

Industrial Hygiene Report

Chemtronics® Konform® AR Filter Efficiency Testing

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Background

Chemtronics® - an acknowledged industry leader providing cleaning, protection and repair solutions for the electronics, telecommunications and critical environments markets – produces Konform® AR as part of a line of polymeric conformal coatings for electronic assemblies. Konform® AR is an acrylic coating that provides fair elasticity and general protection in a one part coating that is easy to apply and remove while providing high dielectric strength and abrasion resistance. Conformal coatings such as Konform® AR can help insulate electronic assemblies from high voltage arcs and shorting as well as mediate current bleed between circuits.

Polymeric coatings are ubiquitous in many manufacturing processes because they are relatively easy to work with and they increase the longevity and durability of electronic goods. These coatings allow sensitive equipment and designs to be used in products that are subjected to significant environmental stresses both from external sources and from the electrical equipment itself. Konform® AR stands out among other polymeric coatings in that it's protective abilities are adequate for many applications, it is easy to apply, and it is easy to remove compared to other polymeric coatings on the market.

Konform® AR is applied with either an aerosol delivery system, in the form of an 11.5 oz spray can or it can be brushed on from a bulk “paint-can” type reservoir. Both of these systems utilize many of the same components in order to apply the polymeric coating to the work piece. Konform® AR utilizes an evaporative curing process where the monomer components of the coating are suspended in a volatile mixture of solvents which prevent the polymerization reaction from occurring; on application of the coating the volatile solvents slowly vaporize allowing the polymerization reaction to take place. This allows Konform® AR to be applied in a one-step process as opposed to the multi-step processes required for many other conformal coatings with similar properties. Furthermore, this one-step approach allows for a much easier cleanup and coating removal. Many other conformal coatings can only be removed via abrasive processes which will oftentimes damage sensitive components. The downside of evaporative curing coatings is that the solvents must go somewhere. This necessitates the use of effective ventilation engineering controls such as Sentry Air Systems Ductless Spray Hoods or Exhaust hoods.

Product Ingredient Information	CAS No.	Wt. % Range
n-Butyl acetate	123-86-4	10.0-20.0
n-propyl acetate	109-60-4	10.0-20.0
Propylene glycol monomethyl ether acetate	108-65-6	10.0-20.0
Ethanol	64-17-5	10.0-20.0
Propane/isobutane blend	68476-86-8	20.0-30.0
Methyl ethyl ketone	78-93-3	2.0-5.0
Acrylic copolymer resin	26760-85-0	5.0-15.0

Figure 1: Konform AR Composition

As shown in Figure 1 there are a number of volatile compounds that make up the aerosol spray form of Konform® AR. It can be inferred that the bulk of the “polymer coating” will be made up of Methyl Ethyl Ketone, typically used as a catalyst for polymerization, and the proprietary monomer mixture. Also included in this list, but not discussed extensively here is the “Propane/Isobutane Blend”, which is assumed to be a propellant. The remaining components are used as solvents which will likely vaporize during the curing process and therefore must be addressed as respiratory hazards. There is also a possible concern regarding aerosol sized particulate being generated by the spray process, however a full analysis of this hazard is outside the scope of this document, further this issue is almost certainly mitigated by the use of a HEPA filter and thus will not be discussed further.

n-Butyl Acetate is an organic liquid used in the production of various lacquers and solvents as well as a flavoring in the food industry. n-Butyl Acetate is also found extensively in nature in many fruits where it contributes to the characteristic “fruity” odor of fruits such as bananas or apples. The Occupational Health and Safety Administration (OSHA) lists the permissible exposure limit (PEL) for n-Butyl Acetate as 150 ppm (710 mg/m³) and suggests the use of an organic vapor cartridge respirator for use in atmospheres up to 1500 ppm. Literature also suggests that long-term exposure to n-Butyl acetate is not recommended and could result in irritation of the eyes, skin, upper respiratory system; headache; drowsiness; and narcosis. Severe irritation of the throat has been reported in individuals exposed to 300 ppm for only 3-5 minutes, though initial exposure is not found objectionable until concentrations rise above 3,300 ppm.

n-Propyl Acetate is an organic solvent liquid used in various fragrances and flavor additives as well as other industrial processes. It is also used as a solvent in many different formulations. OSHA lists the PEL for n-Propyl Acetate as 200 ppm (840 mg/m³) and suggests using an organic vapor cartridge respirator for use in atmospheres up to 1700 ppm. Symptoms of exposure to n-Propyl Acetate include irritation of eyes, nose, throat; narcosis; and dermatitis.

