ISBN 0 - 477- 04616 - 9

RADIOGRAPHIC FILM PROCESSING PROCEDURES

GUIDANCE NOTES FOR THE PROVISION OF A SAFE WORK ENVIRONMENT AND SAFE WORK PRACTICE FOR RADIOGRAPHERS AND DARKROOM TECHNICIANS

1995

First Draft: Dec.2005
G Willson Editor

FOREWORD

These Guidance Notes aim to provide a readable document for all those concerned with the health of radiographers and darkroom technicians who work with potentially hazardous photographic processing chemicals.

They have been written after an extensive review of current work practice and working conditions and in consultation with those who work in Departments of Radiology.

I commend them to you for your use.

DR, J. G. J. STOKE F.F.O.M., F.A.C.O.M., M.C.C.M.(N.Z.), M.B., B.S., D.I.H.
DIRECTOR OF PUBLIC HEALTH
DEPARTMENT OF HEALTH
NEW ZEALAND

PREFACE

These Guidance Notes have been prepared by MARJORIE GORDON D.C.R.(R), M.N.Z.S.R.M.R.T in consultation with IAN LAIRD M.Sc. (London), Dip.H.Ed., M.R.S.H., M.B.O.H.S., Lecturer in Occupational Health at Massey University, and the Committee set up by the New Zealand Society of Radiographers and Medical Radiation Technologists at their Annual General Meeting in September 1984.

The Notes are designed to provide essential information on safe work practice in order to minimise health problems among Radiographers and Darkroom Technicians due to exposure to film processing chemicals.
It is also important for any staff working near Departments of Radiology to realise the hazards.

These Guidelines should be available to all personnel in Radiology, Radiotherapy and Nuclear Medicine and Ultrasound Departments, and are also intended for use by students in Schools of Radiography for instruction about chemical hazards and protection from these hazards.

Notes on 1995 Revision

This revision contains hand written notes and extra pages (inserted as text), made by Marjorie Gordon before her untimely death but never formally produced as the last publication, as she had wished. Finishing her work completes this historical document to the point it would have been. Although even more evidence is now available to justify a further revision, this was not the point of the exercise.

The point was to draw a line marking the contributions made by Marjorie Gordon. Contributions that so raised awareness of the issues she campaigned for, that modern research, working conditions and work education would not be where they are today, or awareness so raised.

Phillippa Martin (*nee Gordon*)
Graham Willson (*Editor*)

ORIGINALLY PUBLISHED BY THE
ACCIDENT COMPENSATION CORPORATION
SHAMROCK HOUSE, MOLESWORTH STREET
PRIVATE BAG, WELLINGTON
NEW ZEALAND

1

INTRODUCTION

Radiographic/photographic developer and fixer solutions contain a number of chemicals, each with varying degrees of toxicity. Among the hazardous components are:

In the Developer	*In the Fixer*
ACETIC ACID DIETHYLENE GLYCOL GLUTARALDEHYDE HYDROQUINONE POTASSIUM HYDROXIDE SODIUM SULPHITE PHENIDONE (1-Phenyl - 3-Pyrazolidone) 5 – NITROINDAZOLE	ACETIC ACID ALUMINIUM CHLORIDE* AMMONIUM THIOSULPHATE

Data Sheets for the chemicals considered to be the most hazardous at the time of publication are included in Appendix V, pages 20 -27. (Not included is Sodium Sulphite which in itself is not dangerous, but becomes hazardous in the mixture with strong acids and oxidising agents and gives off sulphur dioxide fumes when heated).

In the past, exposure that may have caused a variety of symptoms (see Page 7), has resulted largely from ignorance of the dangers presented if the chemicals are not handled with extreme care.

*Aluminium Chloride was replaced by Aluminium Sulphate by most chemical companies in 1986.

2

RESPONSIBILITY FOR SAFE WORKING ENVIRONMENT

2.1 **"It is the duty of every Hospital Board to provide at all times and to maintain such institutions, hospital accommodation, services (including nursing and other services for persons elsewhere than in institutions), and equipment as the Minister from time to time thinks necessary.** [1]

2.2 **It is the responsibility of the occupier** (e.g. a Radiologist - Private Practice), **to ensure that each room in that undertaking is so ventilated as to –**

(a) Provide a supply of fresh air sufficient for the workers using the room, and

(b) Carry off and render harmless, so far as is practicable, all steam, fumes, dust and other impurities, arising in the course of the work done in that undertaking.[2]

(c) Provide and maintain safe processors.

