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Dr. James F. Frank was the project monitor for this project.

Abstract

Laboratory testing showed that when simulator samples at 0.170 grams of ethanol per 210 liters were repeatedly tested with an Intoximeters, Inc. Alco-Sensor IV at 10 degrees C. ambient temperature, some ethanol and water eventually condensed onto the cool airway surfaces of the instrument. When the instrument was operated in screener mode without any heating element and without proper protocols, some of this alcoholic condensate carried over to subsequent screening tests. However, no carry over was seen when the Alco-Sensor IV was operated in the evidential mode, or when the optional CEM heating accessory was used, or when proper test protocols were used.

The results show that the possibility for the occurrence of carry over in breath testing must be addressed when operating at low ambient temperatures, particularly when using unheated breath testers. The results also show that the potential for carry over can be eliminated easily by using procedural controls, such as performing an air blank before the test, or by testing two separate breath samples and/or by using a warm air flushing of the breath tester airway.

A table listing all breath testers on both the NHTSA Conforming Products List (CPL) for Screening Devices, as well as the Evidential Breath Tester CPL indicates whether specific devices have a built-in heater, or a flushing pump, and whether the instructions accompanying them address the possibility of alcohol carry over during low temperature operations.

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Special Testing for Possible Alcohol Carry Over Effects Using the Intoximeters, Inc. Alco-Sensor IV at 10°C

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Roadside breath testing by law enforcement using hand-held breath testers is becoming more important in detecting the drinking driver. Roadside testing at low temperature presents a potential problem not seen with testing done in the protected environments of law enforcement stations or mobile vans. As it exits the mouth, the breath is saturated with moisture. If the ambient air is cold enough, and if the hand held breath tester is unheated, it is possible for the moisture in the breath to condense onto the airway surface of the tester, and cause alcohol present to condense with it. It has been pointed out to NHTSA that if this condensation occurs, it is possible for alcohol in one test to carry over to a second test, which would cause a false positive result. (In order to extend battery life, many hand held breath testers are unheated.) Carry over is not possible if sufficient time is allowed for condensed alcohol to evaporate, if the breath tester is heated and flushed prior to the second test, or if an air blank test is made prior to the breath test to check for the presence of residual alcohol.

The Alco-Sensor IV, a widely used hand held breath tester that is unheated and has no flushing pump was used to investigate the possibility of carry over. The Alco-Sensor IV is designed to automatically capture a small portion of deep lung air as the breath passes through the instrument and deliver it to the fuel-cell sensor for measurement. A series of tests was performed on two versions of the Alco-Sensor IV: a screening version and an evidential/screening version. The screening version allows the operator to begin a test at any time. In the evidential mode, the evidential/screening version will not allow the operator to begin an evidential test until an air blank test indicates that the instrument is clear of residual alcohol. A Cell Enhancement Module (CEM) was used in some of the tests. The CEM is a heated flushing accessory for the Alco-Sensor IV that allows the operator to flush the instrument with warm air to drive off residual alcohol in cold weather operations.

Testing Procedures

Both units, an Alco-Sensor IV, Version 58.12 (screener), and an Alco-Sensor IV.XL, version 1.10 (screener/evidential), were placed in a walk-in environmental chamber, operating at 10°C for a minimum of 2 hours. Two Guth 34C wet bath simulators using 0.170 Breath Alcohol Concentration (BrAC) solutions were used to administer samples into the breath testers. The simulators were kept at ambient temperature outside the chamber, brought briefly into the chamber to conduct a test, then quickly removed. Enough breath was used to satisfy the automatic sampling requirements of the instruments, unless

otherwise noted. New mouthpieces were used for each test. One-inch pieces of Tygon tubing were used to connect the output of the simulators to the mouthpieces of the breath testers. Tests 1-5 were conducted consecutively on the same day, whereas tests 6-18 were conducted consecutively on the next day.

Results

Alco-Sensor IV version 58.12 (screener)

Eight tests were performed on the version 58.12. Tests 7 and 8 used the Cell Enhancement Module (CEM) heated flushing accessory. The screener automatically performs a fuel cell blank between tests, but does not perform an air manifold blank. The unit reports results to three digits and masks all results of BrAC = 0.005 and below.

Test 1: Five 0.170 BrAC samples were introduced to the instrument 2 to 3 minutes apart. Two minutes after the fifth result was reported, the operator blew an alcohol-free breath through the instrument. The test of the alcohol-free breath was negative (0.000 BrAC). This procedure follows normal protocol and is how one would expect the device to be used in the field.

