results from two testing tires on the same truck. One is following the truck in the left wheel path. The results are seen on the left computer screen. The right computer screen shows results from the testing tire in the right wheel path. The coloured horizontal line or threshold is set at .40 Mu. On this particular day at the time of measuring, there were patches of ice as seen by the measurements below .40 Mu, and patches of bare pavement caused by evaporation/sublimation of that ice as seen by the upward spikes reaching .80.

In ending, I would like to repeat an excerpt cited above: *"...Road friction is the main value to keep up to ensure traffic safety. How winter weather affects friction and how it can be measured is part of this session."* (Excerpt from the introduction to the congress session WS 3.1 Winter Indices)



FOR ADDITIONAL INFORMATION PLEASE CONTACT US

European Patent No. EP3749947, US Patent No. 10,775,295, US Patent No. 6,928,857, Canadian Patent No. CA 2,994,127 (Apparatus for Measurement of Road Surface Friction)

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