2.3 **It is the responsibility of employees to:**

(a) Use ventilation equipment in the correct way.

(b) Use protective clothing, respirators and protective equipment where and when recommended.

(c) Report defects or damage to apparatus promptly.

(d) Do nothing that could endanger the health of themselves or of others.

2.4 **Updated Regulations** [1]

The general provisions of the Health and Safety in Employment Bill (1992) require that employers achieve excellence in the management of the health and safety within their places of work. For excellence to be achieved, both employers and employees must play their part.

The requirements of the Management of Substances Hazardous to Health (MOSHH) Regulations (1992) apply more specific controls upon the use and storage of substances defined as "products hazardous to health". The Regulations must be applied to X Ray film processing chemicals or any product containing hazardous chemicals that fall within this definition. Users of toxic chemicals should obtain a copy of the MOSHH

[1] Up-dated from The Health and Safety In Employment Act(1992), Management of Substances Hazardous To Health (Regulations) (1992)

Regulations, and the Guidance Notes for the Management of Substances Hazardous to Health Regulations (1992), for a more detailed presentation of the legal requirements involved.

In brief, the MOSHH Regulations require an employer to carry out the following:

Identify: All products hazardous to health on site.

Assess: Make a written assessment of the risks that these products present of those in the place of work. (This assessment will vary according to the size of the organisation and the number of substances used and the risk posed by these substances. Nevertheless, the single practitioner using X Ray film processing chemicals needs to briefly record that he or she has recognised the hazards posed as part of the "risk control" plan developed according to the principles below.)

Control: Use the best method to control the hazard to ensure that the exposure is reduced to the lowest practical level. Atmospheric or personal monitoring may be used to evaluate the efficiency of the control measures employed.

The best method of control is elimination of that substance (e.g. by substitution of another substance equally effective but less toxic) followed, in order of preference, by isolation, enclosure, mechanical ventilation, and lastly personal protective equipment.

Communication: Ensure that the use of all products hazardous to health is accompanied bysuitable training and information. M containers are required to be labelled, and a current material Safety data sheet (MSDS) must be accessible to workers.

Surveillance: Ensure that, where necessary, all employees exposed to products hazardous to health are kept under regular health surveillance.

CONSULTATION BETWEEN EMPLOYERS AND EMPLOYEES

Employers must fulfil their obligation under the legislation to communicate with and involve their employees in the control of health and safety in the place of work. They must have a clear understanding of the actual (not theoretical) conditions that exist in the place of work, as well as an understanding of the specific concerns of their employees.

There are a variety of ways of ensuring this communication. In large organizations, health and safety committees may be practical. The Code of Practice for Health and Safety Representatives and Health and Safety Committees gives guidance as to this mechanism and is available from local OSH offices (listed in Appendix C). For small employers, communication can be on an individual basis or by integrating health and safety matters into systems currently used for more general matters (e.g. weekly practice meetings, quality circles or total quality programmes).

3

POTENTIAL HAZARDS IN X-RAY PROCESSING

3.1 ***In Current Work Practice***

(a) **Mixing of Chemicals -** skin contact, inhalation, ingestion.

(b) **Operating The Processor**

(i) Fumes given off from the driers at high temperatures by the MIXTURE of developing and fixing solutions impregnated in the film emulsion.

(ii) Fumes given off by the processed film as it is discharged from the hot drier.

(iii) Skin absorption from handling hot emulsion on newly processed film.

(c) **Disposal of Used Fixer and Processor Waste**

(i) Inhalation of fumes - from spillages; from unsealed containers; from containers left in processing areas; from unsealed drains.

(ii) Skin absorption from handling chemical spillage or dirty containers.

(d) **Cleaning Processor**

(i) Skin contact with chemicals

(ii) Inhalation of fumes from processor, and in particular from used fixer tank.

NOTE. Where a manual processor is in use, the hazard from the mixture of chemical fumes is increased in the re-usable tank of fixing solution that contains a mixture of developing and fixing chemicals. Retrieval of films from chemical tanks by hand and the transfer of films between tanks present a potential skin absorption route which should he avoided.

