



## Standard Range of Smoke Generating Systems

# Health and Safety Data

Reviewed January 2012

## Introduction

Concept have been designing and manufacturing Industrial and Military smoke generators since 1964, and are the only such specialist to have held NATO's AQAP 1 and ISO 9001 Quality Assurance Certification.

The cosmetic smoke produced by all reputable manufacturers has been subjected to extensive independent tests to ensure that it is non toxic (and, in Concept's case, non flammable), and a number of these reports are enclosed for your reference.

However, as cosmetic smoke behaves in a similar way to the toxic smoke produced by a fire, many people coming across cosmetic smoke for the first time are understandably cautious about the material and its safety aspects. The information contained herein should re-assure all concerned with the use of Concept's cosmetic smoke as to the material's safety, and Concept's ongoing commitment to the quality of our product.

## Types of Concept Smoke

### Smoke Chemicals (simulants)

(a) Propylene Glycol/Purified Water

(b) Glycerine BP/Purified Water

(c) Intrinsically Biodegradeable Food quality white oil

(d) Dipropylene Glycol/Purified Water

### Used on

Comet 3, Colt 3, Spirit B, Spirit 900  
AirTrace

Comet 4, Colt4, Spirit A, Spirit 900 A.,  
'E' Series, E+ Series

R7, Aviator MKV/X, ViCount, Artem,  
Aerotech, Vulcan

Euro C, Spirit 900C, 'M' series

## Occupational Exposure Limits

The Occupational Exposure Standards (OES) for our simulants are listed below. These standards relate to an 8 hour daily exposure to the chemicals, and whilst dense smoke concentrations exceed these limits, you will see from the various enclosed reports that these limits are of restricted value in assessing the 'toxicity' of the smoke.

Some 'Glycol' based chemicals used for smoke production by our competitors are not allocated OES. This, however, does not mean that these chemicals are any safer than those used by Concept. In fact Concept use what are considered to be the safest of the Glycols, (See extract from ICI's Glycol handbook, Appendix B) and the UK's Health and Safety Executive recommend that, should a chemical not be allocated a exposure limit in its own right, the exposure limit for a similar chemical type should be adopted.

### Long term exposure limit - OES

Propylene Glycol	10mg/m <sup>3</sup>	Glycerine BP grade	10mg/m <sup>3</sup>
White Oil	5 mg/m <sup>3</sup>	Dipropylene Glycol	Not allocated

A cursory comparison of the above limits implies that the water based Glycol and Glycerine smokes are twice as safe as the White Oil smokes that we produce.

However, a comparison of the concentration of water based smokes versus oil based smokes reveals that much less oil is required to achieve comparative smoke densities. Comparing the best (i.e. the most persistent) of the water based smokes, Glycerine, with Concept's 'Smoke Oil' reveals that **only 25-39%** of the amount of oil is required to achieve the same visibility through the smoke (See Appendix C).

If the same comparison is made with the faster dispersing Glycol smokes, then only 10-15% of the amount of oil is required to achieve the same visibility. So, to achieve similar smoke densities, and taking the OES's as a basis for comparison, smoke oil can be demonstrated to be even safer as a simulant than conventional Glycols.

## Particle Size - why is this so critical?

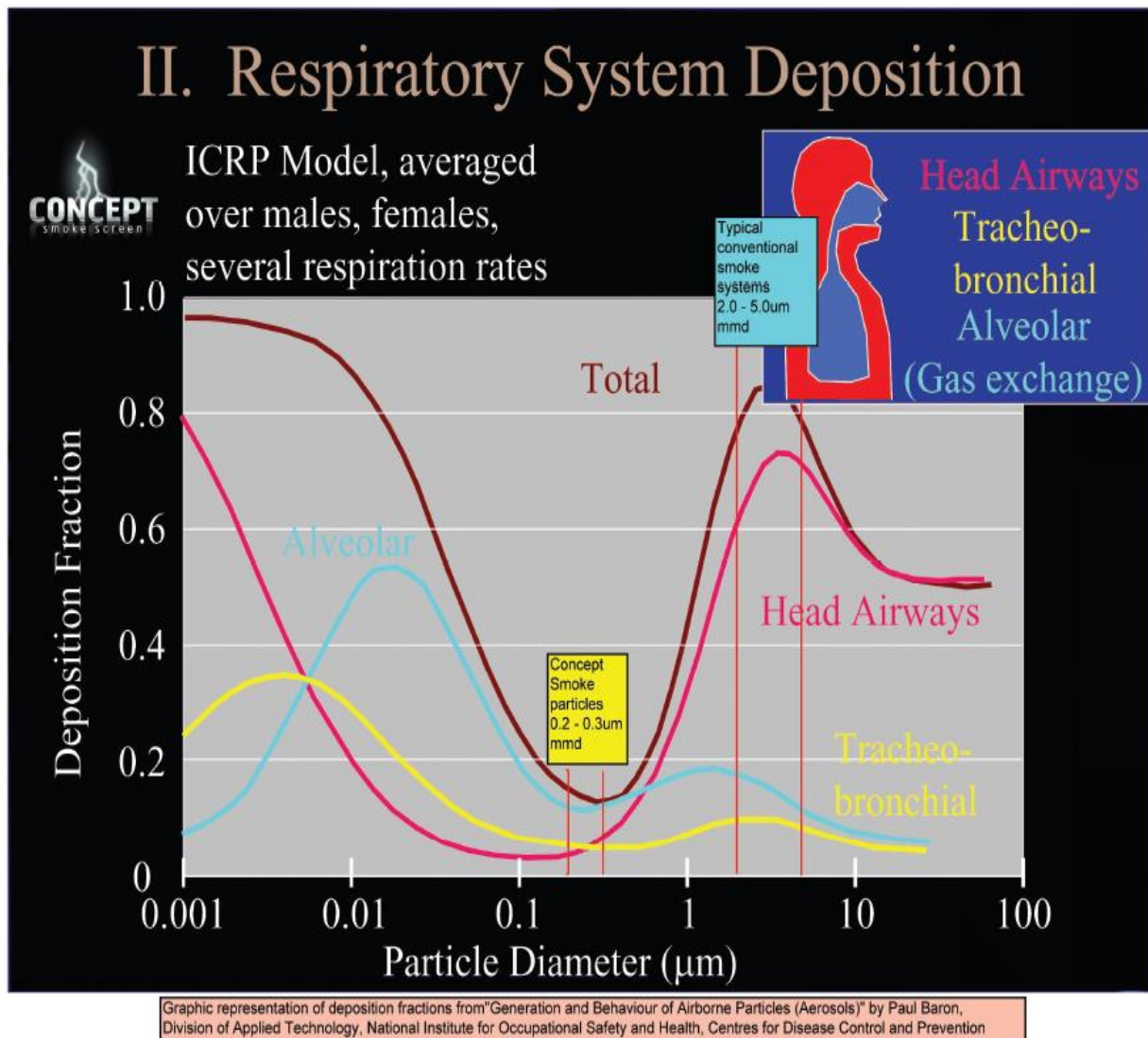
All artificial smoke systems actually produce a fog or liquid particle, and the establishing the size of that particle is critical in making comparisons in the relative safety of smokes produced by differing systems.

Representative samples of Concept generators are tested by the Atomic Energy Authority (AEA). Using this test data we are able to establish that the 'smoke' particles produced by our mains powered systems (i.e. Colt, ViCount and Spirit and Smoke Screen models and derivatives) are truly in a class of their own, with a typical particle size of 0.2 - 0.3 micron, and a typical gsd (Geometric Standard Deviation) of 1.35 - 1.45.

This compares to typical particle sizes of conventional 'smoke systems' of 2.0 – 5.0 microns.

