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HEALTH & SAFETY LABORATORY

Review of commercially available party fog machines suitable for determining the clearance time of paint spray booths and rooms

HSL/2006/43

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EXECUTIVE SUMMARY

Objectives

The objective of this project was to assess the suitability of commercially available party fog machines for determining the clearance times of paint spray booths and rooms, such as used in Motor Vehicle Repair and some commercial spraying premises.

Main Findings and Recommendations

Seven different fog machines were tested for assessing the clearance times of spray booths and rooms, the results were compared to the Colt 4 smoke generator currently used by both HSE inspectors and HSL.

As anticipated, the Colt 4 Turbo machine was superior in performance to the cheaper units tested in this study; it produced the most smoke in a given time; produced the thickest smoke; and was capable of smoke production when disconnected from the mains. However, performance came at a price. At over 10 times the cost of the cheaper units, it is impractical to expect small MVR bodyshops to purchase a professional smoke machine, such as the Colt in order to determine clearance times of its spray booths or rooms.

The commercial fog machines tested are all capable of filling a booth or room so long as the mechanical ventilation is turned off before doing so. However, with the exception of the Vivid fog machine, it would be necessary to wait for the units to reheat a number of times to adequately fill a booth or room. For this reason, coupled with the fact the smoke thinned noticeably over a period of 20 minutes, the Party Fog Machine and the Skytec are not recommended for determining the clearance times of spray booths and rooms.

The remaining machines that do not run continuously (Antari F80Z, Magnum 550 and the Source Smokestream) are all suitable for determining clearance times in spray booths/rooms although it would be necessary to fill a spray booth/room in 'stages'. However, whilst the Vivid fog machine did not the fill the spray room in the quickest time, it was the easiest machine to use. This was largely because it provided a continuous stream of smoke. This has the advantage that users would release smoke for as long as it took to sufficiently fill the booth/room, whereas with the models that cut out there is a real possibility that users may fill a spray booth/room with smoke until the unit cuts out and then start the clearance test with insufficient smoke. Therefore, the recommended best buy of the commercial fog machines tested is the Vivid fog machine. Other, similar fog machines, with similar characteristics would also be suitable.

For situations where very large commercial spray booths, or a large number of standard spray booths, are to be tested, the speed and performance of the Colt smoke machine may justify the associated extra expenditure. For assessing leakage of air from large spray booths a commercial smoke generator, such as the Colt 4, will be needed.

1 INTRODUCTION

Two-pack isocyanate paint, used extensively in the motor vehicle repair (MVR) and other industries, is known to cause occupational asthma. HSE statistics show that vehicle paint sprayers are approximately 80 times more likely of contracting occupational asthma than the average for the UK working population.

Asthma is caused by inhalation of the fine paint mist that is generated when paint spraying. This fine mist is invisible to the human eye in normal lighting conditions. One of the main controls is to ensure that spraying of two-pack isocyanate paint be carried out in a ventilated spray booth or at the very least a spray room. It takes time for spray booths/rooms to become clear of the fine paint mist; this time is known as the *clearance time*. It is important that personnel working in premises where paint spraying is carried out know the clearance times of their booths/rooms. This is because entering a booth or room before it has become clear of paint spray will result in exposure to high concentrations of isocyanates. Similarly, if sprayers remove their air-fed breathing apparatus or raise their visor to check paint coverage, before the fine mist has cleared, they will be exposed to airborne isocyanates. Most UK booth suppliers, until recently, did not appreciate the significance of the clearance time and many have yet to provide users with any information at this time. HSE believe that the only practical way for MVR garages to determine the booth/room clearance time is by filling the booth/room with smoke, which unlike paint mist is easily observed, and timing how long it takes to clear. In order to prove the veracity of the smoke method for determining clearance times, tests were carried out by HSL in both a spray booth and room and compared with quantitative data obtained from tracer gas tests.

Both HSE and HSL use the Colt 4 Basic or Colt 4 Turbo smoke machines manufactured by Concept Engineering for determining clearance times of booths/rooms. These are professional machines and capable of producing a continuous stream of thick, dense smoke, but at £575 the cost is likely to be prohibitive to most MVR bodyshops. However, there are a number of cheap ‘fog’ machines commercially available that may be suitable for use with spray rooms and standard size spray booths. This report identifies commercially available party fog machines and assesses their suitability for testing the clearance time of a spray booth or room. Six different party fog machines were included in the test and the results compared to Colt 4 Turbo smoke machine. Other professional smoke machines are available but the Concept Engineering device appears to be the most popular in the UK.

