TECHNICAL NOTE

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Radio Frequency Interference with the Model 1000SA Alco-Analyzer® Gas Chromatograph

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ABSTRACT: Radio frequency interference (RFI) from available frequencies in the 150 to 170 mHz band has been identified as affecting the analysis of a vapor sample using an Alco-Analyzer® gas chromatograph. Various effects on the recording of the ethyl alcohol concentration curve are discussed and demonstrated for identification of rf-induced changes.

KEYWORDS: forensic science, breath-alcohol testing devices, radio frequency interference

Radio frequency interference (RFI) with breath testing devices has only recently been recognized and brought to the attention of law enforcement officials. An unexpected deviation of the pen recorder during a radio transmission by a certified operator within the proximity of an Alco-Analyzer® gas chromatograph directed our attention to the possible effects that RFI may have on the analysis of a breath sample.

The Alco-Analyzer gas chromatograph, Model 1000SA, has been approved for analysis of ethyl alcohol in evidential breath testing by the Pennsylvania Department of Transportation [*1*], and has been described by Caplan [*2*]. This instrument utilizes a 10.2-cm (4-in.) strip chart recorder to produce a chromatogram and a digital readout is also provided by a Digital Volt Meter (DVM). The manufacturer describes the Alco-Analyzer as a "dual column instrument with a thermal conductivity detector" [*3*].

Experimental Procedure

A Model 1000SA Alco-Analyzer (Serial No. 184) gas chromatograph (GC) was used in all experiments. This GC operates in both differential and integrated modes. In the integrated mode the chromatogram reflects the results of the vapor sample analyzed as the blood alcohol concentration (BAC) on a chart with divisions representing 0.01%. Only the integrated mode of analysis was used for this study as this is the normally used mode in this jurisdiction. The instrument was calibrated according to procedures recommended by the manufacturer and the Pennsylvania Department of Transportation training program [*4*]. Instrument grade helium either 99.995 or 99.997% pure was used as the carrier gas for all testing purposes.

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Simulators, Smith & Wesson or Luckey products, were used to generate simulated breath alcohol samples with ethanol stock solutions, certified as yielding a 0.100 g/100 g reading upon equilibration with air at 34°C, and noncertified ethanol stock solutions. The simulator outputs and room air were used. The certified ethanol stock solutions were supplied by Guth Laboratories, Inc., Harrisburg, PA.

Radio frequency interference (RFI) was generated using available hand-held transceivers on frequencies of 154.980, 155.535, and 159.030 mHz. Either Motorola Model HT220 or General Electric Mastr® Hi-Power portable transceivers rated as 5-W units were used for the indoor radio signal source. All RFI indoors was created in front of the GC, between 15 and 91 cm (6 and 36 in.), by use of the hand-held transceivers. General Electric Mastr II vehicle transmitters rated as 100-W capacity units were also used to generate radio signals on the same frequencies in a position lateral to the GC, at a distance of 9.1 m (30 ft), outdoors.

Room air and ethyl alcohol vapor samples were introduced into the GC with a squeeze bulb attached either directly to the input port or to a simulator attached to the input port. During the analysis period radio frequency (rf) signals were generated and any deviation was recorded as it appeared on the digital readout and on the chromatogram.

Results

RFI from all frequencies available to the author caused a variety of deviations and erroneous results on both the chart recording and digital readout. During the time the integrator and window timers were on, RFI generated at 31 cm (12 in.) caused both positive and negative deflections in the pen recording only (Fig. 1). No deviation was seen in the digital readout.

