OTEX HEALTH & SAFETY REFERENCE GUIDE

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OTEX™
VALIDATED OZONE DISINFECTION

CONTENTS

PREFACE

This booklet has been provided to answer any health and safety issues or questions you may have following the introduction of JLA's OTEX disinfection system into your laundry.

Relevant HSE documents have been included for reference purposes:

EH38: Ozone Health Hazards and Precautionary Measures.

EH64: D83 Ozone, Summary Criteria for Occupational Exposure Limits.

HSE/HELA Work Equipment: Photocopiers LAC90/2

Workplace exposure monitoring has been carried out on behalf of JLA by independent occupational hygienists. The results have shown that exposure to ozone throughout the working day is well below the occupational exposure limit assigned by the HSE. The results also confirm that exposure levels are below those recorded for office staff working with photocopiers.

Copies of the independent occupational hygienist's reports are available on request.

INTRODUCTION TO OZONE

Ozone is a naturally occurring gas composed of three oxygen atoms. When most people think of ozone (O_3), they picture a thin layer of gas high above the earth's outermost atmosphere that protects the earth from the sun's ultraviolet rays. But ozone, often described as the "fresh smell" after a thunderstorm, has a variety of uses closer to home.

Ozone was first discovered in 1840 and has been used as a disinfectant in drinking water since 1893. In comparison to chlorine, the most common water disinfection chemical, ozone is a stronger oxidiser and acts over 3,000 times faster than chlorine.

Ozone is generated via a number of processes such as electrical discharge or UV radiation. It is either produced intentionally for use during a specific process or as a by-product of a process, for example during photocopying. Due to its reactivity ozone rapidly decomposes back to oxygen and is extremely difficult to store. It is normally generated on site.

Ozone has been safely produced industrially in a variety of applications for a number of years. Uses include improving air quality in offices, odour suppressers in hotel rooms, commercial kitchens, food processing, disinfectant in drinking water production, swimming pools and in laundry.

It is present in the air we breath at a typical concentration of 0.001 to 0.05ppm and is detectable at very low concentrations. The human nose can detect ozone at concentrations as low as 0.01ppm. Generally a concentration of 0.02ppm is regarded as the worldwide backgound level. In London during the summer ozone averages between 0.04 and 0.06ppm, but on smoggy days this may increase to 0.2ppm for some hours.

The Health & Safety Executive (HSE) recommended Workplace Exposure Limit (WEL) for ozone is 0.2ppm (0.4mg/m^3). **Taking into consideration the available human toxicity data, the HSE has concluded that no significant effects on health would be expected to occur in normal workplace activities from exposure to 0.2ppm ozone for up to 7 hours.**

OTEX SAFETY CONTROL MEASURES

In order to ensure that the process is properly operated and controlled to minimise the risk to health, satisfactory OTEX systems of work are established and maintained.

All personnel operating ozone-generating plant are fully trained in all aspects of the operation including emergency and first aid procedures.

The OTEX system is fully automatic and requires very little operator input. Ozone is automatically generated and injected into the wash water at a stable concentration throughout the wash programs within the washing machine. It is generated only when the washers are activated and only during washing and rinsing cycles of the program.

Ozone sensors and detectors continually monitor the exposure levels of ozone within the laundry room. These monitors are located within the laundry to measure exposure levels within the breathing zone of the operator, ie by inhalation. These will automatically shut down the OTEX system, but not the washing machines, if the level of ozone reaches a specified level of 0.18ppm. The system will restart automatically once the levels have fallen below 0.18ppm. The sensors are calibrated and regular visits by trained specialist engineers (OTEX system technicians) are programmed to check all aspects of the OTEX system.

In the event of the OTEX system developing a fault, back-up programs for thermal disinfection are provided.

OTEX™
VALIDATED OZONE DISINFECTION

OTEX AND UK HEALTH & SAFETY LEGISLATION

Advice from the Health & Safety Executive has confirmed that a Manufacturers Safety Data Sheet for ozone is not a statutory requirement. The following has supported this:

- Ozone is generated in situ for immediate use.
- JLA supplies equipment that generates ozone and therefore is not supplying a chemical. A comparative situation is the supply of photocopiers and printers.
- The requirement to supply a Manufacturers Safety Data Sheet is given in the CHIP regulations, Chemicals (Hazard Information and Packaging for Supply) Regulations 2002. These stipulate the duties of a *chemical supplier* to provide sufficient health and safety information in the form of adequate labelling and the provision of a MSDS.
- Reference EH64: D83 2002 edition. This document summarises the health and safety criteria for the occupational exposure limit for ozone.

Under the COSHH regulations, essential measures that all employers and employees have to take are detailed. Ozone is covered under these regulations as a substance, which has been assigned a Workplace Exposure Limit by the HSE Guidance EH 40.

Under the COSHH regulations JLA have a duty to protect their employees and so far as is reasonably practicable those of other people at the premises where OTEX is installed. This has been carried out by:

- Provision of a COSHH assessment for the process of working in an OTEX laundry.
- Control of exposure. Ozone is only generated when the washing machines are in wash and rinse mode.
- Use of control measures and maintenance, examination and testing of control measures.
- Monitoring exposure at the workplace. Room sensors are installed for 24-hour monitoring of the workplace environment. These are set up to

provide an audible warning and also to switch off the ozone equipment should the ozone levels reach specific levels below the HSE WEL. In addition occupational hygienists have conducted independent personal monitoring.

- Information, instruction and training at the workplace. Dedicated engineers have been engaged to meet all the requirements.

A risk assessment has been produced as required under Section 2(1) HASWAW 1974 and Regulation 3 of the Management of Health Safety at Work Regulations.

COSHH ASSESSMENT

This document provides a summary of information to staff in accordance with COSHH Regulation 12, the contents of which must be strictly adhered to and complied with.

1.

COSHH Ref. No.	Title of process / Activity	Product / substance(s)	MSDS Ref. No.
	Use of OTEX Validated Ozone Disinfection in Laundry Equipment	*Ozone*	Not Applicable

2. Process Description:

Installation and operation of laundry equipment; washers fitted with JLA OTEX system.

3.

