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NRC-CMRC

***Test Protocol for Vehicular Breath
Alcohol Interlock Devices in Canada***

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Technical Report

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Rapport technique

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Canada

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1 INTRODUCTION

1.1 Purpose

This document describes the proposed test methods required for type acceptance of Breath Alcohol Interlock Devices by the Canadian federal government. It identifies the functional, durability, environmental, accuracy, electromagnetic compatibility and special alcohol interlock performance tests needed to qualify any particular unit, or family of units. It is principally directed at test laboratories and alcohol interlock manufacturers.

Regardless of how a vehicular alcohol interlock is designed, manufactured or used, it must be qualified under this test protocol in order to comply with the Canadian standard.

1.2 Background

This test protocol provides detailed descriptions on how to test alcohol interlocks destined for use in Canada. The document is meant to be distributed to, and used by, testing agencies who will be performing the tests and to manufacturers who must understand what will be required in order to fulfil the requirements of the standard and prepare the devices for testing. This document in no way attempts to outline the definitions nor to explain the purpose, function or construction of the alcohol interlock devices themselves. It is assumed that the manufacturers and testing agencies will have read and understood the technical standard document: “*A Technical Standard for Vehicular Breath Alcohol Interlock Devices in Canada*” [1] for all such topics.

There are a variety of test protocols published worldwide, each describing alcohol interlock test requirements for specific countries, and/or regions of the world. Although some of these documents were drafted for particular Canadian provinces, none of them refer to Canada as a whole. As such, it is of interest for Transport Canada to develop a relevant, and technologically current, test protocol that could be accepted nationwide and adopted by all the provinces and territories. This proposed test protocol is a compendium of the alcohol interlock documents researched to date with any irrelevant or out-dated information removed and any new information, based on new technology, added as necessary. Special attention was paid to information that was deemed to be particularly relevant to Canada, such as climatic conditions. Although many documents were reviewed as part of this program, the following documents formed the primary reference set for the development of this proposed test protocol:

1. Province of Alberta – Qualification testing specifications for BAID 1992 [2]
2. US Federal Register – Model specifications for BAIDs 1992 [3]
3. Australia – Breath alcohol testing devices for personal use 1993 [4]
4. Europe – Test Methods and performance requirements 2007 [5]

1.3 Limitations

This test plan outlines the set of tests that shall be used to measure and quantify the performance of the alcohol interlocks. It is not intended as a means to ensure that the alcohol interlocks are in strict compliance with every aspect of the technical standard, particularly those

criteria which are observed and not measured. As such, certain aspects of the alcohol interlocks such as mouthpiece construction, fusing, documentation and labelling, to name a few, have not been explicitly defined in this test protocol. It will be up to the individual manufacturers to ensure that they have complied with all such aspects of the standard.

2 GENERAL TEST REQUIREMENTS

This section describes the requirements for the testing facilities, the personnel and equipment required to perform the tests that have been stipulated to meet the requirements outlined in the standard.

2.1 General

Tests shall be conducted in the order given in Section 3. The pass/fail criteria for each test is clearly indicated in Section 3 and the result of each test must be entered into the test log (Table 3) as soon after the completion of the test as possible. Should an alcohol interlock, or group of alcohol interlocks fail any test, testing shall be halted and the reasons for test stoppage shall be clearly recorded in the test log (Table 3) for the final test report. Depending on the nature of the failure, and the steps required to correct the failure, a decision shall be made as to restarting the testing from the beginning or from the point at which the device failed. This decision shall be made by Transport Canada or by the test authority on behalf of Transport Canada.

2.2 Test Facility

The testing organization shall have, at a minimum, access to the following facilities:

- A general test area that is clean and large enough to house the alcohol interlocks and a vehicle simulator or an actual vehicle;
- A general test area capable of maintaining a controlled ambient condition of +18 °C to +28 °C with a humidity of not greater than 85% and a pressure of 78 to 118 kPa for the non-climate tests;
- A climate chamber capable of maintaining temperatures from -40 °C to + 85 °C with a relative humidity of at least 90% for the climate tests;
- A shaker table or vibration facility capable of maintaining a vibration of 1,050 Hz and an amplitude (displacement) of +/- 5 mm;
- A component dust chamber; and
- A component water spray test chamber.

2.3 Test Personnel

The tests shall be performed by engineers and/or technologists who are familiar with, and experienced in, the fields of mechanical, electrical, vibration and climatic testing as well as data acquisition, analysis and reporting. It is expected that the test personnel will only require training for the specifics of the alcohol interlocks or evidentiary instruments and not in the fields of test setup, generic testing and analysis/reporting of test results. At all times, the test personnel must remain completely unbiased and may not have a financial or business interest in any of the manufacturers that have provided the alcohol interlocks. During the initial days of

testing for a given manufacturer's unit(s), a technical representative from that manufacturer must be present, or on-call to be present, to assist with any setup or troubleshooting that may be necessary during the testing.

2.4 General Test Equipment

All instruments and test equipment used in the following test procedures shall be in a current calibrated status, traceable to a national standard. A list of recommended test equipment is provided in Section 2.6. At the completion of each major test group, a test report will be issued including a list of the actual test equipment used. The list will include the test equipment name, manufacturer, model, calibration date, scale/range and error. The list will also include any data acquisition systems that are used as part of the test program.

2.5 Special Test Equipment

In order to perform some of the tests described in this document, it will be necessary to acquire specialized test equipment specific to the field of alcohol detection and measurement. These may include breath alcohol simulators and breath alcohol evidentiary instruments. These devices, fully calibrated, may be acquired from RCMP forensic laboratories. The specific test devices must be operated by trained personnel.

Standard alcohol reference solutions must be available or mixed and will be used in the alcohol simulators as defined in Section 2.10.

2.6 Test Equipment List

In addition to generic test and laboratory equipment, the test agency should have, as a minimum, the following alcohol interlock specific equipment, support items and consumables on site to assess the performance of the alcohol interlocks. Some devices required for the referenced ISO and EN Standards may not be listed in Table 1. It will be necessary for the test agencies to acquire and understand all the relevant references ([6] through [12]) listed in this test protocol.

Table 1 – Required test equipment

Item	Classification
2-Propanol	Chemical
Acetaldehyde	Chemical
Acetone	Chemical
Carbon Monoxide	Chemical
Dyethylether	Chemical
Ethyl acetate	Chemical
Methane	Chemical
Methanol	Chemical
n-heptane	Chemical

n-hexane	Chemical
n-octane	Chemical
n-pentane	Chemical
Toluene	Chemical
Data Acquisition System	Data Acquisition Instrument
Laptop computer	Data Acquisition Instrument
Altitude/vacuum Chamber	Facility
Climate/humidity chamber c/w controllers	Facility
Dust Chamber	Facility
Shaker Table	Facility
Water spray chamber	Facility
3g accelerometers	Instrument
Electrical function/wave generator	Instrument
Humidity sensor	Instrument
Pressure transducer	Instrument
Spirometer	Instrument
Stopwatch and timer	Instrument
Thermocouples and temperature probes	Instrument
Voltmeter/Multimeter	Instrument
1mm steel rod	Support Equipment
Aerosol can of compressed air/CO ₂	Support Equipment
Balloons	Support Equipment
Charcoal/filters	Support Equipment
Cigarettes	Support Equipment
Drinking alcohol	Support Equipment
Distilled water	Support Equipment
Fuses	Support Equipment
Gas sample bags/Tedlar® bags	Support Equipment
Gas volume measuring device	Support Equipment
Glassware and plastic cups	Support Equipment
Hoses/clear tubes	Support Equipment
Talcum powder	Support Equipment
Tape measure	Support Equipment
Transformer	Support Equipment
Variable DC Power supply	Support Equipment
Vehicle simulator	Support Equipment
Vehicle with manual transmission	Support Equipment

2.7 Order of Testing

Five major groups of performance tests have been identified:

- Group 1: Durability Tests (Section 3.2);
- Group 2: Environmental/Climatic Accuracy Tests (Section 3.3);
- Group 3: Electrical Tests (Section 3.4);
- Group 4: Special alcohol interlock performance tests (Section 3.5); and
- Group 5: EMI/EMC Tests (Section 3.6).