After the integrator and window timers turned off to allow the ethyl alcohol curve to appear,

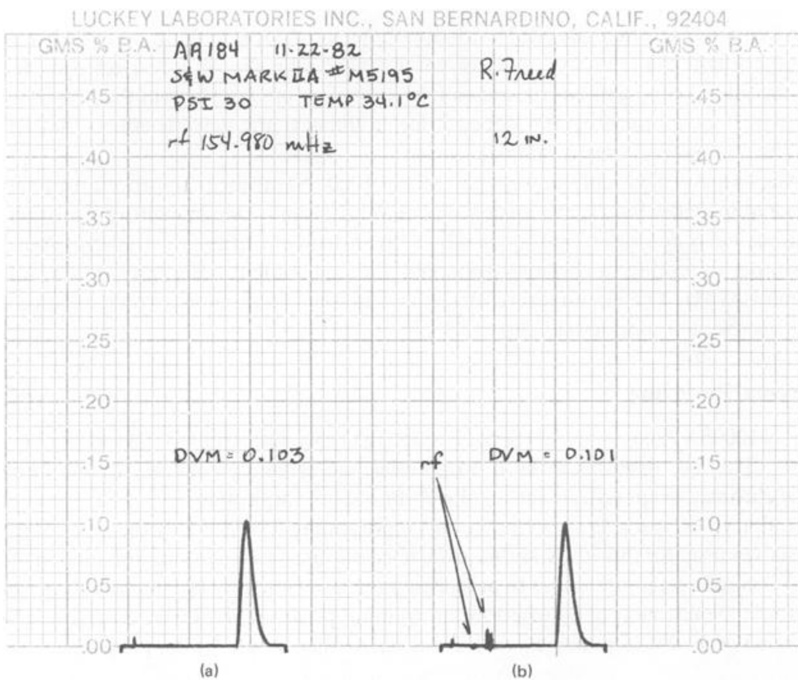

FIG. 1—(a) *Normal analysis of a 0.100 g/100 g certified ethanol stock solution.* (b) *RFI during the integrated portion of the testing cycle. RFI source was a 5-W hand-held transceiver at 30.5 cm (12 in.) from the GC on 154.980 mHz.*

RFI induced a variety of pen movements and DVM responses. Multiple rf-induced responses were recorded at various times and distances in the same analysis cycle (Fig. 2).

RFI generated before the apex of the curve, which was lower than the ethyl alcohol concentration, produced no apparent error in either the chart or the DVM readout (Fig. 3*a*). RFI that generated a response higher than the ethyl alcohol concentration caused an erroneous DVM readout higher than the chart which was, apparently, unaffected (Fig. 3*b*). The DVM readout was locked on the induced concentration. A similar response was seen when RFI was generated after the apex of the curve (Fig. 4). In this case the DVM maximum readout changed from the original concentration to the higher, induced response.

Figure 5 demonstrates the effect of RFI generation at or near the apex of the ethyl alcohol curve. An obvious rf-induced spike is demonstrated in Fig. 5*a*. Less obvious effects are seen as additions to the apex of the curve in Fig. 5*b* and *c*. Note the differences in the recorded apex and the DVM readout.

A variety of rf-generated curves induced when no ethyl alcohol was present are shown in Fig. 6. Notable is the third curve which was recorded with a longer rf signal generation and approximates what could be an ethyl alcohol curve.

Figure 7*b* demonstrates the effect of an rf signal with no voice modulation from a 100-W vehicle transmitter positioned 7.9 m (25 ft and 10 in.) from the exterior surface of a brick-faced, concrete block wall approximately 30.5 cm (12 in.) thick. The instrument was positioned on a table, 0.9 m (2 ft and 10 in.) from the interior surface of the same wall.

An erroneous addition to the apex of the ethyl alcohol curve during the analysis of simulated breath generated with a certified stock solution to yield a 0.100 g/100 g result is demonstrated in Fig. 8. This addition was created by a radio transmission with voice modulation under the same conditions described for the RFI shown in Fig. 7*b*. Note that the erroneous addition to the peak of the ethyl alcohol curve is complemented by the DVM readout.

