

CLEAN AIR TECHNOLOGY

X-RAY FILM PROCESSING IVP ROOM VICTORIA INFIRMARY, GLASGOW

TEST REPORT 15 MAY 2000

Efficacy Tests for the Removal of
Airborne Gaseous Matter in an X-Ray Developer Room
using Electromedia Model 35F(A)
Electric Air Purification Unit

Report prepared by:-

Mr Tom Marshall)
Dr Leslie Campbell) Manufacturers of the Electromedia Model 35F(A)

Circulation list:-

Ms Susie Reid Health & Safety Manager, South Glasgow University Hospitals NHS Trust
Mr Murray Crichton Superintendent Radiographer, South Glasgow University Hospitals NHS Trust
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Mr Eddie McLaughlan Principal Engineer, NHS in Scotland, Healthcare Engineering & Environmental Unit, Glasgow

**EFFICACY TESTS FOR THE REMOVAL OF AIRBORNE GASEOUS MATTER
X-RAY FILM PROCESSING - IVP ROOM VICTORIA INFIRMARY GLASGOW
ELECTROMEDIA MODEL 35F(A) ELECTRIC AIR PURIFICATION UNIT**

1. Background

The above tests were undertaken at the request of Ms Susie Reid, Health & Safety Manager. Measurements of airborne gaseous matter were taken by Dr Ian M Dale, Occupational Hygienist, Glasgow Occupational Health. The operation of the Electromedia equipment throughout the tests was the responsibility of the Electromedia Model 35F (A) manufacturers - Mr Tom Marshall and Dr Leslie Campbell.

2. Objectives

- i) To measure the concentration of airborne gaseous matter in the IVP room as part of a blind study. The Occupational Hygienist did not know at the time of each measurement the disposition of the main filter, chemisorption filter and high voltage (HV) field.(see appendix 1)
- ii) To subjectively assess any changes in the IVP room air environment during the test period.

3. The Electromedia Model 35F(A)

The trolley mounted Electromedia equipment used in the tests was an ‘upflow’ pattern (see appendix 1). Room air intake is at the bottom of the unit and thereafter passes through the filter system to remove solid airborne particulates and designated gaseous matter. The filtered air then exhausts at the top of the unit back into the room at a selected air flow rate.

The three stage filter sequence and filter duties are as follows:

<u>First Stage</u>	Synthetic medium pad (removes large airborne solid particulate matter)
<u>Second Stage</u>	High voltage enhanced cassette type medium (removes sub micron airborne solid particulate matter)
<u>Third Stage</u>	Proprietary chemisorption medium (removes designated gases, fumes and vapours)

Note:- A First Stage synthetic medium pad was not fitted at any stage during the tests to allow all airborne solid particulate matter to be collected on the Second Stage filter and to give an empirical measure by visual inspection (discoloration) if any such solid matter had been collected.

4. Airborne Gaseous Matter Targeted for Measurement

Devalex X-ray Film Developer (Champion Photo Chemistry International Limited) is used in the IVP room x-ray processing. Details of its product description is copied from Champion's Safety Data Sheet. (see appendix 2)

Airborne acetic acid vapour (10/25% w/w in Devalex) was chosen by Dr Dale for measurement throughout the tests.

All measurements were taken using Kitigawa colour reaction tubes specific for acetic acid.

In order to obtain suitable sensitivity a volume of 10 x 100 ml was drawn through each tube; while the exact acetic acid concentration would not be known with certainty the relative values for each measurement would be consistent.

The proprietary chemisorption media used in the Electromedia Model 35F(A) is suitable for the removal of sulphur dioxide, acetic acid, gluteraldehyde and hydroquinone. This can be separately verified by the manufacturers of our carbon technology products.

5. Contaminant Settling Rates (in still air)

Particle sizes ≤ 1.0 micron settle extremely slowly (appendix 3) and can remain airborne on normal air currents generated in an occupied space until removed by some means.

6. IVP Room - Key Parameters (Imperial Units)

a) Throughout the tests the trolley mounted Electromedia Model 35F(A) was programmed to circulate/re-circulate 300 cubic feet of air/minute: -

b) Dimensions of the IVP room are:- 8ft L x 12ft W x 8ft H = 768ft³ (room volume)

a)&b) above provide:- $\frac{18000}{768} = \underline{23.5}$ ACH (air changes/hour) (Rutala et al 1995)¹

c) ACH (Air Changes/Hour)

23.5 ACH exceeds '10 or more room volumes per hour in the work area' as recommended by Champion's Safety Data for Devalex X-ray Film Developer.

