33.4

REC

Safety Studies

Safety Review Actions – 19 December 1995

Package No – None

Tag No – None

Vol 1

Project No -

Raytheon Engineers & Constructors

Report To Pfizer Ltd

Actions from Safety review of 19.12.95

Kilo Laboratory B901

Raytheon Project 2784

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Section 1

Introduction

This report comprises the actions from the Safety Review meeting, ref no. RE&C/PL/2784/MO22, held at New Malden on the 19 December 1995. The actions addressed are as follows:

1. Summary of Process effluent from the Kilo Lab during operations
2. Calculation of HVAC emissions in normal operations and worst case spills
3. Calculation of the required vent height for tank FA3905
4. Calculation of the CO_2 concentration in the laboratory in the case of triggering of the CO2 blanket system

Section 2

Effluent Summary

Raytheon
Engineers & Constructors

CLIENT: PFIZER LTD
SANDWICH, KENT

PROJECT: KILO LABORATORY

RAYTHEON JOB No: 2784

VENTS AND EFFLUENTS SUMMARY

Author:

CERTIFIED: DM/PM _____ DATE _____

QAM _____ DATE _____

CLIENT _____ DATE _____

ISSUE	DATE	DESCRIPTION	BY	CHECK	DATE	APPR	APPR
A1	26/4/96	ISSUED FOR COMMENTS	TRO	TRO	26/4/96	[signature]	

FILE REF.:

SHEET 1 OF 4

DOC. No. 2784-SP-UE1-006

GASEOUS POLLUTANTS

SOURCE	COMPOSITION	QUANTITY (Nm^3/hr)
Scrubber vent	SO_2 HCl Class A VOC Class B VOC N_2 and air	300 mg/m^3 10 mg/m^3 20 mg/m^3 80 mg/m^3 30 mg/m^3
Solvent tank vent	N_2 and air Solvent	$68m^3/hr$- -Trace Note 1
Chemical effluent tank vent	Air	$10m^3/hr$

Note 1 Exit Temp = -10 Deg C.

AQUEOUS LIQUID EFFLUENTS

SOURCE	COMPOSITION	TYPICAL QUANTITY PER WEEK (Litre)
Reactor F/C	Organic and aqueous	100
Filter F/C	Organic and aqueous	50
Tray drier F/C	Organic and aqueous	50
Rotary evap. F/C	Organic and aqueous	50
Cyclone evaporator F/C	Organic and aqueous	50
Chromatography F/C	Organic and aqueous	50
Sink F/C	Organic and aqueous	150
General purpose F/C	Organic and aqueous	50
Vent scrubber	Organic and aqueous	100
IPC laboratory	Organic and aqueous	50
Wash area	Organic and aqueous	50
Material and dispensary area	Organic and aqueous	50
TOTAL		**800**

NOTES:

F/C = Fume Cupboard

SOLID WASTES

SOURCE	COMPOSITION	MAX QUANTITY (kg/batch)
Open pan filter	Organic solids	10
	Spent charcoal	HOLD

NOTES:

1. Pfizer to advise addition sources of solid wastes and quantities.

Section 3

HVAC Emissions

Attached are copies of the calculations for the Process HVAC emissions for the Kilo Lab. The Originals are filed in the Process Calculation file.

The summary results are as follows:

HVAC Emissions: - Modelled using Heptane and Pentane as typical or representative Organics at high and low molecular weights, and 2 cases for each one, spills at 300K (27Deg C) and 400K (127 Deg C) to cover typical and worst case spills, with, typically an accidental spill of 60 litres (most of the reactor contents). Software package used WHAZAN

For Pentane - @ 300K - Emission of 290ppm w/w in the HVAC exhaust
@ 400K - Emission of 3419 ppm w/w in the HVAC exhaust
For Heptane - @ 300K - Emission of 38ppm w/w in the HVAC exhaust
@ 400K - Emission of 962 ppm w/w in the HVAC exhaust.

It must be noted that in the case of Pentane, the concentration calculated is between the Upper and Lower flammability limits.

CALCULATION SHEET

RAYTHEON ENGINEERS & CONSTRUCTORS.