2 DESCRIPTION OF THE FOG MACHINES TESTED

A summary of the specifications of the fog machines tested is given in Table 1 below, the most important features of each machine are discussed in the following section along with a photo of each. The prices in Table 1 were correct at the time of writing this report, (May 2006).

Table 1: Party fog machine specifications

Fog Machine	Price	Supplier	Fluid	Heating Element	Mass (kg)	Dimensions (mm) (LxWxH)
Colt 4 Turbo	£575	Concept-smoke	Concept Smoke Fluid A	2200W Heat Exchanger	7.0	375x150x190
Antari F80-Z	£37.99	Blue Aran	Antari High Octane	700W	3.5	330x160x165
Magnum 550	£59.00	Electromusic	Regular DJ Fluid	640W	5.0	310x217x170
Skytec	£38.95	Cybermarket	Skytronic	700W	4.1	320x235x210
Source Smokestream	£45.00	DJ Store	Source Brand	800W	3.6	330x162x190
Vivid V1 Fogger	£49.99	Maplin	Vivid Fluid LG54J	700W	2.2	260x110x180
Party Fog Machine	£32.50	Giftsandgizmos	Brand Fog Fluid	500W	1.9	280x170x140

2.1 COLT 4 TURBO

The Colt 4, manufactured by Concept Engineering Ltd., is available in two models, the Colt 4 Basic and the Colt 4 Turbo. Both models look identical and use the same smoke fluid. However, the Turbo has a larger heat exchanger and produces almost twice as much smoke in a given time as the Colt 4. The smoke fluid is stored in a pressurised container which screws into the rear of the machine. A single canister is capable of producing approximately 20 minutes of smoke. At 7.0kg it is heavier than all the other machines and one of the largest. It is equipped with a 2.2kW heat exchanger, which means it is capable of smoke production when disconnected from the mains, a feature none of the other machines possesses. This model does not have a remote control but has a sturdy handle and an easily reachable button.

HSE currently use the Colt 4 Basic, however both models are robust, professional smoke machines and previously determined by HSE to be suitable for use in determining the clearance time of spray booths/rooms. The Colt 4 Turbo has been included in this study as a control to compare other machines to. The unit is available direct from Concept, and available from the following stockists online; www.smokemachines.net, www.artem.co.uk and www.concept-smoke.co.uk.

2.2 ANTARI F80-Z

This Antari is of a metal construction. Smoke fluid is stored in a screw-top compartment at the rear. The unit tested was supplied by Blue Aran Ltd. It uses Antari high-octane fuel which is usually available from the stockist in 1 L or 5 L amounts. At 3.5 kg, it is fairly light but lacking a handle, it is awkward to handle and move. The machine has a remote control which includes an indicator light to show when it is ready for use. There are many alternative suppliers for this machine online, these include;, www.terralec.com, www.avbits.co.uk, www.djstore.co.uk and www.djkit.co.uk where it is available in a range of deals including smoke fluid and other accessories.

2.3 MAGNUM 550

The Magnum is of metal construction and draws smoke fluid via a plastic tube connected to a removable container. It was the most expensive party fog machine tested. The unit tested was supplied by Electromusic Ltd. The Magnum machine is one of the larger units tested, and even with the handle is awkward to manoeuvre. It uses Regular DJ Fluid, which is supplied when purchased from www.electromusic.co.uk. Alternative suppliers online are www.djstore.co.uk.

2.4 SKYTEC

The Skytec has a similar exterior to the Antari, but slightly wider. It has a large central carry handle and a magnetic remote control mounted on a long cable with an indictor light to show when ready. At 4.1 kg, the Skytec is one of the heaviest party fog machines. The unit tested was supplied by www.cybermarket.co.uk. It uses Skytronic high density smoke fluid supplied with the machine. No alternative suppliers for this model were located.

2.5 SOURCE SMOKESTREAM

The Source is of similar design to the Antari. It had the largest heating element of any of the units tested (800W). A handle is fixed mounted on the top, and again the casing is metal. At 3.6kg it is reasonably light. The power cord is short, but it is removable allowing a replacement to be used if necessary. The machine has an infrared remote control, the only one tested to do so, and an indicator light on the receiving unit. The unit tested was supplied by www.decks.co.uk. It uses the Source brand smoke fluid supplied. An alternative online supplier is; www.directdistribution.uk.com.