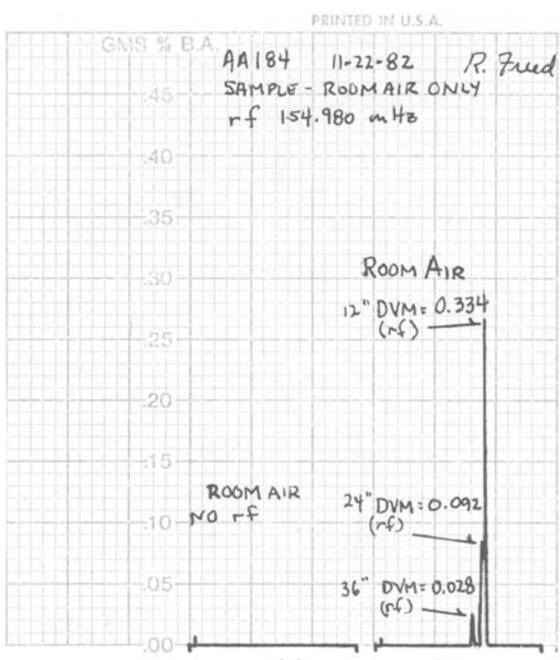

FIG. 2—(a) *Uninterrupted analysis of room air.* (b) *RFI occurring after the integrator timer turned off. RFI source was a 5-W hand-held transceiver at various distances from the GC on 154.980 mHz.*

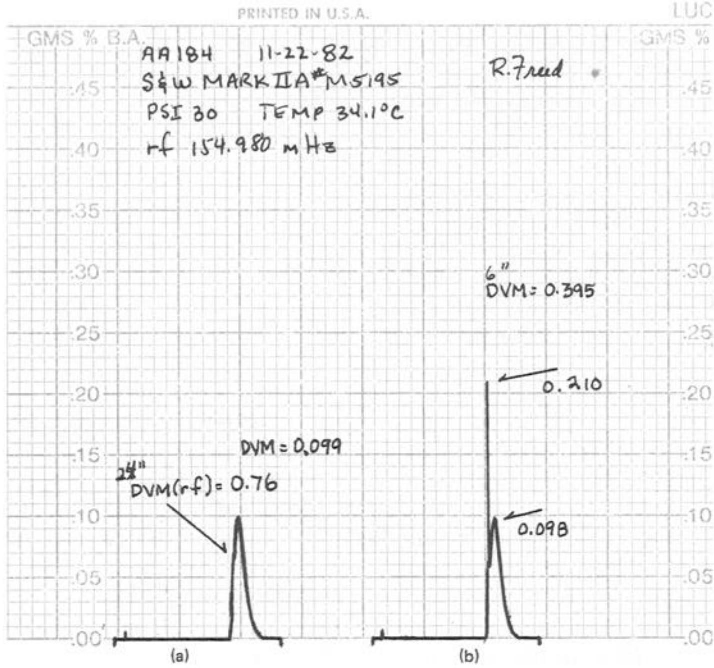

FIG. 3—(a) *RFI, the intensity below the ethanol level before the apex of the curve and* (b) *RFI, the intensity above the ethanol level. RFI source was a hand-held 5-W transceiver at various distances from the GC on 154.980 mHz.*

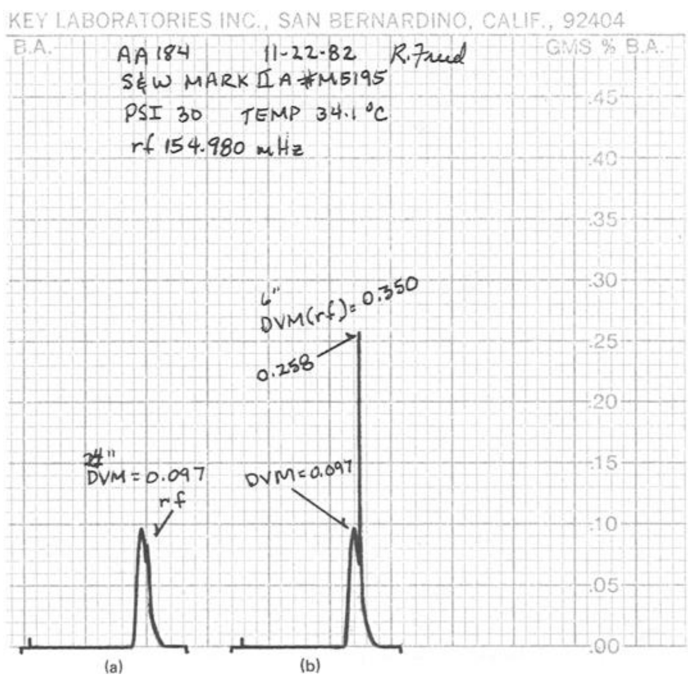

FIG. 4—(a) *RFI, the intensity below the ethanol level after the apex of the curve and* (b) *RFI, the intensity above the ethanol level. RFI source was a 5-W hand-held transceiver at various distances from the GC on 154.980 mHz.*