JOB NO: 2784

TITLE: HVAC EMISSIONS

SUBJECT: ACCIDENTAL SPILL IN F/C

CALC. NO: M-278A-CALC-HVAC1

SHEET NO: 1/8

ISSUE NO: A1

DATE: 25/3/96

BY: PA CH.: TMO

Design Basis:-

1/ Exhaust flow = 12.65 m^3/s. (HVAC)

2/ F/C face velocity = 0.5 m/s. (1.0 m/s design)

3/ Model - n-Pentane, n-Heptane } as representative organics.

CALCULATION SHEET

RAYTHEON ENGINEERS & CONSTRUCTORS.

JOB NO: 2784

TITLE: HVAC EMMISSIONS

SUBJECT: ACCIDENTAL SPILL IN P/C

CALC. NO: M-2784-CALC-HVAC1

SHEET NO: 2/8

ISSUE NO: A1

DATE: 25/3/96

BY: PA CH.: TNO

HVAC exhaust = 12.65 m^3/s

≡ 15.18 kg/s

Pentane.

@ 300K m = 0.0044 kg/s

$w/w = \frac{0.0044}{15.18}$

= 290 ppm w/w

@ 400 K m = 0.0519 kg/s

$= \frac{0.0519}{15.18}$

= 3419 ppm w/w

CALCULATION SHEET

RAYTHEON ENGINEERS & CONSTRUCTORS.

JOB NO: 2784

TITLE: HVAC EMISSIONS

SUBJECT: ACCIDENTAL SPILL IN F/C

CALC. NO: M-2784-CALC-HVAC1

SHEET NO: 5/8

ISSUE NO: A1

DATE: 25/3/96

BY: PA CH.: JLD

Heptane

@ 300K $m = 0.00057\ kg/s$

$$w/w = \frac{0.00057}{15.18}$$

$$= \underline{38\ ppm\ w/w}$$

@ 400K $m = 0.0146$

$$w/w = \frac{0.0146}{15.18}$$

$$= \underline{962\ ppm\ w/w}$$

W H A Z A N Instant Liquid Spill

Date 25-MAR-1996 Time 9: 25

Data Used in Calculations

Chemical - n-Pentane

Spill Size (kg)	= 60.00
Bund Area (m2)	= 1.500
Windspeed (m/s)	= 1.000

Results

Maximum Pool Area (m2)	= 1.500
Time to Max Pool Area (or Bund) (s)	= .309
Pool Area at End of Period (m2)	= 1.500
Mass Vaporised by End of Period (kg)	= 15.69
Max Evaporation Rate (kg/s)	= 4.36E-03
Evap. Rate at End of Period (kg/s)	= 4.36E-03

Continue or Store Data (C or S) :

Ambient temp = 300K

W H A Z A N Instant Liquid Spill

Date 25-MAR-1996 Time 9: 33

Data Used in Calculations

Chemical - n-Pentane

Spill Size (kg)	= 60.00
Bund Area (m2)	= 1.500
Windspeed (m/s)	= 1.000

Results

Maximum Pool Area (m2)	= 1.500
Time to Max Pool Area (or Bund) (s)	= .309
Pool Area at End of Period (m2)	= .0
Mass Vaporised by End of Period (kg)	= 60.00
Max Evaporation Rate (kg/s)	= 5.19E-02
Evap. Rate at End of Period (kg/s)	= .0

Continue or Store Data (C or S) :

Ambient temp = 400K

W H A Z A N Instant Liquid Spill

Date 25-MAR-1996 Time 9: 37

Data Used in Calculations

Chemical - n-Heptane

Spill Size (kg)	= 60.00
Bund Area (m2)	= 1.500
Windspeed (m/s)	= 1.000

Results

Maximum Pool Area (m2)	= 1.500
Time to Max Pool Area (or Bund) (s)	= .323
Pool Area at End of Period (m2)	= 1.500
Mass Vaporised by End of Period (kg)	= 2.059
Max Evaporation Rate (kg/s)	= 5.72E-04
Evap. Rate at End of Period (kg/s)	= 5.72E-04

Continue or Store Data (C or S) :

Ambient temp = 300K

W H A Z A N

Instant Liquid Spill

Date 25-MAR-1996 Time 9: 38

Data Used in Calculations

Chemical - n-Heptane

Spill Size (kg)	= 60.00
Bund Area (m2)	= 1.500
Windspeed (m/s)	= 1.000

Results

Maximum Pool Area (m2)	= 1.500
Time to Max Pool Area (or Bund) (s)	= .323
Pool Area at End of Period (m2)	= 1.500
Mass Vaporised by End of Period (kg)	= 52.49
Max Evaporation Rate (kg/s)	= 1.46E-02
Evap. Rate at End of Period (kg/s)	= 1.46E-02