2.6 VIVID V1 FOGGER

This Vivid is made of moulded plastic and includes a moulded handle making it easy to hold in one hand whilst operating the remote control with the other. It is one of the lightest machines tested at 2.2kg. The handle forms part of the structure enabling it to be moved around easily, though the short 1.8m power cable limits this. It uses Vivid LG54J fluid that is available from all suppliers. The unit tested was supplied by Maplin Electronics Ltd. The Vivid is also available online from www.soundlightuk.com or www.ukdjequipment.co.uk.

2.7 PARTY FOG MACHINE

This machine was described as a "Party fogging machine". It is made of plastic and is fitted with a handle and remote control device. It uses the Woolworths smoke fluid supplied. The unit tested was supplied by Woolworths. At the time of writing this report, the Party Fog Machine was no longer available from Woolworths, but an alternative online supplier can be found at www.giftsandgizmos.co.uk.

All the commercial units tested came with a remote control connected to the machine via a cable, except the Source Smokestream, which had an infrared remote control. In addition, all the units had a 'ready' indicator; this is advantageous simply for ease of use. All the suppliers listed here are online outlets, as these tend to have the greatest range. However, some models are available on the high street from stores such as Argos and Maplin.

3 METHOD

3.1 SMOKE TESTS

Most of the tests were carried out in the Dale Head spray room at HSL Buxton, which has internal dimensions 3.7 m x 3.2 m x 4.0 m and a volume of 47.4 m^3. For each unit the following parameters were tested:

1. *Warm-up time*: The length of time required for the unit to be ready for use after being switched on.

2. *Continuous use time*: The length of time for which the unit produces a constant stream of smoke before cutting out. This was measured twice; once after the initial warm up and again after the unit had reheated after cutting out.

3. *Reheat time*: The time taken for the unit to be ready for use again after cutting out due to reaching its maximum continuous use time. This was measured twice consecutively.

4. *Room fill time*: The total time taken by a unit to fill the HSL spray room. This includes any necessary reheat time but excludes the initial warm-up time. The test room was adjudged full when the walls were no longer visible along the short axis of the room.

5. *Smoke persistence*: A test carried out in the laboratory to see whether the smoke produced disperses or evaporates when left for a 20-minute period. A 3-5 second burst of smoke was released into a scale model of a spray booth with the extract system turned off. After the period of 20 minutes, any variations in the smoke density were noted. This test is not affected by the machine or the booth/room but by the properties of the smoke aerosol produced. Images of the smoke 20 minutes after production are shown in Appendix 1.

6. *Clearance time*: A test to determine the clearance time of a spray booth or room using each party fog machine. A full protocol for determining the clearance time of a booth or room is provided in Appendix 2.

Smoke aerosols are visible because they scatter light; this means that lighting conditions are important. For tests 4, 5 and 6, the lighting should be on for maximum visibility. In addition, the composition of each smoke fluid was determined using mass spectrometry.

3.2 TRACER GAS TESTS

In order to assess the accuracy and applicability of smoke tests for determining the clearance times of spray booths and rooms, clearance times were determined using a tracer gas method.

Tracer gas tests were carried out at the Dale Head test room using tracer gas, 10 % sulphur hexafluoride (SF_6) in nitrogen (N_2). The gas was mixed with the room air and the tracer gas concentration monitored at a number of positions. The detector used was a Miran 104b portable gas analyser operating at 10.6 μm. The tracer gas was allowed to reach a stable and uniform concentration before the extract was then activated and the mixing fan turned off. The concentration decay was then logged onto a laptop computer.

Downdraft spray booths differ from spray rooms in the manner in which air moves within them, air movement creates large recirculation eddies close to the walls. Therefore, tracer gas tests were also carried out in a commercial spray booth installed in an MVR bodyshop. The

extract and supply fans were disabled, tracer gas was mixed with the air in the booth and allowed to reach a stable and uniform concentration. Sample positions were selected in the areas close to the long wall at head height for a standing and kneeling sprayer (identified from smoke tests as large areas of recirculation where the air took longest to clear). The extract and supply were activated and the mixing fan switched off. The concentration decay was then logged onto a laptop computer.

4 RESULTS

4.1 SMOKE TESTS

Detailed test results are given in Table 2 below and a summary review of the performance of each party fog machine and the Colt 4 professional smoke machine follows.