Methodology

Test Equipment and Setup

The unit under test in this study was Sentry Air Systems’ (SAS) 30-inch wide ductless spray hood (SS-330-DSH). The SS-330-DSH was configured with a spray pre-filter (SS-000-IPF), a HEPA filter (SS-300-HF) and a 10lb activated carbon filter (SS-310-CF) — standard equipment recommended for conformal coating applications by SAS. The SS-

000-IPF is a polymer-fiber pre-filter with moderate efficiency used to capture the majority of large diameter overspray particulate, helping to improve the longevity of the HEPA main filter. The majority of respiratory protection is provided by the SS-300-HF which controls particulate contaminants, and the SS-310-CF which helps to reduce VOC concentrations.

In order to simulate typical product usage of Konform[®] AR, several printed circuit boards (PCB) were prepared and staged inside the hood on a fiberglass spilltray (SS-030-AS) that SAS offers as an option for most of their hoods.

The spray test operator was outfitted with a NIOSH-approved respirator, gloves and a personal air sampler pinned to their collar to measure chemical exposure during spraying procedures. For further precaution the operator wore safety glasses and an apron.

During testing, air contaminant concentration was measured using SKC-branded personal air samplers (SKC-224-PCXR4), each calibrated with a BIOS International Defender 510 (Defender 510). The flow rate of each sampler was set, measured and recorded to meet NIOSH (National Institute for Occupational Safety and Health) and/or OSHA (Occupational Safety and Health Agency) test protocol requirements. A sample size was determined by using the timer onboard each SKC-224-PCXR4 air sampler along with their calibrated flow rate. Sampling time was selected according to the Minimum Sample Volume Requirement analysis method.

Testing methodology used in this study was based on NIOSH's Method 1450 Esters 1 test method. This method calls for a flowrate sampling between 0.01 to 0.2 L/min with a maximum sample volume of 1 to 10L when contaminant composition is expected to be approximately 0.5 to 2 times OSHA's permissible exposure limit for the chemical being studied. According to the test method, samples are to be taken using solid sorbent tubes with coconut shell charcoal. This test used SKC-branded Anasorb CSC coconut charcoal sorbent tubes (SKC-226-01) as sample media.

Data Points

During testing, data was gathered from multiple points on the SS-330-DSH unit and throughout the lab space. The purpose of this data was to evaluate the performance of the unit during typical usage of Konform[®] AR, the material under test, in as realistic a scenario as possible. To this end, air composition was measured in a variety of locations to establish:

1. The average contaminant concentration inside the hood during testing;
2. The average contaminant concentration in the treated air at the outlet of the unit's Fan/Filter Unit (FFU);
3. The operator's exposure during conformal coating operations;
4. And the ambient room contaminant concentration before and after testing.

Other pre- and post-test measurement quantities were filter mass, airflow rate, static pressure across the filter stack and total mass of coating sprayed.

The lab space during testing was an air conditioned, non-vented room approximately 12'Wx12'Lx 8'H with the SS-330-DSH unit located atop a 32-inch long table in one corner. Note: Ceiling clearance above the unit was approximately 13.5 inches — which is within normal operating requirements — however, it is expected that a setup with greater ceiling clearance above the unit would yield an increased maximum airflow.

Air concentration sampling locations were named: Point A, Point B, Point C, Point D, Point E and Blank. A preliminary test was conducted however, due to unrelated gas sampling equipment failure, results were not generated. Subsequently, the results presented here and in the lab analysis are listed as “Test 2”. The air composition samples were named using the following convention: T + (Test Number) + (Test Point Letter).

Test point locations are as follows:

Test Point A (T2A)	Located in the interior of the hood above the SS-000-IPF and 6 inches below the FFU inlet.
Test Point B (T2B)	Located on the exterior of the FFU just above the outlet. Note: The sample taken at T2B was made with the sampling hose perpendicular to exhaust airflow.
Test Point C (T2C)	Located directly in front of the apparatus, about 14 inches above the table top to which the SS-330-DSH was mounted and about 8 inches away from the front face of the unit. Note: The sample taken at T2C was at the operator’s collar and was attached using a SKC accessory included with their air sampling kit.
Test Point D (T2D) & E (T2E)	Located on a shelf in the lab space approximately 5 feet from the test apparatus and about 5 feet off the floor. Note: T2D was taken before any spraying was done and T2E was taken just after spraying was completed.
Blank	This was a sorbent tube from the same lot number as the other sample tubes and was subjected to the same handling procedures as the other samples however no air was pulled through it.