Substance(s) involved:	Workplace Exposure Limits (WEL): Reference HSE Publication EH40/2005 LTEL	STEL
Ozone	Not Applicable	0.2ppm

Results of independent occupation exposure monitoring 0.03 – 0.05ppm

4.

Nature of Exposure:	√	Description of Hazard to Health:
Inhalation	√	*Irritating to respiratory system. May cause headache and dryness to the nose and throat.*
Ingestion		*Not an expected route of entry*
Eye Contact	√	*Irritant to the eyes.*
Skin Contact	√	*Mild irritant to the skin although not expected route of entry.*

5. Control-measures implemented, including Personal Protective Equipment to be used:

Ensure adequate ventilation. Provision of air monitoring sensors.

6. Details of handling and / or Waste Disposal requirements:

Ozone is unstable and rapidly decomposes to oxygen. Therefore ozone cannot be stored.

Avoid contact with oxidizable materials, powerful reducing agents and heat or flame.

7. Staff Training Requirements:

Staff to receive on the job training. Staff to be fully conversant with COSHH/Risk Assessment.

8.

Emergency and First Aid Treatment:	*If a person is overcome by ozone, the following precautions should be adopted:*
Inhalation	*Remove patient to a warm uncontaminated atmosphere and loosen tight clothing at neck and waist. Seek medical attention immediately.*
Eyes	*Immediately flush eyes with large amounts of water for 15 minutes. Seek medical attention immediately*

9. Details of authorised signatory confirming acceptance of this assessment:

NAME:		SIGNATURE:	
TITLE:		DATE:	

RISK ASSESSMENT								
HAZARD	**AT RISK**	**CONTROL MEASURES**			**PROBABILITY WORST CASE OUTCOME**			
Hazard from:	**Who, how many** and **when** are persons at risk from hazards identified	**Control by:** t**raining, supervision, safety equipment, health monitoring, safe working procedures, hygiene etc.**	**Existing**	**Proposed**	**Possible Outcome**	**Likelihood**	**Risk**	**Action level**
OTEX - Generation of Ozone	JLA engineers/technical staff Laundry personnel	All operatives working with laundry equipment/room fitted with OTEX disinfection system will have received adequate information, instruction and training.	✔		Lead health effect: irritation of the mucous membranes of the upper respiratory tract. Irritant to eyes and mild irritant to skin. Nausea, headaches	Unlikely	Low	On going
		Staff to be fully conversant with the contents of COSHH assessment.	✔					
		JLA staff to be supplied with personal ozone monitors.	✔					
		Monitors fitted to measure levels of ozone in vicinity of laundry equipment. Monitors linked into OTEX control panel. The ozone sensor switches production of ozone off on detecting levels at 0.18ppm.	✔					
		Staff are trained in the correct procedures in the event of machine shut down.	✔					
		Only authorised personnel allowed to adjust the level of ozone generation.	✔					
		The sensor and systems are checked and serviced on a six monthly maintenance routine checked by trained specialist engineers. Records of checks are maintained.	✔					
		Verification system installed to monitor and record ozone emissions from laundry equipment.	✔	✔				
		Pipework and seals are checked regularly. Staff instructed to report hazards and defects immediately.	✔					
Signed: Name:		Date: Review Date:			Further action required: Y/N			

OTEX HEALTH & SAFETY REFERENCE INFORMATION

The relevant documents have been enclosed for reference purposes. These include:

Comparative Occupation Exposure Limits For Ozone in the Workplace.

HSE Publications:

- EH38: Ozone Health Hazards and Precautionary Measures.
- EH64: D83 Ozone, Summary Criteria for Occupational Exposure Limits.
- HSE/HELA Work Equipment: Photocopiers LAC90/2

COMPARATIVE OCCUPATION EXPOSURE LIMITS FOR OZONE IN THE WORKPLACE			
Activity		**Ozone ppm**	**Reference**
Nursing Home – personal monitoring of laundry staff		0.03 to 0.05	Independent occupational hygienist Scientifics Ltd, Doncaster. Report reference LRDON 1312 August 2004 & LRDON1395 December 2004
Hotel – personal monitoring of laundry staff		0.098	
Photocopier – after 100 copies produced around cooling fan		0.12	Health & Safety Local Authorities Enforcement Circular LAC Number 90/2
Workplace Exposure Limit (WEL)	**Short-term exposure limit (15 minute reference period)**	**0.2**	**Health & Safety Executive Occupation Exposure Limits Reference EH 40/2005**

EH Series

Ozone: health hazards and precautionary measures EH38

First published 1996, reprinted 1998

ISBN 0717612066

TOPIC SEARCH CATEGORIES: HEALTH: INCIDENTS; First aid: LEGISLATION; Regulations: MANAGEMENT; Training: PEOPLE; Safety representatives: PLANT, MACHINERY AND EQUIPMENT; Personal protective equipment: RISK MANAGEMENT; Control measures, Monitoring, sampling and surveillance: SUBSTANCES; Hazardous substances.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance as illustrating good practice.

INTRODUCTION

1

This Guidance Note is particularly aimed at employers and managers of people exposed to ozone in the course of their work. Other groups, such as employees and health and safety professionals, will find this guidance useful. It draws attention to the potential ill health which exposure to ozone could cause and indicates potential sources of exposure at work. It gives advice on the precautions which you may need to take to prevent or control exposure as required by the *Control of Substances Hazardous to Health Regulations 1994*[1] (COSHH). It does not discuss environmental exposure to ozone or atmospheric ozone-depleting substances.

2

This guidance should be read in conjunction with the Approved Code of Practice, *Control of Substances Hazardous to Health* (the COSHH general ACOP)[2].

OCCURRENCE AND PROPERTIES

3

Ozone, O_3, is a form of oxygen. It is a colourless gas with a distinctive odour and is a normal constituent of the earth's atmosphere. It is about 1.6 times heavier than air (density 2.144 g/l).

4

Ozone is produced naturally from oxygen whenever sufficient ultraviolet (UV) radiation or electrical discharges occur, for example at high altitudes or by the action of lightning. Such natural occurrences are unlikely to produce hazardous concentrations at ground level. The majority of ozone found near ground level is formed by photochemical reactions involving oxides of nitrogen and hydrocarbons.