Table 2: Party fog machine performance results

Fog Machine	Warm Up Time (Supplier) (mm:ss)	Warm Up Time (Measured) (mm:ss)	Continuous Use (mm:ss)	Reheat Time (mm:ss)	Smoke Persistence (mm:ss)	Total Time to Fill Room (mm:ss)	Clearance Time (Dale Head) (mm:ss)
Colt 4 Tubo	4:00	3:30	N/A See Note*	N/A	20:00 +	1:00	12:50
Antari F80-Z	4:00	3:45	0:35 0:46	1:03 1:00	20:00 +	2:10	11:00
Magnum 550	5:00	7:55	0:54 0:55	1:45 1:40	20:00 +	3:20	11:15
Skytec	5:00-10:00	4:35	1:02 0:52	1:35 1:20	20:00 +	6:20	10:10
Source Smokestream	5:00	4:00	0:34 0:35	1:33 1:20	20:00 +	4:40	N/A See Note**
Vivid V1 Fogger	2:45	2:00	N/A See Note*	N/A	20:00 +	3:40	10:50
Party Fog Machine	5:00-8:00	3:30	2:35 2:00	0:42 0:50	20:00 +	7:30	N/A See Note**

*Machines produce constant smoke and do not cut out.

** Due to technical difficulties with the machines, it was not possible to obtain clearance times for these machines.

4.1.1 Colt 4 Turbo

The warm up time was 3m 30s but the manufacturer states that optimum results are obtained after 6 minutes. The Colt can continuously produce a large amount of thick smoke as a powerful jet. The total time to fill the spray room was 1 minute. In the smoke persistence tests, the smoke was still easily visible after 20 minutes.

4.1.2 Antari F80Z

Warm up time was 3m 45s, which was slightly less than the manufacturers guide time. The unit was able to produce smoke continuously for 35s and 46s with reheat times of 1m 03s and 1m respectively. From when the unit was ready for operation the total time to fill the booth was 2m 10s which was the fastest of all the machines except the Colt 4 Turbo. Smoke was emitted in a thick powerful jet providing fast, even distribution of smoke. The smoke was persistent after 20 minutes.

4.1.3 Magnum 550

The warm up time was the longest of the units tested at 7m 55s, the only unit to exceed the warm up time stated by the manufacturer. The unit produced smoke continuously for 54s and 55s with reheat times of 1m 45s and 1m 40 respectively. The total time taken to fill the test room was 3m 20s. Smoke is emitted in a thick powerful jet providing a fast even distribution of smoke. The smoke was persistent after 20 minutes.

4.1.4 Skytec

The warm up time was slightly less than the manufacturers stated value. The unit was able to produce smoke continuously as a powerful jet for 1m 2 s and 52 s with reheat times of 1m 35s and 1m 20s respectively. From when the it was ready for operation, it took 6 m 20s to completely fill the spray room, including the reheating times when the unit cut out. The smoke was not suitably persistent, being apparent after 20 minutes but noticeably thinned from initial production, see Appendix 1.

4.1.5 Source Smokestream

Warm up time was 4 minutes, which was 1 minute faster than the manufacturers guide time. The unit has the largest heating element of the units tested but this did not appear to provide any improvement in performance. The unit was able to produce smoke continuously for 34s and 35s with reheat times of 1m 33s and 1m 20s respectively. From when the unit was ready for operation it took 4m 40s to completely fill the room. The smoke was persistent after 20 minutes.

4.1.6 Vivid V1 Fogger

The warm up time was 2 minutes, slightly less than stated by the manufacturer. The unit was able to produce smoke continuously for long enough to fill the test room without reheating, and did not cut out even when operated continuously for 6 minutes. From when the unit was ready for operation it took 3m 40s to fill the test room. The smoke emitted did not appear particularly dense, but was emitted with reasonable power and resulted in an even distribution of smoke. The smoke was persistent after 20 minutes.

4.1.7 Party Fog Machine

Warm up time was 3m 30s, quicker than most of the units tested. The unit produced smoke continuously for 2m 35s and 2 minutes with reheat times of 42s and 50s respectively. The total time taken to fill the room from when the unit was ready was 7m 30s, the longest of any of the units tested. The smoke emitted was dense, but the jet was not very powerful, and the unit must be moved around to provide an even distribution of smoke. The smoke was apparent after 20 minutes though it was noticeably thinned, see Appendix 1.

