From the Laboratory of
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REPORT OF THE SUBCOMMITTEE ON ALCOHOL: TECHNOLOGY, PHARMACOLOGY AND TOXICOLOGY

COMMITTEE ON ALCOHOL AND OTHER DRUGS
NATIONAL SAFETY COUNCIL
Orlando, FL
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Subcommittee Co-Chairs: Patrick Harding, Kurt Dubowski, Ph.D.
Report prepared by Patrick Harding

Mr. Chairman,

Report on the Specificity of Breath Alcohol Analyzers

Claims that breath alcohol analyzers used in highway safety programs may produce falsely elevated results due to the presence of non-ethanol substances remains a common defense in impaired driving cases. In October 1994 this subcommittee evaluated the likelihood of falsely elevated breath alcohol results being caused by non-ethanol substances in the breath of conscious humans. Literature appearing in the published, recognized scientific literature that directly and indirectly addressed the issue of breath alcohol analysis specificity were reviewed, evaluated and summarized. At that time 41 articles were identified. The articles were categorized by compound(s) referenced and instrumentation employed for analysis. A five-point system was developed which was used to rate the relevance of the article to issue at hand. The highest ratings (1 – 2) were given to studies that utilized human subjects and breath alcohol analyzers, as they directly address the issue. Lower ratings were assigned in-vitro studies, letters to the editor and studies that did not utilize breath samples.

At the present time we have updated the October 1994 evaluation. The number of articles reviewed has increased to 50 since that time. The citations and evaluations for each article are attached to this report. The additional articles include in-vitro studies of the effect of volatile organic compounds and in-vivo studies of various asthma inhalers using both infrared and fuel cell instruments, as well as several case histories and one study of the occurrence of volatile organic compounds in the blood of a non-occupationally exposed population.

Taken as a whole, the literature that was reviewed continues to support the conclusions of the 1994 report. In order for a non-ethanol substance to produce a significant response on any breath alcohol testing instrument in use it must:

1. Be a volatile organic compound capable of appearing in the breath of a living, conscious human being.
2. Be present in sufficiently high concentration to be measured by the instrument after a 15 to 20 minute pretest observation period.

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3. Be able to produce a response on the instrument that is indistinguishable from ethanol.

The literature, and practical experience, indicate that endogenous (naturally occurring) compounds in human breath do not significantly affect breath alcohol testing instruments. With the exception of acetone, these compounds do not appear in sufficient concentrations to be considered potential interferents. Breath acetone concentrations, although potentially elevated in diabetic and fasting individuals, have no deleterious effect on current breath alcohol testing instruments.

Exogenous compounds appearing in the breath of non-occupationally exposed individuals will have no deleterious effect on breath alcohol testing instruments. Allegations of exogenous volatile organic compound interference of breath alcohol results must be evaluated on a case-by-case basis using the criteria listed above. For the most part compounds that are theoretically capable of causing falsely elevated ethanol results are characterized by short half-lives in breath, characteristic odors and significant toxicity. As such, the possibility of unrecognized falsely elevated breath alcohol results from these compounds in actual law enforcement practice is remote at best.

National Safety Council, Committee on Alcohol and Other Drugs
Subcommittee on Alcohol: Technology, Pharmacology, and Toxicology
February 15, 1999, Orlando, FL

Report on the Specificity of Breath Alcohol Analyzers
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Reference list compiled by Patrick Harding.
Contributions by Mack Cowan, Kurt Dubowski, Ph.D., Rod Gullberg and Brian Hodgson.