3.2 ***Faulty Processors***

(a) Disconnected exhaust outlet.

(b) Leaking exhaust hose connection.

(c) Ill-fitting lids, and leaking chemical tanks.

(d) Chemical deposit on feed-in tray caused by incorrect placing of exhaust fan thus drawing up chemicals in an aerosol spray from the processor across the breathing zone of operator.

3.3 ***Toxic Fumes given off during processing***

(a) From the chemicals mentioned on Page 4., fumes of SULPHLTR DIOXIDE, GLUTARALDEHYDE, ACETALDEHYDE and some ACIDS have been detected in the atmosphere. More fumes can be given off at the higher temperatures that modern processors require. Particularly dangerous at higher ambient temperatures are the aldehydes. (See data sheets - Appendix V)

(b) Chemical poisoning can occur as a cumulative effect of day after day low-level exposure, as well as by a chemical accident, with the same end result. The difference between the pulmonary transfer of toxic substances as opposed to the gastro- intestinal route is that material is delivered directly into the bloodstream from the lungs. The toxic effects appear more rapidly as access to the liver with its detoxifying enzymes is delayed. The delicate membranes of the respiratory passages are irritated and damaged en route. Workers with a pre-existing health problem may be more seriously affected by the chemicals. "Exposure to substances can result in intake into the body by inhalation, by ingestion, or by absorption through the skin or by a combination of these. Inhalation is usually the most important route of entry into the body." [5]

4

EFFECTS ON HEALTH

4.1 ***Symptoms of chemical exposures***

If these symptoms occur and persist they should not be disregarded:

Respiratory

Recurrent nasal discharge, catarrh, sinusitis, laryngitis, bronchitis.

Non-respiratory

Sore eyes, skin rash, lip sores, mouth ulcers, tinnitus (ringing in the ears), severe headaches, had taste in mouth, hoarseness, nausea, tightness in chest, chest pains, unexpected fatigue, heart arrhythmias, painful joints, loss of feeling in extremities, prostatitis, menstrual irregularities.

4.2 Prudence requires that pregnant women avoid exposure to toxic chemicals in the first trimester in particular. If work with chemicals continues during pregnancy, it may be advisable to take additional precautions (e.g. use of a respirator) to minimise inhalation of potentially hazardous chemicals.

4.3 ***Chemical Handling***

The known harmful effects and symptoms of exposure to some chemicals identified in these guidelines are summarised in the Data Sheets - see Appendix V

It should be noted that the data sheets refer to the 'pure' chemicals, whereas they may he present only as part-constituents, of radiographic/photographic chemical solutions. Details of incompatabilities of the 'pure' chemicals in the mixtures are also shown.

4.4 ***Sensitisation***

An occupational illness may occur if a person becomes 'sensitised' to a chemical. Sensitisation is a complex process with three stages of development:

(a) **Pre-sensitisation:** A period during which a person is exposed to a small amount of a particular chemical. This may be a short or very lengthy period.

(b) **Sensitisation:** When the immune system is suddenly triggered. It must be stressed that only a small percentage of those exposed actually become sensitised. (Sensitisation can also occur after a single extreme exposure).

(c) **Reaction:** Once sensitised, a person may suffer a severe adverse reaction (e.g. inflammation of the respiratory tract) following exposure to even a minute quantity of that chemical.

4.5 There may of course be other causes for the symptoms mentioned in 4.1. Assault and withdrawal testing can he carried out by the individual, to confirm if symptoms subside or disappear at weekends or holiday periods and recur on return to the chemical environment.

5

ASSESSMENT OF HAZARDS

5.1 ***Ways in which hazards may be identified***

(a) **Smell**

Ammonia, Hydrogen Sulphide (from processor)
Glutaraldehyde (from drier and film emulsion).

Note. Do not rely on smell alone, as sense of smell may become unreliable after daily exposure, particularly to Hydrogen Sulphide.

E.g. Acetic Acid	- acrid odour
Glutaraldehyde	- pungent odour
Sulphur Dioxide	- strong suffocating odour
Hydrogen Sulphide	- odour of rotten eggs
Ammonia (anhydrous)	- sharp irritating odour

Variations in smell may be caused by variations in the pH content of the water. Radiographic chemicals are usually buffered for a pH of 7. Ammonia will be given off when the pH is above 7.

Hydrogen Sulphide will he given off when the pH content is less than 7.