4.2 TRACER GAS TESTS

Figure 1 below shows how the concentration of tracer gas within the HSL spray room decays with time. The concentration at each sampling point decays at a similar rate, this allows us to assume the air in the room is close to perfect mixing.

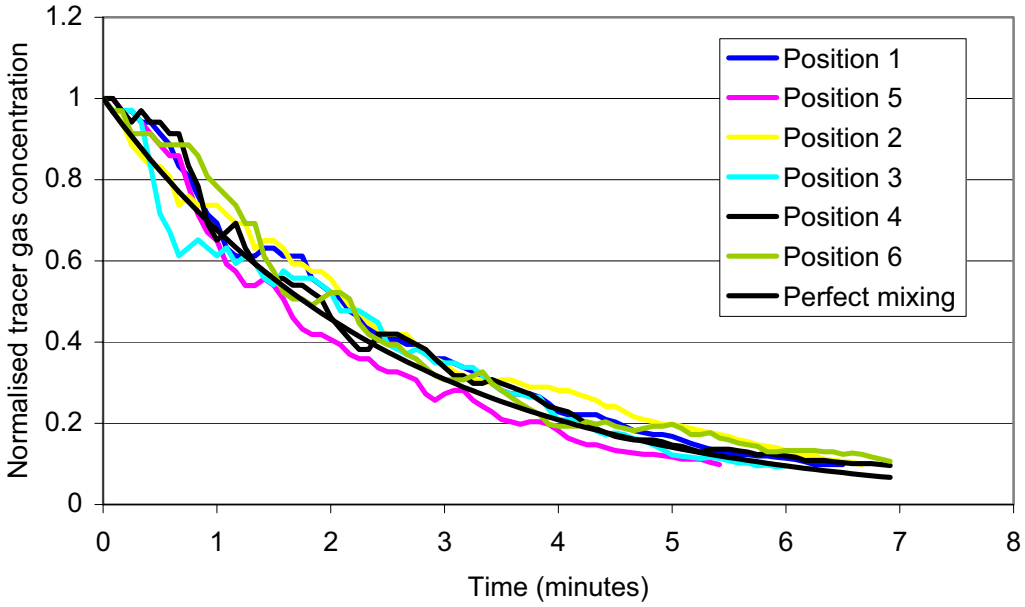

Figure 1: Concentration decay of tracer gas in Dale Head Spray Room

It is therefore possible to extrapolate to calculate the concentration of tracer gas at the clearance times measured using the party fog machines. This data is shown below in Table 3. As can be seen at a time equal to the measured clearance times the concentration of tracer gas has dropped to less than 2 % of the initial concentration. In addition, even when the measured clearance times of two machines differ, by almost three minutes in the case of the Colt 4 Turbo and Skytec, this represents a difference in tracer concentration of less than 1.3 % of initial concentration; the consequences of this are discussed later in Section 5.

Table 3: Clearance times of Dale Head spray room

Fog Machine	Clearance Time / s	% [SF_6] at t = 0
Colt 4 Turbo	770	0.65
Colt 4 Basic	730	0.85
Antari F80-Z	660	1.35
Magnum 550	675	1.22
Skytec	610	1.86
Vivid V1 Fogger	650	1.44

As was discussed in Section 3.2, the pattern of air movement within booths is different to that within rooms. Tracer gas tests were carried out in a commercial spray booth; the results from these tests are shown below in Table 4 along with measured clearance times using two selected machines. At both measured clearance times the concentration of gas has dropped to less than 2 % of the initial concentration.

Table 4: Results from smoke tests and tracer gas tests in a commercial spray booth

Smoke Tests		Tracer Tests	
		% [SF6] at t = 0	
Machine	Clearance Time	Standing	Kneeling
Colt 4 Turbo	170	1.5	0.8
Vivid	177	1.4	0.8

4.3 SAFETY CONSIDERATIONS

Table 5 below shows the active component of each fog fluid. Of these glycols, only diethylene glycol has a UK occupational exposure limit, though it is not irritating to eyes and skin (Chung & Unwin, 2002). However, when the room or booth is being filled it is recommended that it be filled until the facing wall is no longer visible across the short axis of the room, this means that the airborne concentration of the smoke aerosol will be high. Although the substances used to produce the smoke are of low toxicity, it is not good practice to inhale high concentrations of smoke; it is therefore recommended that whilst performing smoke tests, RPE should be worn. The type of RPE worn depends upon the substance used to generate the smoke. All of the party fog machines use low boiling point glycols; therefore, RPE with a combination A/P3 filter will provide sufficient protection. For devices such as the Colt 4, which produce a glycerol based smoke, a P3 cartridge or FFP3 device would be suitable. As with all tight fitting RPE it is important that it be fit tested for the user and worn correctly.