2.8 Alcohol Interlocks Delivered to the Test Facility

Any manufacturer wishing to qualify an alcohol interlock model for testing shall deliver six identical units of that model to the testing agency. From that group of six units, two will be randomly selected to be sequentially subjected to all of the tests in Groups 1 through 4 above. These test units will be clearly labelled as 'A' and 'B' and will remain marked as such throughout the entire test program. If requested, the manufacturer will be allowed to calibrate the units before testing. None of the units may be re-calibrated at any time during the test sequence with the exception of the long term stability/calibration tests. A third unit will be randomly selected from the remaining four units and labelled as unit 'C'. Unit 'C' will be used for the EMI/EMC tests which may be performed at any time throughout the test sequence.

2.9 Conditions for Testing

With the exception of the tampering and circumvention tests, all anti-tampering features may be turned off for the tests.

Batteries may be replaced or recharged before individual tests are conducted.

All tests shall be conducted with the alcohol interlocks connected to the power supply voltage and power switched to 'On'.

Unless specifically noted, and with the exception of the climatic tests (Group 2 tests at Section 3.3), all tests shall be performed under the following conditions:

- Ambient temperature of +20 °C, +/- 5 °C;
- Humidity less than 85%;
- Supply voltage of +/- 2V of that specified by the manufacturer with the exception of some electrical tests performed at Section 3.4 ;
- Ambient pressure of 98 kPa +/- 20 kPa;
- Test gases: dry test gases, temperature 23 °C +/- 5 °C; wet gases, temperature +34 °C +/- 2 °C;
- Test gas flow: 0.25 L/sec +/- 0.05 L/sec
- Uncertainty of the test gas concentrations: +/- 0.01 mg/L; and
- Test gas volume: 1.2 L +/- 10%

2.10 Preparation of Standard Alcohol Reference Solutions

This test plan requires the use of various alcohol solutions. The following procedure shall be used when preparing the solutions:

- 77.0 mL of absolute ethanol, at 25 °C, shall be measured out and poured into a 1 L flask.
- Distilled water shall then be added to the flask up to the 1 L mark. This solution should then be sealed and labelled with the date of preparation.

Standard reference solutions should be mixed by pipetting the requisite amount of the above solution into a 5 L volumetric flask and diluting to the 5 L mark, as follows:

- For 15 mg%, dilute 15 mL stock solution to 5 L;
- For 20 mg%, dilute 20 mL stock solution to 5 L;
- For 25 mg%, dilute 25 mL stock solution to 5 L
- For 30 mg%, dilute 30 mL stock solution to 5 L; and
- For 35 mg%, dilute 35 mL stock solution to 5 L.

The solution is thoroughly mixed by capping the flask securely and inverting several times.

Each solution should be stored in a tightly closed container and labelled with the solution concentration and the date of preparation.

Each solution should be tested using suitable evidentiary equipment before and after being used in the tests requiring the use of the solutions.

2.11 Manufacturer's Requirements

In addition to the six alcohol interlocks of each model supplied to the test facility, the manufacturer shall provide the following:

- Alcohol interlock specifications;
- Installation and operation instructions/manuals;
- An external automobile simulator complete with power supply to power the simulator as well as an external power supply to power the alcohol interlock. The simulator must also incorporate an ignition switch, engine on indicator and horn/siren. If not available on the alcohol interlock itself, the simulator should provide a digital readout of measured BrAC to at least 1 mg%. If the manufacturer cannot provide an automobile simulator, arrangements must be made to provide an actual vehicle for the purposes of testing. In this case, the manufacturer will assist the test facility with the installation of the equipment on the test vehicle;
- The alcohol interlock must be supplied with the same firmware and software as used in the most current model in the field.

- Instructions and all software required to download archived alcohol interlock activity data to a computer; and
- Any alcohol interlock test data from previous tests.

2.12 General description of test groups

2.12.1 Group 1: Durability Tests

The purpose of these tests is to provide a level of confidence regarding the ruggedness of the units and to confirm that the devices can still operate properly *after* being subjected to shock, vibration, humidity and temperature extremes. A functional test will be performed before and after the full suite of durability tests to confirm that none of these factors have altered the units' ability to perform their functions.

2.12.2 Group 2: Environmental Accuracy Tests

Unlike the tests described in Section 2.12.1, these tests are designed to ensure that the devices maintain their functional effectiveness *while* at extreme climatic conditions. The functional temperature range is -40 °C to +85 °C and a relative humidity level of not less than 95% at +40 °C. There shall also be tests for higher altitudes and high dust contamination. A functional test will be performed before and after each environmental/climatic test to confirm that none of the environmental factors have altered the units' ability to perform their functions.

2.12.3 Group 3: Electrical Tests

These tests are designed to test the generic electrical features of the devices with the exception of EMI/EMC tests which are performed under Group 5.

2.12.4 Group 4: Special Alcohol Interlock Performance Tests

There are many tests that are specific to alcohol interlock performance. Group 4 tests will include the deep lung sample tests, the alcohol specificity tests, tampering and circumvention tests and calibration stability tests.

2.12.5 Group 5: EMI/EMC Tests

These tests are designed to ensure that the alcohol interlocks are not adversely affected by other electrical devices that may be in close proximity to the alcohol interlocks, and vice versa.

3 SPECIFIC TEST PROCEDURES

In order for a particular alcohol interlock model to be qualified under this proposed standard it must be subjected to, and receive a passing grade for, each of the specific tests described below. Unless noted otherwise, all tests shall be carried out on two alcohol interlocks (units A and B) for each model. Where necessary, blown fuses or tripped circuit breakers may be replaced or reset after individual tests.

3.1 Functional Tests

The functional tests are referenced throughout Section 3 and will be specifically called out to be performed according to one of the two following test types:

3.1.1 *Test Type 1*

The setpoint shall be adjusted to 0.25 mg/L.

Test gas with an alcohol concentration of 0.30 mg/L shall be applied to the alcohol interlock successively ten times in intervals of not less than three minutes. The alcohol interlock shall remain in the blocked state for each test.

Test gas with an alcohol concentration of 0.20 mg/L shall then be applied to the alcohol interlock successively ten times in intervals of not less than three minutes. The alcohol interlock shall go into the unblocked state for each test.

3.1.2 *Test Type 2*

The setpoint shall be adjusted to 0.25 mg/l.

Test gas with an alcohol concentration of 0.35 mg/L shall be applied to the alcohol interlock successively ten times in intervals of not less than three minutes. The alcohol interlock shall remain in the blocked state for each test.

Test gas with an alcohol concentration of 0.15 mg/L shall be applied to the alcohol interlock successively ten times in intervals of not less than three minutes. The alcohol interlock shall go into the unblocked state for each test.