Test 2: Five 0.170 BrAC samples were introduced to the instrument 2 to 3 minutes apart. Two minutes after the fifth result was reported, a breathless sample was taken. This was accomplished by pressing the manual button when the instrument signaled that it was ready. The breathless sample gave a positive (0.084 BrAC) result. This procedure was conducted to determine whether any residual alcohol remained in the manifold in the absence of any flushing action before the device would be used again for another breath test.

Test 3: Five 0.170 BrAC samples were introduced to the instrument 2 to 3 minutes apart. Two minutes after the fifth result was reported, 5 breathless samples were taken 2 minutes apart. The results were: 0.071, 0.054, 0.047, 0.037, and 0.032 BrAC. These tests were conducted to determine how rapidly the residual alcohol remaining in the manifold evaporated with time.

Test 4: Five 0.170 BrAC samples were introduced to the instrument 2 to 3 minutes apart. Two minutes after the fifth result was reported, the instrument was taken from the chamber and various volumes of ambient temperature (23.5°C) air were injected 2 minutes apart into the mouthpiece before depressing the manual button. First 20 cc was injected (0.080 BrAC result), then 50 cc (0.059 BrAC result), then 60 cc (0.035 BrAC result), and finally 1 liter (0.012 BrAC result.) These tests were conducted to determine how effective minimal amounts of room temperature air (about 22° C) would be in flushing alcohol from the manifold.

Test 5: One 0.170 BrAC sample was introduced to the instrument. Two minutes later, an alcohol-free breath produced a 0.006 BrAC result. After two more minutes, a second alcohol-free breath produced a 0.000 BrAC result. Unlike Test 1, Test 5 produced a minimal BrAC reading, because the device had been exposed to repeated samples of alcohol vapors from the four previous tests, whereas no alcohol had been introduced into the system before Test 1.

Eighteen hours elapsed between tests 5 and 6. The units were again put into a 10°C temperature chamber for 2 hours. The simulator solutions were replenished.

Test 6: Six 0.170 BrAC samples were introduced to the instrument 2 to 3 minutes apart. Two minutes after the sixth result was reported, an alcohol free breath produced a 0.006 BrAC result. After two more minutes, a second alcohol-free breath produced a 0.000 BrAC result.

The CEM was used for the following two tests.

Test 7: Six 0.170 BrAC samples were introduced to the instrument 2 to 3 minutes apart. Two minutes after the sixth result was reported, an alcohol-free breath produced a 0.000 BrAC result.

Test 8: Ten 0.170 BrAC samples were introduced to the instrument 2 to 3 minutes apart. Two minutes after the tenth result was reported, an alcohol-free breath produced a 0.000 BrAC result.

Alco-Sensor IV-XL version 1.10 (screener/evidential)

Ten tests were performed on the XL version 1.10. Tests 13 through 18 used the Cell Enhancement Module (CEM) heated flushing accessory. The XL can be operated in either screening mode or evidential mode. While in screening mode, the XL operates similarly to the version 58.12. While in the evidential mode, the XL performs two tests two minutes apart. Before the subject first blows into the instrument, the instrument automatically samples the air within the manifold for residual alcohol in the following manner: The operator presses a "set" button cocking an internal diaphragm. The instrument then automatically releases the diaphragm sending some of the air in the manifold to the fuel cell. If the air is alcohol-free, the XL allows the first test to be performed. If not, the unit instructs the user to press the set button again. If repeated presses of the set button do not clear the manifold, the unit voids the test. The test sequence then must be restarted. Between the first and second breath test, the XL performs a fuel cell blank, instead of a manifold blank, to ensure that the fuel cell is clear. While in evidential mode, the unit reports results to two digits, masking the third decimal.

All of the following tests were conducted in evidential mode. Two evidential 0.170 BrAC runs were performed two minutes apart. After five minutes, an alcohol free evidential run was attempted. If the manifold air was not alcohol-free and the test was voided, the sequence was repeated every two minutes until it was successful. These tests were conducted to verify whether there was ever any carry over alcohol that might contaminate subsequent tests within two decimal places (0.00 BrAC).

Test 9: After the two 0.170 BrAC runs, the manifold cleared within five minutes. The two subsequent alcohol-free breath tests runs produced 0.00 BrAC results.

Test 10: After the two 0.170 BrAC runs, the manifold cleared after twenty-seven minutes. During the first 0.170 BrAC run, not enough air was provided to satisfy the automatic sampling requirement. The test had to be repeated before proceeding to the second run. The two subsequent alcohol-free breath tests produced 0.00 BrAC results.

Test 11: After the two 0.170 BrAC runs, the manifold cleared after eleven minutes. The two subsequent alcohol-free breath tests produced 0.00 BrAC results.