Ref.	Compound(s)	Analytical Method	Subj, N	Relevance*	Comments
1	Various Volatiles	GC/MS	600+	4	11 VOCs found in 75%+ of population studied. Reference values established for use in evaluating VOC exposure.
2	Diethyl Ether	IR (9.5), Breathalyzer 900, Gas Chromatography	2	1	Positive results by IR up to 1hr. after exposure in 1 subject. No response with wet chemical method (Breathalyzer).
3	Isopropanol	Gas Chromatography	12	4	Workers exposed occupationally to isopropyl alcohol (IPA). Environmental IPA ranged from 7-645 mg/m3. No IPA det'd in blood or urine.
4	Toluene, Styrene, MEK, Acetone, Dimethlyform-amide, Cyclohexane, Hexane, Methylcyclopentane, 2-methylpentane, 3-methlypentane	Gas Chromatography	41-115	4	Concentrations of listed solvents in breath reported after occupational exposure. Correlated alveolar to environmental concentrations. Low ratios found for compounds with high blood solubility.
5	Toluene, m-Xylene, o-Xylene, Methanol, Isopropanol	Intoxilyzer 5000	in-vitro	2	Potential for interference is Methanol >> Toluene> Xylenes >> Isopropanol. Low liklihood of interference in practice.
6	Toluene	Gas Chromatography	12	3	Alveolar, arterial and venous toluene measured during and after exposure. 22% decrease in alveolar air in 1st half hour, 9% of max remained after 1 hour.
7	Various Volatiles	GC/MS	8	4	A total of 69 trace organic cmpds found in normal human breath.
8	Gasoline	IR: Intoxilyzer 4011	1	3	Subject inhaled gasoline fumes for 15 min. No BrAC response 10 min. after exposure.
9	Acetaldehyde	IR: Intoxilyzer 4011AS-A	in-vitro	2	Max physiological breath acetaldehyde concentrations will not falsely elevate BrACs. Not flagged as interferent.
10	Acetaldehyde,Acetone, Acetonitrile, Isoprene IPA, MeOH, MeCl, MEK, Toluene, 1,1,1 trichloro-	IR: Intoxilyzer 4011AS-A	in-vitro	2	Response and potential for interference evaluated. Only IPA, Toluene and MEK could reasonably be expected to elevate BrACs slightly and not be det'd as interferent.

* Relevance to specificity of breath alcohol testing instruments on a scale of 1 - 5, with 1 being most relevant

Ref.	Compound(s)	Analytical Method	Subj, N	Relevance*	Comments
11	Gasoline	IR: Intoximeter 3000	1	3	No effect on BrAC within 20 min of rinsing mouth w/ 8ml petrol.
12	Diethyl Ether	IR (9.5 μm): Breath-analyser Seres 679 T-B	1	3	Letter, case history. Extremely elevated BrAC, negative BAC by GC and ADH methods. Ether in blood detected by GC/MS.
13	MeOH, Toluene, Xylene	IR: Intoximeter 3000	2	3	Subjects exposed to paint spray for 2.25 hrs. No BrAC after exposure, low BrAC only during exposure for one subject.
14	Literature Review	IR(3.39, 3.48 μm), Taguchi breath analyzers		4	Acetone, toluene, gasoline, methane and acetaldehyde have only remote likelihood of interfering on IR, possible on Taguchi instruments.
15	Acetone	Oxidation, IR, GC, Taguchi breath test analyzers	in-vitro	2	Intoxilyzer 4011 , ALERT J3-D and J3R (Taguchi) showed some response to high acetone concs. Other instruments showed no significant response. Acetone not a problem for traffic law enforcement purposes.
16	Acetone	Fuel Cell, IR, Taguchi	in-vitro	2	Fuel cell and IR breath testers showed little or no response. Taguchi detector instruments significantly sensitive to acetone.
17	Toluene, Acetone	IR: Intoxilyzer 5000	1	4	Letter. Male cabinet maker tested after work shift. Recorded BrACs of 0.312 and 0.245, "interferent subtracted." Blood acetone 0.026, blood toluene 11 mg/L, no ethanol.
18	Acetone, Methanol	IR: Intoxilyzer 4011, Breathalyzer 1000, Mark IV GC Intoximeter	in-vitro	2	3.48 μm instrmments had no problems with acetone, 3.39 μm GC-Intoximeter and Breathalyzer 1000 had no response to acetone or Methanol (MeOH). Intoxilyzer 4011's responded to MeOH.
19	Acetone	Gas Chromatography	28352	3	Based on blood samples from drivers, only 8 cases (0.028%) would have had acetone > 300 μg/L in breath (.> 0.01 g/100 mL in blood).
20	Acetone	Intoxilyzer 4011A, ALERT J3C, Literature review	in-vitro	2	No practical significance of acetone interference in BrACs from drivers.
21	Acetaldehyde, Ethanol	Gas Chromatography	3	3	Alveolar breath acetaldehyde levels plateaued at 650-1000 ng/100ml when alveolar ethanol conc. was at least 15-25 μg/100ml
22	Toluene	Gas Chromatography	6	2	Blood toluene conc's ranged from 9.8 to 31.2 mg/L after inhaling. Blood:breath ratio of 18.2:1 found in one subject.