Continue or Store Data (C or S) :

Ambient Temp = 400 K

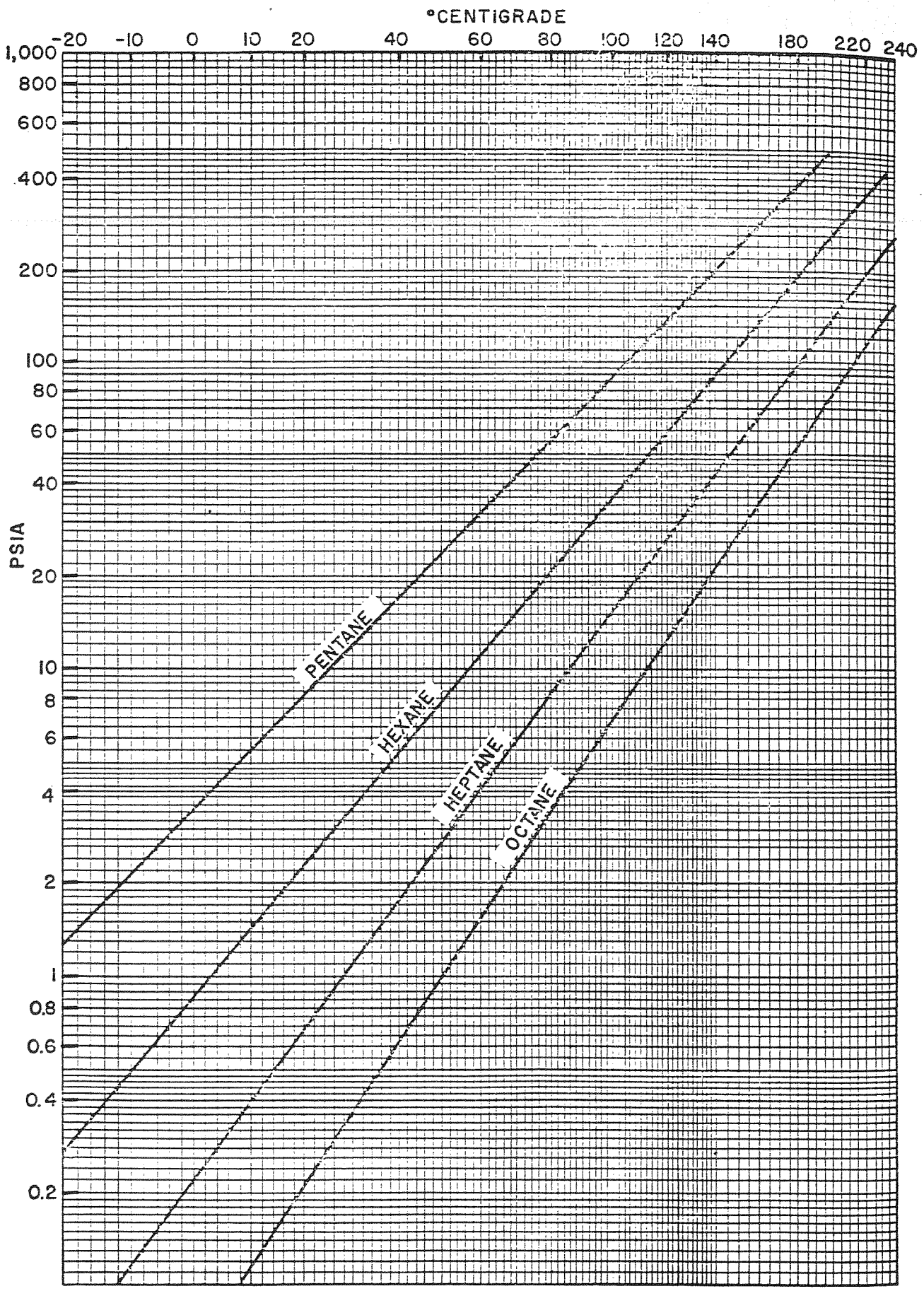


Figure 15-1. Vapor pressure for C_5-C_8 alkanes over a range of —20° C to +240° C.