Producing a smaller particle not only means that dense smoke concentrations can be achieved using much less chemical, (a benefit in health and safety terms, % LEL (flammability) and running costs) but also impacts on the respiratory system to the minimum possible degree. This is well illustrated on the accompanying graph from the US National Institute for Occupational Safety and Health where the appropriate bands relating to Concept and more conventional artificial smokes have been appended.

Note: Deposition Fraction is defined as the amount of material deposited in the tissue divided by the amount of material inhaled.



## Our current operating instructions carry the following heading:

“Health and Safety - The smoke produced by all Concept smoke generators has been rigorously tested to ensure that in normal conditions it is non toxic. Independent health and safety reports indicate that dense smoke concentrations can be entered without any serious health risk for short periods of time. However, we recommend that persons who are asthmatic or suffer from a respiratory complaint are not subjected to dense smoke concentrations, and the use of suitable PPE in the event of extended exposure to such environments. Should the artificial smoke be used in conjunction with live fires, where, by definition the potential for products of combustion to be formed from the fireplace would occur along with other hazards (unburnt propane etc), breathing apparatus should be worn. Copies of independent reports on the safety aspects of Concept smoke are available on request.”

## Inert Propellant – ViCount Range

At full output, the ViCount range of oil based smoke systems uses approximately 1.5m<sup>3</sup> of propellant gas per hour of operation. Either CO<sub>2</sub> or Nitrogen can be used as the propellant.

## Reports

A number of reports and approvals are enclosed within this information pack. Please take time to read them carefully.

## Appendices

'A'	ISO 9001 Quality Assurance & Scope
'B'	Extract on the toxicology aspects of Glycols (ICI) – text
'C'	Comparison of oil mist and Glycerol (Glycerine) mist concentrations to achieve similar smoke densities.
'D'	Product Safety Data sheet - Colt 3/Spirit B
'E'	Product Safety Data sheet - Colt 4/Spirit A
'F'	Product Safety Data sheet - ViCount/Vulcan/ MKV/Artem
'G'	Product Safety Data sheet - Euro C/Spirit C/M series
'H'	Justification and Approval (USN) - text
'I'	Assessment of Flammability & Toxicity Hazard (Health & Safety Executive) - text
'J'	Fog/Smoke generators report (National Occupational Hygiene Service) - text
'K'	Extract from Letter 5th Jan 1994 from Atomic Weapons Establishment.

## Appendix A – Quality Assurance



Concept first gained 3<sup>rd</sup> party quality assurance certification through the Defence Quality Assurance Board, when we achieved AQAP1 certification (NATO's highest quality standard) in September 1991.

This certification was supplemented by ISO9001 Quality Assurance Approval in March 1995.

The scope of our ISO9001 approval is as follows:

“Design and Manufacture of Non Toxic Smoke Generating Equipment for Military, Security and Industrial Use”

## Appendix B – Toxicology

The ethylene and propylene glycols described in this publication are of a low order of toxicity. Having low volatilities they present little hazard from inhalation. They are not absorbed from the skin in harmful quantities, nor are they skin irritants. Glycol splashes entering the eye may cause transient irritation.

Whereas propylene glycol may be regarded as practically non-toxic, the oral ingestion of only a few fluid ounces of ethylene glycol can cause serious damage and may prove fatal. The toxic properties of diethylene, triethylene and dipropylene glycol lie somewhere between those of ethylene glycol and propylene glycol.

### Ethylene Glycol

Ethylene glycol is slowly oxidised in the body to oxalic acid, and in this way the drinking of antifreeze solutions has been known to have fatal results. The lethal dose for an adult is approximately 100g and ingestion of amounts in excess of this have mostly been due to use of temporary containers previously used for beverages. Suitable warning labels are considered essential on retail packages.

### Diethylene Glycol

Like ethylene glycol, diethylene glycol is toxic when taken internally, and deaths have been known to result from accidental drinking of the material.

### Triethylene Glycol

This glycol is reported to have a lower order of oral toxicity than diethylene glycol. From published results of studies with animals, in addition to trials of air disinfection involving the exposure of large numbers of humans, it has been concluded that indefinitely long exposure to air substantially saturated with triethylene glycol vapour at room temperature is harmless.

### Propylene Glycol

Propylene glycol is the least toxic of the ICI glycols, being toxicologically similar to glycerol and substantially less toxic than ethylene glycol. It has no action on the skin.

### Dipropylene Glycol

The toxicity of dipropylene glycol is reported to be twice that of propylene glycol, although it is less harmful than ethylene glycol.

## Appendix C – Light Absorption

% Light Absorption	Glycerol Mist	Concept Smoke Oil Mist
	mg/m <sup>3</sup>	Mg/m <sup>3</sup>
10	190	49
20	370	138
30	520	204
40	800	276
50	1300	385

It can be seen that, in order to achieve the same level of light absorption, the concentration of oil mist required is only 25% - 30% of that required for Glycerol mist.

Source: BBC/NOHS

# Appendix D – Safety Data Sheet

## Smoke Simulant Fluid – Colt 3 / Spirit B

### 1. Identification of the substance/preparation and company/undertaking

Name: Colt 3 / Smoke Fluid B  
Synonyms: Propylene glycol \* propane – 1,2-diol

Supplier: **Concept Engineering Limited**  
7 Woodlands Business Park, Woodlands Park Avenue  
Maidenhead, Berkshire SL6 3UA  
Telephone: 01628 825555 Facsimile: 01628 826261  
Emergency Number: As above

### 2. Composition/information on ingredients

Chemical - Mono Propylene Glycol  
CAS - 57-55-6

### 3. Hazards Identification

Low toxicity under normal conditions of handling and use.

### 4. First Aid measures

Exposure Route	Symptom	Treatment
Inhalation	Irritation of Breathing Passages	Remove from Exposure, rest and keep warm. In severe cases, or if recovery is not rapid or complete, seek medical attention.
Skin Contact	Mild irritation	Drench the skin with plenty of water. Remove contaminated clothing and wash before re-use. If a large area of the skin is damaged or if irritation persists, seek medical attention.
Eye Contact	Mild irritation	Irrigate thoroughly with water for at least 10 minutes. Obtain medical attention.
Ingestion	Mild irritation of gastrointestinal tract.	Wash out mouth with water. Do not induce vomiting. Give water to drink. If patient feels unwell, seek medical attention.

Immediate treatment/Antidote: Symptomatic treatment.

### 5. Fire Fighting Measures

Suitable Extinguishers – CO<sub>2</sub>, Dry powder, Polar resistant foam or Water-fog.

Hazardous Combustion Products – Oxides of carbon

Special Equipment for Fire Fighting – Self contained breathing apparatus.

### 6. Accidental Release Measures

**Safety Precautions** – Wear appropriate PPE – see section 7

**Environmental Precautions** – Prevent entry into drains and water courses.



**Clean up Procedure** – Bind or absorb material with sand, earth or other suitable absorbent material. If possible, transfer to a salvage tank, otherwise absorb residues and place in suitable labelled containers and hold for waste disposal.

## 7. Handling & Storage

Handling

Ventilation: General Ventilation

Recommended procedures & equipment:

Avoid prolonged skin contact. Avoid contact with eyes. Avoid inhalation of high concentrations of mists.

Storage

Temperature Range:

Ambient

Humidity range:

Dry.

Keep away from:

See section 10

Suitable storage media:

Mild steel, aluminium, stainless steel

## 8. Exposure Controls/Personal Protection

Exposure Limits: 10 mg.m<sup>3</sup>, particulates; 150ppm (470mg/m<sup>3</sup>), Total, ShTWA Type: OES

Monitoring Method:

As propane-1,2-diol Protective Measures

Respiratory:

Type approved RPE for organic vapours and mists if reqd.