(b) **Taste**

The unpleasant taste that radiographers and darkroom technicians may experience comes from the mixture of chemicals in the work environment.

*E.g.	Ammonia	- bitter taste on lips
	Diethylene Glycol	- weak sweetish taste
	Hydrogen Sulphide	- sweet taste
	Acetaldehyde	- irritating fruity taste

(c) **Deposit** of crystals on working surfaces, sills, ledges, processors etc.

5.2 ***Method of Testing*** - Air sampling

A multi-gas detector (e.g. Drager tubes) -.may he used for spot tests. A more detailed analytical approach may be necessary if there are indications of health problems among staff (Consult local District Health Office).

Air sampling will not provide a complete assessment of the environment unless tests conducted at the busiest time of the working day are included. An accidental spillage or leakage may increase levels of toxic fumes in the atmosphere.

To give the most representative estimate of exposure, air sampling should be undertaken over a complete shift, i.e. to give an 8-hour time-weighted average. Further sampling should be carried out whenever there is a change of processing apparatus in use.

Temperature and humidity must be taken into account as in a humid atmosphere where the gas molecules will remain suspended far longer than in drier conditions. Many gas molecules are heavier than air and in normal conditions will sink to lower levels as they cool. High temperatures and high humidity may increase the degree of exposure to a substance, as do any factors that impose additional stress on the body, such as long hours of work. Low humidity is equally undesirable as the drying out of the mucous membranes of the respiratory system renders them more liable to damage from the chemicals.

(See Appendix III for examples of detection methods used successfully to detect low levels of gases from the mixture of chemicals.)

Safe tolerance levels of the MIXTURE of chemical fumes in radiographic departments have not been determined, but for the purpose of a safe work environment levels should be kept as low as possible.

Testing already carried out has shown a dramatic increase in formaldehyde levels when the air temperature rises from 20^{o}C to 25^{o}C.

*from The Toxic & Hazardous Industrial Chemicals Safety Manual (1982).

6

SAFE WORK PRACTICE

Protection against potential hazards is mainly achieved by:

6.1 ***Engineering Controls***

All fumes should be ducted direct from processors and driers to *outside the building. In* addition a cowl and exhaust system should be installed over the film outlet to prevent escape of fumes from the processed film. It is important that the film is allowed to cool before removal to the viewing area, which must be ventilated and which should be situated at a distance from the processor.

6.2 ***Ventilation*** - See Appendix 1, page 14.

6.3 ***Safe Work Practice***

(a) All processors should be inspected daily before use for deposits of chemical crystals or signs of leakage.

(b) Personnel should not remain in close vicinity of the processor while it is operating.

(c) Strict hygiene must be observed; benches and floors must be cleaned immediately after spillages. Used fixer must not be left uncovered or in the processing area.

(d) Auto-mixers may be used in preference to mixing chemicals by hand. The advantage of auto-mixers is that contact with the chemicals is reduced. However,*thev must be cheeked daily* for leakages. An auto-mixer must have a close fitting lid, a device for piercing the replenishment bottles automatically, and a fume ducting system.

6.4 ***Waste disposal***

(a) Drains - see Appendix II, page ??

(b) Used fixer should be piped into sealed containers sited outside the processing area, If silver reclamation is carried out, good ventilation is of particular importance. WASTE FIXER SHOULD NOT BE RECYCLED FOR FURTHER USE.

(c) Contact your local District Health Office or Local Authority for regulations concerning the disposal of hazardous waste.

6.5 ***Personal Protection***

(a) Avoid inhaling the vapours while mixing chemicals. Asthmatics should never mix chemicals alone.

(b) Wear a chemical respirator with appropriate cartridge when handling chemicals, where considered necessary. (See Health Department booklet No. 2 "Occupational Health" for types of respirator and instructions on care of respirators.)

(c) Avoid skin contact with the chemicals.
"When handling or mixing chemicals wear eye protection, impervious gloves and other recommended protective clothing. Eye protection against splashes should take the form of safety glasses, visors, or specialised chemical goggles.