3.2 Group 1: Durability Tests

Units A and B will both be subjected to the tests outlined in Section 3.2.1 through 3.2.5

3.2.1 *Durability Pre-Test Functional Check at Ambient Conditions*

1. Perform a general inspection of the alcohol interlocks to ensure that all the cables are properly connected and that all systems are responding, including the display.
2. Perform the functional test type 1 as described in Section 3.1.1.
3. Make any notes/comments regarding the performance of each alcohol interlock and make any repairs or replacements as necessary.

3.2.2 *Temperature Cycling Test*

1. Two classes of ambient temperatures are defined as follows:
 - a. $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ for parts fitted in the passenger or luggage compartment; and
 - b. $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ for parts fitted inside the engine compartment.
2. Install units A and B in temperature chambers capable of maintaining the temperatures listed at step 1. Prepare the chambers to monitor ambient and alcohol interlock case temperatures. The components may be tested simultaneously in two separate chambers with different hot temperatures or back to back in the same chamber.
3. Adjust the alcohol interlocks so they are in the low power/sleep/quiescent state.
4. Run the chamber(s) for five temperature cycles each consisting of two hours at $-40\text{ }^{\circ}\text{C}$ and two hours at the appropriate high temperature ($+85\text{ }^{\circ}\text{C}$ or $+125\text{ }^{\circ}\text{C}$), with transition times of one hour.
5. Upon completion of the temperature cycling tests, allow the devices to return to normal operating temperature. Inspect the devices for any physical anomalies and perform the functional test type 1 as described in Section 3.1.1. A transition and recovery time of up to six hours is allowed between the end of the temperature tests and the start of the functional tests.

3.2.3 *Condensed Water*

1. Adjust the alcohol interlocks so they are in the low power/sleep/quiescent state.
2. Units A and B shall be tested for humidity resistance according to standard EN 60068-2-30. [6]
3. Upon completion of the condensed water tests, inspect the devices for any physical anomalies and perform the functional test type 1 as described in Section 3.1.1.

3.2.4 Vibration Test

1. Install units A and B on the vibration table and secure to the table in the vertical orientation. Mount an appropriately sized accelerometer to the vibration table, near the alcohol interlocks. Expose the alcohol interlocks to the vertical random vibration specifications of SAE J1211 [7] shown in Appendix B for a duration of three hours.
2. Remount the test units on the vibration table for exposure in the longitudinal axis. Expose the alcohol interlocks to the longitudinal random vibration specifications of SAE test J1211 [7] shown in Appendix B for a duration of three hours.
3. Remount the test units to the vibration table for exposure in the lateral axis. Expose the devices to the lateral random vibration specifications of SAE test J1211 [7] shown in Appendix B for a duration of three hours.
4. Upon completion of all three vibration tests, inspect the devices for any physical anomalies and perform the functional test type 1 as described in Section 3.1.1. A transition and recovery time of up to six hours is allowed between the end of the vibration tests and the start of the functional tests.

3.2.5 Handset Drop Test

1. With units A and B installed in a vehicle, or a vehicle simulator, turn the devices 'on' and ensure they power up properly and are responding.
2. Remove the mobile handsets from units A and B.
3. The mobile handsets of the alcohol interlocks shall be dropped six times from a height of 0.8 metres at random positions, onto a clean concrete surface that is free of water, snow and ice.
4. After the drop tests, the handsets shall be plugged back into the test units and the power shall be turned on to ensure that dropping the handsets did not affect the performance of the units.
5. Perform the functional test type 1 as described in Section 3.1.1.

3.2.6 Type of protection

Test for protection on Units A and B as per the following guidelines:

3.2.6.1 Parts fitted entirely inside the passenger cabin of hard top vehicles

- All parts to be fitted entirely inside the passenger or luggage compartment must conform to IP40: *Protection from objects not greater than 1 mm in diameter*. There is no requirement for waterproofing for these items. All such items shall be tested as follows, as per EN 60529:1991 [8]:
 1. A rigid steel wire with a diameter of 1.0 +0.05/-0.00 mm with edges free from burrs shall be pushed against any openings in the device (with the exception of ventilation grilles, tubes, ports or orifices used to accept a breath sample) with a force of 1 N +/- 10%. The steel wire shall be constructed as per Figure 1 in EN 60529 [8]. The protection is considered satisfactory if the full diameter of the probe does not pass through any openings
 2. Using the same steel wire, Step 1 shall be repeated for any ventilation grilles, or tubes, ports or orifices used to accept a breath sample. The protection is considered satisfactory if the full diameter of the probe does not make contact with any electronic components.

3.2.6.2 Parts fitted inside the passenger compartment of roadsters and convertibles

- All parts fitted inside the passenger compartment of roadsters and convertibles and vehicles with moveable roof panels must conform to IP42: *Protection from objects not greater than 1 mm in diameter and protection from vertically dripping water (tilted up to 15 degrees)*. All such items shall be tested as follows, as per EN 60529:1991 [8]:
 1. A rigid steel wire with a diameter of 1.0 +0.05/-0.00 mm with edges free from burrs shall be pushed against any openings in the device (with the exception of ventilation grilles, tubes, ports or orifices used to accept a breath sample) with a force of 1 N +/- 10%. The steel wire shall be constructed as per Figure 1 in EN 60529 [8]. The protection is considered satisfactory if the full diameter of the probe does not pass through any openings
 2. Using the same steel wire, Step 1 shall be repeated for any ventilation grilles, or tubes, ports or orifices used to accept a breath sample. The protection is considered satisfactory if the full diameter of the probe does not make contact with any electronic components.
 3. Construct a drip box as per Figure 3 in EN 60529.
 4. Adjust the water flow rate to 3 +0.5/-0.0 mm/minute.
 5. Place the unit inside the drip box, mounted at 15 degrees from the vertical plane.
 6. Subject the unit to a drip test for 150 seconds.
 7. Repeat steps 5 and 6 in three different orientations of 15 degrees from the vertical.
 8. Upon completion of the tests, open up the alcohol interlock for inspection. The protection is considered satisfactory if there is no evidence of water inside the unit or if any and all water is directed to an appropriate drain hole away from the electronics.

3.2.6.3 Parts fitted outside of the passenger cabin

- All other parts must conform to IP54: Complete protection against contact and dust deposits and protection from splashed water. Both alcohol interlocks shall be tested for dust as follows, as per EN 60529:1991, Section 13.4 [8].
 1. Construct a dust chamber similar to that illustrated in Figure 2 of EN 60529 [8]. The powder circulation pump may be replaced by other means suitable to maintain the talcum powder in suspension in a closed test. The talcum powder used shall be able to pass through a square meshed sieve. The nominal wire diameter used to make the mesh shall be 50 μm and the nominal gap between the wires shall be 75 μm . The amount of talcum powder to be used shall be 2 kg per cubic meter of test chamber volume.
 2. A category 1 enclosure [7] shall be used.
 3. A suction connection must be created on the alcohol interlocks and a vacuum hose shall be secured to this connection.
 4. A volume of air 80 times the volume of the alcohol interlocks shall be drawn into the alcohol interlocks without exceeding a rate of 60 volumes per hour. In no event shall the vacuum exceed 2 kPa on the manometer shown in Figure 2 of EN 60529 [8].
 5. Place the alcohol interlocks inside the test chamber and perform the dust tests for the following amount of time:
 - Two hours for an extraction rate between 40 to 60 volumes per hour; or
 - Eight hours for extraction rates less than 40 volumes per hour.
 6. After the test has been completed, open the alcohol interlocks for inspection. The performance of the alcohol interlocks is considered acceptable if talcum powder has not accumulated in a quantity or location that it could interfere with the correct operation of the alcohol interlock.
- Both alcohol interlocks shall be tested for spraying and splashing water, as per EN 60529:1991, Section 14.2.4 [8].
 1. Construct an oscillating tube test chamber as per Figure 4 in EN 60529 [8]. The support for the alcohol interlock shall be perforated so as to avoid acting like a baffle.
 2. The flow rate of the water shall be adjusted as per Table IX in EN 60529 [8].
 3. The spray tube shall oscillate through an angle of nearly 360 degrees, 180 degrees on either side of the vertical and the time to complete one full cycle shall be 12 seconds.
 4. The test shall continue for a period of 10 minutes.
 5. Upon completion of the tests, open up the alcohol interlock for inspection. The performance of the alcohol interlocks is considered acceptable if there is no water on sensitive components that could be damaged or rendered un-usable if wet. If there are any drain holes on the alcohol interlocks, it shall be proven by inspection that all of the water exited the alcohol interlock through the drain holes.
- Upon completion of the dust and water tests, inspect the devices for any physical anomalies and perform the functional test type 1 as described in Section 3.1.1.