Table 5: Components of smoke fluids

Fog Machine	Largest component of fluid
Colt 4 Turbo	Glycerol
Antari F80-Z	Diethylene glycol
Magnum 550	Triethylene glycol
Skytec	Diethylene glycol
Source	Triethylene glycol
Vivid V1 Fogger	Triethylene glycol
Party Fog Machine	Dipropylene glycol

5 DISCUSSION

As anticipated, the Colt 4 smoke machine was superior in performance to the cheaper units used in this study.

The test room was relatively small for a spray room, for larger rooms the reheat time will become more of a factor in determining overall fill time. The criterion for determining whether the test room was filled with smoke was subjective; the room was treated as filled when the walls were no longer visible on the short axis of the room under maximum lighting.

The smoke machines that had a powerful jet (Antari, Vivid and Magnum) achieved a more even distribution of smoke. This attribute is important in filling the spray room or booth evenly; machines with more powerful jets can fill the room when placed in one corner, whereas units with less powerful jets need to be moved around. This can become problematic due to the generally short length of the power cords and therefore an extension cable is recommended.

In all cases, the smoke was sufficiently persistent to fill the test room without problems, however, for particularly large spray rooms the smoke supplied with the Party Fog Machine and Skytec machines may start to disperse in a time shorter than that required to fill and clear the room (see Appendix 1). The method used to determine the smoke fluid composition did not indicate the proportion of water in the fluid; hence differences in glycol concentration may explain variations in performance during the smoke persistence test for different fluids containing the same glycol.

The machines generally produced smoke for a minute or less before cutting out, with a reheat time of less than 2 minutes. Exceptions were the Vivid fogger, which did not cut out at all during the test, and the Part Fog Machine, which could produce smoke continuously for more than 2 minutes. However, the Party Fog Machine produced smoke at a much slower rate than any of the other units, although it did have the shortest reheat time of any model.

The results from the tracer gas tests in a commercial spray booth showed that, after a time equivalent to the clearance time determined by the use of a smoke machine, the concentration of the tracer gas has decayed to less than 2 % of the initial concentration. In tests carried out in the spray room at HSL simulating paint spraying, airborne concentrations of isocyanate were measured. These were typically of the order of hundreds of μgm^{-3}; although there were some exceptions. Spraying primer or spraying solvents through the gun led to unusually high levels of isocyanate, in excess of 1000 μgm^{-3}. However, it is considered best practice to only wash guns in a sealed bespoke gun-cleaning machine. Therefore, if we assume a typical spraying situation and set a high initial value for isocyanate concentration of 1000 μgm^{-3}, at the end of the measured clearance time the level will be less than 2 %, which is less than 20 μgm^{-3}. The UK 8 hour time weighted average O.E.L is 20 μgm^{-3}. This demonstrates that the clearance time, as measured using a smoke or fog machine is sufficient to ensure that concentrations of pollutants in the booth air have been reduced to below the control levels.

While the study has concentrated on clearance times, another use of smoke is to check that the booth/room and it's associated ductwork is not leaking air back into the workshop area. This is probably best done while the extraction is on, and may well require the use of a professional smoke machine such as the Colt.

6 CONCLUSION

The professional Concept Colt 4 Turbo was superior to the other commercial fog machines; it produced the most smoke in a given time; produced the thickest smoke; and was capable of smoke production when disconnected from the mains. Nevertheless, all the commercial smoke machines tested were capable of filling a booth or room so long as the mechanical ventilation was turned off before doing so. However, with the exception of the Vivid smoke machine, it is necessary to wait for the units to reheat a number of times to adequately fill a booth or room. For this reason, coupled with the fact the smoke thinned noticeably over a period of 20 minutes, the Party Fog Machine and the Skytec are not recommended for testing the clearance times on spray booths and rooms.