After testing was completed all of the air composition samples were immediately refrigerated and couriered to a third party analytical lab, HIH Laboratories, for next day testing. Sample refrigeration is a requirement in the NIOSH test method being used. HIH Laboratories analyzed the samples for n-Butyl Acetate and n-Propyl Acetate and results were reported in mg of target reagent. This information was converted to mg/m³ by calculating the total volume of air sampled at each individual test point.

Mass measurements were made using an ADAM CPQ plus-35 scale and airflow measurements were taken using an EXETECH 407119A hot-wire anemometer following instructions for airflow measurement that can be found in Appendix B. Static pressure was measured using a HHP886 digital barometer. These measurements are for reference only and did not significantly contribute to the test results.

Test Procedure

1. The FFU and enclosure for the SS-330-DSH were assembled on the lab table.
2. All pre-test filter mass measurements were taken.

3. Air sampling media for T2A, T2B, T2C and T2D were calibrated using the SKC-224-PCXR4 and the Defender 510 to an approximate flowrate of 200 mL/min, making sure to record the exact flowrate for each sample.
4. The static pressure sensor was installed in the FFU and the SS-000-IPF was installed in the SS-330-DSH enclosure.
5. The remaining filters were installed in the FFU in the following order, starting from the fan outlet: SS-300-HF, SS-310-CF.
6. The SS-030-AS with the PCBs was placed inside the enclosure with the Konform[®] AR conformal coating spray as well as the air sampling equipment for T2A then the hood sash was closed.
7. The test apparatus was turned on with the motor control set to the highest fan setting.
8. After allowing the apparatus airflow to stabilize, pre-test static pressure readings were taken along with pre-test airflow measurements. The airflow measurements were taken in accordance with the method outlined in Appendix B.
9. Air samplers outside of the hood were put into their respective places and staged for sampling to begin.
10. The pre-test ambient sample T2D was taken, allowing the sampler to run for 25 minutes before shutting down the sampler and capping the sample media.
11. The post-test ambient sample media was calibrated using the same method as before with the sample media inlet being capped after the sampler was staged at T2E for the post-test ambient sample.
12. The operator, wearing appropriate PPE, began spraying the Konform[®] AR according to the manufacturer's specifications.
13. Spraying was continued for 5 minutes in order to allow the apparatus enclosure's interior composition to stabilize before measurements were taken.
14. After 5 minutes, the samplers for T2A, T2B and T2C were started.
15. Spraying then continued for 25 minutes.
16. After 25 minutes the samplers at T2A, T2B and T2C were turned off, capped and their sampling times were recorded.
17. Immediately after spraying was finished the air sampler at T2E was started and ran for 28 minutes.
18. After 28 minutes the sampler at T2E was turned off, capped and its sampling time recorded.
19. After testing, the airflow and static pressure were measured as before.
20. Following this the post-test filter masses were also recorded.
21. The air samples were then refrigerated and couriered to HHH Laboratories the following day in a box containing ice.

Data/Findings

Konform [®] AR Industrial Hygiene Test Data			HIH Laboratories Analysis Results	
Test Point ID	Sample Time (minutes)	Sample Flow Rate (mL/min)	n-Butyl Acetate (mg)	n-Propyl Acetate (mg)
T2A	25	208.08	< 0.003	< 0.003
T2B	25	203.15	1.1	1.2
T2C	25	207.71	0.005	0.004
T2D	25	202.5	< 0.003	< 0.003
T2E	25	201.37	0.005	0.004
Blank	28	n/a	< 0.003	< 0.003

Test Point ID	Calculated Results				
	Sample Indicated Concentration				
	Sample Volume (m ³)	n-Butyl Acetate (mg/m ³)	n-Propyl Acetate (mg/m ³)	n-Butyl Acetate (PPM)	n-Propyl Acetate (PPM)
T2A	5.202E-03	0.577	0.577	0.138	0.121
T2B	5.079E-03	216.589	236.279	51.9	49.7
T2C	5.193E-03	0.963	0.770	0.231	0.162
T2D	5.063E-03	0.593	0.593	0.142	0.125
T2E	5.034E-03	0.993	0.795	0.238	0.167
Blank	n/a	n/a	n/a	n/a	n/a

Indicated Performance	
n-Butyl Acetate % Efficiency	n-Propyl Acetate % Efficiency
99.734%	99.756%