5

Ozone is an unstable substance, but its rate of decomposition varies widely depending on temperature and humidity. A given ozone output which yields a faint trace of ozone in a workroom atmosphere on a humid day may create an undesirable concentration on a dry day. These factors are important when considering occupational exposure to ozone.

6

Ozone is a powerful oxidising agent and can react explosively with oil and grease. Low concentrations of ozone have a significant effect upon textiles, fabrics, organic dyes, metals, plastics and paints and cause the characteristic cracking of stressed rubber, commonly called 'weathering'. A few substances, such as glass and some grades of stainless steel are, however, resistant to the oxidising effects of ozone.

7

Ozone is not classified under the Chemicals (Hazard Information and Packaging for Supply) Regulations 1994 (the 'CHIP 2' regulations). Ozone cannot be stored or transported in vessels because it decomposes spontaneously in the presence of oxidisable impurities, humidity and solid surfaces. It is always generated *in situ*, for immediate use, and is extremely unlikely to be supplied as a commodity. Labelling phrases are therefore inappropriate.

EFFECTS ON HEALTH

8

Since ozone is a highly reactive substance, any adverse health effects will be found essentially at the sites of initial contact: the respiratory tract (nose, throat and airways), the lungs, and at higher concentrations, the eyes. The principal health effects are produced by irritation of and damage to the small airways of the lung. However, people have considerable variation in sensitivity. Uncontrolled exposure to relatively high levels of ozone could lead to more severe health effects. including lung damage. At the levels of exposure likely to be normally found in the workplace the main concern is irritation of the (upper) airways, characterised by coughing and a feeling of tightness in the chest. This guidance on establishing effective risk management measures for controlling exposure to ozone, focuses on the control of exposure to levels at which any health effects, if they did occur, would not be significant (see paragraph 25).

OZONE IN THE WORKPLACE

9

Ozone is produced industrially by bombarding oxygen with UV radiation or by passing air through a high voltage AC electrical discharge. It is used for a wide variety of industrial purposes including the following:

- to improve air quality in offices and as an odour suppresser in hotel bedrooms, commercial kitchens and cafeterias, food and fish processing plants, rubber compounding plants, chemical plants, sewage treatment works and cold stores;
- as a disinfectant in the production of drinking water;
- to overcome taste, odour and peaty colour problems in drinking water;
- as part of the water treatment process in the removal of pesticides;
- as a disinfectant in swimming pools;
- for pre-treatment in coating applications - including inks, wood finishing, metal decorating and general industrial finishing;
- for pre-treatment of plastic surfaces immediately before printing;
- as a bleaching agent in both the textile and foodstuff industries;
- as a reaction initiator in the chemical industry

Ozone is also produced as an incidental by-product of many industrial activities, some of which are described below.

Ultraviolet radiation

10

During high quality precision welding (including TIG and MIG techniques), metals are arc welded in the presence of a shielding gas. The ultraviolet radiation from the arc produces significant quantities of ozone, the risks of exposure being particularly significant during the welding of aluminium and stainless steel. Titanium is highly reactive and generally welded inside a sealed and inert enclosure.

11

Ozone is also produced near many types of lamp which emit ultraviolet radiation. Such lamps are used in a variety of processes, for example:

- ink curing: some printing inks, varnishes and lacquers are composed of chemicals formulated to polymerise rapidly into hard resins upon exposure to UV radiation;

- projection lamps: high pressure xenon lamps used in cinema projectors emit some UV radiation and also produce ozone.

High voltage electrical equipment

12

Ozone is also produced around high voltage equipment and by electrical discharges in specific processes. Some examples are given below:

- electrostatic precipitators: these are used to remove dust and some airborne contaminants from the air where ozone is produced incidentally;

- static eliminators: these are used in industry to remove static electricity from recently moulded plastic articles. The main factor which determines the amount of ozone generated is the voltage across the collector plates; the higher the voltage the more ozone is produced;

- X-ray machines.

ADVICE ON COMPLYING WITH THE COSHH REGULATIONS

Control of exposure to the occupational exposure standard (OES)

13

The current OES for ozone is 0.2 ppm in air averaged over a 15-minute reference period. If exposure to ozone cannot be prevented then the exposure by inhalation should be reduced to this standard (0.2 ppm). If exposure by inhalation does exceed the OES, this can still be considered as adequate control provided the reasons have been identified and you are taking appropriate steps to reduce exposure to the OES as soon as is reasonably practicable.

Assessment

14

Regulation 6 of COSHH requires that employers shall not carry out any work which is liable to expose any employees to any substance hazardous to health unless they have made suitable and sufficient assessment of the risks created by that work to the health of those employees and of the steps that need to be taken to meet the requirements of the COSHH Regulations. You will need to carry out a ‘suitable and sufficient’ risk assessment wherever exposure to ozone is likely to occur.

15

The HSE booklet *A step by step guide to COSHH assessment*[3] describes in general terms how to make an assessment. Guidance is also given in the COSHH general ACOP. An action plan/check list for assessment would involve:

- where is ozone likely to be generated?
- is exposure likely?
- who is likely to be exposed?
- can the exposure be prevented?
- if the exposure cannot be prevented estimate the potential level of exposures (in some cases this may involve personal exposure monitoring). If you can demonstrate that your estimate of exposure is unlikely to exceed the OES, you do not need to take any further action;
- if exposures exceed or are likely to exceed the OES, decide what control measures are needed and take appropriate action. The assessment must be reviewed regularly.

Low risk work activities

16
With some work activities, there may be exposure to small amounts of ozone that is without any significant risk to health. These low risk work activities are mainly encountered in office type environments. They include working with most types of photocopiers, printers, projectors, X-ray machines (all types: medical, dental, industrial), and some types of room deodoriser.

17

The risks to health are slight - and in general any symptoms shown will be irritation of the respiratory tract. However, employers should be aware that it is possible in certain cases to build up levels of ozone in excess of the occupational exposure standard (OES) in inadequately ventilated rooms (see paragraph 13).

18

Manufacturers and suppliers should provide recommendations on the siting and use of such equipment, and in normal use it is unlikely that you would need do more than comply with the recommendations to ensure the OES is not exceeded. The preferred option is to put the equipment in a dedicated room. Where this is not practicable, it may be necessary to site the equipment in a well ventilated area. However, if the siting is not in accordance with the manufacturers recommendations you should make a more detailed assessment of the potential risks.