Hand:

Gloves

Eye:

Goggles

Skin:

Overalls and boots

Hygiene Measures: Always wash thoroughly after handling chemicals.

## 9. Hazards Identification

Not regarded as hazardous in normal conditions of handling and use.

## 10. Physical & Chemical Properties

Appearance	Colourless liquid
Boiling Point/range	188°C
Melting Point/range	< - 57°C, tends to supercool.
Flash Point	103°C (closed cup)
Explosive Limits	2.6 – 12.5 %v/v
Autoignition temperature	371°C
Vapour Pressure	30Pa @ 25°C
Relative density	1.04 @ 20/20°C
Solubility in water	Miscible
Solubility in solvent	Miscible with chloroform and acetone
Partition coefficient	-2.6

## 11. Stability & Reactivity

Stability: Stable in normal conditions, material is hygroscopic.

Material to avoid: Strong oxidisers

Hazardous decomposition products: Oxides of carbon, including propionaldehyde.

## 12. Toxicological Information

Effects: Extremely low oral toxicity, large doses may produce effects on liver, kidneys and central nervous system. Unlikely to be hazardous by inhalation because of the low vapour pressure, however large concentration of mist may irritate the respiratory tract. Prolonged or repeated skin contact may cause irritation. Causes slight eye irritation but permanent damage is unlikely.

LD<sub>50</sub> 21000 – 33700 mg/KG oral – rat >10000 mg/Kg skin-rabbit

### 13. Ecological Information

#### Environmental Effects

Mobility: Liquid with low volatility, soluble in water. Predicted to have high mobility in soil.

Degradability:  $BOD_5 = 1.08 \text{ gO}_2/\text{g}$ ;  $ThOD = 1.68 \text{ gO}_2/\text{g}$ ;  $COD = 1.63 \text{ gO}_2/\text{g}$ ;  $BOD_{20}/ThOD = 86\%$  The substance is substantially biodegradable.

Bioaccumulative potential: Low

#### Aquatic Toxicity

$LC_{50}$ , fathead minnow = 4600 – 54900 mg/l

$EC_{50}$ , Daphnia magna = 4850 – 34400 mg/l

### 14. Disposal Considerations

Substance: Via an authorised waste disposal contractor to an approved waste disposal site, observing all local and national regulations.

Container: As substance. Used containers must not be cut up or punctured until completely purged of product residues.

### 15. Transport Information

This product is not regulated as hazardous in bulk form.

When packaged in aerosol format the goods are classified as hazardous because of the nature of the pressurised container. The propellant within the canister is inert nitrogen

Aerosols are classified as UN1950, Hazard Class 2.2. Normally shipped as “limited quantities”.

### 16. Regulatory Information

Supply label details:

Ref. CHIP 2

Label name:

Mono Propylene Glycol

Symbol

No risk or safety phrases stipulated

Risk phrases

No risk or safety phrases stipulated

Safety phrases

No risk or safety phrases stipulated

Users are advised to consult these regulations for further information. The information contained in this data sheet does not constitute an assessment of workplace risks

### 17. Other Information

This material is usually used for:

It must not be used for:

Further details may be available upon request from Concept Engineering.

**Legal Disclaimer** The above information is based on the present state of our knowledge of the product at the time of publication. It is given in good faith, no warranty is implied with respect to the quality or the specification of the product. The user must satisfy themselves that the product is entirely suitable for their purpose.

# Appendix E – Health and Safety Data

## Smoke Simulant Fluid – Colt 4 / Spirit A / E Series

### 1. Identification of the substance/preparation and company/undertaking

Name: Colt 4 / Comet 4 aerosol liquid contents Smoke Fluid A

Supplied by:

#### Concept Engineering Limited

7 Woodlands Business Park  
Woodlands Park Avenue  
Maidenhead, Berkshire SL6 3UA

Telephone: 01628 825555 Facsimile: 01628 826261

Emergency Number: As above

### 2. Composition/information on ingredients

Chemical -	Glycerine
Exposure -	10 mg/m <sup>3</sup>
CAS -	56-81-5
EINECS -	200-289-5

### 3. Hazards Identification

Not generally regarded as hazardous in normal conditions of handling and use.

### 4. First Aid measures

Exposure Route	Symptom	Treatment
Inhalation	Irritation of Breathing Passages	Remove from Exposure, rest and keep warm. In severe cases, or if recovery is not rapid or complete, seek medical attention.
Skin Contact	Mild irritation	Drench the skin with plenty of water. Remove contaminated clothing and wash before re-use. If a large area of the skin is damaged or if irritation persists, seek medical attention.
Eye Contact	Mild irritation	Irrigate thoroughly with water for at least 10 minutes. Obtain medical attention.
Ingestion	Mild irritation if swallowed in large doses	Wash out mouth with water. Do not induce vomiting. Give water to drink. If patient feels unwell, seek medical attention.

Immediate treatment/Antidote: Symptomatic treatment.

### 5. Fire Fighting Measures

Suitable Extinguishers – Water mist, alcohol resistant foam, dry powder, CO<sup>2</sup>.

Hazardous Combustion Products – Oxides of carbon

Special Equipment for Fire Fighting – Self contained breathing apparatus.

### 6. Accidental Release Measures

Safety Precautions – Wear appropriate PPE – see section 8

Environmental Precautions – Prevent entry of large spillages into drains and water courses.

Clean up Procedure –

Bind or absorb material with sand, earth or other suitable absorbent material. If possible, transfer to a salvage tank, otherwise absorb residues and place in suitable labelled containers and hold for waste disposal. Wash spill site with plenty of water after material has been taken up.

## 7. Handling & Storage

Handling Ventilation:	General Ventilation
Storage Temperature Range:	Ambient
Humidity range:	Dry.
Keep away from:	See section 10
Suitable storage media:	Store in original containers

## 8. Exposure Controls/Personal Protection

Exposure Limits:	10 mg.m <sup>3</sup> , 8h TWA	Type: OES
Monitoring Method:	As mist	

Protective Measures

Respiratory:	Type approved RPE for organic vapours and mists if required.
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Hand:	Gloves
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Eye:	Goggles
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Skin	Overalls and boots
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Hygiene Measures - Always wash thoroughly after handling chemicals.

## 9. Physical & Chemical Properties

Appearance	Colourless liquid
PH	Neutral
Boiling Point/range	Ca. 290°C
Melting Point/range	Ca. 18°C, solidifies at a much lower temperature.
Flash Point	177°C
Autoignition temperature	400°C
Vapour Pressure	<0.01 mbar @ 20°C; <1 mbar @ 100°C
Relative density	1262 Kg/m <sup>3</sup> @ 20°C
Solubility in water	Miscible
Solubility in solvent	Miscible with ethanol, slightly soluble in acetone, insoluble in ether and in chloroform.
Partition coefficient	-2.6
Viscosity	Ca. 1300 mPa.s @ 20°C

## 10. Stability & Reactivity

Stability: Stable in normal conditions

Known Hazardous reactions: Violent or explosive reactions with some oxidising agents

Conditions to avoid: Moisture, extremes of temperature

Materials to avoid: Strong oxidising agents

Hazardous decomposition products: Thermal decomposition may release acrolein.

## 11. Toxicological Information

Effects: Low oral toxicity. Slightly irritating to rabbit skin and eyes; unlikely to cause irritation in humans.

## 12. Ecological Information

Environmental Effects

Mobility: Soluble in Water

Degradability: Biodegradable. BOD<sub>5</sub> / COD : 0.87 / 1.16 gO<sub>2</sub>/g

Aquatic Toxicity: LC<sub>50</sub>, fish > 5000 mg/1; IC<sub>50</sub>, algae > 2900 mg/1; EC<sub>50</sub>, bacteria > 10000mg/1

## 13. Disposal Considerations

Substance: Via an authorised waste disposal contractor to an approved waste disposal site, observing all local and national regulations.