7. Test Results

- i) Appendix 4 contains a copy of the blind data faxed to Dr Dale on 19th April 2000 (Ref: TEM/LCC/MENV34)
- ii) Appendix 5 contains a copy of Dr Dale's recorded measurements with annotations dated 20th April 2000.

Detailed hereunder are the values recorded by Dr Dale with direct reference to the 'unblinded' data of the filter(s) in use at each reading and the HV field status:- see page 4

EFFICACY TESTS FOR THE REMOVAL OF AIRBORNE GASEOUS MATTER X-RAY FILM PROCESSING - IVP ROOM VICTORIA INFIRMARY GLASGOW USING ELECTROMEDIA MODEL 35F(A) ELECTRIC AIR PURIFICATION UNIT

Dr Ian M Dale's Recorded Measurements (Appendix 5) Compared to the Blind Test Configuration Data (Appendix 4)

Date	Value Recorded	Main Filter	Chemisorption Filter	HV Field
11-2-00	10.0 (Prior to Tests)	-	-	-
14-2-00	3	Main fitted, earthed on remote metal mesh side	Chemisorption fitted (metal mesh both sides)	HV OFF
29-2-00	1.5	No main	Chemisorption fitted (metal mesh both sides)	HV OFF
2-3-00	3	No main	Chemisorption fitted (metal mesh both sides)	HV OFF
3-3-00	3	No main	Chemisorption fitted (metal mesh both sides)	HV OFF
6-3-00	1	No main	Chemisorption fitted (earthed on remote metal mesh side plastic/metal sided filter)	HV ON
21-3-00	0.5 No obvious odour	Main fitted, earthed on remote metal mesh side	Chemisorption fitted (metal mesh both sides)	HV ON
28-3-00	1 No obvious odour	No main	Chemisorption fitted (earthed on remote metal mesh side plastic/metal sided filter)	HV ON
10-4-00	7.0 (unit switched off for one week)	-	-	-

Note: Electromedia 35F(A) unit on daily time switch 6.00am to 6.00pm.

8. Conclusions

With regard to the objectives of the efficacy tests (paragraph 2) there was a significant reduction in the Value Recorded data measured when the HV field was On and the Second Stage and Third Stage filters were in place. Also in that mode 'no obvious odour' was recorded by the Occupational Hygienist.

On an empirical basis, and after 2 weeks into the tests, the Second Stage filter was noticeably discoloured due to the collection of solid particulate matter. The discoloration intensified as the test period extended. The Second Stage filter is available for examination.

It is concluded that all three filter stages be fitted in the Electromedia equipment and the HV be On at all times during removal of airborne solid particulate matter and removal of gaseous matter in x-ray processing.

9. General Observations During Tests

The Electromedia equipment provides a cooling effect and in such operations obviates the need for portable fans. In addition Electromedia is designed for closed room operation allowing the room to operate in a closed mode. Radio frequency interference (RFI) was experienced during tests etc. -

During the design/development stages, the 35F(A) was tested for EMC compliance and was found to have levels of emission below current recommended levels.

However, during this present series of tests mild radiated interference was seen on two nearby ultra-sound scanners. This interference was identified as coming from the 35F(A) unit, and was picked up by the sensitive ultra-sound scanning heads. An external in-line mains filter was inserted, as the mains socket for the 35F(A) machine, and the interference was almost eliminated. It was found to be intermittent in nature.

To cure this pick-up problem, a small in-line mains filter was fitted inside the 35F(A) unit and the interference seen previously on the ultra-sound units was eliminated. The radiation appears to have been coming from the long mains lead used during these tests.

The IVP room requires a limited number of cosmetic modifications (appendix 6) which would give significant air environment benefit.

10. Electromedia Product Information

The trolley mounted Electromedia Model 35F(A) consumes 70/80 watts of electricity (12p/24 hour day). It is CE marked (MDD) and is the smallest Electromedia product producing an air volume of 300 cubic feet/minute (cfm).