Section 4

Relief Vent Elevations

Attached are copies of the calculations for the Relief Vent Elevation for Vessel FA3905 in the Kilo Lab. The Originals are filed in the Process Calculation file.

The summary result is as follows:

Vent stack Height (FA3905): - Modelled for HCl and SO_2 as exhaust gases of interest, with short term exposure values of 5ppm, and acceptable Ground Level Concentrations of 0.5ppm. Software package used WHAZAN.
Hydrogen sulphide was used to model HCl (near identical MWs) as WHAZAN does not have a data base for HCl.

Result - Effective stack height required = 7.0 metres from grade.

CALCULATION SHEET

RAYTHEON ENGINEERS & CONSTRUCTORS.

JOB NO: 2784

TITLE: Kilo Lab Pfizer

SUBJECT: Dispersion modelling for catch tank FA-3905

CALC. NO: 2784-CALC-FA3905

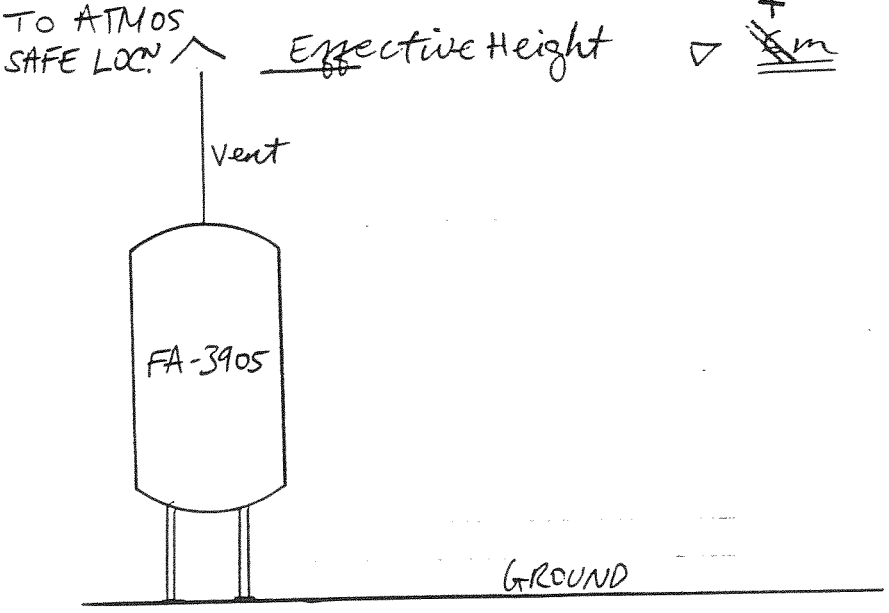
SHEET NO: 1/6

SUBJECT:

DATE: 20/3/96

BY: LS CH: TO

Modelling effective height of vent:



Basis:

Exhaust gases to be modelled are:

- Sulphur dioxide (SO_2)
- Hydrogen chloride (HCl)

Gases	ρ (kg/m³)	Flowrate (Nm³/h)	exhaust Flowrate (kg/s)
SO_2	2.73	1.1	0.84×10^{-3}
HCl	1.53	1.1	0.47×10^{-3}

Gases	short term exposure (10mins)	GLC (ppm)
SO_2	5ppm (7 mg/m³)	0.5 ppm
HCl	5ppm (13 mg/m³)	0.5 ppm

Say release duration of exhaust gases = 1 hr.
= 3600s.

See attached Printouts for effective height.

Form 5007 (Rev. 4/93)

Raytheon
Engineers & Constructors
A Consolidation of Badger and UE&C

GENERAL COMPUTATION SHEET

CALCULATION SET NO.			REV.	COMP. BY	CHK'D BY
2784 - CALC - FA390S					
PRELIM.	FINAL	VOID	0	DATE	DATE
	✓				
SHEET 2 OF				DATE	DATE
J.O.					

PROJECT 2484

SUBJECT DISPERSION MODELLING FOR CATCH TANK FA-390S

HEIGHTS FROM WHAZAN MODEL (PLUME DISPERSION)

SULPHUR DIOXIDE = 6.5 metres

HCl (H_2S MODELLED) = 7.0 metres

∴ CHOOSE 7.0 metres as conservative.