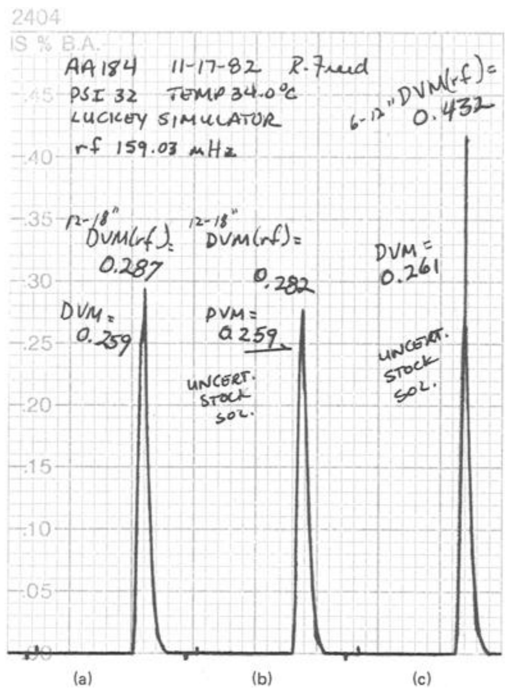

FIG. 5—*RFI additions to the analysis of an uncertified ethyl alcohol solution near the apex of the curve. The deviations were induced using a 5-W hand-held transceiver on 159.030 mHz.*

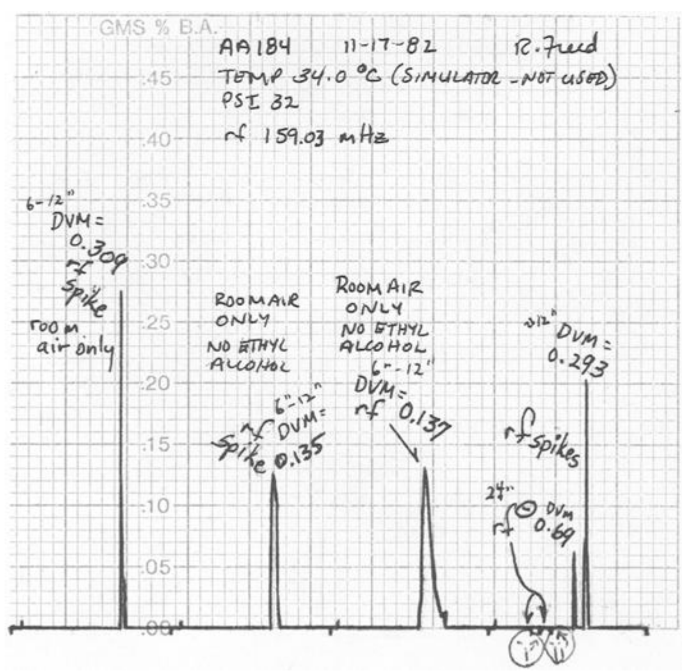

FIG. 6—*RFI induced curves and defects with no ethyl alcohol solution present. A 5-W hand-held transceiver on 159.03 mHz was used between 15.2 to 30.5 cm (6 to 12 in.) to cause the deviations.*