Impervious gloves may he made of rubber or PVC and can be of the disposable variety. The cuffs should be long enough to prevent chemicals splashing over them and coming

into contact with the skin. NEVER use a punctured glove. The use of cotton gloves within the impervious gloves sometimes makes for greater comfort. After handling chemicals, wash the outside of the gloves thoroughly before taking them off, "hen wash both the inside of the gloves and your hands in running water. If cotton gloves are used they should be changed at least daily. The use of barrier cream is not recommended."[3]

(d) DO NOT SMOKE in processing or darlwoom areas.

(e) Keep away from the processing areas unless actually working there.

(f) DO NOT eat or drink in processing areas.

(g) Wash hands thoroughly at the end of the working session, as indicated in (c) above.

6.6 ***Training and Education***

(a) Darkroom staff should he given clear instructions to warn against the hazards mentioned, and ways of avoiding them.

(b) It should be the responsibility of the Radiographer-in-Charge to see that good hygiene is practised by all personnel in the department, and to see that all procedures are carried out according to instruchons.

(c) All staff should read manufacturers' labels carefully and the data sheets of the various chemicals they use.

(d) Chemicals must be stored correctly and safely, in accordance with manufacturers' recommendations.

(e) Radiography Schools should instruct students on safety with chemicals as part of the training syllabus.

7

EMERGENCY PROCEDURES

7.1 ***Spillages*** should be cleaned up immediately, using water to dilute the chemicals. A large spillage should be absorbed by dry sand or sawdust. Protective clothing - goggles, respirator and rubber gloves ***must*** be worn. Rubber boots may be necessary also.

It may be advisable to call the Fire Brigade to deal with a very large accidental spillage and a policy of action in this respect should be known to all. Sand, sawdust and emergency protective clothing location should be known and placed with appropriate signs.

7.2 If an exhaust from the processor is found to he faulty and leaking, or becomes disconnected accidentally, the processor must be switched off immediately and the work area cleared for decontamination.

7.3 ***Fires.*** All staff should be trained in fire fighting procedures in general and fires in the processing rooms specifically. Staff must be trained and familiar with the use of the equipment provided for that purpose.

Details of quantities of chemicals together with the list of chemicals stored or mixed and in use and the site of chemical storage should be kept in the main office and made available to fire-fighters in the event of a major fire.

Evacuate the area immediately to assigned places if urgent action fails to bring the fire under control or if the alarm is a general alert for some other area. Switch off all machinery before leaving except main extractor fans.

7.4 ***First Aid***

(a) **Skin contamination -** wash immediately with plenty of water, and use a ph neutral hand cleaner, e.g. Neutrogena, or Bodyline if available. (These cleaners should always be available at cleaning stations – checks to ensure their presence and condition should be made on a regular schedule)

(b) **A victim of inhalation** of fumes should be removed to fresh air immediately and given artificial respiration (CPR) if breathing has stopped. Medical aid should be sought urgently by one free person.(See (e) below)

(c) **Accidental ingestion.** If conscious give plenty of water to drink. Seek medical aid immediately if necessary. (Read manufacturers' recommendations.) **Do not induce vomiting.**

(d) **Eye splashes.** Wash eye(s) with copious quantities of water for 15 minutes. If irritation persists or the degree of contact has been severe, obtain medical advice. If in doubt, medical aid should be sought immediately and eye washing continued.

(e) **Policy Initiatives**. Some consideration should be given to an external room visual alarm also connected to the main office. In the event of emergency, staff can hit a large red button as they egress for first aid ***or*** localised fire.

8

HEALTH SURVEILLANCE

All employees who work in radiography should have a health assessment before they begin work, and at regular intervals during their employment. Records should be kept by Occupational Health Departments. Suggested model questionaires are given below and on the following page.

PRE-PLACEMENT HEALTH QUESTIONNAIRE

Name: ……Date: ……/……/ ……

Date of birth: ……./ ……../ …… **M**ale/**F**emale ☐

1. Have you ever worked with radiographic/ photographic chemicals before? Y/N ☐
2. Did you have any adverse health effects, specifically related to the work? Y/N ☐
3. If 'YES', what were the effects? ……

……

4. Do you now, or have you in the past had any of the following?
   - (a) Hayfever Y/N ☐
   - (b) Asthma Y/N ☐
   - (c) Eczema Y/N ☐
   - (d) Prescribed drug allergies Y/N ☐
   - (e) Work-related dermatitis Y/N ☐
   - (f) Heart problems Y/N ☐
   - (g) Hepatitis Y/N ☐
   - (h) Any other illness (Specify) ……

   ……..……
5. Have you ever had a blood transfusion? Y/N ☐
6. Do you smoke? Y/N ☐

PERIODIC HEALTH SURVEILLANCE QUESTIONNAIRE

(To be administered by the Charge Radiographer and kept on file).
This questionnaire is designed for use in ongoing health supervision. It should be readministered at regular intervals, in conjunction with the initial Health Surveillance Questionnaire (page ??). It is suggested that these health assessments be carried out annually.