19

Ozone oxidises airborne organic matter and inhibits the growth of bacteria (although it does not kill them). To use this effect, slow output ozone generators are often used to improve air quality in offices or to act as a commercial odour suppressor. These generators emit small quantities of ozone: assessment of the most appropriate siting and ventilation should be carried out in the same way as for printers and copiers.

20

Employers need to ensure that, where appropriate, their employees are aware of the precautions required to reduce the risks from exposure to ozone, and the control measures that are used. Employees should be told to report any obvious problems - such as a closed ventilation window in a copier room - to their supervisor or employer.

21

If your risk assessment shows that these are the only sources of ozone in your workplace, and you have followed the above guidance, then you need only keep these measures under review to comply with COSHH.

Higher risk work activities

22

COSHH requires that precautions should be taken for the protection of every employee who may be exposed to hazardous substances. In the case of ozone, experience shows that certain work activities described in paragraphs 9 to 12 will present a significant potential for exposure. Such exposures to higher levels of ozone can cause serious health effects and present a *higher risk to people*. The control measures employers need to take are explained in detail in the rest of this guidance.

PREVENTION AND CONTROL OF EXPOSURE

23

The COSHH Regulations require employers to ensure that the exposure of their employees to substances hazardous to health is either prevented or, where this is not reasonably practicable, adequately controlled.

24

The advice in the following paragraphs should help you when considering prevention and/or control procedures. These should be adapted to suit local conditions. Arrangements should be made to review the adequacy of precautions taken, particularly if the circumstances of use change or in the light of new technical developments. For instance, the continued use of static eliminators in poorly ventilated rooms can cause a build up of ozone above the occupational exposure limit (OEL).

Prevention of exposure

25

Prevention of exposure to ozone should be the preferred approach. For many processes, the release of ozone into the workplace can be prevented or substantially reduced by its destruction at source.

Control measures

26

Adequate control should be achieved, as far as reasonably practicable, by the use of process or engineering controls. Where these measures are not adequate, you should consider further controls, such as improved systems of work and the use of respiratory protective equipment. Whatever system is chosen, there is a need to check that it is effective and remains effective.

Engineering control

27

Engineering control measures needed will vary depending on the requirements of each workplace. The following methods will adequately encompass most situations:

- Where the source of ozone emission can be defined, for instance the use of ultraviolet lamps in ink curing, it may be reasonably practicable to use local exhaust ventilation close to the source of the emission (with UV lamps this is the lamp enclosure). This prevents or significantly reduces the amount of ozone entering the workroom air. Extracted air may need to be passed through an appropriate filter to remove the ozone before discharge.

- Where the source of ozone is less well defined, or the use of local exhaust ventilation is not reasonably practicable, the workroom should be equipped with adequate general ventilation.

- In plant rooms, where ozone is generated, it is recommended that there is sufficient ventilation to allow potentially dangerous accumulations of gas to be rapidly dispersed.

- During welding operations, it may be possible to reduce the quantity of ozone produced (as an incidental by-product) by shrouding the workpiece to prevent the escape of UV light.

Respiratory protective equipment (RPE)

There will be situations where other control measures are either not reasonably practicable or fail to achieve adequate control. In these circumstances the use of RPE is a valid control strategy. For instance, it may be necessary to use RPE when dealing with an ozone leak from a generator, or when undertaking inert gas shrouded welding operations on production plant.

29

The RPE selected should be suitable and manufactured to an appropriate standard. Employees should be properly trained in their use and supervised. The equipment should be regularly cleaned and checked to ensure that it remains effective. Further guidance on the selection and use of RPE is contained in the HSE booklet *Respiratory protective equipment - a practical guide for users*[11].

MAINTENANCE, EXAMINATION AND TESTING OF CONTROL MEASURES

30

Regulation 9 of COSHH requires that every employer who provides any control measure to meet the requirements of Regulation 7 shall ensure that it is maintained in an effective state, in an efficient working order and in good repair.

31

In order to comply with regulation 9 you should ensure that::

- all measures used to control exposure to ozone are maintained in good working order and in good repair (the manufacturer/supplier of the plant should be able to help you with appropriate information);

- competent persons undertake frequent visual checks and periodically carry out thorough examinations of the equipment to ensure they are being maintained adequately;

- all local exhaust ventilation plant is examined and tested at least every 14 months (a record of such tests must be kept for at least 5 years after the date on which they were made).

32

Further general information about LEV is contained in the HSE booklets *The Maintenance, examination and testing of local exhaust ventilation*[10], *An introduction to local exhaust ventilation*[9], and in the COSHH general ACOP[2].

MONITORING EXPOSURE

33

The result of a COSHH assessment will help you decide whether there is a need to carry out monitoring. When the COSHH assessment indicates that there might be wide variations of exposure at certain times and in certain operations, then measurement of exposure to ozone might be necessary to confirm that adequate engineering control is being maintained to control the exposure at or below the OES. Any monitoring regime should be planned carefully, and the advice of an occupational hygienist could prove to be useful. General guidance on monitoring and its frequency, and the record-keeping required, is given in the COSHH general ACOP[2]. Detailed advice on monitoring strategies can be found in Guidance Note EH42 *Monitoring strategies for toxic substances*[5].

Detector tubes

34

Short-term detector tubes capable of measuring ozone are available from a number of manufacturers. They provide an inexpensive and simple method for estimating the concentration of ozone in workplace air over a short time period, and can therefore be useful for making screening measurements to identify peak exposures or potential leaks from machines or control equipment. However, it is generally not valid to use detector tube measurements to calculate time-weighted average exposures for comparison with the OES. Also, ozone measurements made with detector tubes can be relatively imprecise and are susceptible to positive interference from other oxidising agents, for example chlorine and nitrogen dioxide.

35

For personal monitoring the use of a direct-reading instrument or an indirect method is recommended when assessing the pattern and duration of exposure.

Direct reading instruments

36

A wide range of direct reading instruments for measuring ozone are available commercially. Most are fixed-site or transportable instruments that are only suitable for making screening measurements. However, there are some portable instruments available that are suitable for measuring personal exposure. Since direct reading instruments are continuously reading, they can be used for making measurements of time-weighted average exposure over short-term (15 minutes) or long-term (8 hour) reference periods for comparison with the OES.