The ceiling mounted Electromedia Models 50c and 100c produce 500 and 1000cfm respectively (appendix 7)

By way of example, 20 ACH (air changes/hour) can be achieved in the following room volumes by each Electromedia model:-

<i>Room Volume</i>	<i>900ft³</i>	<i>1500ft³</i>	<i>3000ft³</i>
<i>Electromedia Model</i>	<i>35F(A)</i>	<i>50c</i>	<i>100c</i>

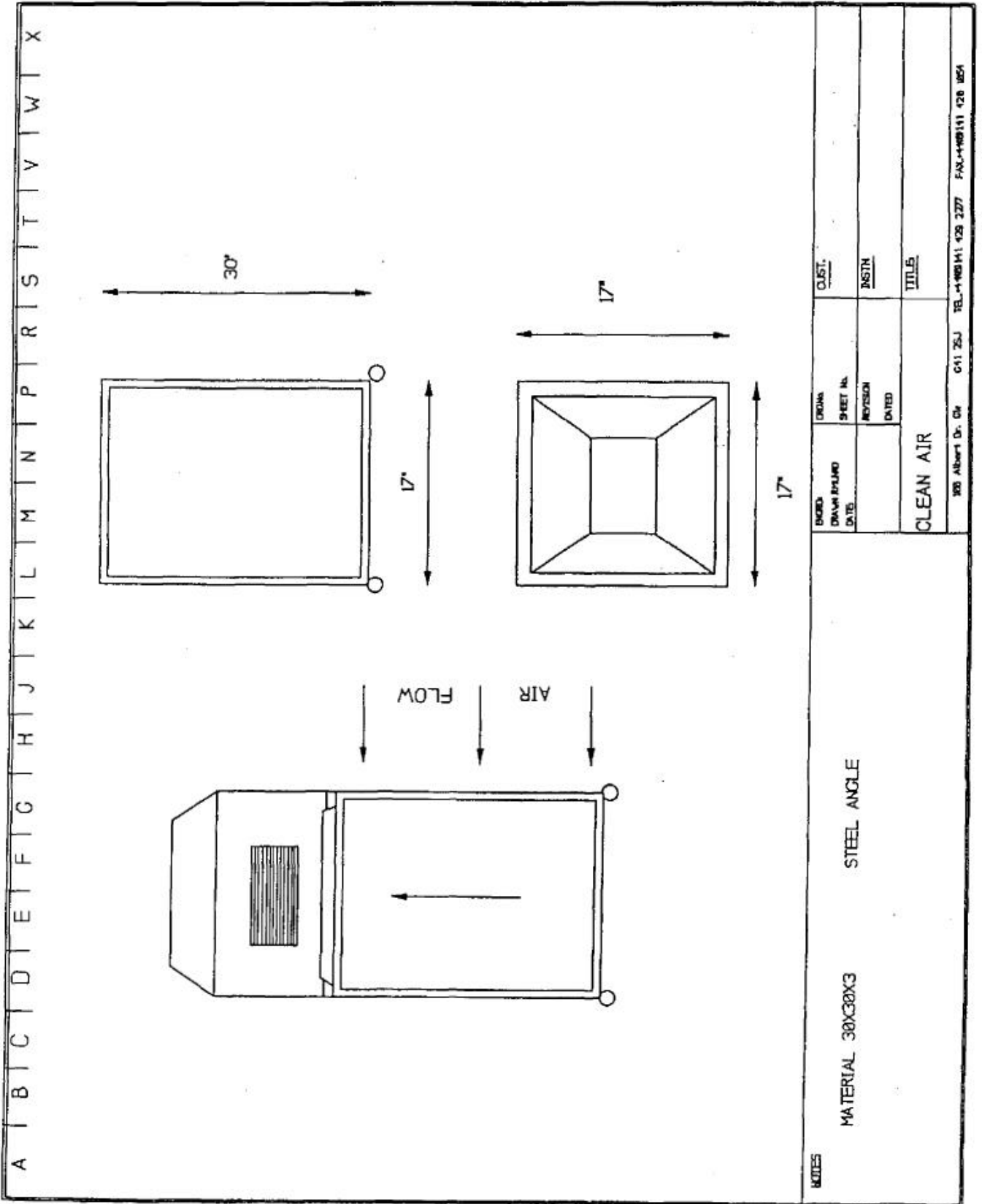
The IVP room at the Victoria Infirmary Glasgow has a room volume of:-