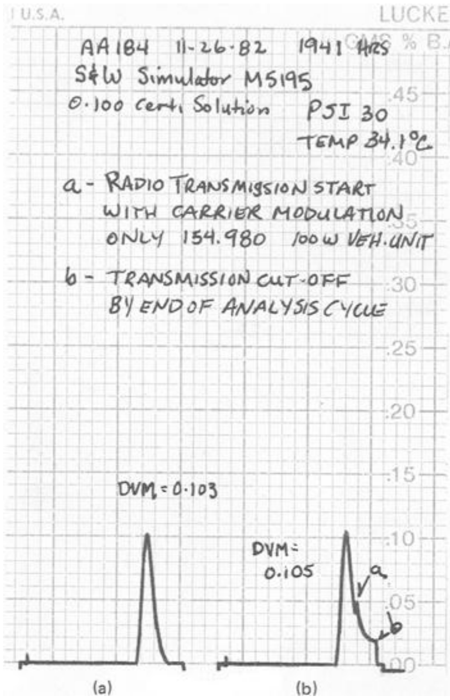

FIG. 7—(a) *Normal ethanol curve (certified solution).* (b) *RFI induced deviation using a 100-W vehicle transmitter on 154.980 mHz.*

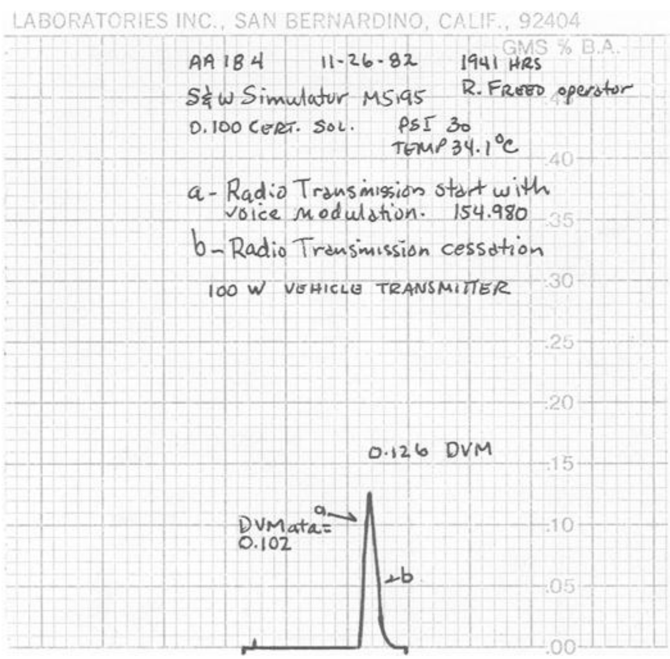

FIG. 8—*RFI addition to the apex of an ethanol curve (0.100 g/100 g solution) using a 100-W vehicle transmitter on 154.980 mHz with voice modulation.*

Conclusion

The Model 1000SA Alco-Analyzer gas chromatograph is subject to Radio Frequency Interference. The appearance and recognition of RFI in this instrument may be obvious under the controlled scrutiny of a trained operator/technician. Many of the RFI induced changes would, based on these results, be readily identifiable as errors. Of concern is the RFI that affects the curve in a subtle manner with only a slight deviation. In these instances the results could adversely affect a defendant unless the interference is recognized and the test invalidated by the operator. Corrective action should be taken to ensure the validity of the testing procedure by eliminating any local radio transmission in the proximity of the instrument.

This study was completed without the benefit of the National Highway Traffic Safety Administration's recently issued recommended procedures [5] for RFI testing of evidential breath alcohol equipment. It would be beneficial for additional studies to be performed with this and similar instruments under these and stricter guidelines.

References

[1] Pennsylvania Department of Transportation Regulations, Title 67, Chapter 154.2, effective 7 Oct. 1977.

[2] Caplan, Y. H., "The Determination of Alcohol in Blood and Breath," *Forensic Science Handbook*, R. Saferstein, Ed., Prentice-Hall, Inc., Englewood Cliffs, NJ, pp. 636-637.

[3] *Alco-Analyzer Instruction Manual*, Luckey Laboratories, Inc., San Bernadino, CA, undated, p. 2.

[4] Pennsylvania Department of Transportation Regulations, Title 67, Chapter 154.3(a).

[5] *NHTSA Alternative General Procedures for Testing for Radio Frequency Interference in Evidential Breath Alcohol Testing*, U.S. Department of Transportation, National Highway Traffic Safety Administration, 400 Seventh St., S.W., Washington, DC 20590.

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