3.3 Group 2: Environmental/Climatic Accuracy Tests

In order for a particular make and model of alcohol interlock to pass Group 2 testing, both units A and B must perform within the specifications listed below. In addition, the test units shall show no physical degradation at the conclusion of the tests.

3.3.1 Temperature Test at -40 °C

1. Install test units A and B in the vehicle simulator or vehicle in the climate chamber and setup the instrumentation to monitor case and ambient temperatures.
2. Set the climate chamber to -40 °C and allow it to soak until the temperature has stabilized.
3. Test units A and B shall be supplied with 75% of their nominal voltage supply.
4. Monitor the alcohol interlocks' case temperatures until they stabilize at -40 °C and then allow the units to soak at -40 °C for one hour.
5. With the vehicle or vehicle simulator still inside the chamber, perform the functional type 2 tests described at Section 3.1.2 at -40 °C and record the test results.
6. Upon completion of the tests, inspect the test units for any external damage or anomalies.

3.3.2 Temperature Test at +85 °C

Note: If the vehicle climate chamber is not capable of sustaining temperatures as high as +85 °C, this test may be performed using a demonstrator in a component climate chamber. Where possible, the doors to the chamber should be opened as infrequently as possible and for as little time as possible.

1. Install test units A and B in the vehicle simulator or vehicle in the climate chamber and setup the instrumentation to monitor case and ambient temperature.
2. Set the climate chamber to +85 °C and allow it to soak until the temperature has stabilized.
3. Test units A and B shall be supplied with 125% of their nominal voltage supply.
4. Monitor the alcohol interlocks' case temperatures until they stabilize at +85 °C and then allow the devices to soak at +85 °C for one hour.
5. Perform the functional type 2 tests described at Section 3.1.2 at +85 °C and record the test results.
6. Upon completion of the tests, inspect the test units for any external damage or anomalies.

3.3.3 Warm up Time

1. Test units A and B shall be set to the sleep/quiescent mode at 20 °C +/- 5 °C and standard atmospheric pressure.
2. Test units A and B shall be turned on and be ready to accept a breath test within one minute of being turned on.
3. Perform the functional type 1 tests described at Section 3.1.1 and record the test results.
4. Test units A and B shall be setup in a climate chamber that has been soaked and stabilized at -40 °C.
5. Test units A and B shall be supplied with 85% of their normal operating voltage and set to the sleep/quiescent mode.
6. Monitor the alcohol interlocks' case temperatures until they stabilize at -40 °C and then allow test units A and B to soak at -40 °C for one hour.
7. The alcohol interlocks shall be turned on and be ready to accept a breath test within five minutes of being turned on.
8. Perform the generic type 2 tests described at Section 3.1.2 and record the test results.

3.3.4 High Relative Humidity Test

1. Install test units A and B in a component temperature/humidity chamber and power up the devices. Setup the humidity and temperature instruments as well as the data acquisition system.
2. Run the climate chamber at +40 °C and 95% relative humidity until all temperatures and ambient humidity have stabilized, then allow the test units to soak for 12 hours in these conditions.
3. Perform the generic type 1 tests described at Section 3.1.1 under these ambient conditions and record the test results.
4. Upon completion of the tests, inspect the devices for any external damage or anomalies.

3.3.5 Altitude Test

1. Setup test units A and B in a vacuum chamber and fit a suitably sized tube or pipe from each alcohol interlock inlet port through an access port in the chamber to a valve and simulator on the outside of the chamber. Any electrical wires should also be routed through air tight pass-throughs.

2. By experimentation, determine the starting chamber pressure required when the air/vacuum pump is on such that after opening the valve to supply a simulator sample to the test units and then shutting the valve when the sample is acquired, the final pressure is at 557 +/- 10 torr (74.2 +/- 1.3 kPa). 557 torr is roughly equivalent to an altitude of 2.5 km above sea level. As soon as the breath sample valve is closed, the vacuum pump should be turned off to maintain a vacuum as close as possible to 557 torr.
3. Once the correct ambient conditions have been achieved, perform the generic type 1 tests as described at Section 3.1.1 while the alcohol interlocks are inside the chamber and record the test results.

3.4 Group 3: Electrical Tests

3.4.1 Supply Voltage

1. Alcohol interlocks A and B shall each be tested for the influence of supply voltage according to ISO 16750-2, 4.2 [9] with the following test conditions:

Alcohol interlocks with 12 V nominal operating voltages: Code C (9V and 16V)

Alcohol interlocks with 24V nominal operating voltages: Code F (16V and 32V)

2. Perform the generic type 1 tests described at Section 3.1.1 and record the test results.

3.4.2 Supply voltage

1. Test units A and B shall each be supplied with 1.5 times the nominal operating voltage for a period of one hour at +45 °C (in accordance with ISO 16750-2, 4.3.1 or 4.3.2 [9] or equivalent).
2. The units will then be subjected to twice the nominal voltage for a period of one minute (in accordance with ISO 16750-2, 4.3.1.2 [9] or equivalent).
3. The units will then be subjected to reversed polarity at nominal vehicle voltage (i.e. -13 V instead of +13V +/- 10%) for a period of one minute (in accordance with ISO 16750-2, 4.7.2.3 [9] or equivalent).
4. Any blown fuses or fusible links may be replaced between tests.
5. Perform the generic type 1 tests described at Section 3.1.1 and record the test results.

3.4.3 Energy consumption in quiescent state

1. The vehicle or vehicle simulator shall be turned off and the test unit A shall be set to the quiescent/standby state.

2. Using an appropriate current or power measuring device that can be coupled to a data acquisition system, record the total current draw from the vehicle's battery to the alcohol interlock for a period of 24 hours. The sampling frequency shall be one sample every minute. (Note: If performing the tests with a conventional vehicle, do not take this measurement at the battery since other vehicular systems, such as the clock, may be drawing from the battery).
3. Calculate the time weighted average current draw over the 24 hour period.
4. The time weighted average of current draw from the battery to the alcohol interlock shall be 20 mA or less.
5. Repeat steps 1 through 4 for test unit B.

3.4.4 Removal of handset

1. If the handset may be detached by the user, detach it from test unit A for a period of 10 seconds and subsequently re-attach it and note the time of day for each event.
2. While the handset is detached, the alcohol interlock must not go into the unblocked state. Verify that the data log shows the detachment and re-attachment and the time of day for the events.
3. Repeat steps 1 and 2 for test unit B.