Indirect method

37

The US Occupational and Health Administration (OSHA) has published an indirect method for measuring personal exposure to ozone for comparison with limit values. OSHA Method ID-214[7] describes a procedure which involves drawing air through a glass fibre filter impregnated with nitrite. Ozone present in the sampled air oxidises nitrite to nitrate, which is determined by ion chromatography. Precautions should be taken to avoid positive interference by sulphur dioxide or particulate nitrate, which may be present in the test atmosphere.

HEALTH SURVEILLANCE

38

In general, routine health surveillance is unlikely to be necessary, but employees should be made aware of the possibility of exposure to ozone, and should be encouraged to inform their employer and their doctor if they develop any respiratory problems. People with allergic conditions such as asthma or hay fever might form a sensitive group in which exposure to ozone could worsen their condition.

FIRST AID

39

If a person is overcome by ozone, the following precautions should be adopted:

(a) Remove the person to a warm uncontaminated atmosphere and loosen tight clothing at the neck and waist.

(b) Keep the person at rest.

(c) If the person has difficulty in breathing, oxygen may be given provided that a suitable apparatus and a trained operator are available.

(d) If breathing is weak or has ceased, artificial respiration should be started. Mouth-to-mouth or mouth-to-nose methods should be used.

(e) Seek medical help.

Ozone poisoning should be treated symptomatically. A period of medical observation may be necessary because of the risk of delayed lung damage

INFORMATION, INSTRUCTION AND TRAINING

40

To comply with Regulation 12 of COSHH, employers should give all their employees who may be exposed to ozone at work sufficient information, instruction and training to understand the risks to their health caused by exposure to ozone and the precautions which should be taken to avoid or minimise exposure. For example welders may be unaware that the UV radiation from the arc generates ozone and that they could be exposed to it. Employers should provide adequate supervision, particularly to new and inexperienced workers. The training should include details on how control measures are to be used. Employees should be told to report any obvious defects in the control measures to their supervisor. Where RPE is used employees should be trained to check that it fits properly, and given clear instructions about when it should be used, serviced or, if it is disposable, thrown away.

EMERGENCY PROCEDURES

41

Emergency action plans should be prepared for all sites where ozone is generated in potentially hazardous quantities. Where leaks from pipes or equipment are detected, ozonators should be capable of being shut down if abnormal operating conditions prevail (for example air drier failure, cooling water failure, excess system pressure). In the event of an ozone leak do not attempt a plant restart until the source of leakage has been identified and rectified. Leak detection by nose is not satisfactory because even slight leaks cause the sensation of smell to be numbed and lead to the false conclusion that a leak no longer exists.

42

Appropriate warning signs indicating the presence of a potential toxic gas hazard should be displayed on ozone plant access doors or in passageways leading to the plant room.

SAFETY REPRESENTATIVES

43

Where trade union safety representatives are appointed under the Safety Representatives and Safety Committees Regulations 1977, they should be consulted by the employer. Such consultations allow the safety representatives to assist employers to develop control measures.

APPENDIX: REFERENCES AND SOURCES OF FURTHER INFORMATION

COSHH Regulations and ACOPs

1 *The Control of Substances Hazardous to Health Regulations 1994* SI 1994 NO 3246 HMSO ISBN 011 043721 7

2 Approved Code of Practice, *Control of Substances Hazardous to Health* 5th Edition 1994 HSE Books ISBN 07176 0819 0

Other COSHH guidance

3 *A step by step guide to COSHH assessment* HSG97 1993 HSE Books ISBN 011 886379 7

HSE Guidance Notes, Environmental Hygiene (EH) Series

4 *Occupational Exposure Limits* EH40 1996 HSE Books (revised annually) ISBN 07176 0876 X

5 *Monitoring strategies for toxic substances* EH42 1989 HSE Books ISBN 011 885412 87

6 *Occupational Exposure Limits: criteria document summaries* EH64 1995 supplement HSE Books ISBN 07176 0883 2

Measurement methods

7 US Occupational Safety and Health Administration OSHA Analytical Methods Manual 2nd Edition *Method ID-214: Ozone in workplace atmospheres (impregnated glass fiber filter*) USDOL/OSHA Salt Lake City 1995

Health surveillance

8 *Health surveillance under COSHH: guidance for employers* 1990 HSE Books ISBN 07176 0491 8

Exhaust ventilation

9 *An introduction to local exhaust ventilation* HSG37 1993 HSE Books ISBN 011 882134 2

10 *The maintenance, examination and testing of local exhaust ventilation* HSG54 1990 HSE Books ISBN 011 885438 0

11 *Respiratory protective equipment - a practical guide for users* HSG53

end of selection

EH Series

Summary criteria for occupational exposure limits EH64

First published 1996, updated edition 2002

ISBN 0717625699

TOPIC SEARCH CATEGORIES: HEALTH: LEGISLATION; Regulations: PEOPLE; Employees, Managers, Safety representatives: SUBSTANCES; Chemicals - general: Toxic substances

SECTION D: OES SUMMARIES

D83: OZONE

occupational exposure standard	
15-minute ref period:	**0.2 ppm**
IDENTITY AND PROPERTIES	
CAS No:	100028-15-6
EEC No:	233-069-2
Formula:	O_3
Synonyms:	triatomic oxygen
Boiling point:	-112 C
Conversion factor:	1 $mg.m^{-3}$ = 0.5 ppm;
	1 ppm = 2 $mg.m^{-3}$ at 20 C

Ozone (O_3) is a bluish gas and is about 1.6 times heavier than air. Its odour resembles newly mown hay and the odour threshold is approximately 0.01 ppm. O_3 is a powerful oxidising agent; because of its reactivity O_3 rapidly decomposes to oxygen but the rate of decomposition is affected by temperature, humidity and air contaminants. It is not classified under the CHIP 2 Regulations (1994). This will not change when the CHIP Regulations 1996 come into force. Ozone is always generated in situ, for immediate use, and it is extremely unlikely to be supplied as a commodity. Labelling phrases are therefore inappropriate.