Container: As substance

## 14. Transport Information

This product is not regulated as hazardous in bulk form. It is not classified by IMDG as a marine pollutant.

When packaged in aerosol format the goods are classified as hazardous because of the nature of the pressurised container. The propellant within the canister is inert nitrogen

Aerosols are classified as UN1950, Hazard Class 2.2. Normally shipped as "limited quantities"

## 15. Regulatory Information

Supply label details:

Ref. CHIP 2

Label name:

Glycerine

Symbol

No risk or safety phrases stipulated

Risk phrases

No risk or safety phrases stipulated

Safety phrases

No risk or safety phrases stipulated

Users are advised to consult these regulations for further information. The information contained in this data sheet does not constitute an assessment of workplace risks

## 16. Other Information

Further details may be available upon request from Concept Engineering.

**Legal Disclaimer** The above information is based on the present state of our knowledge of the product at the time of publication. It is given in good faith, no warranty is implied with respect to the quality or the specification of the product. The user must satisfy themselves that the product is entirely suitable for their purpose.

# Appendix F – Health and Safety Data

## Smoke Simulant Fluid – Smoke Oil 135/180/Artem Smoke canister

March 08

### Recommended Uses

Concept Smoke Oil 135/180, in addition to its use as a smoke simulant, is used as a component in the pharmaceutical, food, cosmetic and plastics industries for applications that demand an extremely high standard of oil purity.

### Known Misuses/Abuses

None known.

The disposal of Concept Smoke Oil 135/180 to soil, watercourses and drains is a legal offence.

IDENTIFICATION OF THE SUBSTANCE & OF THE COMPANY / UNDERTAKING	
1	<p>IDENTIFICATION OF THE SUBSTANCE OR PREPARATION</p> <p><b>Smoke Oil 135 and Smoke Oil 180 are intrinsically biodegradable liquid paraffins complying with the British Pharmacopoeia for liquid mineral hydrocarbons and with the Statutory Instrument 1073 Mineral Hydrocarbons in Food Act. Pass the UV Absorption requirements of DAB VIII and USPXXX.</b></p> <p>CAS No: 8042-47-5 EINECS No: 232-455-8</p>
	<p>COMPANY IDENTIFICATION</p> <p>Concept Engineering Ltd</p> <p><b>7 Woodlands Business Park</b></p> <p><b>Woodlands Park Avenue</b></p> <p>Maidenhead</p> <p><b>Berkshire SL6 3UA</b></p>
	<p>EMERGENCY TELEPHONE NO: 01628 825555</p>
2	<p>COMPOSITION / INFORMATION ON INGREDIENTS</p> <p><b>Very highly refined hydrocarbon mineral oils.</b></p>
3	<p>HAZARDS IDENTIFICATION</p> <p><b>On the basis of our knowledge of the highly refined mineral oils used, Concept's smoke oils are unlikely to be hazardous to man in normal use. In the environment, these oils are likely to biodegrade slowly.</b></p>

<b>4 FIRST AID MEASURES</b>	
<b>TYPE OF EXPOSURE</b>	<b>FIRST AID MEASURES</b>
<b>Ingestion</b>  <b>Likely to be harmless if swallowed in small amounts - larger quantities may cause nausea and diarrhoea.</b>  <b>Skin</b>  <b>Unlikely to cause irritation. Prolonged and/or frequent contact, particularly where there is poor personal hygiene, may eventually cause irritation which could possibly, in sensitive individuals, lead to dermatitis.</b>  <b>Eyes</b>  <b>May cause minor irritation with short-term redness and stinging.</b>  <b>Inhalation</b>  <b>Unlikely in normal use.</b>	<b>Ingestion</b>  <b>Wash mouth out with water. Do not induce vomiting because of the danger of aspiration. If aspiration occurs or is expected get immediate medical advice.</b>  <b>Skin</b>  <b>Wash skin as soon as possible with soap and water. Change contaminated clothing and launder before reuse.</b>  <b>Eyes</b>  <b>Wash out thoroughly with water. If redness and/or irritation continues get medical advice.</b>  <b>Inhalation</b>  <b>If inhalation of fumes irritates the nose or throat or causes coughing remove to fresh air. Get medical advice if irritation continues.</b>
<b>5 FIRE-FIGHTING MEASURES</b>	
<b>Extinguish with Dry Powder, Foam or Water Fog. For small fires use CO2 or BCF - the adverse environmental effects of BCF/Halon are such that their use is no longer considered acceptable.</b> <b>Do not tackle fires with water except as a fog; water may be used to cool the area surrounding fires.</b> <b>Fires in closed or confined spaces should be tackled by trained personnel who should wear breathing apparatus.</b>	
<b>6 ACCIDENTAL RELEASE MEASURES</b>	
<b>May cause slippery surfaces.</b>  <b>Contain spillage - do not wash spillage down drain. Absorb using absorbent clay, diatomaceous clay or other suitable absorbent.</b>	

## HANDLING AND STORAGE

### 7.1 Handling

**It is recommended that, where there is likely to be prolonged and/or frequent contact protective clothing, as detailed in Section 8, should be worn when handling the Concept's range of oils.**

### 7.2 Storage

**Drums should be stored on their sides on racks preferably under cover, out of direct sunlight, in well-ventilated conditions.**

**Other types of containers should be stored under cover out of direct sunlight, in well-ventilated conditions. Care should be taken to avoid over-stacking.**

## 8 EXPOSURE CONTROL / PERSONAL PROTECTION

**As with all mineral oil based products keep skin contact to a minimum and ensure good hygiene standards**

Respiratory protection **is unlikely to be required in normal use. Note: Occupational Exposure Limits for Oil Mist quoted in current HSE Guidance Note EH 40. (Reference Health & Safety reports within the main Concept H&S data pack).**

Long term exposure limit - **(8 hour TWA reference period) 5 milligrams per cubic metre.**

Short term exposure limit - **(15 minute reference period) -10 milligrams per cubic metre.**

Hand and skin protection - **if continued or repeated exposure is likely protective clothing should be worn including gloves (nitrile rubber or neoprene).**

Eye protection - **eye protection should be worn if splashing is likely.**

## 9 PHYSICAL AND CHEMICAL PROPERTIES

SMOKE OIL:	135	180
Appearance	—Water-white liquids—	
Density at 15°C	<b>0.843</b>	<b>0.847</b>
Flash Point COC °C	<b>186</b>	<b>208</b>
KV/40°C cSt	<b>14.3</b>	<b>18.6</b>
Saybolt Viscosity SUS@100°F	<b>79</b>	<b>99</b>

## 10 STABILITY AND REACTIVITY

Conditions to Avoid - **excess heat can lead to decomposition of constituent additives with evolution of oxides of carbon.**

**Materials to Avoid - may react with strong oxidising materials.**

Hazardous Decomposition Products - **oxides of carbon, with incomplete combustion carbon monoxide.**