Apparatus Properties	Fan Static P (inH ₂ O)	Avg In-flow rate (ft ³ /min)	Mass SS-300-HF (kg)
Pre-Test	2.64	270	3.17
Post-Test	2.56	247	3.17

Apparatus Properties	Mass SS-310-CF (kg)	Mass SS-300-IPF (kg)	Mass of Spraycan (kg)
Pre-Test	4.5	0.7	0.45
Post-Test	4.73	0.72	0.14

Results Summary

HHH Laboratories processed the samples and analyzed for the components n-Butyl Acetate and n-Propyl Acetate. According to HHH Laboratories, the reporting limit for the analysis was 0.003 mg of analyte. Meaning any samples made in areas of very low concentration might not register on this analysis and, with certainty, the sample contained less than this amount.

Considering it is better to underestimate filter performance, the results presented for this test will follow the convention that if a sample has a reported value of “< 0.003 mg” that value will be taken as 0.003 mg. This results in the reported filter efficiency being considerably lower than its actual efficiency; however following this convention also guarantees that the filter’s performance is no worse than the reported value.

HHH Laboratories’ analysis found 1.1 mg of n-Butyl Acetate and 1.2 mg of n-Propyl Acetate detected at test point T2B resulting in measured concentrations inside the apparatus of 216 mg/m³ and 236 mg/m³ of n-Butyl Acetate and n-Propyl Acetate, respectively. Outlet concentrations at test point T2A were calculated at 0.14 PPM for n-Butyl Acetate and 0.12 PPM for n-Propyl Acetate.

Based on the measured difference in concentration across the filter stack, the indicated filter efficiency for the materials analyzed were 99.73% (n-Butyl Acetate) and 99.76% (n-Propyl Acetate). This corresponds with the change in atmospheric concentration of these analytes over the course of the test which was 0.14 to 0.24 PPM for n-Butyl Acetate and 0.13 to 0.17 PPM for n-Propyl Acetate.

A qualitative indicator of filter performance is the change in mass of the carbon filter over the course of the test. Without knowing the exact composition of Konform[®] AR it would be difficult to estimate filter efficiency from this data, but it is apparent that a significant amount of the material sprayed during testing was captured by the carbon filter; approximately 0.23 kg which is about 75% of the total mass sprayed.

Some reduction in airflow rate was indicated by the test data, however it is likely that this is a result of test equipment accuracy as little change was detected in the mass of the SS-300-HF over the duration of the test.

With regards to operator exposure, analysis of the sample taken at T2C indicated a concentration of approximately 0.23 PPM n-Butyl Acetate and 0.16 PPM n-Propyl acetate.

Conclusions and Considerations

Given the results presented here, it is likely that the use of a SS-330-DSH unit for conformal coating applications using Konform[®] AR would prove beneficial for reducing operator exposure below what would be expected if no precautions were taken. As mentioned earlier, it is likely that the carbon filter efficiency results are lower than its “real” value as the contaminant concentrations at the filter outlet were too low to measure given current test setup limitations, the sources of which are beyond the scope of this document.

Furthermore, test results indicate that mixtures of various volatile organic compounds (VOCs) do not seem to have a deleterious effect on filter performance. Previous SAS studies tested individual chemicals using very pure feedstock to generate fumes within the unit. Given the rather complex mixture of compounds in Konform[®] AR and the excellent filter performance results, it seems likely that the adsorption-filtration mechanics of activated carbon filter media are not adversely affected when subjected to a VOC mixture as opposed to a pure reagent. This is an encouraging result that provides a sound basis for extrapolating filter efficiency data obtained while testing individual components of products containing VOC mixtures and other chemicals.

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References

http://www.omega.com/toc_asp/frameset.html?book=Green&file=AIRFLOW_MEAS_REF

<http://www.cdc.gov/niosh/idlh/123864.html>

<http://www.cdc.gov/niosh/npg/npgd0072.html>

<http://www.cdc.gov/niosh/idlh/109604.html>

<http://www.cdc.gov/niosh/npg/npgd0532.html>

http://en.wikipedia.org/wiki/N-propyl_acetate

http://en.wikipedia.org/wiki/Butyl_acetate

Appendix A

SECTION 1: CHEMICAL PRODUCT AND COMPANY INFORMATION

Company Address:
8125 Cobb Center Drive
Kennesaw, GA 30152

Product Information: 800-TECH-401
Customer Service: 800-645-5244

Emergency: (Chemtrec) 800-424-9300
Revision Date: February 17, 2010

Product Identification

KONFORM[®] AR
(Formerly Konform[®] AR 2000)