768ft³

Bibliography

1. Rutala WA, Jones SM, Worthington JM, et al. Efficacy of portable filtration units in reducing aerosolized particles in the size range of Mycobacterium tuberculosis. Infect Control Hosp Epidemiol 1995 Jul, 16(7): 391-8

APPENDICES



ELECTROMEDIA SPECIFICATIONS

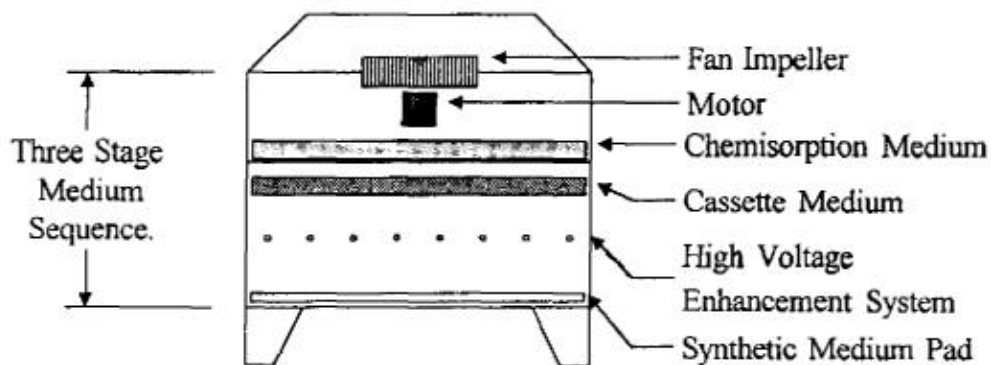
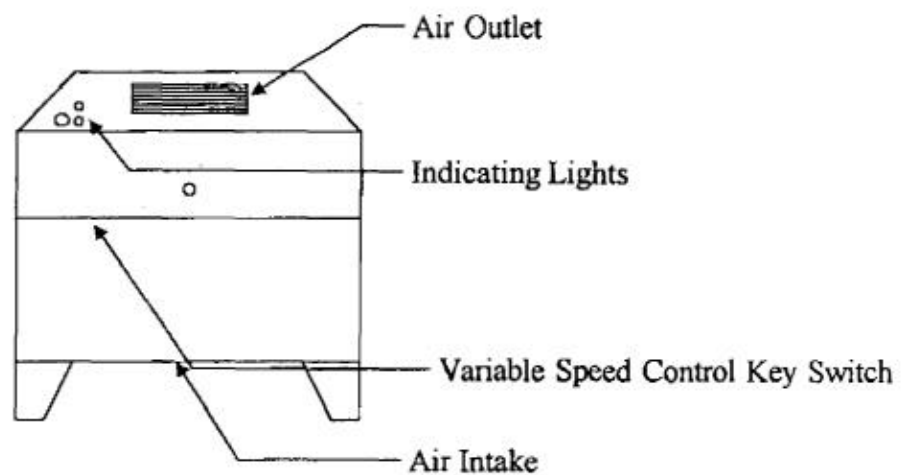
Dimension: 457 x 457 x 502mm (18 x 18 x 20in)

Weight: 23.6kg (52lb)

Air volume: 5.7m³/min - 8.5m³/min (200CFM* - 300CFM*)

Power: 220/240 Volt 50Hz 70/80 Watt

* Cubic Feet / minute



REF: UK/CAHL/REV/O/ES

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SAFETY DATA SHEET

1) IDENTIFICATION

Product Name: DEVALEX X-Ray Film Developer

Champion Product Code: 120102, 120103, 120104

Presentation: Compaks to make 2 x 20, 40 or 2 x 5L

Supplier: CHAMPION PHOTOCHEMISTRY
INTERNATIONAL LIMITED
Hubert Road
Brentwood
Essex CM14 4QQ
United Kingdom

Telephone No: +44 (0) 1277 263646

Fax: +44 (0) 1277 260832

2) COMPOSITION/INFORMATION ON INGREDIENTS

Product Description:

A three part machine X-Ray film developer containing the following components contributing to hazard

	CAS NO	%w/w
<u>Part A</u>		
Hydroquinone	123-31-9	5-10
Potassium Hydroxide	1310-58-3	2-5
<u>Part C</u>		
Acetic Acid	64-19-7	10-25
<u>Working Solution</u>		
Glutaraldehyde	111-30-8	<0.5
Hydroquinone	123-31-9	1-5

Note

The Part B concentrate contains Glutaraldehyde - Potassium Bisulphite complex and is not classified as hazardous. Glutaraldehyde is liberated in situ in the working strength solution

3) HAZARDS IDENTIFICATION

Human Health Hazards:

Part A Corrosive to eyes and mucous membrane, irritating to skin. Part C Irritating to eyes and skin.