Test 12: After the two 0.170 BrAC runs, the manifold cleared after seventeen minutes. The two subsequent alcohol-free breath tests produced 0.00 BrAC results.

Test 13: After the two 0.170 BrAC runs, the manifold cleared after seven minutes. The two subsequent alcohol-free breath tests produced 0.00 BrAC results.

The CEM was used for the following five tests.

Test 14: After the two 0.170 BrAC runs, the manifold cleared within five minutes. The two subsequent alcohol-free breath tests produced 0.00 BrAC results.

Test 15: After the two 0.170 BrAC runs, the manifold cleared within five minutes. The two subsequent alcohol-free breath tests produced 0.00 BrAC results.

Test 16: After the two 0.170 BrAC runs, the manifold cleared within five minutes. The two subsequent alcohol-free breath tests produced 0.00 BrAC results.

Test 17: After the two 0.170 BrAC runs, the manifold cleared within five minutes. The two subsequent alcohol-free breath tests produced 0.00 BrAC results.

Test 18: After the two 0.170 BrAC runs, the manifold cleared within five minutes. The two subsequent alcohol-free breath tests produced 0.00 BrAC results.

Discussion

The above results show that the possibility for the occurrence of carry over in breath testing must be addressed when operating at low ambient temperatures, particularly when using unheated breath testers. The results also show that the potential for carry over can be eliminated easily by using procedural controls, such as performing an air blank before the test or by testing two separate breath samples and/or by using a warm air flushing of the breath tester airway.

Table 1 lists all hand held breath testers currently on both the NHTSA Conforming Products List (CPL) for Screening Devices, as well as the Evidential Breath Test CPL. The table indicates whether specific devices have a built-in heater, or a flushing pump, and whether the instructions accompanying them address the possibility of alcohol carry over during low temperature operations.

NHTSA will consider this potential problem in the next modification of the NHTSA model specifications for both evidential breath testers as well as alcohol screening devices.

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Table 1

Hand Held Breath Testers on NHTSA Conforming Products Lists. Devices on the Evidential CPL may also be used as Screening Devices. Presence or Absence of Features to Prevent False Positives due to Residual Alcohol at Low Temperatures are indicated.

Features: **Heated** sample airway; **Flushing** of previous sample before next test; **Instructions** address possibility of carry over at low temperature operation.		**Heated**	**Flushing**	**Instructions**
Screening CPL				
Alco Check International	Alco Check 3000 DOT Alco Screen Alco Check 9000	yes	yes	no
Guth Laboratories, Inc.	Alco Tector Mark X[1] Mark X Alcohol Checker[1]	no	no	no
PAS Systems International, Inc.	PAS IIIa PAS Vr[2]	yes	yes	yes
Han International Co., Ltd.	A.B.I.	no	no	no
Repco Marketing, Inc.	Alco Tec III	no	no	no
Sound Off, Inc.	Digitox DOT Alco Screen 1000	no	yes	no
Evidential CPL				
Alcohol Countermeasures Systems Corp.	Alert J3AD, PBA 3000C[3,4]	no	no	no
CMI, Inc.	Intoxilyzer 200, 200D, 300[3], 400[3], 400PA[2], SD2, SD5[6]	no	no	no
Draeger Safety, Inc.	AlcoTest 7410, 7410 Plus Breathalyzer 7410, 7410-II	yes	yes	no
Gall's Inc.	ADS 500[1]	yes	yes	no
Intoximeters, Inc.	Alco Sensor III, IV[5], IV-XL[5], IV AZ[5] RBT-AZ[5], III, III-A, IV[5]	no	no	no
Lifeloc Technologies, Inc.	PBA 3000B[3,4], 3000-P[3,4], 3000C[3,4], Alcohol Data Sensor, Phoenix, FC-10[6], FC-20[6]	no	no	no
Lion Laboratories, Ltd.	Alco Meter 300[3], 400[3], SD-2 Intoxilyzer 200, 200D	no	no	no
National Draeger, Inc.	Alco Test 7410, 7410 Plus Breathalyzer 4710, 7410 Plus	yes	yes	no
Seres	Alco Pro[7]	yes	yes	Not available
Sound-Off, Inc.	Seres Alco Pro[7]	yes	yes	Not available
	Alco Data[1]	yes	yes	no

[1] No longer manufactured.
[2] User activated heater.
[3] Design of mouthpiece minimizes potential for carry-over.
[4] Auto air blank

[5] Carry over not possible in evidential mode. CEM heated flushing accessory available for Alco-Sensor IV, RBT IV models.
[6] Devices have passed testing against the NHTSA model specifications for EBTs, but a new CPL for EBTs has not yet been published.

[7] No longer sold in U.S.