OCCURRENCE AND USE

O_3 is a naturally occurring gas generated in the higher layer of the atmosphere by the action of ultraviolet (UV) light from the sun on oxygen. At the lower atmosphere O_3 is produced from the photochemical oxidation of atmospheric pollutants such as oxides of nitrogen and hydrocarbons in the presence of oxygen. In the industrial setting, O_3 is generated using UV radiation or an electrical discharge either intentionally for use in a specific process such as water purification; or as a by-product of a process eg. during photocopying. Due to its reactivity, it is extremely difficult to store and transport O_3

O_3 can be used for a variety of applications which include the following: disinfection and purification of water; treatment of sewage and waste water; surface treatment of plastics prior to printing; air quality improvements (odour treatment); as a bleaching agent in textiles and food industry; and as a reactant or initiator in the chemical industry.

EXPOSURE

Workplace exposure to O_3 can arise during its use in a process or when released as a by-product of a process operation. In almost all cases, the daily exposure to O_3 is for short periods of time. The number of people potentially exposed to this gas during intentional use is estimated to be in the region of 1000 and the extent of daily exposure is limited to short periods because of process automation and the entry to 'ozone' areas are controlled by alarm systems. Under normal operating conditions, 15-minute (TWA) exposures are likely to be below 0.1 ppm. The published data indicate that the 8-hour TWA exposures are likely to be in the region of 0.05 ppm.

A large number of people are potentially exposed to O_3 generated as a by product of various activities. The major proportion of this exposed group are office workers who use photocopiers. Reports from various parts of the world including UK indicate that short term TWA exposures to O_3 among this group of workers are well below 0.1 ppm. However, in some cases exposure can reach up to 0.5 ppm, mainly due to inadequate general ventilation. The exposure of welders to O_3 can be minimised or eliminated by taking precautions against other hazards such as metal fumes.

MEASUREMENT

Short-term detector tubes for measuring ozone are available and are capable of estimating the concentration of ozone in workplace air over a short time period.

A number of liquid sorbent methods for measuring personal exposure to ozone have been published, all of which involve reaction with a reagent solution in a midget impinger followed by UV spectrophotometry. However, the potential for interference by both oxidising and reducing agents and the inconvenience of the liquid sorbent technique makes the use of these methods relatively unattractive in comparison to direct reading instruments.

A wide range of direct reading instruments exists for measuring ozone. Most are fixed-site or transportable instruments, but there are some portable instruments available that are suitable for measuring personal exposure over short-term (15-minute) or long-term (8-hour) reference periods.

Biological monitoring

There are no known methods currently available for biological monitoring of ozone.

TOXICOKINETICS

Very few data are available on the toxicokinetics of O_3. It is highly reactive towards biological molecules and therefore toxic effects are anticipated at the initial sites of contact (namely the respiratory tract and lungs); but it is not expected that there would be significant systemic distribution. Following exposure (duration unknown) of rabbits, guinea pigs and beagles to concentrations of <2 ppm O_3, more than half the amount of gas inhaled was absorbed across the nasal and pharyngeal mucosa in all three species. No data are available on excretion. Following inhalation exposure of humans, O_3 is very well absorbed with a significant proportion being removed in the upper respiratory tract.

HEALTH EFFECTS

Animal studies

Since O_3 is a gas and highly reactive, there are no data available in relation to oral or dermal exposure.

The acute toxicity of O_3 is high, with 3- and 4-hour LC_{50} values of between approximately 5 and 35 ppm having been determined for several different species including rats, mice and guinea pigs. The primary site of damage following single exposure is the lung, characterised by pulmonary congestion, oedema and haemorrhage. In rats, single exposures (4-6 hours) to O_3 at concentrations between 0.65 and 3 ppm resulted in a number of changes. An increased number of neutrophils in the nasal lavage fluid and the lungs was seen at 0.65 and 2 ppm. At a higher concentration of 3 ppm, severe damage of the type I cells of the centro-acinar area and bronchiolar cells and hyperplasia of the type II cells of the alveoli were observed. No adverse effects were seen at approximately 0.1 ppm following exposure for 6 hours. However, no data are available on the effects of a single exposure to concentrations of O_3 in the range of interest ie above 0.1 ppm, but below 0.65 ppm.

No data are available on skin or eye irritation, or sensitisation. However, O_3 is anticipated to be an eye irritant at high exposure concentrations.

In a large number of fairly recent and apparently well-conducted studies involving repeated exposure to O_3, the primary site of damage in various species (including rats, mice and rabbits) was the ciliated epithelium of the trachea. Effects observed included an increase in alveolar macrophages and type 11 cells (at 0.12 ppm and above), secretory cell hyperplasia (at 0.15 ppm and above in some species), necrosis (at 0.15 ppm and above) and loss of cilia (at 0.96 ppm and above). In monkeys exposed for 8 hours/day for either a 6- or 90-day period, ciliated cell necrosis, shortened cilia and secretory cell hyperplasia of the nasal mucosa have also been observed at 0.15-0.3 ppm. On the basis of these findings, a lowest observed adverse effect level (LOAEL) of 0.12 ppm can be identified in rats. A no observed adverse effect level (NOAEL) for repeated exposure to O_3 has not been identified.

Following repeated inhalation exposure, the changes in the lungs described for single exposures to O_3 were found to be succeeded by an easing in the inflammatory response accompanied by an increase in lung collagen content with indications of lower airways constriction. In rats and monkeys undergoing more prolonged exposure to O_3 (8 hours/day at 0.95 ppm for 90 days or 0.6 ppm for 1 year respectively), mild interstitial fibrosis together with an increase in smooth muscle was noted in the alveolar ducts and respiratory bronchioles in the rats, and irreversible deposition of abnormal lung collagen in monkeys. Following previous exposure to O_3, a tolerance to subsequent exposures (after a 21-day period of non-exposure) has also been observed.

Repeated exposure to O_3 has also been demonstrated to have an effect upon lung function in animals. In rabbits exposed for 6 hours/day for between 3 and 7 days it produced a reduction in dynamic compliance and an increase in pulmonary airflow resistance at levels of 1-2 ppm. Added to this, an adverse effect upon immunological defence capacity of the lung manifested as an increased susceptibility to bacterial and viral infections has also been noted upon repeated exposure of mice to this gas at concentrations of 0.5 ppm and above for exposure periods up to 56 days duration. No such effects were seen at O_3 exposure concentrations of between 0.1 and 0.4 ppm.