Working Strength Solution

Prolonged or repeated contact with skin may cause irritation or sensitisation.
Inhalation of vapour may cause respiratory irritation

Safety Hazards:

Part A and Working Strength Solutions

Contact with acids liberates toxic gas, (sulphur dioxide)
Contact with X-Ray Fixer liberates irritant gas from the Fixer, (ammonia)

Environmental Hazards

Part A and Working Strength Solution

Will cause short term oxygen depletion if allowed to enter aquatic environment

4) FIRST AID MEASURES

Eyes:

Flush immediately with eye-wash solution or clean water for at least 15 minutes holding the eyelids apart. Part A - obtain immediate medical attention. Parts B and C obtain medical attention if irritation develops

Inhalation:

Inhalation of the product is unlikely to occur In the event of inhalation move to fresh air and obtain medical attention

Skin Contact:

Remove any contaminated clothing Wash skin thoroughly with cold water, then thoroughly with a neutral cleanser and water Thoroughly wash contaminated clothing before re-use. Obtain medical attention if irritation develop

APPENDIX 2

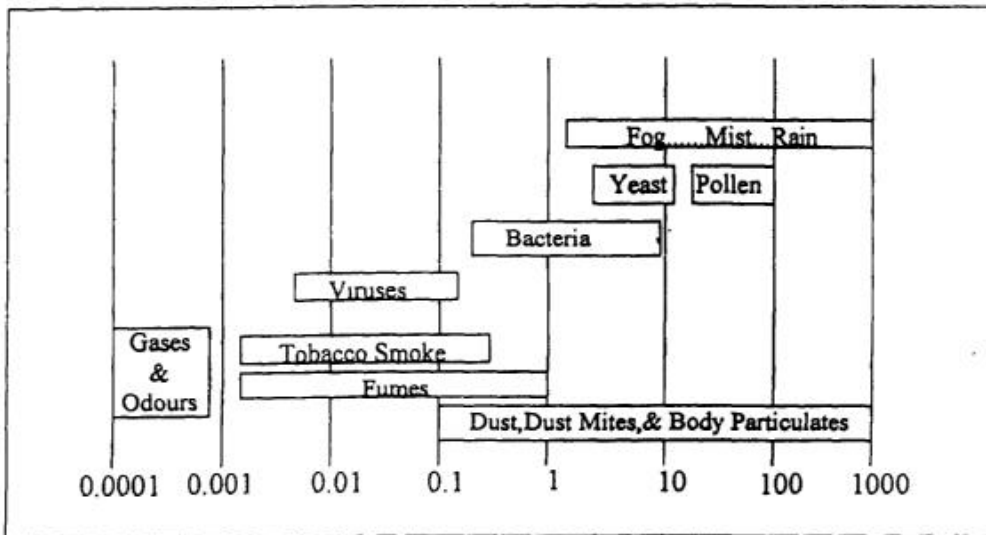
**HEALTH HAZARDS
OCCUPATIONAL EXPOSURE LIMITS (OEL)**

PRODUCT	SUBSTANCE	% WEIGHT LIMITS IN	OEL		CPL CLASSIFICATION
			8 HR TWA*	10 MIN TWA**	
Devalex Part 'C' and Mydochrome 6 Developer Starters	Acetic Acid	10 - 25%	10ppm	5ppm	IRRITANT
Mydoprint Stabiliser Rapadex Part 'B' Acetic Acid 80%	Acetic Acid	70 - 80%	10ppm	15ppm	CORROSIVE
Hand Cleaner Ink Anti-set	Diethanolamine	1 - 5%	3ppm	-	HARMFUL
Colour Developers Machine X-Ray Devs Graphic Arts Devs	Diethylene Glycol	1 - 70%	23ppm	-	HARMFUL
Colour Negative and Reversal Film Rinses and Stabilisers	Formaldehyde	3 - 25%	2ppm	2ppm	IRRITANT (1-5%) HARMFUL (5-25%)
Devalex Part 'B' and Rapadex Part 'C'	Gluteraldehyde	10 - 20%	0.2ppm	0.2ppm	IRRITANT
Monochrome, X-Ray and Graphic Arts Developers	Hydroquinone	2 - 14%	2mg/M ³	4mg/M ³	HARMFUL
Ink Anti-stick Glass Cleaner	Propan-2-ol	5 - 7%	400ppm	500ppm	HARMFUL
Glass Cleaner Plate Deleting Gel Deleting Pencils	1, Methoxy Propan-2-ol	5 - 50%	100ppm	300ppm	HARMFUL
Film Cleaner	N-Butyl Acetate	1 - 5%	150ppm	200ppm	HARMFUL
Mydochrome 6 Reversal Bath	Propionic Acid	5 - 10%	10ppm	15ppm	IRRITANT
Fixer Hardeners	Sulphuric Acid	2 - 7%	1 mg/M ³	-	IRRITANT
Film Cleaner	Toluene	1 - 5%	50ppm	150ppm	HARMFUL
Mydoprint HP RA RA Professional and Plus Colour Developers	Triethanolamine	30 - 40%	3ppm	9ppm	IRRITANT
Novoplate Ink Anti-skin	White Spirit	20 - 100%	100ppm	125ppm	HARMFUL
* Long Term Exposure Limit - 8 hour time-weighted average					
** Short Term Exposure Limit - 10 minute time-weighted average					

APPENDIX 3