3.4.5 Electrical out of service

1. With test unit A in a blocked state, the electrical power from the vehicle to the alcohol interlock shall be disconnected for a period of at least 10 seconds and the time of day recorded.
2. The alcohol interlock's electrical power shall then be re-connected and the device must remain in the blocked state, not allowing the engine to be started until an accepted breath test has been delivered.
3. Verify that the data log shows the detachment and re-attachment of the electrical power and the time of day for the events.
4. Repeat steps 1 through 3 for test unit B.

3.5 Group 4: Special Alcohol Interlock Performance Tests

3.5.1 *Volumetric Flow rate*

1. The test shall be performed with air as the test gas at +20 °C +/- 5 °C and standard atmospheric pressure.
2. Using a spirometer, collect and measure the expelled volume of air passing through the test units. Three tests for each of test units A and B shall be conducted at different volumetric flow rates: one at 0.1 L/s, one at 0.3 L/s and one at 1.0 L/s.
3. Verify that the test units accept the flow of 0.3 L/s as a valid flow and provide visual or audible failure messages at flows of 0.1 L/s and 1.0 L/s.

3.5.2 *Test for Deep Lung Sample*

1. The lower limit value for the breath volume of test units A and B shall be set to 0.95 L.
2. The test shall be performed with air as the test gas. Samples of 0.75 L and 1.15 L shall be prepared.
3. The two volumes of air shall be delivered to each test unit, one at a time and within the range of acceptable flow rates through a spirometer.
4. Verify that the alcohol interlocks accept the volume of 1.15 L as a valid sample and provide a visual or audible failure message at the volume of 0.75 L.

3.5.3 *Exhalation Time*

1. The minimum exhalation time to deliver a breath sample shall be 3 seconds.
2. The limit value for the breath volume of test units A and B shall be adjusted to 1.0 L. The test shall be performed with air as the test gas and a test gas flow of 0.5 L/s delivering 1.25 L in 2.5 seconds.
3. Verify that the alcohol interlocks do not accept the breath sample.

3.5.4 *Response Time*

Deliver breath samples to test units A and B and verify the output message or signal as follows:

- No more than 10 seconds after analyzing a test gas with an alcohol concentration of 0 mg/l.

- No more than 15 seconds after analyzing a test gas with an alcohol concentration of 0.25 mg/l.
- No more than 20 seconds after analyzing a test gas with an alcohol concentration of 0.35 mg/l.

3.5.5 Cigarette smoke

1. A person who normally smokes shall smoke a cigarette and then shall exhale smoke into test units A and B to provide an accepted breath sample. The person providing the breath sample shall have a breath alcohol level less than 0.10 mg/L.
2. Verify that the alcohol interlocks did not go into the blocked state.

3.5.6 Alcohol specificity tests

1. The test units' setpoints shall be adjusted to 0.10 mg/L.
2. Tests shall be performed on both units A and B.
3. Each of the substances listed in Table 2 shall be accurately combined with air inside individual gas sample bags (Tedlar® or equivalent) to achieve the given concentrations. Once the valves are closed, the bags shall be left to stabilize in a chamber at 34 °C for a period of two hours.

Table 2 – Solution concentrations

Substance	Concentration in Air (mg/L)
Acetaldehyde	0.08
Acetone	0.25
Carbon Monoxide	0.10
Dyethylether	0.15
Ethyl acetate	0.08
Methane	0.15
Methanol	0.05
n-heptane	0.10
n-hexane	0.10
n-octane	0.10
n-pentane	0.10
Toluene	0.10
2-Propanol	0.05

The substances in Table 2 are derived from OIML R-126 [10] (currently under revision) and the alkanes are added because alcohol interlocks are installed in vehicles. The concentrations of the OIML R 126 are lowered by a factor of 2.

3. Using one bag at a time, expel the substance/gas mixture into each of alcohol interlocks A and B.
4. Verify that the test units did not go into the blocked state when tested with each of the gas/air mixtures listed in Table 2.

3.5.7 Tampering and circumvention

The following tests are used to confirm the techniques incorporated into the alcohol interlocks to prevent the use of non-human samples or filtered samples from unblocking the vehicle's engine.

For the tampering and circumvention tests, ensure all human driver recognition features and tampering/circumvention detection features are enabled on units A and B. Ensure that all human subjects are fully trained in the use of the devices. All tests shall be conducted on test units A and B. The alcohol interlock setpoint shall be adjusted to 0.20 mg/L for all the tests.

3.5.7.1 Filtering

1. Adjust the alcohol interlock setpoint to 0.20 mg/l on test units A and B.
2. Use a human subject whose BrAC is above 0.30 mg/L as measured by evidentiary equipment.
3. Provide the subject with a filter constructed of a 10 cm long tube with a diameter of 2 cm that is filled with activated charcoal. The subject shall deliver a breath sample through the filter into test unit A.
4. Repeat the test for a total of five trials on unit A and five trials on unit B. A minimum of three minutes must be allowed to elapse between tests on the same device. The subject's breath alcohol level should be re-tested before the beginning of the last test to ensure it is still above 0.30 mg/L.
5. Verify that the alcohol interlocks remained in the blocked state for all 10 tests.

3.5.7.2 Condensation

1. Adjust the alcohol interlock setpoint to 0.20 mg/l on test unit A and B.
2. Use a human subject who has a BrAC above 0.30 mg/l as measured by evidentiary equipment.
3. Provide the subject with a tube that is 50 cm long with a diameter of 2 cm and has been cooled to -10 °C. The subject shall deliver a breath sample through the tube into test unit A.
4. Repeat the test for a total of five trials on unit A and five trials on unit B. A new tube shall be used for each test. A minimum of three minutes must be allowed to elapse

between tests on the same device. The subject's breath alcohol level should be re-tested before the beginning of the last test to ensure it is still above 0.30 mg/L.

5. Verify that the test units remained in the blocked state for all 10 tests.

3.5.7.3 Water

1. Adjust the alcohol interlock setpoint to 0.20 mg/l on test unit A and B.
2. Use a human subject who has a BrAC above 0.30 mg/l as measured by evidentiary equipment.
3. Provide the subject with a 0.5 L commercial plastic cup with a lid containing 0.25 L of water at +24 °C. The subject shall deliver a breath sample to test unit A by first bubbling the breath sample through the water.
4. Repeat the test for a total of five trials on unit A and five trials on unit B. A minimum of three minutes must be allowed to elapse between tests on the same device. The subject's breath alcohol level should be re-tested before the beginning of the last test to ensure it is still above 0.30 mg/L.
5. Verify that the test units remained in the blocked state for all 10 tests.

3.5.7.4 Alternative sources of air/breath sample

1. A human subject with a BrAC lower than 0.1 mg/L must blow into a balloon until the balloon is completely filled.
2. The test engineer/technologist must then take the balloon and allow the balloon's trapped air to escape into test unit A's inlet port in such a manner to provide an accepted breath sample (i.e. with respect to volume and flow rates) in an attempt to circumvent the alcohol interlock.
3. Steps 1 and 2 must be repeated on Unit A two more times for a total of three tests.
4. Steps 1 through 3 must be repeated on Unit B.
5. Verify that the test units remained in the blocked state for all 6 tests.
6. Repeat steps 1 through 5 using a canister of compressed air or CO₂ for each test unit.
7. Verify that the test units remained in the blocked state for all tests.

3.5.7.5 Bypass

The following steps must be performed using an actual vehicle rather than a vehicle simulator.