11 TOXICOLOGICAL INFORMATION
<b>The mineral oil components of these oils may be considered not to be essentially toxic in normal handling.</b>
12 ECOLOGICAL INFORMATION
<p><b>Air:</b> Concept Smoke Oil 135/180 is a mixture of non-volatile components, which are not expected to be released to air in any significant quantities.</p> <p><b>Water:</b> If released to water, Concept Smoke Oil 135/180 will form a floating layer on the surface and its components will not evaporate or dissolve to any great extent. Dissolved components will be absorbed in sediments. In aerobic water and sediments they will biodegrade slowly, but in anaerobic conditions they will persist. Concept Smoke Oil 135/180 is practically non-toxic to aquatic organisms but contains components which have a high potential to bioaccumulate.</p> <p><b>Soil:</b> Small volumes released on land will be absorbed in the upper soil layers and be biodegraded slowly. Larger volumes may penetrate into anaerobic soil layers in which the product will persist and may reach the water table on which it will form a floating layer. The more soluble components may dissolve but their high soil absorption coefficient and the low solubility will prevent significant contamination of ground water.</p> <p><b><u>These oils are intrinsically biodegradeable</u></b></p>
13 DISPOSAL CONSIDERATIONS
<b>Disposal - by incineration or by methods approved by Local Authority.</b>
14 TRANSPORT INFORMATION
<p><b>Not applicable; non-hazardous when shipped as bulk</b></p> <p>When packaged in aerosol format the goods are classified as hazardous because of the nature of the pressurised container. The propellant within the canister is inert. Aerosols are classified as UN1950, Hazard Class 2.2. Limited quantity provisions can apply.</p>
15 REGULATORY INFORMATION
<b>As far as is known not classified according to EEC Directives 67/548/EEC and 88/379/EEC.</b>
16 OTHER INFORMATION
Further information can be found in various publications, a list of which may be obtained from the Health & Safety Executive.

**LEGAL NOTICE**

The information in this Data Sheet applies only to the products designated herein and produced or supplied by Concept Engineering Ltd. It is based on our experience and on the data available to us at the time of its issue and is accurate to the best of our knowledge. The customer is strongly advised to observe and ensure that its employees and customers observe all directions contained herein. However, no warranty is made or implied that the information is accurate or complete and no liability will be accepted whatsoever - (other than liability in respect of the matters referred to in Section 2 Unfair Contract Terms Act 1977) arising out of the use of the information or the products designated herein. Where third party products are used in conjunction with or instead of products produced or supplied by Concept Engineering Ltd, the customers should obtain all necessary technical, health and safety information about such products from the third party. The above information is based on the present state of our knowledge of the product at the time of publication. It is given in good faith, no warranty is implied with respect to the quality or the specification of the product. The user must satisfy themselves that the product is entirely suitable for their purpose.

# Appendix G – Health and Safety Data

## Smoke Simulant Fluid – Fluid C

### 1. Identification of Material

Name: Smoke Screen Smoke Fluid C, as used in Euro C, Spirit 900C, and 'M' Series

Supplier: **Concept Engineering Ltd** Source: Dow Chemicals  
7 Woodlands Business Park  
Maidenhead, Berks, SL6 3UA  
Telephone: 01628 825555  
Faxsimile: 01628 826261  
Emergency Number: As above

### 2. Composition

A solution containing Dipropylene Glycol and Distilled Water. Dipropylene Glycol is formed by the addition of one molecule of propylene oxide to one molecule of propylene glycol (1,2-propanediol) and the commercial product is a mixture of three possible structural isomers.

Dipropylene Glycol is a colourless, viscous liquid which is miscible with water, mildly hygroscopic

### 3. Hazards Identification

This product is not listed as a dangerous substance in the relevant EC directive for the packaging and transporting of hazardous materials, other than in aerosol form. See section 14

### 4. First Aid Measures

Eye Contact	- Symptoms: Concentrated fluid may cause eye irritation - First Aid: Flush with water
Skin Contact	- Symptoms: Possible skin irritation - First Aid: Wash skin with water
Inhalation	- Symptoms: Nil
Ingestion	- Symptoms: Concentrated fluid may cause nausea & irritation - First Aid: Drink water

### 5. Fire Fighting Measures

Flash Point PMCC	124°C
Flammability Limits LFL/UFL	Not Determined
Hazardous Combustion products	May include CO <sup>2</sup> and CO
Extinguishing Media:	Water Fog, CO <sup>2</sup> , Dry Chemical
Special Fire Fighting Procedures:	None

### 6. Accidental Release Measures

For large spills, use containment dike if possible. Recover with vacuum truck. Small amount can be soaked up with absorbent material and shovelled into drums. Wash down remaining small amount with water. Dispose of material through proper license waste channels..

### 7. Handling and Storage

Keep containers tightly closed when not in use.

Do not expose to temperatures > 50°C.

For aerosol canisters do not pierce or burn, even after use. Do not spray on naked flame or incandescent material

## 8. Exposure Controls/Personal Protection

These apply to handling of large quantities of the concentrated fluid; in the aerosol and bulk pack configuration **no** special measures are required.

Eye Protection:	Safety glasses
Protective Clothing:	Rubber gloves in case of prolonged hand contact
Respiratory Protection:	Nil required
No exposure limits established	

## 9. Physical and Chemical Properties

Colour (Hazen units):	max 15
Specific Gravity (@20/20°C):	1.022-1.028
Distillation Point:	1013 mbar - 236°C
Vapour Density:	4.63
Vapour Pressure:	0.0013KpA AT 20c

## 10. Stability and Reactivity

Normally Stable, hazardous Polymerization does not occur

## 11. Toxicological Information

Eye Irritation (Rabbit): Application of a 0.5ml of undiluted DiPropylene Glycol caused no or mild injury (scored 0-1 where 5 is severe injury) (\*a)

LD<sub>50</sub> ORAL (RAT)13.3g/kg (In a normal sized human being this would require the ingestion of 1 kilogram of fluid to cause serious effect)

## 12. Ecological Information

*12.1 Environmental Fate:* Bioconcentration potential is low (BCF<100 or Log Kow<3). Log octanol/water partition coefficient (log Kow) is -0.67. Henry's Law Constant is estimated to be 3.58 E-09 atm-m<sup>3</sup>/mol

*12.2 Degradation and Persistence:* Biodegradation under aerobic static laboratory conditions is moderate (BOD20 or BOD28/ThOD between 10 and 40%). 5 Day biochemical oxygen demand (BOD5) is below detectable limits. 10 Day biochemical oxygen demand (BOD10) is 0.14p/p. Theoretical oxygen demand (ThOD) is calculated to be 1.91p/p

*12.3 Ecotoxicity:* Material is practically non toxic to fish on an acute basis (LC50 greater than 100mg/L). Acute LC50 for fathead minnow (*Pimephales promelas*) is >100mg/L. Acute LC50 for clawed toad *Xenopus laevis* is 3181mg/L.

In aerosol form Smoke Screen Smoke Fluid is pressurised by oxygen free nitrogen gas, and therefore contains no propellant alleged to damage ozone.

## 13. Disposal Considerations

Accidental Release

For large spills, use containment dike if possible. Recover with vacuum truck. Small amount can be soaked up with absorbent material and shovelled into drums. Wash down remaining small amount with water. Dispose of material through proper license waste channels..

## 14. Transport Information

This product is not regulated as hazardous in bulk form.

When packaged in aerosol format the goods are classified as hazardous because of the nature of the pressurised container. The propellant within the canister is inert nitrogen

Aerosols are classified as UN1950, Hazard Class 2.2 Air. Limited quantity provisions can apply.

## 15. Regulatory Information

This product is not a Hazardous Chemical as defined by the OSHA

## 16. Other Information

The material detailed above is for use in conjunction with Smoke Screen Systems only. Follow the manufacturers recommendations in all respects

The information contained herein is supplied in good faith and believed to be accurate as of the effective date shown above

References:

MSDS DOW CHEMICALS MSD 000075 printed 03/19/98

MSDS 999.0003556-004.003 prepared 1/5/98, Ashland Chemical Co.

