Evaluation of Ozone Exposure from Use of the Electrostatic Detection Apparatus

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Use of the Electrostatic Detection Apparatus in evaluating documents for hidden indentations creates ozone. Ozone can cause respiratory irritation and breathing difficulty. Ozone discharge was measured for an hour during continuous operation at two different locations. Results indicated that continuous use can generate ozone concentrations that will exceed the permissible exposure limit mandated by the Occupational Safety and Health Administration. Ozone levels can be controlled by shutting the corona wand off when not in use and by using local exhaust ventilation.

Introduction

The Electrostatic Detection Apparatus (ESDA) is used by forensic document examiners to visualize indented impressions in paper evidence, which may provide additional information in criminal cases. Indentations can be developed by both cascade and aerosol methods. When using the cascade method, the document is placed on a sintered metal vacuum bed and then covered with a thin polymer film. The film is charged using a corona wand, which is passed over the surface of the film. Carrier beads coated with a toner are cascaded over the surface of the film. Indentations are developed as black lines against a lighter background. The indentations can then be preserved with a transparent adhesive covering (Foster and Morantz, 1979). The corona wand is not required for the aerosol method.

When the corona wand is used, the electric filament generates ozone. Ozone is a colorless gas with a distinctive odor. Ozone occurs naturally, being generated by ultraviolet light in the upper atmosphere and during lightning. Ozone is also generated by electrical equipment and by automotive exhaust. Ozone generation during ESDA operation has been noted as potentially hazardous to forensic document examiners (Masters, 1995).

Human exposure to ozone can produce cough, soreness on deep inspiration, shortness of breath, chest tightness and dryness of mucous membranes. Non-respiratory effects include headache, nausea, weakness and dizziness (Lipsett, Susterman and Beard, 1994). The US Environmental Protection Agency designates maximum outdoor ozone levels of 0.12 parts per million (ppm) over an eight-hour period in the National Ambient Air Quality Standards (Code of Federal Regulations, Title 40, 2000). The Occupational Safety and Health Administration (OSHA) sets an eight-hour permissible exposure limit (PEL) for workers of 0.1 ppm. (Code of Federal Regulations, Title 29, 2000). The California OSHA also allows a 15-minute Short Term Exposure Limit (STEL) of 0.3 ppm (California Code of Regulations, 2000).

An evaluation of ozone emissions from the ESDA has been previously performed (Lundblad, 1985). Samples were collected immediately next to the wand or collected into a 5-liter sample bag and measured with a colorimetric detection tube. An average emission rate for a 10-second period was determined. Results of that evaluation indicated that both the PEL and STEL could be exceeded using today's regulatory standards. However, an evaluation of the buildup of ozone was not measured. Additionally, the measurements

were made close to the wand and not in the worker's breathing zone.

As part of a health hazard evaluation required by the California Department of Justice's Injury, Illness and Prevention Program, two ESDA machines used by the Questioned Document Sections, located in Sacramento and Riverside, were measured for ozone generation in the worker's breathing zone to determine whether hazardous ozone levels were being produced.

Methods and Materials

The ESDA machine was activated according to the manufacturer's procedures (Foster + Freeman, Ltd.). The corona wand was turned on and left on top of the ESDA, facing up. Ozone measurements were made with Colorimetric Indicator Tubes (Draeger #6733181, batch ARNH-5020) with an ozone detection level of 0.05 ppm (Figure 1). Samples were collected five feet above the floor over the unit to simulate the worker's breathing zone. Ten pump strokes were required which took approximately three minutes per sample. Tubes were read immediately after the measurement was taken. Measurements were made without local ventilation and with local ventilation on.

Results

Tables 1 and 2 provide the results. The tables give a range of values because Colorimetric Indicator tubes are generally considered to be accurate to plus/minus 25% (American Industrial Hygiene Association, 1976).

In two separate locations, continuous operation of the corona wand for over 30 minutes without local ventilation produced levels of ozone exceeding the PEL and potentially above the STEL.

The Sacramento ESDA built-up levels exceeding the PEL within 5 minutes of continuous use. However, those levels dropped over time to one-half of the PEL after an hour. With the ventilation system on, the exposure was never above the detection limit of the tube.

The Riverside ESDA remained below the PEL until the 60-minute reading was taken. More specifically, after 15 minutes the ozone levels started to increase with a high level (0.26-0.42 ppm) reached after 60 minutes. This exceeded not only the PEL, but the STEL as well. When the exhaust hood was turned on, the levels dropped below detection.