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Ref.	Compound(s)	Analytical Method	Subj, N	Relevance*	Comments
23	Toluene	IR: Intoxilyzer 4011AS, Gas Chromatography	1	4	Letter. Male exposed to lacquer thinner spray. Toluene det'd in blood. Elevated (0.102) BrAC (consumed alcohol also) ~1hr post-exposure.
24	Toluene, 1,1,1 trichlorethane, Butane	IR: Intoximeter 3000, Camic, Gas Chromatography, MS	6	1	Exposure chamber used, breath measured by MS and IR, blood by GC. Air conc. to subjects did not exceed Occupational Exposure Limits. No significant apparent BrACs, even though compds det'd in breath and blood .
25	Mineral Spirits, Nonane	IR: Intoximeter 3000, Camic, MS	8	1	Same protocol as #22 with simulated painting task added. Low max BrAC's (~0.002) up to 55 min. post-exposure.
26	Mineral Spirits	IR: Miran Gas Analyzer	1	3	TWA's measured during 25 painting tasks. Concentrations achieved in practice were much lower than those found in #23 simulated task.
27	Inhalers and nasal sprays	IR: Intoximeter 3000, Camic Taguchi, K2Cr2O7 crystals	In-vitro	2	25 inhalers and 5 nasal sprays tested. No effect on BrAC.
28	Salbutamol	IR: Intoximeter 3000	8	3	No effect on BrAC or blood:breath ratios of drinkers using this type of inhaler.
29	Chlorophyll	Chemical Oxidation (?)	8	4	4; No effect on BrAC concs or Bl:Br ratio.
30	Acetone	IR: BAC Verifier DataMaster	35945	3	Review of flagged interferents in DUI case BrACs. Only 0.064% of cases could be considered as having acetone present.
31	Auto paint solvents	IR: Intoxilyzer 5000	2	4	Letter. Two auto painters tested 2 times/week for 2 weeks before and 10 minutes after 7 hr shift. Negative BrACs, painters wore masks during shift.
32	Acetone, Isopropanol	Fuel Cell: Alcolmeter S-L2, IR: Intoxilyzer 5000, GC	1	1	Case history, positive alcohol on fuel cell, interferent detected on Intoxilyzer, blood negative for alcohol with high concs. of acetone and IPA.
33	Acetone	Gas Chromatography	16(+)	2	Small dose of ETOH reduced breath acetone by 40% after 12 hr fast and 18% after 36 hr. fast.
34	Acetone	Gas Chromatography, IR: Intoxilyzer 4011, Alcotest 7010	6	1	Breath acetone 2.3-4.0 mg/L after 12 hr fast, no IR response. After 36 hr fast acetone 33.6-157.2 mg/L; Alcotest 0.005, 4011 0.002 g/210L.