**Legal Disclaimer** The above information is based on the present state of our knowledge of the product at the time of publication. It is given in good faith, no warranty is implied with respect to the quality or the specification of the product. The user must satisfy themselves that the product is entirely suitable for their purpose.

# Appendix H – USA Approvals

J& A No: 89 003

## JUSTIFICATION AND APPROVAL FOR ESTABLISHMENT OF A QUALIFICATION REQUIREMENT AND DETERMINATION REGARDING SPECIFICATION OF STANDARDS FOR QUALIFICATION

### 1. ***Nature and/or description of Action being Approved***

The Assistant Deputy Under Secretary of the Navy (Safety and Survivability) (ADUSN (S&S)) has certified commercial devices demonstrated to meet the qualification requirements for smoke generators used to operationally enhance fire fighting and damage control training. In accordance with "Justification for Establishment of Qualification Requirements for Operational Safety Items" dated 7 April 1988, this action establishes the qualification requirement and includes a determination that it is unreasonable to specify, at this time, the standards for qualification of the smoke generators discussed herein.

### 2. ***Description of Supplies/Services***

#### ***i. Brief description (nomenclature and part number) of the item(s) qualifying for use:***

AS 10689 Comet Colt "4" Smoke Generator  
AS 10690 Comet Spirit Smoke Generator

Accessories:

AS 10688 Smoke Stimulant for Colt "4"  
AS 10687 Smoke Stimulant for Spirit  
AS 10686 Ducting Adaptor for Colt "4"  
AS 10685 Ducting Adaptor for Spirit  
AS 10684 Flexible Hose

#### ***Manufacturer:***

***Concept Engineering Limited***  
7 Woodlands Business Park  
Woodlands Park Avenue  
Maidenhead, Berkshire  
England. SL6 3UA

#### ***ii Brief Description of the end use of the Item:***

The smoke generators and accessories described above are used primarily to enhance fire fighting simulations by providing dense, harmless smoke in a room or compartment. By allowing the fire fighter to practice manoeuvres in this type of environment, the individual is better prepared in an actual fire situation to safely attack and extinguish the fire or rescue victims trapped in a smoke-filled room.

The materials used for simulating the "smoke" are by composition propylene glycol, polyethylene glycol or glycerine and water mixed in appropriate proportions to give dense smoke.

### 3. ***Authority for Establishing Qualification Requirement***

Public Law 99 - 661  
FAR 9.2

### 4. ***Necessity for Qualification Prior to Award***

Effective fire fighting and damage control occurs only when the individuals performing these operations are properly trained. Some training is obtained through qualification courses taught at Navy Shoreside Damage Control/Fire Fighting Schools. Here the trainees can experience realistic exposure to smoke and flame in a controlled environment; however, once they return to the ship their periodic "fire drills" involve neither flame nor smoke. The fire party must "imagine" smoke within a closed compartment.

With the recent introduction of commercial fire fighter's equipment and aids such as the fire fighter's thermal imager for seeing through dense smoke, a smoke filled compartment is necessary for realism. Since we cannot set our ships on fire, the logical alternative is to use smoke generators. Use of smoke generators results in increased proficiency of the fire fighter which develops effective and safe tactics in an actual conflagration. This is substantiated by the fact that our NATO allies use smoke generators to train on their ships and the commercial Fire Brigades of European countries routinely train with simulated smoke.

The Colt 4 and Spirit smoke generators are in service with the Federal Republic of Germany, the United Kingdom Ministry of Defence, and the US Air Force in Europe. The smoke generators underwent an operational assessment on USS SIMPSON (FFG-56), USS PREBLE (DDG-46), USS TRIPOLI (LPH-10), USS LEXINGTON (AVT-16), and the Fleet Mine Warfare Training Center, Charleston SC in 1988. Responses were highly favourable regarding the performance of these smoke generators.

The smoke simulants used in both as described above have undergone extensive testing in the US and abroad to verify they are non-toxic, non-flammable, and non-corrosive. BUMED INST 3403.1 approved polyethylene glycol and mixtures with water as a liquid chemical simulant. There have been no proven safety hazards associated with these smoke generators and their simulants.

The smoke generators of this qualification provide the following features:

- a. provide a non-toxic, non-flammable, non-corrosive, water based dense smoke.
- b. designed to be portable, compact and lightweight (less than 25lbs) and durable in construction.
- c. operates on 110VAC 60Hz power with push button control.
- d. have warm up times of less than 5 minutes to provide smoke durations from 15 to 45 minutes, with densities reducing visibility to less than 5 feet.
- e. are supplied with operating instructions, smoke simulant, and service kits.

Delaying the qualification of the Colt 4 and Spirit smoke generators cited herein increases the risk of severe injuries and potentially the loss of life of fire fighters unprepared to operate in near zero visibility smoke filled rooms or compartments. Naval Training Commands urgently need these types of devices to effectively train Navy fire fighters.

## 5. Certification

The Colt 4 and Spirit smoke generators provided by the supplier listed in section 2 above are devices that meet the Navy's qualification requirements and are certified and approved for immediate use by all commands having available discretionary funds. Other qualified sources are continuing to be sought.

I hereby certify that the facts and representations which are included in this qualification requirement, certification and approval and which form a basis for his action are accurate to the best of my knowledge.

JOSEPH K TAUSSIG JR  
Assistant Deputy Under Secretary  
of the Navy (Safety & Survivability)

Date 1/24/89

## APPROVAL

Based on this justification No 89-003, the foregoing qualification requirement is established. Pursuant to FAR 9.202 (b), it is further determined that the requirements of FAR 9.202 (a) (1) (ii) through (4) are waived for two (2) years as it is unreasonable to specify all the standards for qualification which a potential offeror (or its product) must satisfy.

Head of the Contracting Activity (NCA)

D W MCKINNON JR  
RADM, SC

Commander, Naval Supply Systems Command

# Appendix I – HSE Report

## Repayment Contract Report

### HEALTH AND SAFETY EXECUTIVE RESEARCH AND LABORATORY SERVICES DIVISION

Harpur Hill, Buxton, Derbyshire SK17 9JN

#### ASSESSMENT OF FLAMMABILITY AND TOXICITY HAZARD FROM SMOKE GENERATORS WHEN USED IN FIRE AND RESCUE TRAINING EXERCISES

by

T J Snee PhD

IR/L/IN/82/9

#### **Distribution**

Mr D L Ward (CEGB)  
Dr D J Bryce (F18)  
Mr S J Silk (F19)  
Dr J McQuaid  
Dr A F Roberts  
Mr A R Baker  
Dr G Artingstall  
Dr T J Snee  
RPS  
Registry File

issue authorised by  
Dr J McQuaid

5 August 1982

#### **To HSE Staff**

Issued under a contract, not to be communicated outside HSE without the approval of the authorising officer.  
SME 123/608/04/T169

### **1. INTRODUCTION**

On 23 June 1982, at the request of Mr D L Ward (Occupational Hygiene Group, Central Electricity Generating Board) experiments were carried out on various types of smoke generator in the fire and rescue training room at Carrington Power Station. The experiments were designed to assess the possible fire, explosion and toxic hazard when smoke generators are used to reduce visibility to a level suitable for fire and rescue training exercises.

### **2. EXPERIMENTAL PROCEDURE**

The smoke generator under test was placed on the floor of a room measuring 7.3m x 1.8m x 2.1m and run until the visibility was reduced to a level which was considered by a Fire and Rescue Training Instructor to be suitable for training exercises. The fuel concentration was then measured using an instrument developed by Snee (1980) for the detection of combustible airborne material (conventional explosimeters being unsuitable for measuring concentrations of heavy vapours and fuel mists.) In each experiment two readings of concentration were taken and the illumination was measured using a light dependent resistor (orp12) placed, facing upward, on the table in the room. The room was illuminated by two fluorescent lights. Concentrations were measured approximately 1.5m above the floor in the region above the light dependent resistor.