CONTAMINANT PARTICLES SIZES

The following table gives a good indication of the relative sizing of some of the most common contaminants. To put things in perspective, a human hair is approximately 80-100 Microns in thickness, pollen is approximately 50 microns, and viral and bacterial contaminants range from 0.005 - 10 microns in size



Contaminant Settling Rates (in still Air)

Particle Size

5.0 micron
2.0 micron
1.0 micron
0.5 micron
0.25 micron

Time to Fall 1 Foot

2.5 minutes
14.5 minutes
54 minutes
187 minutes
590 minutes

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APPENDIX 4

To: Dr Ian M Dale

VICTORIA INFIRMARY

Blind Test Configuration - Removal of Airborne Fumes Level D IPV Room

Electromedia 35F Unit

Disposition of Main Filter, Chemisorption Filter and HV Field

(February - April 2000)

19 April 2000

TEM/LCC/M/ENV34

Test Dates	Main Filter	Chemisorption Filter	HV Field Active	Unit Serial No.	Notes
14 Feb (8.30am) to 21 Feb (8.30am)	Yes	Yes	No	9	Airborne fumes and limited quantities of particulate matter should be collected
21 Feb (8.30 am) to 28 Feb (8.30am)	No	Yes Fitted with metal mesh both sides	No	9	Airborne fumes primarily should be collected
28 Feb (8.30am) to 6 Mar (8.30 am)	No	Yes Fitted with metal mesh both sides	No	9	Airborne fumes primarily should be collected
6 Mar(8.30pm) to 9 Mar (4.00pm)	No	Yes Earthed on remote metal mesh side plastic/metal sided filter	Yes	9	Significant quantities of airborne particulate matter should be collected
9 Mar (4.00pm) To 16 Mar (4.30pm)		35F withdrawn	from	tests	
16 Mar (430pm) to 27 Mar (8.30am)	Yes Earthed on remote metal mesh side	Yes Fitted with metal mesh both sides	Yes	9	Airborne fumes and significant quantities of particulate matter should be collected
27 Mar (8.30am) to 3 Apr (8.30am)	No	Yes Earthed on remote metal mesh side plastic/metal sided fitted	Yes	9	Significant quantities of airborne fumes should be collected
3 Apr (8.30am) to	Yes Earthed on remote metal mesh side	No 35F unit withdrawn	Yes from	9 tests	Significant quantities of airborne particulate matter should be collected

Note: Electromedia 35F unit on daily time switch 6.00 am to 6.00 pm

Dr Ian M Dale, Occupational Hygienist, Glasgow Occupational Health

Mr Murray C Crichton, Superintendent Radiographer, South Glasgow University Hospitals NHS Trust

Mr Thomas E Marshall, Manufacturer Electromedia Model 35F Unit

VICTORIA INFIRMARY**TEST OF ELECTROMEDIA 35F UNIT****IVP ROOM**

All measurements were taken using Kitigawa colour reaction tubes specific for acetic acid as this is one of the vapours which can be present in the atmosphere of an X-Ray processing room.