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Ref.	Compound(s)	Analytical Method	Subj, N	Relevance*	Comments
35	Acetone	Gas Chromatography	1044	2	Median blood acetone conc. in arrested drivers was 2.03 mg/L, Type 1 diabetes mellitus 1.90, blood donors 1.26 mg/L.
36	Acetaldehyde	IR: Intoxilyzer 4011 Gas Chromatography	10	1	Ca Carbimide-treated subjects given low ETOH dose. BrAC by IR and GC at 15 min intervals. No effect on IR BrAC
37	Methanol, Isoprene, Acetone, Ethanol	Gas Chromatography	10	2	Endogenous cmpds measured. MeOH in breath 0.21 to 0.70 µg/L, acetone 0.57 to 4.01 µg/L. (ie - no BrAC interference from endogenous cmpds).
38	Acetone, Isopropanol, Methyl Ethyl Ketone, Gasoline	IR: Intoxilyzer 5000, GC	56	1	Blood analyzed from drivers with interferents flagged on Intoxilyzer. Listed compounds found in 31 drivers, 25 drivers had no VOCs detected, normal blood:breath ratios.
39	Methanol	IR: Intoximeter 3000 Fuel cell, Taguchi analyzers	3	1	Case histories- #1 had 0.27 BrAC by Taguchi cell, 0 BAC. Subj dead 24 hrs later. #2 had 0.20 BrAC by fuel cell, 0 BAC, subj. died 2 days later. #3 had 0.345 BrAC by IR, 0.212 BAC along with volatiles from denaturant. Methanol found in #1 & #2.
40	Acetaldehyde	IR: Alcytron Gas Chromatography	4	3	Breath acetaldehyde closely followed BrAC in men infused with ethanol. Acetaldehyde 2000x less than ETOH. BrAC (IR) used to monitor time course of ETOH.
41	102 volatiles	GC/MS	28	4	Three major constituents of normal breath accounted for 51% of mean organic contents (acetone, 120; isoprene, 33; acetonitrile 24 ng/L of breath). 102 cmpds identified.
42	general	IR (9.5 vs. 3.39, 3.48 µm)		5	Letter to editor speculating on specificity of 9.5 µm instrmments vs. 3.39 or 3.48 µm for use in IR breath testers.
43	Isopropanol	IR: BAC Verifier Datamaster, GC/MS	1	1	In arrested driver. Interferent det'd by BrAC instrs. (2) on multiple samples. GCMS of saved breath sample and blood showed IPA and acetone.
44	Asthma Inhalers, Decongestants	IR: BAC Verifier Datamaster	3	2	No effect after 15 minutes from any of several products studied

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Ref.	Compound(s)	Analytical Method	Subj, N	Relevance*	Comments
45	Acetone, Toluene	Breathalyzer	in-vitro	2	No effect on Breathalyzer 900A.
46	Acetaldehyde, Acetone,	Fuel Cell:	in-vitro,	2	Only acetaldehyde, ether, IPA and methanol gave positive responses
	Ether, Ethylene Glycol,	Alcolmeter S-L2	2		in-vitro, and only at toxic or lethal concentrations. No effect from various
	Isopropanol, Methanol,				inhalers tested on 2 subjects.
	Methylene Chloride, Toluene,				
	Trichloroethylene, Inhalers				
47	Methyl Ethyl Ketone	Gas Chromatography	not given	3	Exposed workers tested at end of shift had blood MEK concs. of
					842-9573 μg/L, mean 2630 μg/L; breath concs. 4-26, mean 26.4 μg/L.
48	various volatiles	GC/MS	not given	4	Describes development of portable spirometer for collecting primarily
					alveolar breath into 1.8 L canisters for subsequent analysis.
49	Acetone	GC, IR: PE 221@ 8.25 μm	169	2	Mean expired acetone conc. in fasting subjects. Non-diabetic 1.1 mg/L,
					diabetic 30.1 mg/L.
50	Asthma Inhalers	Fuel Cell: Alert J3A,	5	1	No effects after 8 minutes (if ethanol-containing). Freon caused
		Oxidation: Breathalyzer			interference on Mark IV, none after 4 minutes.
		900A, GC: Mark IV			
		GC Intoximeter			

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