The genotoxicity of O_3 has not been explored. Preliminary results from standard 2-year and lifetime NTP studies showed no carcinogenicity in rats and male mice and only equivocal response for lung tumours in female mice

No studies were available on the effects of O_3 on reproduction; however, no specific reproductive toxicity would be anticipated given that O_3 is not expected to undergo significant systemic distribution.

Human data

There is a large amount of reasonable quality information available on the effects of exposure of humans to O_3. This has been obtained both from controlled exposure of volunteers within exposure chambers and from epidemiological studies conducted on adolescents and children undergoing ambient exposure (largely in North America). As would be anticipated from the experience in animal studies, O_3 is a lung irritant in humans and has given rise to respiratory symptoms of cough, breathlessness and pain on deep breathing.

Impairments in physical performance during exercise (demonstrated by significant reductions in peak expired minute ventilation, oxygen uptake, tidal volume and work load) were noted in human volunteer studies at an 0_3 concentration of 400 pg.m^{-3} (0.2 ppm) - the highest exposure concentration tested. No effects were seen at concentrations in the range, 120-240 µg.m^{-3} O_3 (0.06-0.12 ppm). No pathological changes were reported.

The most reliable and useful data on effects of O_3 on lung function have come from experimental chamber studies. In such studies, measurable decrements in FEV_1, FVC and $FEF_{25\text{-}75\%}$ together with increases in specific airways resistance and airways resistance have been obtained in some individuals exposed to concentrations of O_3 at 0.08 ppm and above for varying lengths of time (between 2 and 7 hours' approximately) whilst engaging in physical exercise. Such effects appear to be transient in nature and of minor health significance. Upon further repeated exposure the airways become tolerant to the effects of O_3.

A wide variation in lung function response to exposure to O_3 has been demonstrated in humans; a percentage fall in FEV, ranging from 0-37% was seen in subjects following exposure to 0.12 ppm for approximately 7 hours. Reductions in lung function indices are proportional to both exposure concentration and duration, with exercise enhancing the effect of any given concentration of O_3.

With respect to the available human dose-response data obtained following exposure for between approximately 2 and 7 hours, it has not proved possible to identify a clear threshold for the effects of O_3 on lung function. At concentrations below 0.1 ppm, changes in lung function may occur in some individuals undergoing exercise. No effects will be noticed in the great majority of individuals upon exposure to O_3 concentrations in the range 0.1-0.15 ppm even whilst taking vigorous exercise. Within this same concentration range, cough and possibly some discomfort on deep breathing may be experienced in a small percentage of people whilst engaging in heavy exercise. At levels of O_3 between 0.15 and 0.2 ppm, impaired performance will be experienced by more individuals whilst taking vigorous exercise and similarly in those particularly sensitive to O_3 during moderate exercise.

Changes in lung function indices will be noted in most individuals exposed to concentrations in excess of 0.2 ppm with those who are particularly sensitive to the effects of O_3 being most affected.

Although a precise NOAEL has not been identified for effects on lung function (as a result, of great variation in individual responsiveness), an analysis of the available human data indicates that at 0.2 ppm O_3 no significant effects would be expected to occur in the great majority of individuals upon exposure for between approximately 2 and 7 hours.

The only data available for occupational exposure to O_3 relates to exposure in welders, and was derived from a secondary literature source. The reliability of these data is questionable due to uncertainties in exposure conditions and the occurrence of mixed exposures to other substances as well as $O_{3,}$. Therefore no definite conclusions can be drawn from them. However, although exposures were mixed no effects were reported in atmospheres reported to contain 0.2-0.25 ppm $O_{3.}$

No data were available on genotoxicity, carcinogenicity or effects upon reproduction.

BASIS FOR SETTING THE LIMIT

There are sufficient human data available to enable the determination of an occupational exposure limit. Irritation of the mucous membranes of the upper respiratory tract is considered to be the lead health effect and the setting of a health-based limit is considered to be appropriate for O_3.

Data obtained from experimental chamber studies are considered to be the most reliable since exposures were carefully controlled and simultaneous exposure to other substances prevented. On the basis of the data obtained in such studies it can be seen that exposure to O_3 at concentrations below 0.1 ppm for a number of hours can affect lung function in some individuals undergoing exercise, whilst the majority of people will remain unaffected during exposure to concentrations up to 0.15 ppm for similar exposure times even whilst engaging in quite vigorous exercise. At concentrations of O_3 within the range 0.15-0.2 ppm, impaired exercise performance will be experienced by more people during strenuous exercise and changes in lung function indices will occur in most individuals exposed to concentrations in excess of 0.2 ppm for a number of hours. Furthermore, such effects appear to be transient with subsequent recovery occurring following exposure. Although no clear NOAEL can be identified due to variations in individual susceptibility, overall the available human data indicate that no significant effects on health would be expected to occur in the majority of individuals employed in normal workplace activities upon exposure to 0.2 ppm O_3 for between approximately 2 and 7 hours.

Given that the lead health effect of O_3 is primary irritancy occurring on initial contact with the upper respiratory tract, an 8-hour TWA limit is considered inappropriate and a short-term exposure limit (STEL) more suitable to control for such effects in this case. Furthermore, consideration of the pattern of workplace exposure to O_3 indicates that daily exposure is usually for short periods of time and is unlikely to be prolonged during the working day. On consideration of the available health-effects data, it is considered that no significant health effects would be expected to occur in the majority of healthy individuals exposed to 0.2 ppm for up to 7 hours. On this basis, it is considered that 0.2 ppm would be an appropriate value for a 15-minute STEL. Available data indicate that it is practicable both to control and to measure to such a STEL.

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Work Equipment

Photocopiers
LAC90/2

Health & Safety Executive/Local Authorities Enforcement Liaison Committee (HELA)

Revised: September 2000

To: Directors of Environmental Health/Chief Environmental Health Officers of London, Metropolitan, District and Unitary Authorities and Chief Executive of County Councils

For the attention of: Environmental Services/Trading Standards/Fire Authorities/Other

This circular gives advice to local authority enforcement officers

Introduction

1

This circular explains the operation of a typical photocopier and examines the hazards to health.