Product Code: CTAR-12, CTAR-12C

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

Product Ingredient Information	CAS No.	Wt. % Range
n-Butyl acetate	123-86-4	10.0-20.0
n-propyl acetate	109-60-4	10.0-20.0
Propylene glycol monomethyl ether acetate	108-65-6	10.0-20.0
Ethanol	64-17-5	10.0-20.0
Propane/isobutane blend	68476-86-8	20.0-30.0
Methyl ethyl ketone	78-93-3	2.0-5.0
Acrylic copolymer resin	26760-85-0	5.0-15.0

SECTION 3: HAZARD IDENTIFICATION

Emergency Overview: Clear, colorless liquid with strong, fruity, ethereal odor. This product is extremely flammable. Liquid will irritate eyes and skin under repeated or prolonged exposure. Breathing high concentrations of product may produce drowsiness and a headache.

Potential Health Effects:

Eyes: Liquid, aerosols and vapors of this product are irritating and can cause pain, tearing, reddening and swelling accompanied by a stinging sensation.

Skin: Contact causes skin irritation.

Ingestion: Harmful if swallowed. Irritating to the mouth, throat and stomach. May cause vomiting.

Inhalation: Harmful if inhaled. High concentrations in immediate area can displace oxygen and cause dizziness, unconsciousness and even death with longer exposure. Keep people away from such vapors without self-contained breathing apparatus.

Pre-Existing Medical Conditions Aggravated by Exposure: Heart, lung, skin, eye.

SECTION 4: FIRST AID MEASURES

Eyes: Immediately flush with plenty of water. After initial flushing, remove any contact lenses and continue flushing for at least 15 minutes. Have eyes examined and tested by medical personnel if irritation develops or persists.

Skin: Wash skin with soap and water. Remove contaminated clothing. Get medical attention if irritation develops or persists. Wash clothing separately before reuse.

Ingestion: If swallowed, do not induce vomiting. Keep head below knees to minimize chance of aspirating material into the lungs. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Inhalation: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

SECTION 5: FIRE FIGHTING MEASURES

Flash Point: 30 F (-1C) (liquid TCC), -156 F (-104C) (propellant) **LEL/UEL:** Not determined (% by volume in air)

Extinguishing Media: Use alcohol foam, carbon dioxide or water spray when fighting fires involving this material.

Fire Fighting Instructions: As in any fire, wear self-contained breathing apparatus (pressure demand, MSHA/NIOSH approved or equivalent) and full protective gear.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Large Spills: Shut off leak if possible and safe to do so. Wear self-contained breathing apparatus and appropriate personal protective equipment. Absorb spill with inert material (i.e. dry sand or earth), then place in a chemical waste container for proper disposal. Do not flush to sewer. Avoid runoff into storm sewers and ditches that lead to waterways.

Small Spills: Absorb spill with inert material (i.e. dry sand or earth), then place in a chemical waste container for proper disposal.

SECTION 7: HANDLING AND STORAGE

Avoid prolonged or repeated contact with skin, eyes or clothing. Wash hands before eating. Use with adequate ventilation. Avoid breathing product vapor. Do not reuse this container. Store in a cool dry place, away from heat, sparks or flames. Keep container tightly closed when not in use. Do not store in direct sunlight.

KEEP OUT OF REACH OF CHILDREN.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION**Exposure Guidelines:**

CHEMICAL NAME	ACGIH TLV	OSHA PEL	ACGIH STEL
Propylene glycol monomethyl ether acetate	NA	NA	NA
n-Propyl acetate	200 ppm	200 ppm	250 ppm
n-Butyl acetate	150 ppm	150 ppm	200 ppm
Ethanol	1000 ppm	1000 ppm	NA
Methyl ethyl ketone	200 ppm	200 ppm	300 ppm
Propane	NA	1000 ppm	NA

Work/Hygienic Practices: Good general ventilation should be sufficient to control airborne levels. Local exhaust ventilation may be necessary to control any air contaminants to within their TLVs during the use of this product. If vapor concentration exceeds TLV, use NIOSH approved organic vapor cartridge respirator. Wear safety glasses with side shields (or goggles) and rubber or other chemically resistant gloves when handling this material.