1. Install test unit A into a vehicle equipped with a manual transmission.
2. The vehicle shall be started by means of push starting. A breath sample will not be delivered to the test unit.
3. The vehicle will then be driven for a period of at least two minutes. Verify that the data logger on test unit A recorded this bypass event within 30 seconds of the engine being started and that the test unit displayed some form of error message.
4. Repeat steps 2 and 3 for unit B.
5. A vehicle with test unit B still installed (type of transmission is optional) shall be started by means of 'hot wiring' or circumventing the vehicle's ignition system. A breath sample will not be delivered to the test unit B.
6. Verify that the data logger recorded this bypass event within 30 seconds of the engine being started and displayed some form of error message.
7. Repeat steps 5 and 6 for unit A.

After all the circumvention and tampering tests have been performed, download all the logged data from the alcohol interlocks to a computer and compare the logged events, and time stamps, to the test records. Ensure that steps 3 and 5 at 3.5.7.5 caused the data log to register some form of error message.

3.5.7.6 Start period

1. Adjust the start period to 5 minutes for test units A and B.
2. A breath sample shall be delivered to test unit A that causes the unit to go to the unblocked state. A timer shall be started. At 4 minutes and 50 seconds, verify that test unit A is still in the unblocked state. Verify that after 5 minutes and 10 seconds, test unit A has switched to the blocked state.
3. Repeat step 2 for test unit B.

3.5.7.7 Restart period

1. The restart period on each test unit shall not be adjustable to less than one minute and shall not be more than 30 minutes.
2. With test unit A installed, turn on the ignition for the vehicle or the vehicle simulator.

3. Verify that it is not possible to bring the alcohol interlock to a blocked state by any means of manual reset while the engine is still running.
4. The restart period shall then be adjusted to 5 minutes. The ignition shall be turned off and a timer started. After 4 minutes and 50 seconds after the ignition was turned off, the alcohol interlock shall still be in the unblocked state. After 5 minutes and 10 seconds after the ignition is switched off, the alcohol interlock shall be in the blocked state.
5. Repeat steps 2 through 4 for unit B.

3.5.8 Calibration reminder

1. Testing shall be performed on both test units A and B. The calibration interval shall be set to two days. It shall only be possible to set the calibration interval by performing a calibration.
2. The alcohol interlock shall remind the user of the expiry of the calibration interval after the two day period.
3. The alcohol interlocks shall be capable of going into a blocked state throughout the test period and including a seven day grace period after the expiry date.

3.5.9 Service reminder

1. Testing shall be performed on both test units A and B. The service interval shall be set to two days.
2. The alcohol interlock shall remind the user of the expiry of the service interval after the two day period.
3. The alcohol interlocks shall be capable of going into a blocked state throughout the test period and including a seven day grace period after the expiry date.

3.5.10 Calibration stability and lockout test

1. Testing shall be performed on both test units A and B. The manufacturer shall be allowed to calibrate test units A and B. The calibration recall timer shall be reset to its typical setting; however, the testing will be scheduled for the calibration expiration time plus an additional seven days beyond the normal interval. Therefore, if the required calibration interval is, say, 60 days, this series of tests will require 67 days to complete. The alcohol interlocks shall be connected to the supply voltage continuously throughout these tests.
2. Each of test units A and B will be installed in a vehicle or vehicle simulator in a test area and operated with alcohol test samples of 0.30 mg/l, 10 times each working day and not more than twice per hour.

3. Once every two weeks, breath with cigarette smoke shall be used for at least five trials of the allotted daily 10 trials.
4. Near the completion of the calibration stability interval, ensure the 'Service Reminder', 'Immediate Recall' and 'Lockout' conditions occur for each test unit.
5. In intervals of 28 days, the alcohol interlock shall fulfil the requirements of functional type 1 test as described in Section 3.1.1.
6. On completion of the 67 day calibration stability interval testing, perform the functional type 1 test as described in Section 3.1.1.

3.6 Group 5: EMI/EMC Tests

3.6.1 General

Alcohol interlocks must be tested against Canadian standard CAN/CSA-C108.4-M92 (R2003) [10] "*Limits and methods of measurement of radio interference characteristics of vehicles, motorboats, and spark-ignited engine-driven devices*".

In certain situations it may be necessary to remove unnecessary equipment, such as CB radios, from the vehicle so that the performance of the alcohol interlock is not compromised. The alcohol interlock manufacturer should itemize any devices that could pose such an interference.

3.6.2 Supply lines

In addition to the general tests, test unit C shall be tested for the influence of electrical disturbances along power supply lines according to ISO 7637-2 [11] (or equivalent) with the following test conditions:

- test pulses 2a, 2b (Figure 1), 3a, 3b (Figure 2) with functional status: Class A and test pulse 4 (Figure 3) with functional status class C;
- test level: IV.

The precise details regarding the equipment required to perform these tests may be found in the ISO standard [11]. However, the required pulses are shown below:

5.6.2 Test pulses 2a and 2b

Pulse 2a simulates transients due to sudden interruption of currents in a device connected in parallel with the DUT due to the inductance of the wiring harness (see Annex F).

Pulse 2b simulates transients from d.c. motors acting as generators after the ignition is switched off (see Annex F).

The pulse shapes are given in Figures 6 and 7; for the parameters, see Tables 4 and 5, respectively.

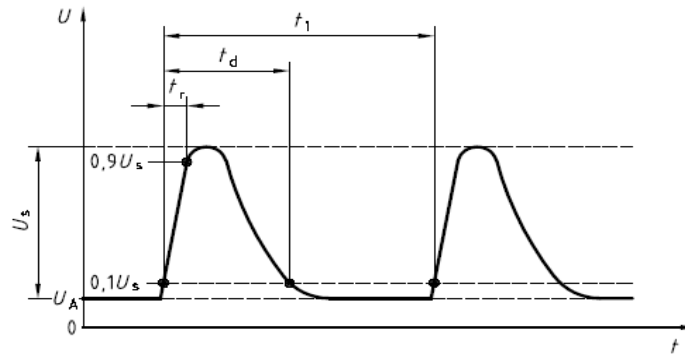


Figure 6 — Test pulse 2a

Table 4 — Parameters for test pulse 2a

Parameter	12 V system	24 V system
U_s	+ 37 V to + 50 V	
R_1	2 Ω	
t_d	0,05 ms	
t_r	(1 _{-0,5} ⁰) μ s	
t_1^a	0,2 s to 5 s	

^a The repetition time t_1 can be short, depending on the switching. The use of a short repetition time reduces the test time.

Figure 1 – Test pulses 2a and 2b

5.6.3 Test pulses 3a and 3b

These test pulses are a simulation of transients which occur as a result of the switching processes. The characteristics of these transients are influenced by distributed capacitance and inductance of the wiring harness (see Annex F).

The pulse shapes for these test pulses are given in Figures 8 and 9; for the parameters, see Tables 6 and 7, respectively.