Date: ……/……/ …….

Name: …….

Date of birth: ……./ ……../ …… **M**ale/**F**emale ☐

Hospital/Radiological Practice ……

Since your last health surveillance have you had any problems with, (Please describe)

EYES ……..

EARS/NOSE/THROAT……..

MOUTH……..

HEAD……..

CHEST…….

ABDOMEN…….

ARMS/HANDS……

LEGS/FEET…….

OTHER……

(Describe symptoms)

Have you consulted your Medical Practitioner since your last health surveillance in connection with any of the above? **Y**/**N** ☐ Do you intend to consult your GP **Y**/**N** ☐

If Yes to either, approximately when? ……/…../……..

If you do consult your Medical Practitioner, explain fully your work situation and the chemicals used. If necessary, referral can then he made to the appropriate Consultant for investigation.

APPENDIX I

GUIDANCE NOTES FOR TESTING VENTILATION TEMPERATURE AND HUMIDITY IN RADIOGRAPHICPROCESSING AREAS

VENTILATION

A. **Instruments**

Air flow measurements can be carried out with anemometer for flat openings, or pitot and tube device for diffusers.

Note: Either of these devices may require correction factors[2]

B. **Procedures**

1. Measure air flow at face of all vents, both supply and exhaust. A number of measurements are required to obtain a true average for each vent or duct.
2. Measure vent and grille sizes.

Calculate the volume of air extracted or supplied by using the following formula:

$$R = A \times V \times 60$$

Where: R = Volume of air extracted or supplied (m^3/hour)
V = Mean velocity of air in metres per minute
A = Area of duct (m^2 x correction factor[1])

C. **Ventilation Criteria**

1. The following ventilation rates are recommended as a guideline:

1 Medium-sized processor extract 300 m'/hour
For 2 or more processors, extract 200 m'/hour from each processor.

Fumes should be extracted through a hood, duct and extractor fan over the processor to outside the building. 2/3 of the air extra~ should come from the processor, the remainder from the darkroom. Fresh air should be supplied to the darkroom at a ventilation rate slightly less than is extracted to maintain a negative pressure between the darkroom and other areas. This prevents the outward flow of contaminants from the darkroom. The air inlets to the processing room should he correctly designed to ensure that the required air change rate does not produce excessively draughty conditions. The fresh air supply should be preheated to prevent cold draughts in winter (or cooled in summer).15 air changes per hour in a room measuring 2.5m x 2.5m with a ceiling height of 2.5m are desirable. The extractor hood should be fitted above the processor to take the rising hot fumes; it must exceed the dimensions of the processor, including the delivery tray, by 25% all round.

2. ***Tab&-top Processors.*** Without ducting, the Exhaust of fumes create a dangerous work environment. They *must* therefore be fitted with a hood and exhaust system. Ventilation as outlined in 1. above must be applied. This will prevent the outward flow of contamination from the processor and darkroom.

For processors sited wholly in the darkroom the same criteria apply.

For processors sited with feed-in tray in darkroom and film expel tray in adjacent work area, a separate hood must he provided for both sides of the processor. In these situations the air flow must always be from working area to darkroom to processor. Fumes must always be ducted away from the operator's breathing zone.

[2] Correction factor depends on instrument used.

Daylight systems where fumes are properly ducted should also stand m a work area with ***positive pressure.***

Note: Positive pressure is maintained by supplying fresh air at a greater rate than it is extracted.