### 3. EXPERIMENTAL RESULTS

The results of the tests are summarised in Table 1.  
Table 1

SMOKE TYPE (SMOKE COMPOSITION)	GENERATOR	TIME FROM START (MIN)	ILLUMINATION (LUX)	CONCENTRATION	
				(%LEL)	(mg/m <sup>3</sup> )
COMET 3 (PROPYLENE GLYCOL /NITROGEN)		8.5	11.8	2	1.8 x 10 <sup>5</sup>
		10.5	12.4	4	3.6 x 10 <sup>5</sup>
GENIE MK5 (SMOKE OIL 135 CARBON DIOXIDE)		4.0	5.8	2	0.9 x 10 <sup>5</sup>
		5.0	5.4	3	1.3 x 10 <sup>5</sup>
COMET 4 (GLYCEROL/ NITROGEN)		3.5	8.8	0	<1.2 x 10 <sup>5</sup>
		4.5	7.4	0	<1.2 x 10 <sup>5</sup>

In Table 1, LEL stands for lower explosive limit.

Concentration readings expressed as % LEL are based on the approximation that the ratio of LEL to stoichiometric concentration is 0.5. The value of this ratio for a mineral oil is around 0.51 and for propylene glycol 0.52. Little published information is available on flammability limits of glycerol, but experiments at the Health and Safety Laboratories indicate that the ratio of LEL to stoichiometric concentration is around 0.4.

The LUX is a unit of illumination equal to 1 lumen per square metre. Typical values are: moonlight - 0.1 LUX, 60W bulb at 1 M - 50 LUX, fluorescent lighting - 500 LUX.

### 4. FLASH POINTS

The flash points (in degrees centigrade) of the materials used to form the smoke are:

CONCEPT SMOKE OIL	182°C *
GLYCEROL	160°C (published value)
PROPYLENE GLYCOL	99°C (open test, published value)

- Measured at the Health and Safety Laboratories using a Seta-Flash apparatus, at a barometric pressure of 727 mm Hg.

## ASSESSMENT

### 5.1 Flammability

The experimental results indicate that, when these smoke generators are properly maintained and used in the prescribed manner under the type of conditions prevailing during the course of these trials, there is little risk of the formation of a flammable atmosphere, except possibly in the immediate vicinity of the nozzle. When a smoke generator similar in type to those used in the trials was run for long periods in a small enclosure in a laboratory experiment, concentrations exceeding 100% LEL were detected, but such conditions are unlikely to occur in any practical application of these devices.

### 5.2 Toxicity

The relevant Threshold Limit Values (TLVs) - Time Weighted Average (TWA) and Short Term Exposure Limit (STEL) - are listed in Table 2 (HSE 1990)

Table 2

SUBSTANCE	TWA (Adopted Values) (mg/m <sup>3</sup> )	STEL (Tentative Values) (mg/m <sup>3</sup> )
Oil mist (mineral)	5	10
Glycerol Mist	10	*
Propylene Glycol	*	*

- \* = not listed



The concentrations of these substances measured during the trials greatly exceed the corresponding threshold limit values.

However, there are a number of mitigating factors:

1. Breathing apparatus would normally be worn during a fire and rescue training exercise.
2. "Smoke Oil 135" is a drastically refined mineral oil and would not be expected to represent the same toxic hazard as a typical mineral oil containing much higher levels of polycyclic aromatic hydrocarbons.
3. Glycerol mist is classified as a nuisance particulate which does not produce significant organic disease or toxic effects when exposures are kept under reasonable control. The recommended limit for a normal workday does not apply to brief exposures at higher concentrations.
4. Propylene glycol, for which a threshold limit has not yet been adopted, has a low toxicity comparable with that of glycerol (ICI data sheet).

It is assumed in the above discussion that no chemical changes take place when the material is heated to form the mist.

## Conclusion

The experimental results indicate that, provided the smoke generators are not run for excessively long periods or in small enclosures, low visibility can be achieved without the risk of forming a flammable atmosphere. The toxicity data suggest that, if breathing apparatus is worn or exposure is brief, these atmospheres can be entered without any serious health risk.

## REFERENCES

Snee T J, I CHEM E

Symposium Series Chemical Process Hazards - VII 1980

Health and Safety Executive, Guidance note EH 15/80  
Threshold Limit Values 1980

ICI Petrochemicals and Plastics Division, Data Sheet, Propylene Glycol  
96/2

# Appendix J – NOHS (Copy)

## THE NATIONAL OCCUPATIONAL HYGIENE SERVICE LTD

Council of management:

BB Pugh  
N Deaville  
GR Streatfield  
MN Rodger  
E King

12 Brook Road  
Fallowfield  
Manchester  
M14 6UH  
0161 224 2332/3

1 September 1982

BBC  
Room 575  
33 Cavendish Square  
London

For the Attention of Mr D Short

Dear Sirs

### Re: *Smoke/Fog Generators*

This report was requested by Mr D Short of the BBC, and concerns the potential risk to health in using the Concept Comet 4 generator and the OFT generator.

### Concept Comet 4 Generator

This equipment uses a glycerol/water mixture which produces a 'smoke' of glycerol droplets. The glycerol used was of a very pure grade.

### Toxicity

Glycerol (glycerin) is a widely used oily liquid. It occurs in pharmaceutical preparations, cosmetics, soaps, and as a moistener in tobacco. It boils at 290°C. If it is a 'pure' form, the vapour/mist produced by boiling is simple glycerol in an unchanged form. If salts are present as an impurity, the boiling may produce acroleins - intensely irritating substances.

Glycerol itself is generally considered to be 'non toxic'. However, there is one paper (Campanacci, L Panminerva Med. 7: 490 (1965)) that reports that on very high doses in animals it may overload the kidney excreting mechanism, to give a 'toxic' effect. A further paper by Ackermann, RH et al Infusiontherapie 2:9 (1975) on biokinetics, allowed the data of Campanacci to be transferred to man. It is suggested that the normal man should be able to excrete over two grammes of glycerol per eight hour day without risk. Taking this into account, the American Conference of Governmental Industrial Hygienists recommended a T L V of 10mg/m<sup>3</sup> - the 'nuisance' TLV. However, 'nuisance' TLV s are based upon the undesirability of the substances in the air of the working environment. It would be very difficult to argue that 'fog' or 'smoke' is an undesirable component of a television scene requiring it. Thus, the 'risk' for glycerol must be considered in its own right, and not with reference to a 'nuisance' TLV. There are three aspects.

- (a) The generator heats the water/glycerol mixture to produce the smoke or fog. With impure glycerol, this could possibly give rise to the irritants, acroleins. These substances are in fact so irritant that they are more readily detectable by their effects on the eyes than by chemical methods. In the course of the work later described, I spent 15 minutes in a room at a 'glycerol' concentration of 1300mg/m<sup>3</sup> with no irritant effect whatsoever.
- (b) Many oily materials, if inhaled in liquid form as occasionally happens with nasal 'droppers', may cause a lipid pneumonia by flooding the air sacs of the lung with oil. Such an occurrence is virtually unknown with oil mists, and the value of 4000mg/m<sup>3</sup> given in the letter from Shell Oil to Concept Engineering of the 5<sup>th</sup> September 1972 would appear to be on the careful side. Again in the experiments described later, I spent some two hours exposed to levels ranging from 200mg/m<sup>3</sup> with no subsequent ill effects.

/.....cont.