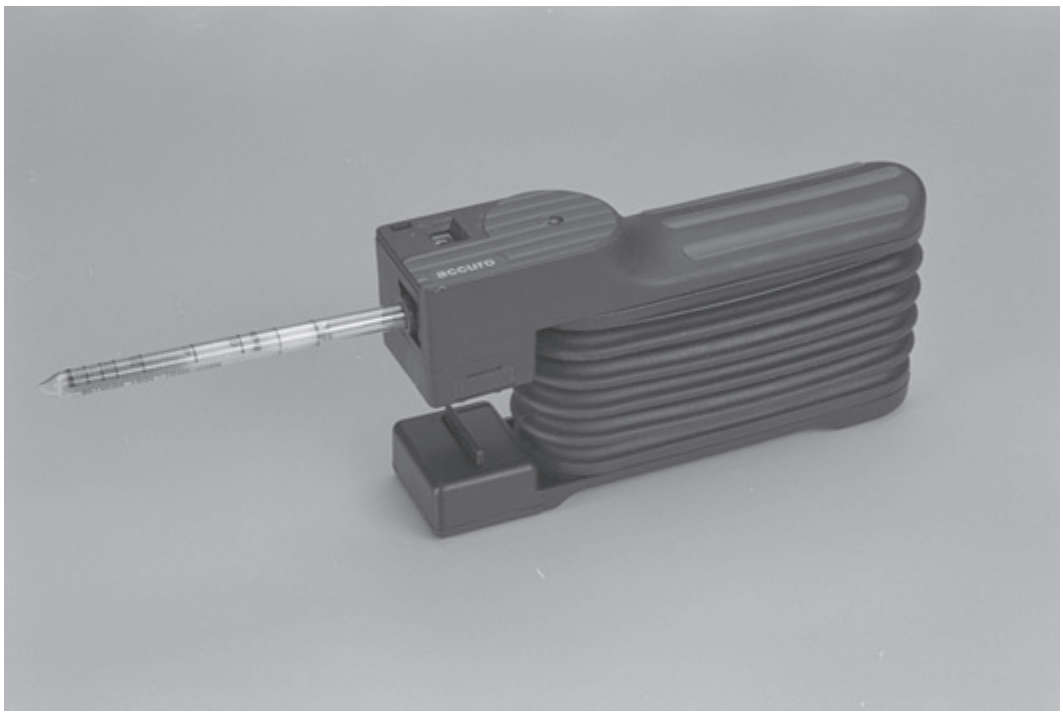

Figure 1

Sacramento Office			
Sample: No ventilation	Ozone (ppm)	Sample: Ventilation on	Ozone (ppm)
Background	<0.05	Background	<0.05
After 1 minute	<0.05		
After 5 minutes	0.16-0.24	After 5 minutes	0.04-0.06
After 15 minutes	0.14-0.22	After 15 minutes	0.04-0.06
After 30 minutes	0.08-0.12	After 30 minutes	0.04-0.06
After 45 minutes	0.08-0.12	After 45 minutes	0.04-0.06
After 60 minutes	0.04-0.06	After 60 minutes	0.04-0.06

Table 1. Ozone Air Monitoring: Sacramento Office

Riverside Lab			
Sample: No ventilation	Ozone (ppm)	Sample: Ventilation on	Ozone (ppm)
Background	<0.05	Background	<0.05
After 1 minute	0.04-0.06		
After 5 minutes	0.02-0.04	After 5 minutes	<0.05
After 15 minutes	0.02-0.04		
After 30 minutes	0.05-0.07		
After 60 minutes	0.26-0.44	After 60 minutes	<0.05

Table 2. Ozone Air Monitoring: Riverside Lab

Discussion

The results varied by office due to the local ambient ventilation conditions. The Sacramento ESDA was located in a small room with limited ventilation; the Riverside ESDA was located in a former hallway, which provided a larger area for air mixing.

The Sacramento ESDA built up ozone levels for 30 minutes, but then the levels decreased. The probable reason was that the small room had a ceiling HVAC (Heating, Ventilating & Air Conditioning) register. The HVAC system may have been activated, thereby supplying fresh air to dilute the ozone levels. However, the dilution levels were still at or above the PEL for ozone.

The possible reason for the build-up in the Riverside ESDA was probably due to the larger area that the ESDA occupies. The larger area would allow accumulation of ozone to take longer be-

fore it would be detectable. The area did not have any air registers since it was a hall/entry way. This means that there was no dilution ventilation available to limit the build-up of ozone if the machine was left on for a long time.

It should be noted that a forensic document examiner would not normally continuously run the corona wand. The corona wand would be turned on to electrostatically charge a document and then be turned off. The 1-minute samples measured at both locations indicate that the ozone levels are well below the PEL, even without ventilation. However, by keeping the corona on for this evaluation, a true "worst case" scenario was measured. If many documents were being examined and the corona wand was turned off in-between each use, it could be assumed that the exposure would be less.

Conclusions

Short uses of the ESDA machine will not likely result in ozone exposures exceeding the PEL or the STEL. However, due to the variable build up of ozone possible in different locations, the use of local exhaust ventilation at all times is recommended.

References

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