The remaining machines that do not run continuously (Antari F80Z (£37.99), Magnum 550 (£59.00), and the Source Smokestream (£45.00)) are all suitable for determining clearance times in spray booths/rooms (given that it would be necessary to fill a spray booth/room in 'stages'). However, whilst the Vivid fog machine did not the fill the spray room in the quickest time, it was the easiest machine to use. This was largely because it provided a continuous stream of smoke. This has the advantage that users would release smoke for as long as it took to sufficiently fill the room, whereas with the models that cut out there is a real possibility that users may fill a spray booth/room with smoke until the unit cuts out and then start the clearance test with insufficient smoke. Therefore, the recommended ‘best buy’ is the Vivid fog machine, which is available from Maplin Electronics for £49.99. Other, similar fog machines, with similar characteristics would also be suitable.

For situations where very large commercial spray booths, or a large number of standard spray booths, are to be tested, none of the party fog machines would be adequate. In these cases the speed and performance of the Colt 4 smoke machine may justify the associated extra expenditure. In order to challenge spray booths or rooms and assess ductwork for leaking air a professional smoke machine, such as the Colt 4 may be needed.

7 REFERENCES

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EH40/2005 “Workplace Exposure Limits” HSE 2005

8 APPENDIX 1: SMOKE PERSISTENCE TESTS

The empty spraybooth model

Model filled with smoke, t = 0

Colt 4 Turbo after 20 minutes

Antari F80-Z after 20 minutes

Magnum 550 after 20 minutes

Skytec after 20 minutes

Source Smokestream after 20 minutes

Vivid V1 Fogger after 20 minutes

Party Fog Machine after 20 minutes

The only noticeable thinning of smoke in 20 minutes are from the Party Fog Machine and the Skytec, it is recommended that these machines not be used to determine clearance times in spray booths or rooms.

9 APPENDIX 2: MEASURING PAINT SPRAY BOOTH CLEARANCE TIME (VERSION 1)

This is a procedure for measuring the clearance time of a spray booth or room using a party fog machine or professional smoke machine. The clearance time should be checked just before the filters in the spray booth or room are changed to give a worst-case time. It is recommended that a clearance time test should also be included in the 14-month thorough maintenance examination of the booth or room; however, more frequent testing may be required.

1. The spray booth or room should be empty when measuring the clearance time. This is because the volume of the car will effectively reduce the volume of a booth or room and give a lower clearance time. In addition, the smoke generated is made of a glycol aerosol and may leave a greasy deposit on any vehicle or body part in the booth/room.
2. The booth or room should be set up for normal spraying operations except with the ventilation deactivated (see No. 3) and the lights on maximum to enable the smoke aerosol to be seen.
3. Ensure that the extraction system is turned off. There are two reasons for this; (i) in a booth with the ventilation running it would be very difficult to fill the room completely. (ii) Filling the booth with the extraction turned off will give a clearance time showing the worst case scenario ensuring the room is clear before anybody enters, or sprayers remove their RPE.
4. Fill the room with smoke, making sure to distribute smoke evenly throughout the room (an extension lead may be useful in allowing all areas of the room to be reached).
5. The room shall be regarded as full when the facing wall is no longer visible when viewed across the short axis of the room. Depending on the fog machine used, it may cut out and require time to reheat one or more times before this is achieved.
6. Switch on the ventilation system and start a timer.
7. During the smoke test the opportunity should be taken to do a visual inspection of the exterior of the booth and any associated ductwork to check for any leaking air.
8. The room shall be regarded as clear when smoke is no longer visible in any part of the room. A lamp (viewed from a narrow angle towards the beam of light) may be useful in judging this, though ensuring that the room is truly full at the start of the measurement is more important than precise judgement of when the smoke has cleared. The difference between clear by eye and clear using a lamp is typically 30 seconds longer.
9. Note the time at which the room is judged to be clear of smoke. This time should be rounded up to the next quarter minute. This should be put on a notice and displayed on the door or entrance of the booth or room, and all personnel who need to know should be told.

Note: Appropriate RPE should be worn during the clearance time measurement; a disposable dust mask with a combination A/P3 filter will suffice. The smoke used is of low toxicity but may cause a slight irritation of the throat because of the high concentration, and it is not good practice to expose people to high smoke concentrations.

Smoke is most likely to linger and form eddies close to all the walls of a downdraft spray booth; in a room, the smoke will mix with the air and dilute evenly.

By disabling the extraction before filling the room with smoke a maximum clearance time is measured. As the extraction is usually running during normal spraying operations, the clearance time may be less than this but as a safety margin, it is important that the maximum time is observed.