NFPA and HMIS Codes:

	NFPA	HMIS
Health	1	1
Flammability	3	3
Reactivity	1	1
Personal Protection	-	B

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIESPhysical State: Clear, colorless liquidOdor: Strong, fruity, ethereal solventpH: NAVapor Pressure: 12 mmHg @ 68 FBoiling point: liquid: >210F (>99C); propellant: -43.7 F (-42C)Vapor Density: >1 (Air=1)Solubility in Water: negligibleSpecific Gravity: 0.91 @ 68F (liquid only)Evaporation Rate: >1 (Butyl acetate=1)Viscosity: >1 (Water =1)Percent Volatile: 90%**SECTION 10: STABILITY AND REACTIVITY**Stability: This product is stable. Conditions to Avoid: Do not spray near open flames, red hot surfaces or other sources of ignition.Incompatibility: Do not mix powdered alkali and alkaline earth metals or strong oxidizing agents.Products of Decomposition: Thermal decomposition may release carbon monoxide, carbon dioxide and incompletely burned hydrocarbons.Hazardous Polymerization: Will not occur. Conditions to avoid: NA**SECTION 11: TOXICOLOGICAL INFORMATION**Inhalation:

n-Butyl acetate	human	TCLo 200 ppm
n-Propyl acetate	human	TCLo 1000 mg/m ³
Methyl ethyl ketone	human	TCLo 100 ppm/5M
Ethanol	LC50 rats	20,000 ppm/10 hrs

Eye:

n-Butyl acetate	rabbit	20 mg open; SEV
n-propyl acetate	rabbit	500 mg/24H MLD
Methyl ethyl ketone	human	350 ppm
Ethanol	rabbit	500 mg; SEV

Ingestion:

Propylene glycol monomethyl ether acetate	LD50	8532 mg/kg
n-Butyl acetate	LD50/rat	10768 mg/kg
n-Propyl acetate	LD50/rat	9370 mg/kg
Methyl ethyl ketone	LD50/rat	2737 mg/kg
Ethanol	LD50/rat	7060 mg/kg

Skin:

Propylene glycol monomethyl ether acetate	LD50/rabbit	> 5000 mg/kg
n-Butyl acetate	rabbit	500 mg/24H MOD
n-Propyl acetate		500 mg open MLD
Methyl ethyl ketone	rabbit	500 mg/24H MOD
Ethanol	rabbit	400 mg open MLD

Cancer Information: No ingredients listed as human carcinogens by NTP or IARC

Reproductive effects: none

Teratogenic effects: none

Mutagenic effects: none

SECTION 12: ECOLOGICAL INFORMATION**Environmental Impact Information**

Avoid runoff into storm sewers and ditches which lead to waterways. Water runoff can cause environmental damage.

REPORTING

US regulations require reporting spills of this material that could reach any surface waters. The toll free number for the US Coast Guard National Response Center is: 1-800-424-8802

SECTION 13: DISPOSAL CONSIDERATIONS

Dispose of in accordance with all federal, state and local regulations. Water runoff can cause environmental damage.

SECTION 14: TRANSPORTATION INFORMATION

Proper Shipping Name	UN Number	Class	Sub. Risk	Pkg. Group	Hazard Label	Pkg. Instr.	Max. Quantity
<u>Air:</u> Aerosols flammable	UN 1950	2.1	NA	NA	Flammable Gas	203	75/150 kg
<u>Ground:</u> Consumer Commodity ORM-D	NA	ORM-D	NA	NA	ORM-D	Pkg. Auth.	173.306

SECTION 15: REGULATORY INFORMATION**SECTION 313 SUPPLIER NOTIFICATION**

This product contains no toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 (40CFR372).

This information should be included on all MSDSs copied and distributed for this material.

TOXIC SUBSTANCES CONTROL ACT (TSCA). All ingredients of this product are listed on the TSCA Inventory.WHMIS: Class A; Class B5; Class D2B

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

SECTION 16: OTHER INFORMATION

Product is a Level 3 aerosol. Do not puncture or incinerate containers. Normal ventilation for standard manufacturing practices is usually adequate. Local exhaust should be used when large amounts are released.

To the best of our knowledge, the information contained herein is accurate. However, all materials may present unknown hazards and should be used with caution. In particular, improper use of our products and their inappropriate combination with other products and substances may produce harmful results which cannot be anticipated. Final determination of the suitability of any material is the sole responsibility of the user. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that may exist.

Appendix B

MEASURING AIR FLOW in Ducts, Pipes, Hoods and Stacks

Anemometers have traditionally been employed for air duct balancing. This cumbersome task requires performing a traverse of the opening, measuring and manually recording the velocity at numerous points, calculating the mean velocity, and then multiplying the mean velocity by the cross-sectional area of the duct or opening to obtain the total volumetric flowrate measurement in cubic feet per minute (CFM) flow rate.