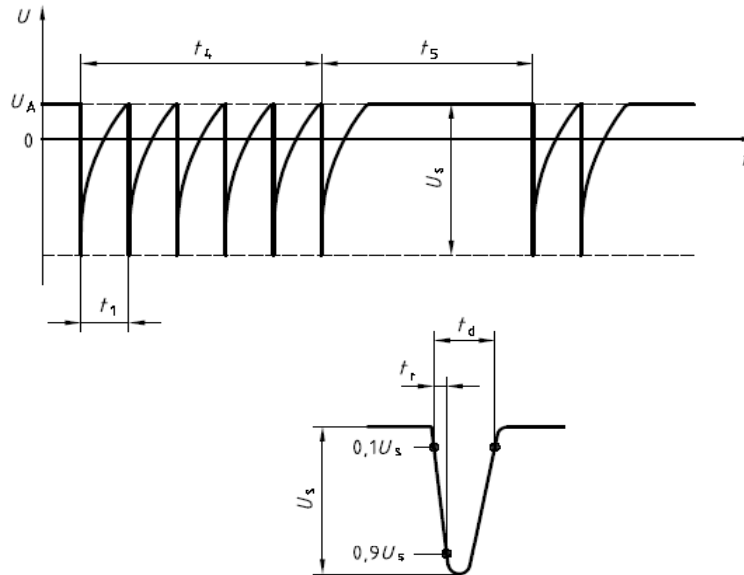


Figure 8 — Test pulse 3a

Table 6 — Parameters for test pulse 3a

Parameter	12 V system	24 V system
U_s	- 112 V to - 150 V	- 150 V to - 200 V
R_1	50 Ω	
t_d	$(0,1^{+0,1}) \mu\text{s}$	
t_r	5 ns \pm 1,5 ns	
t_1	100 μs	
t_4	10 ms	
t_5	90 ms	

Figure 2 - Test pulses 3a and 3b

5.6.4 Test pulse 4

This pulse simulates supply voltage reduction caused by energizing the starter-motor circuits of internal combustion engines, excluding spikes associated with starting (see Annex F).

The pulse shape and parameters are given in Figure 10 and Table 8.

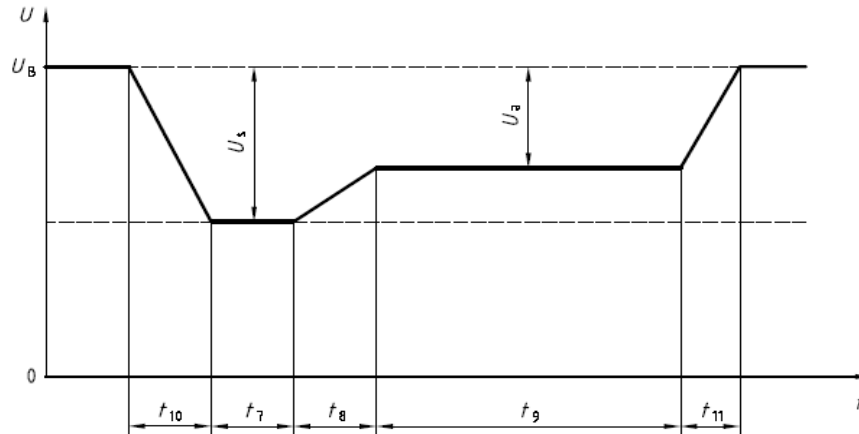


Figure 10 — Test pulse 4

Table 8 — Parameters for test pulse 4

Parameter	12 V system	24 V system
U_s	- 6 V to - 7 V	- 12 V to - 16 V
U_a	- 2,5 V to - 6 V with $ U_a \leq U_s $	- 5 V to - 12 V with $ U_a \leq U_s $
R_1	0 Ω to 0,02 Ω	
t_7	15 ms to 40 ms ^a	50 ms to 100 ms ^a
t_8	\leq 50 ms	
t_9	0,5 s to 20 s ^a	
t_{10}	5 ms	10 ms
t_{11}	5 ms to 100 ms ^b	10 ms to 100 ms ^c

^a The value used should be agreed between the vehicle manufacturer and the equipment supplier to suit the proposed application.

^b t_{11} = 5 ms is typical of the case when engine starts at the end of the cranking period, while t_{11} = 100 ms is typical of the case when the engine does not start.

^c t_{11} = 10 ms is typical of the case when engine starts at the end of the cranking period, while t_{11} = 100 ms is typical of the case when the engine does not start.

Figure 3 - Test pulse 4

3.6.3 *Lines other than supply lines*

Test unit C shall be tested for the influence of electrical disturbances along lines other than supply lines according to ISO 7637-3 [12] (or equivalent) with the following test conditions:

- functional status: Class A;
- test pulse a, b;
- test level: IV

The precise details regarding the equipment required to perform these tests may be found in the ISO standard [12]. However, the required pulses are shown below:

4 TEST REPORT

After completion of the tests, the test organization will issue a report with the following information:

- The name, address and accreditation of the facility that performed the tests;
- All information relating to the alcohol interlocks that were tested;
- Organization for which the tests were performed (e.g. manufacturer, distributor, importer, government agency);
- The test equipment and apparatus that were used;
- The test procedures that were followed including any deviations from the approved test plan;
- Data, results, observations, conclusions;
- A discussion involving any anomalies that occurred;
- Date, time and ambient conditions of the tests;
- An Executive Summary.

LIST OF ACRONYMS/ABBREVIATIONS

A	Amps
AC	Alternating Current
BAC	Blood Alcohol Content
BrAC	Breath Alcohol Content
C	Celsius
CB	Citizen's Band
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
CSTT	Centre for Surface Transportation Technology
DC	Direct Current
Deg	Degree
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
HVAC	Heating, Ventilation and Air Conditioning
kPa	Kilopascals
L	litre
mg	milligram
NRC	National Research Council Canada
RF	Radio Frequency
RH	Relative Humidity
RTC	Real Time Clock
SAE	Society of Automotive Engineers
sec	Seconds
Torr	Torrucelli (unit of pressure equal to 1/760 of an atmosphere)
V	Volts
VDC	Volts, Direct Current
W	Watts

REFERENCES

- [1] Technical Standard for Vehicular Breath Alcohol Interlock Devices in Canada; CSTT-HVC-TR-114; National Research Council, Centre for Surface Transportation Technology; Patten, JD, March 2009.
- [2] Qualification Test Specification for Breath Alcohol Ignition Interlock Devices (BAIID) for use in the Province of Alberta. Project # 355A02, Document # 355A02-1; Electronics Test Centre, Albert Research Council; October 1992.
- [3] Model Specification for Breath Alcohol Ignition Interlock Devices (BAIIDs), National Highway Traffic Safety Administration, Docket # 91-07, Notice 2; US Federal Register Vol 57, No 67; April 7th, 1992.
- [4] Breath Alcohol Testing Devices for Personal Use, Standards Association of Australia; ISBN 0 7262 8065 8; AS 3547; Second Edition, 1993.
- [5] Alcohol Interlocks – Test Methods and Performance Requirements, CENELEC BTF 116-2, Europe, prEN 50436-2; July 2007 and 50436-1, November 2005.
- [6] EN 60068-2-30:2005; Environmental testing – Part 2-30 – Tests, Damp heat, cyclic (12h + 12 h cycle); December 2005.
- [7] Handbook for Robustness Validation of Automotive Electrical/Electronic Modules; Society of Automotive Engineers, SAE J1211. Issued June 1978, Updated April 2009.
- [8] EN 60529:1992 – Degrees of protection provided by enclosures (IP Code); Incorporating Amendments Nos. 1 and 2; August 2000.
- [9] ISO 16750-2 – Road Vehicles, Environmental conditions and testing for electrical and electronic equipment; ISO 2/2003.
- [10] OIML R-126; Organization Internationale de Metrologie Legale; Evidential Breath Analyzers, 1998 (E).
- [11] ISO 7637-2 – Road vehicles, Electrical disturbances from conduction and coupling; ISO 2/2004.
- [12] ISO 7637-3 – Road vehicles, Electrical disturbances from conduction and coupling; ISO 2/2004.