BACKGROUND

The direct process

2

An image is formed directly on specially treated paper. The process is akin to conventional photography, in that special light sensitive paper is required. This is developed within the machine, often using an ammonia-based process. The remainder of this circular deals with the transfer process which was developed in the 1940's in the USA and originally called 'xerography' (literally 'dry-writing').

The transfer process

3

A major advantage of this process is that it produces copies on plain paper. An image of the original document is first formed on a light-sensitive surface called the photo conductor (PC) and is then transferred to the paper. The following paragraphs describe the cycle followed to reproduce an image on plain paper.

Charging the PC

4

In some machines the photo-conductor is an aluminised plastic film coated with an organic material about 10 microns thick. When exposed to an electric field, polarisation takes place through the depth of the film so that the surface carries a strong negative charge. In the darkness the PC will store this charge; exposure to light dissipates the charge. Because the charge sensitivity of the film diminishes with use it has to be replaced at intervals. The electric field is created by a 'corona', a line wire carrying a very high voltage (7 to 10000 volts) in a three sided metal enclosure or shield. In other machines the PC is a layer of selenium metal (often with additives such as arsenic) flash coated on to a drum.

Exposing the PC

5

In order to expose the PC the original document is placed on a glass sheet and scanned by a beam of light which is reflected from the document and through a lens system onto the PC. The PC discharges where the light strikes. Light is not reflected from dark areas of the original the corresponding parts of the photo conductor remain charged. A latent image has now been formed on the PC.

Developing the image

6

In the dry system the developer is a combination of beads of plastic-coated granular substance; the toner is finely powdered carbon black and a polymer resin. When the beads and toner are rubbed together a static charge is generated causing the toner to cling to the beads. This mix is cascaded onto the PC drum and the charge toner in the mix is attracted to the charged areas of the PC drum forming a visible image. The beads fall back into the bottom of the developer reservoir for recycling and additional toner is added to the mix as required.

7

Wet toners contain carbon black in a hydrocarbon solvent and are applied to the PC by a roller and bath. Wet toners are almost invariably handled by a sealed system of containers that plug into the reservoir.

Transferring the image

8

During the transfer stage the image is transferred from the PC to the paper which passed at a tangent to the PC drum. At this point an electric field from the transfer corona places a strong charge on the back of the paper, attracting the toner is the form of the developed image from the drum to the paper.

Fusing the image

9

From the PC drum the paper is now moved to the fusing area where heat from a moving fuser lamp which travels along with the paper fuses the toner-polymer mixture to the paper. The finished copy is then delivered to a storage tray.

Cleaning the PC

10

Most of the toner transfers to the paper but some remains on the PC drum. The remaining toner is cleaned off by exposing it to another corona which dissipates its charge. A rotating brush and an exhaust system remove the toner to the cleaning canister filter bag.

Hazards

Ultra violet light

11

The high powered lights used to expose the PC drum produce light in the visible wave band and some ultra violet light (UV), part of which is absorbed by the glass screen. Eye irritation from glare and UV light is prevented by the provision and use of a hinged lid over the glass top of the copier. Damaged lids or covers and the copying of thick books will allow some leakage of light which should be avoided. Operators should not look directly at the light.

Ozone

12

Both the UV light and the corona scan produce ozone by ionising the air. In the latter case it is unavoidable but is reduced in a properly adjusted machine; e.g. correct high voltage adjustment (which is variable to alter the 'darkness' of the copy) and regular cleaning of dust from the corona shields etc. Ventilation of the copier, designed to prevent heat build up, also dissipates the ozone but this can be retained in an unventilated or small room. The Occupational Exposure Standard (OES) for ozone is 0.2 ppm (8hr) and 0.4 ppm (15 mins). Under foreseeable conditions of use, it is unlikely that ozone concentrations would approach either the long or short term standard. Tests have found 0.12 ppm at the discharge from a cooling fan after 1 100 copies have been produced but, more typically, 0.02 ppm was measured in a number of locations at which a very slight smell of ozone was perceptible. 0.02 ppm is generally regarded as the world wide background concentration level of ozone. In London in summer it averages between 0.04 and 0.06 ppm. On smoggy days it may reach 0. 2 ppm for some hours.

Toner

13

Toners are fine powders which have a faint plastic odour. Depending on the size of the copier, they are typically composed of iron oxide or manetite, organic charging agent, acrylic or polyester resin, carbon black and/or inorganic pigments, amorphous silica, and salicyclic acid chromium (III) chelate. There are 8-hour TWA OESs for dust of 10 mg/m^3 (total inhalable) and 5 mg/m^3 (respirable), for iron oxide of 10 mg/m^3 (total inhalable) and 5 mg/m^3 (respirable), and for amorphous silica of 6 mg/m^3 (total) and 3 mg/m^3 (respirable).

14

Exposure to total inhalable dust during the use of photocopiers has been measured in the range 0.05-0.23 mg/m^3, well below the OES for total inhalable dust. The toner component was found to be less than 20% of the total inhalable dust, and therefore exposure to the individual components was well below the respective OESs.

15

During normal use, toner dusts are not considered to present a significant hazard to health.

Heat

16

Operators, particularly those working photocopiers for long periods, often complain of discomfort, e.g. sore eyes and sore throats. The hot, dry air produced by these machines is likely to be responsible and improved ventilation, with or without humidification, may alleviate the problem.

Precautions

17

In machines using a selenium coated drum, it is customary to replace the drum every few months, or after damage to its surface. Service contracts etc. usually ensure that they are handled by a trained engineer and returned for disposal/reclamation. It is not thought that special protective clothing is necessary, but removal of excessive toner dust, etc., should be done with care.

18

Severity of the hazards referred to in paragraphs 11 to 16 is dependent on the amount of use and the siting of the photocopier. Careful consideration should be given to the sitting of machines which are in constant use to ensure a good standard of ventilation. A means of forced ventilation may be necessary in some circumstances.

19

Photocopiers are now able to use coloured toners and certain litho printing plates (for short runs) can also be produced by photocopying.

ENFORCEMENT APPROACH

The Paper and Printing Sector Group would be interested to hear of any health and safety problems encountered in the use of photocopiers. Information should be passed via the Area Enforcement Liaison Officer.