With the newest microprocessor-based anemometers, up to a thousand data points can be stored in the memory for mean velocity calculation. Some units can even multiply the mean velocity by the cross-sectional area to give the readout in CFM. These capabilities provide tremendous new convenience for the HVAC professional.

TOTAL FLOW RATES

Total flowrate through an opening (Q in SCFM) is determined by the following relationship:

$$Q = \bar{V}A, \text{ where:}$$

\bar{V} = average velocity in SFPM (standard feet per minute), and
A = cross-sectional area of duct or pipe (in ft²).

To determine the average velocity \bar{V} , divide the opening into a number of equal areas. Take a velocity reading at the center of each area and numerically average the results. If the velocity profile is relatively flat, only a few equal areas are needed. If the profile is non-uniform, several equal areas should be used. Generally, it is a good idea to make a rapid traverse across the duct in two dimensions to determine the uniformity of the air velocity. If the velocity is not constant at one measuring point, use the mean velocity between the upper and lower readings. Generally, the velocity profile is more uniform on suction openings than on supply openings. If a supply opening is covered by a grille, the probe should be placed about 1" in front of the grill to obtain the average velocity reading as above.

If information is given on the coefficient of discharge for a specific grille, the probe should be placed against the grille and centered over the open areas in the grille.

Choose several grille openings through which to obtain an average air velocity. In this case, the total flow is:

$$Q = K\bar{V}, \text{ where:}$$

K = the given coefficient discharge

A = the area of the grille as specified by the manufacturer

If a return or suction opening is covered by a grille and it is necessary to compute the total flow into the opening, take a number of readings at the centers of equal areas, as in the case where there is no grille, and determine the average velocity. The probe should be placed in the plane of the opening and close to the grille. The flowrate can be computed fairly accurately with the following equation:

$$Q = F\bar{V}A, \text{ where:}$$

F = application factor (see table below)

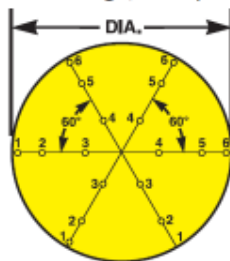
A = designated area in square feet

Grille Type	Application Factor, F	Designated Area
None	1.00	Full duct area
Square Punched	0.88	Free (daylight) area
Bar	0.78	Core Area
Steel Strip	0.73	Core Area

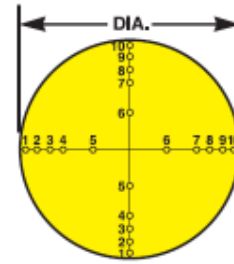
For applications requiring higher accuracy, it is suggested that a duct extension be used having a length at least as great as the largest dimension of the grille. This duct extension is placed against the grille, and the procedures for an open grille are followed to compute flowrate. For highest accuracy, a smoothly tapered flow nozzle should be placed over the supply grille. In this case, the velocity profile at the exit jet of such a nozzle is very flat.

Duct Traversing

The log-linear method provides high accuracy ($\pm 3\%$) in flow totalization by taking into consideration the effect of friction along the walls of a duct. For round ducts, the three-diameter, six-point method is the preferred traverse. If the three-diameter method cannot be used (because of inaccessibility), then the two-diameter method is acceptable. This method consists of taking two sets of ten readings, 90° apart.



Log linear-traverse for round ducts, three-diameter approach.



Log-linear traverse for round ducts, two-diameter approach.

With rectangular ducts, the following procedure is recommended:

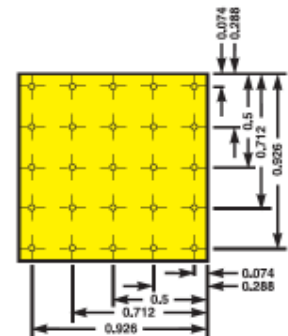
1. The table below indicates that any rectangular duct dimension less than 30" requires five traverse lines on that side. Thus, a 28 x 20" duct will require 25 readings, because each side needs five traverse lines. A 38 x 20" duct will require 35 readings (seven traverse lines on the 38" side and five on the 20" side).

Duct Side Dimension	Number of Traverse Lines
< 30"	5
>30" but < 36"	6
>36"	7

2. The minimum number of readings should be 25.

3. The points where the readings are to be taken should be located at the intersection of the traverse lines as shown (as proportions of the traverse measurement) below:

No. of Traverse Lines		
5	6	7
0.074	0.061	0.053
0.288	0.235	0.203
0.500	0.437	0.366
0.712	0.563	0.500
0.926	0.765	0.634
	0.939	0.797
		0.947



Example of a 25-point log linear-traverse for rectangular ducts.