PROJ. NO. : 4784
CLIENT : PFIZER

EFFECTIVE VENT HEIGHT FOR FA 3905

W H A Z A N

Plume Model

Date 20-MAR-1996 Time 16: 45

Data Used in Calculations

Chemical - Sul. Dioxide

Height (m)	= 6.000
Release Rate (kg/s)	= 1.00E-03
Concentration of Interest (ppm)	= .500
Wind speed (m/s)	= 3.000
Ambient Temperature (K)	= 293.0
Surface Roughness Parameter	= 1.00E-01

Results

Max Downwind Effect Distance (m)	= 102.0
Max Crosswind Effect Distance (m)	= 4.284
Max Concentration at Ground (ppm)	= .676
Max Toxic Effect (Prob of Fatality)	= 2.98E-07

Continue or Store Data (C or S) :

Actual flowrate of SO_2 $= 0.84 \times 10^{-3}$ kg/s.

Min. allowable data entry $= 1 \times 10^{-3}$ kg/s.

$\therefore$ GLC $= 0.676$ ~~Accepted~~

Hence Height = >6 m from grade

GLC (adjusted) $= 0.676 \times 0.84 = 0.567$. above allow. figure

W H A Z A N

Plume Model

Date 29-APR-1996 Time 15: 10

Data Used in Calculations

Chemical - Sul. Dioxide

Height (m)	= 6.500
Release Rate (kg/s)	= 1.00E-03
Concentration of Interest (ppm)	= .500
Wind speed (m/s)	= 3.000
Ambient Temperature (K)	= 293.0
Surface Roughness Parameter	= 1.00E-01

Results

Max Downwind Effect Distance (m)	= 95.00
Max Crosswind Effect Distance (m)	= 3.047
Max Concentration at Ground (ppm)	= .576
Max Toxic Effect (Prob of Fatality)	= 2.98E-07

Continue or Store Data (C or S) :

Actual release rate = 0.84×10^{-3} kg/s

adjusted GLC : $0.84 \times 0.576 = 0.483$

Stack height = 6.5m

PLOT NO : 2104
CLIENT : PFIZER

EFFECTIVE VENT HEIGHT FOR FA-3905

W H A Z A N Plume Model

Date 29-APR-1996 Time 14: 25

Data Used in Calculations

Chemical - Hy. Sulphide

Height (m)	= 7.000
Release Rate (kg/s)	= 1.00E-03
Concentration of Interest (ppm)	= .500
Wind speed (m/s)	= 3.000
Ambient Temperature (K)	= 293.0
Surface Roughness Parameter	= 1.00E-01

Results

Max Downwind Effect Distance (m)	= 157.0
Max Crosswind Effect Distance (m)	= 7.844
Max Concentration at Ground (ppm)	= .933
Max Toxic Effect (Prob of Fatality)	= 2.98E-07

Continue or Store Data (C or S) :

Hydrogen Sulphide chosen to model HCl, as it is a very similar molecular weight (34 vs 36).

The actual release rate is 0.47×10^{-3} kgs^{-1}, but

Minimum allowed data entry = 1×10^{-3} kgs^{-1}

∴ Actual max concentration at ground = $0.47 \times 0.933 = 0.43$ ppm

7m height is O.K.

W H A Z A N Plume Model

Date 29-APR-1996 Time 15: 4

Data Used in Calculations

Chemical - Hy. Sulphide

Height (m)	= 6.000
Release Rate (kg/s)	= 1.00E-03
Concentration of Interest (ppm)	= .500
Wind speed (m/s)	= 3.000
Ambient Temperature (K)	= 293.0
Surface Roughness Parameter	= 1.00E-01

Results

Max Downwind Effect Distance (m)	= 165.0
Max Crosswind Effect Distance (m)	= 8.976
Max Concentration at Ground (ppm)	= 1.270
Max Toxic Effect (Prob of Fatality)	= 2.98E-07

Continue or Store Data (C or S) :

actual release rate = 0.47×10^{-3} kg s^{-1}

$\therefore$ Actual Max Conc = $0.47 \times 1.27 = 0.59$ ppm

NOT ACCEPTABLE

Section 5

CO2 Dispersion

Calculations and Tests have been carried out for Raytheon by How Fire Limited. These indicate that in normal CO_2 blanketting situations, i.e the release of one cylinder of CO_2, the CO_2 concentrations in the main laboratory will not exceed 4%. These calculations were carried out in accordance with NFPA Section 12. (National Fire Protection Association).