### Re: *Fog/Smoke Generators* contd/.

There is only one paper previously mentioned suggesting damage by overloading the kidney. A computer search of the literature on glycerol gave no further evidence of harmful effect. However, accepting that one paper, and the calculation coming from it that the human can excrete over two grammes per eight hour day without risk, we need to consider possible exposure during use. The active man takes in about 15 cubic metres of air per eight hour day. Assuming a two gramme, or 2000mg acceptable intake, the exposures could be to 130mg/m<sup>3</sup> for the whole day, or 400mg/m<sup>3</sup> for one third of the day or 1066mg/m<sup>3</sup> for one hour before this intake - let alone the excretion after partial metabolism - was exceeded.

### Experimental

Fog/Smoke was generated with a Concept Comet 4 generator in a small closed office (8' x 12' x 9'0 with a circulating fan to disperse the fog. A photo flood lamp and a lightmeter were used to measure the 'opacity' in terms of percentage loss of lightmeter reading. Air sampling devices consisting of 'total' and 'respirable' mist samplers, and a Cascade impactor, were used to measure the glycerol in air levels just outside the light path.

The Cascade impactor was used a 2.5 1pm, to give size fractions of mean 18u on first slide, 14u on second, 6u on third and 1.4u on the fourth, referred to PVA 1400 spheres. Finer particles were collected by the backing GF/A disc. On three separate runs, at about 900mg/m<sup>3</sup> and 2300mg/m<sup>3</sup> total oil level, the distributions were:-

	<u>Total mg/m<sup>3</sup></u>		
	<u>800</u>	<u>1300</u>	<u>2500</u>
% 1 <sup>st</sup> slide (18u)	7.0	9.9	9.1
% 2 <sup>nd</sup> slide (14u)	4.7	12.0	14.0
% 3 <sup>rd</sup> slide (6u)	6.7	5.1	6.0
% 4 <sup>th</sup> slide (1.4u)	18.0	7.0	17.0
Backing (fines)	64	56	54

This data shows that the bulk of the material was in the 'respirable' range ( slides 3 and 4 plus fines). The increase on the first two slides with increasing concentration almost certainly shows faster agglomeration with decreasing distance between droplets.

The difference was also found in the total: respirable samples. These were evaluated by weight gain, as were the cascade impactor samples by light absorption at 20mu in water solution. The two 'analyses' agreed, suggesting that the airborne particles were in fact glycerol rather than a water/glycerol mixture. The data against light absorption gave:-

<u>% Light Absorption</u>	<u>mg/m<sup>3</sup> Total</u>	<u>% Respirable</u>
10	190	92
20	370	94
30	520	90
40	800	88
50	1300	85
60	2500	80

When plotted, these data give a curve, suggesting a change in light absorbing characteristics with increasing air level, probably due to more rapid agglomeration and consequent changing particle size distribution.

Subjectively, to me, all levels above 370 /mg<sup>3</sup> were reminiscent of the worst of the 1940/1950 London smogs as regards visibility (down to about 2' at 800mg/m<sup>3</sup>), but without the irritancy of these fogs. The impression was one of 'blandness'.

### Conclusion

Taking a thick fog level of 520mg/m<sup>3</sup> , one would need some two hours exposure to take in the two grammes of glycerol that has been suggested as being safe (as regards excretion) in the course of an eight hour day.

As I understand the use of these equipments, such protracted exposures to such high levels are most unlikely for both actors and technicians, and I cannot therefore visualise any problem as regards risk to health or even momentary discomfort with the reasonable use of this generator.

#### (B) OFT Generator

This equipment was using "Smoke Oil 135" , an oleum treated light mineral medicinal oil of foodstuffs quality, and not to be confused with 'mineral oil' in the normal sense of the term in occupational hygiene.

### Toxicity

I understand that there has been an attempt to apply to this oil the Threshold Limit Value of 5 mg/m<sup>3</sup>. In the Documentation of Threshold Limit Values (4<sup>th</sup> Edition) it states that the TLV is applied to 'airborne mist of petroleum base cutting oils or white mineral petroleum oil. These have an odour like lube oil, a boiling point of 68°F (this is a printing error - it should be 680° F and a flash point of 275°F. "Smoke Oil 135" simply does not fit this description and the TLV of 5mg/m<sup>3</sup> is not applicable. However, even in its own right, for use with cutting oils etc., this TLV is suspect.

For carcinogenic oils, it has no real margin of safety. As the documentation states, there are virtually no reported cases of illness related to non carcinogenic oil mist exposure, and even animal experiments prove negative - I personally exposed rats to 1100mg/m<sup>3</sup> of respirable oil mist for 16 hours per night for a year in 1957, with no effect except to improve their survival rate from natural causes above that of the controls.

On the basis of evidence, the only possible TLV would be that for a 'nuisance' material. However, the specific matters also discussed with reference to glycerol need to be dealt with to allow comparison.

- There is no chemical basis for irritancy, and I spent some ninety minutes at levels of from 50 to 400mg/m<sup>3</sup> during the experimental work, with no 'irritant' response whatsoever.
- The arguments as regards lipid pneumonia are the same as those for glycerol.
- There is no documentary evidence - I have had a computer scan - relating this type of oil to kidney damage.

## **Experimental**

The experimental work was carried out in the same way as described for glycerol, using the same experiments and room.

The Cascade impactor data were:

	<u>Total mg/m<sup>3</sup></u>	
	<u>49</u>	<u>385</u>
% 1 <sup>st</sup> slide (18u)	5.0	21.0
% 2 <sup>nd</sup> slide (14u)	5.1	19.0
% 3 <sup>rd</sup> slide (6u)	6.5	16.0
% 4 <sup>th</sup> slide (1.4u)	8.0	14.0
Backing (fines)	75.0	30.0

These data show a large increase in non-respirable droplets with the increase in total concentration.

The 'total' respirable samples gave the following light absorption data:-

% Light Absorption	Mg/m <sup>3</sup>	% Respirable
10%	49	92
20%	138	89
30%	204	79
40%	276	67
50%	385	63

These data again show a curve of concentration against light absorption, with clear evidence of agglomeration coming from the decreasing percentage of 'respirable' oil with increasing concentrations. It proved very difficult to reach 60% light reduction, except by almost continuous emission in the enclosed space, and no measurements were made.

As stated, I was in the room for the whole of this time - some ninety minutes with no evidence of irritation or pulmonary effect. As with the glycerol, the overall impression was of a 'bland' environment with visibility down to about 2' at 50% light reduction.

## **Conclusion**

On the basis of short term (up to one hour) exposures to even 'high' (up to the levels used in this work) concentrations of this oil mist, I cannot conceive any problem as regards risk to health. As with the glycerol, the only applicable TLV is that of a nuisance material, and this cannot be taken seriously in circumstances where the material is not present as a 'nuisance', but as an integral part of the job.

## **Comparison of Generators**

Since neither generator is likely to present a risk to health in normal use, the choice must be made on technical desirability. From the limited data obtained, from experiments designed to quantify 'risk to health' only, it would appear that the Concept Comet 4 generator gave a more stable 'fog' than did the OFT generator, albeit at a cost of a greater mass per unit volume for the same opacity.

Yours faithfully  
E King  
Chief Executive

## Appendix K – AWE Extract

### Extract from a letter dated 5<sup>th</sup> January 1994

**From:**

**Atomic Weapons Establishment  
Aldermaston, Reading RG7 4PR**

**To:**

**Concept Engineering Limited**

“DEAR MR.DUNNINGTON,

Last April a colleague and myself visited your factory to collect samples of smoke for analysis. We were supporting a Brown and Root project and had been asked to verify that the smoke did not contain pyrolysis products. My apologies for the delay but I can confirm that using gas chromatography / mass spectrometry techniques we found no evidence of decomposition having occurred in either the Smoke Fluid A or Smoke Oil.”