In order to obtain suitable sensitivity a volume of 10x100ml was drawn through each tube; while the exact acetic acid concentration would not be known with certainty the relative values for each measurement would be consistent

<u>Date</u>	<u>Condition of filter/room</u>	<u>Value recorded</u>
1 February	Prior to installation, window closed	10
14 February	Filter operating, window slightly open, door open	3
16 February	Filter switched off, window closed, door open	5
29 February	Filter operating, window slightly open, blind down door open	1.5
2 March	Filter operating, window slightly open, blind down door open	3
3 March	Filter operating, window slightly open, blind down door open	3
6 March	Filter operating, window slightly open, blind down door closed	-1

APPENDIX 5

6 - 16 March	Filter switched off	
21 March	Filter operating, window slightly open, blind up door open, no obvious odour	-0.5
28 March	Filter operating, window slightly open, blind up door open, no obvious odour	-1
10 April	Filter switched off (for one week due to electrical interference), window slightly open, blind down, door closed	7

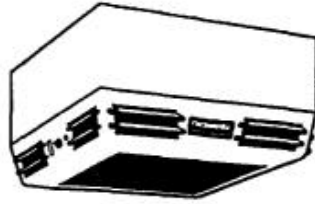
Ian M Dale
Occupational Hygienist
Glasgow Occupational Health
20 April 2000

Victoria Infirmary
X-Ray Processing Rooms
(4th February 2000)

Points for consideration:

1. The areas are relatively small and poorly ventilated.
2. They are warmer than adjacent rooms, because of equipment heat losses.
3. The fresh air entering the rooms is restricted, as the doors are closed and the gap areas around the doors have been sealed to stop light ingress
4. Chemical usage is relatively small, but the machines are operating at elevated temperatures causing evaporation and vapours released are expected to be self-extracted by the machines ventilation system. However, this is operating against a negative pressure when the door is closed and may be partially ineffective
5. There appears to be some evidence that staff are being effected by vapours in the air when in the processing rooms. So far there is limited test evidence to indicate which chemicals may be involved Measurements have shown trace levels, apparently below established safety levels for routine exposure.
6. Today, it is hoped to explore and determine a procedure based on using a *Clean Air Machine*, to treat the air within the rooms concerned by providing at least 6 total air treatments per hour. The treated air being passed through a 3 stage filtration unit, capable of particulate removal and vapour extraction to levels associated with clean room conditions
7. With some evidence of the vapours likely to be present in the room's atmosphere, it will be possible to tune the final stage carbon absorption filter to deal with those troublesome gasses However, it is imperative that we establish a clinical procedure that will yield repeatable and reliable test results, which can be used to define the quality of the working conditions in the rooms.

Electromedia Specifications



Specification	50c	100c
Dimensions (in) (mm)	14.9 x 23.5 x 23.5 380 x 597 x 597	14.9 x 23.5 x 47.5 380 x 597 x 1206
Weight	80 lbs.	120 lbs.
Power Consumption	225 watts	337 watts
Input Power	2.8 amps	3.9 amps
Finish	Off-white designed to blend into any décor	
Air Capacity	861 m ³ /hr 507 cfm	1738 m ³ /hr 1023 cfm

FILTER FACTS

Prefilter	1 inch polyester pad 1.78 ft ² (1650 cm ²)	1 inch polyester pad 4.0 ft ² (3715 cm ²)
Prefilter Holding Capacity	300 grams	675 grams
Prefilter Arrestence	89%	89%
Main Filter	Patented Electromedia Filtration Technology	
Main Filter Efficiency	99.9+% DoP Minimum at full flow	

Blower Facts

Motor	Thermally protected PSC 1/4 hp	Thermally protected PSC 1/3 hp
Blower	Backward inclined direct drive	
Gas Filtration	6.5 lbs carbon, 3/4" bed	13 lbs carbon, 1" bed
Sound Pressure Level	64 dBA @ 1 meter	64 dBA @ 1 meter



**It's All About
Clean Air.**