The communication and calculations from How Fire Limited are filed with the Raytheon HVAC group.

BS5306 part 4 1986 Section One, gives guidelines for exposure to CO_2. These are that above levels of 10% CO_2, CO_2 should be regarded as toxic, as asphyxiation will rapidly occur. Levels of 5% or less will lead to shortness of breath and headaches, and is not regarded as toxic at these levels.

Under normal fire blanketting situations, then, the levels of CO2 exposure can be regarded as safe.

How Fire Limited

Hillcrest Business Park
Cinderbank, Dudley, West Midlands DY2 9AP
Telephone: 01384 458993 Fax: 01384 458981

Facsimile Cover Sheet

To: John Saint
Company: Ratheon E & C
Phone:
Fax: 0181 388 0350

From: Daniel Claridge
Our Ref: 9299/1
Date: 25.04.96 N.B.!!
No. Pages: 3 Re transmitted 08/05/96 JJackson
(Including this one)

Further to a recent telecon between our Mr J Jackson and John Saint we are now pleased to provide our response.

1) Site tests have concluded that no appreciable leakage of Co2 will occur through the fire dampers.

2) Taking 1) into consideration the only leakage area is the gap of 0.075m x 3.0m. Additionally, should the doors to a fume cupboard be open, the leakage would then be from an area of 1.0m x 1.3m.
This gives a total area of leakage of 1.525m².

As this area is at the bottom of the risk, we must assume that all of the gas released will eventually leak into the main room. We have therefore carried out the following calculations.

i) The room volume, including all fume cupboards, sink areas and the lobby is: 759m³.

ii) The room volume, excluding all fume cupboards, sink areas but <u>including</u> the lobby area is : 627m³

We have used the above to calculate on a number of possible scenarios.

a) The concentration in (i) i.e 759m³, if one cylinder is discharged is less than 3%.
b) The concentration in (i) if all seven cylinders are discharged is approx 19%.
c) The concentration in (ii) if one cylinder is discharged is less than 4%.
d) The concentration in (ii) if all seven cylinders are discharged is approx 23%.

3) In light of the changes in leakage, the Co2 quanitity calculations have now been ammended as follows:

Reactor Fume Cupboard

Nett Volume	=	$24m^3$		
Volume Factor	=	$1.01Kg/m^3$		
Co2 Concentration	=	43% (based on ethanol)		
Material Conversion Factor	=	1.3		
∴ Basic Co2 required	=	24 x 1.01 x 1.3	=	31.512Kg
Leakage	=	$1.525m^2$ x $5Kg/m^2$ x 1.3	=	9.91Kgs
		Total Gas Required	=	41.432Kg

General Purpose Fume Cabinet

Nett Volume	=	$5m^3$		
Volume Factor	=	$1.01Kg/m^3$		
Co2 Concentration	=	43% (based on ethanol)		
Material Conversion Factor	=	1.3		
∴ Basic Co2 required	=	5 x 1.01 x 1.3	=	6.565Kg
Leakage	=	$1.525m^2$ x $5Kg/m^2$ x 1.3	=	9.91Kgs
		Total Gas Required	=	16.475Kg

NB The above calculations exclude Co2 nozzle upstream of the fire dampers.

We would deem that it is very unlikely that all seven cylinders would discharge at the same time and as such the risk is generally about a 4% concentration. The effects of Co2 are quoted from the British Standards below:

BS5306 Part 4 1986 Section One

3.2 Hazards to Personnel

The discharge of amounts of carbon dioxide to fight fires may cause a hazard to personnel (see also clause 34) and this characteristic shall be considered in the design of the system.

Facsimile Continuation Sheet

COMMENTARY AND RECOMMENDATIONS ON 3.2. *In addition to being an asphyxiant, carbon dioxide should be regarded as a toxic gas.*

Exposure to atmospheres containing about 5% carbon dioxide leads to shortness of breath and slight headache, while at the 10% level headache, visual disturbance, ringing in the ears (tinnitus) and tremor are followed by loss of consciousness.

Fire extinguishing concentrations of carbon dioxide, which are normally in excess of 30%, especially near to the point of discharge from total flooding or local application systems, carry a risk of almost immediate asphyxiation.

We trust this is the information you require. Should you have any further queries please contact us.

Regards

D Claridge
Commercial Engineer