Appendix A
Test Log

Table 3 – Test log

	Name of Test	Device A Result/reading	Device B Result/reading	Comment, inspection result, repairs.
3.2.1	Durability pre test			
3.2.2	Temperature cycling test			
3.2.3	Humidity exposure test			
3.2.4	Vibration test (vertical)			
3.2.4	Vibration test (longitudinal)			
3.2.4	Vibration test (lateral)			
3.2.5	Handset drop test			
3.2.6	Type of protection			
3.3.1	Temperature test at -40C			
3.3.2	Temperature test at +85C			
3.3.3	Warm up time test at 20 C			
3.3.3	Warm up time test at -40 C			
3.3.4	High relative humidity test			
3.3.5	Altitude test			
3.4.1	Supply voltage A			
3.4.2	Supply voltage B			
3.4.3	Quiescent energy consumption			
3.4.4	Removal of handset			
3.4.5	Electrical out of service			
3.5.1	Volumetric flow rate			
3.5.2	Test for deep lung sample			
3.5.3	Exhalation time			
3.5.4	Response time			
3.5.5	Cigarette smoke			
3.5.6	Alcohol specificity tests Acetaldehyde			
3.5.6	Alcohol specificity tests Acetone			
3.5.6	Alcohol specificity tests Carbon Monoxide			
3.5.6	Alcohol specificity tests Dyethylether			
3.5.6	Alcohol specificity tests Ethyl acetate			

	Name of Test	Device A Result/reading	Device B Result/reading	Comment, inspection result, repairs.
3.5.6	Alcohol specificity tests Methane			
3.5.6	Alcohol specificity tests Methanol			
3.5.6	Alcohol specificity tests n-heptane			
3.5.6	Alcohol specificity tests n-hexane			
3.5.6	Alcohol specificity tests n-octane			
3.5.6	Alcohol specificity tests n-pentane			
3.5.6	Alcohol specificity tests Toluene			
3.5.6	Alcohol specificity tests 2-Propanol			
3.5.7.1	Filtering test #1			
3.5.7.1	Filtering test #2			
3.5.7.1	Filtering test #3			
3.5.7.1	Filtering test #4			
3.5.7.1	Filtering test #5			
3.5.7.2	Condensation #1			
3.5.7.2	Condensation #2			
3.5.7.2	Condensation #3			
3.5.7.2	Condensation #4			
3.5.7.2	Condensation #5			
3.5.7.3	Water #1			
3.5.7.3	Water #2			
3.5.7.3	Water #3			
3.5.7.3	Water #4			
3.5.7.3	Water #5			
3.5.7.4	Alternative sources of air/balloon #1			
3.5.7.4	Alternative sources of air/balloon #2			
3.5.7.4	Alternative sources of air/balloon #3			
3.5.7.4	Alternative sources of air/CO ₂ #1			
3.5.7.4	Alternative sources of air/CO ₂ #2			
3.5.7.4	Alternative sources of air/CO ₂ #3			
3.5.7.5	Push start bypass			
3.5.7.5	Hotwire bypass			
3.5.7.6	Start period			
3.5.7.7	Re-start period			

	Name of Test	Device A Result/reading	Device B Result/reading	Comment, inspection result, repairs.
3.5.8	Calibration reminder			
3.5.9	Service reminder			
3.5.10	Calibration and lockout test			
3.6.1	EMI/EMC			
3.6.2	Supply lines			
3.6.3	Lines other than supply			

Appendix B

Random Vibration Spectrum

Various curves from SAE J1211 were studied based on specific locations in the vehicle's cabin and engine bay. These curves were combined to form a single plot to represent the types of vibrations that may be experienced by interlock devices. The resultant power spectral density (PSD) plot is shown at Figure B-1 and the breakpoints used to develop this plot are shown in Table B-1.

Table B-1 – Vibration PSD break points

Frequency (Hz)	G ² /Hz
5	0.0092
10	0.2078
100	0.1039
300	0.0053
500	0.052
2000	0.052

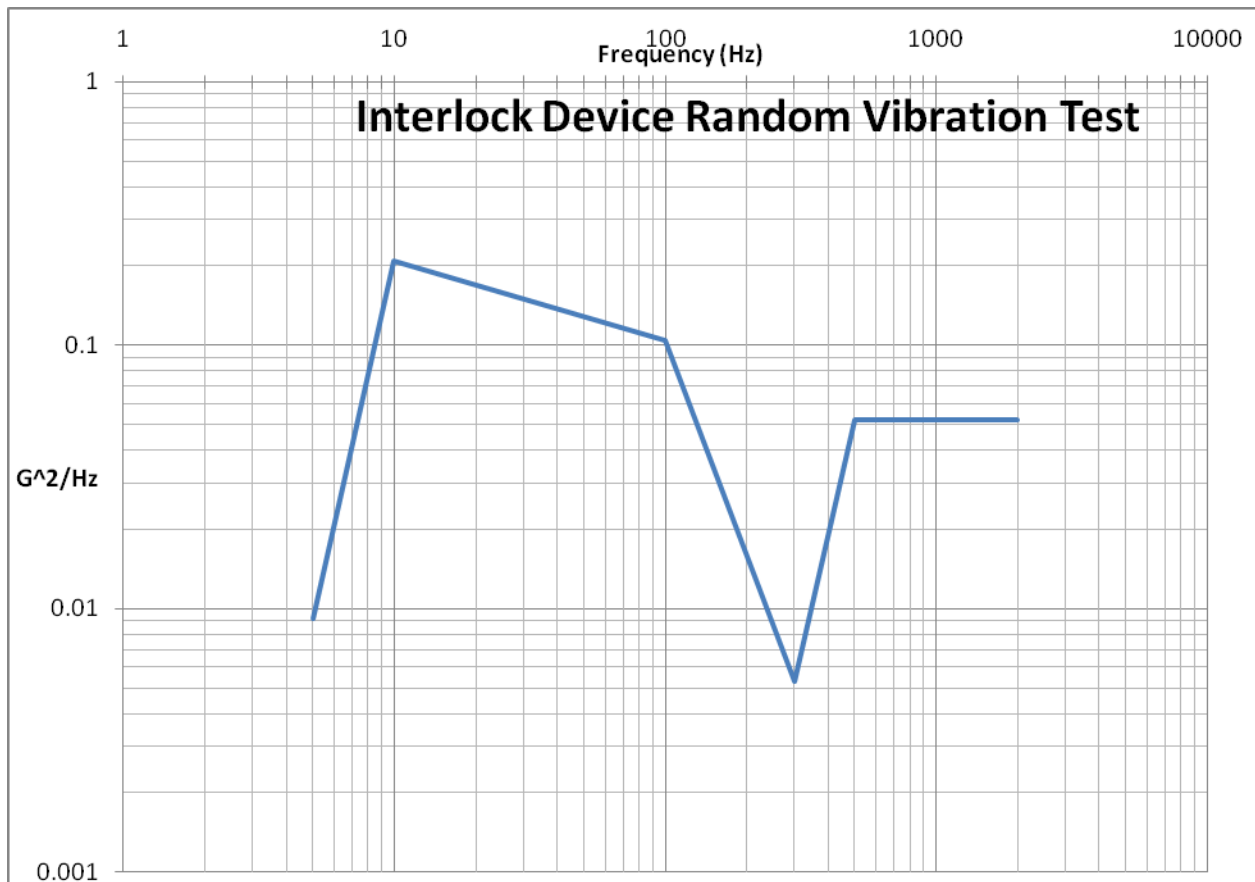


Figure B-1 - Random vibration spectrum