3. An independent system (separate from main air conditioning plant) to exhaust the air to outdoors should be provided. The exhaust from the film drier may be connected into the darkroom exhaust. To maintain the integrity of the film during processing, a good quality filter should be installed in the air supply system for the darkroom area.
4. Air intakes for the ventilation or air conditioning system must not be located at or new ground level or in the vicinity of exhaust outlets from the hospital or adjoining buildings. Intakes should he located to prevent entry of polluted air from chimneys, ventilation exhausts or other sources of noxious fumes. The lower level of outdoor air intakes serving central systems should be situated as high as practicable, but not less than 1.8m above ground level, or if installed above the roof, 0.9m above the roof level.
5. Exhaust outlets should be located where the noxious fumes will not contaminate the air supply of adjacent buildings.
6. It is STRONGLY RECOMMENDED that ventilation systems be left running continuously

TEMPERATURE & HUMIDITY

A. **Instruments**

A whirling hygrometer can be used to% measure the air temperature and relative humidity of the darkroom area

B. **Background**

Thermal conditions are affected by the length of time processing equipment and other machines have been operating, outside temperature and solar intensity. Extremes of temperature (in a building without correctly functioning air conditioning) usually occur in February and August in New Zealand. In an air-conditioned building temperatures should remain fairly constant and variations of more than two or three degrees G. would not he expected. Readings at one-hour intervals over a period of three days should suffice.

C. **Temperatures**

The following temperatures (dry bulb) are recommended:

Summer	*Winter*
18 - 22^{0}C	18 - 21^{0}C

Temperatures greater than these are undesirable as staff will work less effectively if their environment is uncomfortable. Documented cases of respiratory problems in X-ray processing departments indicate that symptoms are worse during the hotter summer months. Other factors such as air movement will have an effect on comfort.

D. **Humidity** should he measured to ensure that it is in the normal range from 35-60%.

CONCLUSION

The ventilation criteria outlined above provide guidelines which should he followed to prevent health problems among personnel working in X-ray processing areas using toxic chemicals. Advice should be sought from the Health Protection Officer of the local District Health Department and, if necessary a specialist Ventilation Engineer.

APPENDIX II

DARKROOM DESIGN & REQUIREMENTS

It has become the practice in recent hospital construction for radiology departments to be sited at the centre of the complex for ease of access from all departments. This has resulted in radiographic rooms without windows and fresh air intake. This practice is deplored, as traditional air conditioning is not enough to obviate the problems of toxic chemical fumes in the work area. The following recommendations are designed to rectify this situation:

1. If radiographic departments are designed to be at the centre of a hospital complex, it is desirable that they be built round a central well or courtyard to enable fresh air intake to he provided.
2. Attention should he given to the source of air intake which should not be from another contaminated source from within the building. Air intake and exhaust should be from and to the outside of the building.
3. Care should be exercised to ensure that the air intake and exhaust are well separated to avoid cross contamination.
4. Heating should be provided in the air intake to ensure comfortable working conditions. A darkroom temperature of 18-22^{0}C. is recommended. (See Appendix 1)
5. Insulated duct work may he necessary and correct sizing and positioning of the extractor fans is required to avoid noise nuisance. If noise is excessive the darkroom staff will be reluctant to switch on the ventilation system. Extractor fan noise levels should be <40-50 Db peak maximum from harmonic resonance and <20-30Db RMS.

   (Db = Noise criteria in decibels, RMS = root mean square or "average")

DARKROOM FINISH

1. To facilitate easy cleaning, special attention should be paid to wall and floor coverings, and to ceilings:
   (a) Floors should be of an impervious material coved up the wall to a height of 75mm. There should he a floor drain to enable the technician to rinse away any chemical spillage. The entire surface should be scaled to ensure that no chemical spillage can soak into the floor covering.
   (b) The drain should he fitted with a water-trap to prevent a blow-back of fumes into the darkroom. The drain should he rodded out regularly to prevent a build-up of sludge and chemical deposits. The angle of the drain and diameter of the pipe must be sufficient for waste materials to be flushed away as quickly as possible. The tlow of water must be sufficient for fast removal of waste. External drains must be covered. Copper should not be used for drains from processors.
   (c) Walls should be clad with an impermeable surface (such as laminated plastic, or a suitable hard surface gloss paint), which can he easily washed down.
   (d) lights should be recessed to he flush with the ceiling, which should have an impervious surface.
2. All room fixtures such as examination or dry benches should also have an impermeable surface.
3. Wet areas should he constructed of a low carbon grade stainless steel such as Grade 116.
4. Waste chemicals should not be collected in the working area. They should be piped directly into containers sited in a special storage area from where they can he easily removed in accordance with local authority bylaws and environmental safety regulations.