Appendix C

HIH LABORATORY, INC.

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Report Number 35270

LABORATORY ANALYSIS REPORT

SENTRY AIR SYSTEMS
 6999 W. LITTLE YORK RD. STE P1
 HOUSTON TX 77040

Attention:
 Mr. Ben Davis

Report Number 35270
Client Number: 779 6

Date Received: 03/28/2013
Date Reported: 03/29/2013

<i>HIH Sample Number:</i>	<i>Client Sample ID</i>	<i>Date Collected</i>	<i>Sample time (min)</i>	<i>Sample Vol. (L) or Area</i>				<i>Lower 95% Confidence Limit</i>	<i>Upper 95% Confidence Limit</i>
<i>Analyte</i>		<i>Result</i>	<i>Units</i>	<i>Actual Exp</i>	<i>Units</i>	<i>Test date:</i>	<i>Reporting Limit</i>	<i>Blank Corrected</i>	
455183	T2A	3/27/2013							
n-Butyl acetate		< 0.003	mg			3/28/2013	0.003 mg	Yes	
RUSH									
		3/27/2013							
n-Propyl acetate		< 0.003	mg			3/28/2013	0.003 mg	Yes	
RUSH									
455184	T2B	3/27/2013							
n-Butyl acetate		1.1	mg			3/28/2013	0.003 mg	Yes	
RUSH TUBE ID T2F									
		3/27/2013							
n-Propyl acetate		1.2	mg			3/28/2013	0.003 mg	Yes	
RUSH TUBE ID T2F									

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Analyte	Result	Units	Actual Exp	Units	Test date:	Reporting Limit	Blank Corrected	Lower 95% Confidence Limit	Upper 95% Confidence Limit
455185	T2C	3/27/2013							
n-Butyl acetate	0.005	mg			3/28/2013	0.003 mg	Yes		
RUSH									
		3/27/2013							
n-Propyl acetate	0.004	mg			3/28/2013	0.003 mg	Yes		
RUSH									
455186	T2D	3/27/2013							
n-Butyl acetate	< 0.003	mg			3/28/2013	0.003 mg	Yes		
RUSH									
		3/27/2013							
n-Propyl acetate	< 0.003	mg			3/28/2013	0.003 mg	Yes		
RUSH									

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HIH Sample Number:	Client Sample ID	Date Collected	Sample time (min)	Sample Vol. (L) or Area					
Analyte	Result	Units	Actual Exp	Units	Test date:	Reporting Limit	Blank Corrected	Lower 95% Confidence Limit	Upper 95% Confidence Limit
455187	T2E	3/27/2013							
n-Butyl acetate	0.005	mg			3/28/2013	0.003mg	Yes		

		3/27/2013							
n-Propyl acetate	0.004	mg			3/28/2013	0.003mg	Yes		

455188	BLANK	3/27/2013							
n-Butyl acetate	< 0.003	mg			3/28/2013	0.003mg	N/A		

		3/27/2013							
n-Propyl acetate	< 0.003	mg			3/28/2013	0.003mg	N/A		

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35270

SUPPLEMENTARY QUALITY ASSURANCE INFORMATION

Analyte	Method	Media	Test date:	Analyst:	Instrument:	MSD % RECOVERY:	NUMBER OF SPIKES:	MS % Recovery:	LCS % Recovery:	Precision (% Sr)	Result:	DUP RPD	MS/M SD RPD:	Batch No:	Lit Ref	Smp #
n-Butyl acetate	OSHA 7	SKC 226-01	03/28/2013	EP	58902S	96.4	---	99.2	---	---	---	---	2.86	28242		455183
n-Propyl acetate	OSHA 7	SKC 226-01	03/28/2013	EP	58902S	99.6	---	100	---	---	---	---	0.401	28242		455183

Method Literature References

HIH Laboratory did not collect these samples; therefore, calculations are based on client-supplied sampling data.
Samples arrived in good condition unless otherwise noted.

Carole Newman

Digitally signed by Carole Newman
DN: CN = Carole Newman, C = US, OU = HIH Laboratory, Inc.
Reason: I have reviewed this document
Date: 2013.04.01 08:59:09 -05'00'

Approved By:

Esteban P. Piña, Technical Manager