AN EVALUATION OF SULPHUR DIOXIDE FUME LEVELS AND THE PREVALENCE OF DARKROOM SYPMTOMS AMONGST MEDICAL IMAGING PERSONNEL IN NAMIBIA

DISEASE

By

Christine Damases

A thesis

in fulfillment of the requirements for the

MASTER OF TECHNOLOGY

To the

Department of Radiography

Durban University of Technology

2006

DECLARATION:

This thesis contains no material that has been accepted for the award of any qualification at any other institution and, as far as I know and can ascertain, it contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

We, the undersigned approve of the submission of this dissertation,

26/02/07

MS. Christine Damases **DATE**

07/03/07

MRS. L. Moodley -ND Radiography (Diagnostic-*cum laude*); B.Tech.Radiography (Therapy); M.Tech. Radiography (cum laude) **DATE**

06/03/2007

MRS.MLC.Munro -N Rad (D); MA (UNISA); Post Grad Dip; Pub Admin (UDW); Cert for Trainers (UNISA) **DATE**

1-3-2007.

Mrs.SN.Naidoo- Master of Applied science (Uni.Syd. Australia) DATE

CHAPTER ONE

BACKGROUND TO THE STUDY

1.1 INTRODUCTION

Chemicals have become a part of life, sustaining many activities, preventing and controlling diseases. Chemicals in the workplace may, if not properly used, endanger health and poison the environment (Kolarzyk, Stepniewski,& Zapolska, 2000). Extensive use of x-ray processing chemistry on a world-wide basis has raised professional concerns regarding darkroom disease (Hewitt, 1993; Smedley, Inskip, Weild, 1996; Glass, 1997;Genton,1998).

Darkroom disease describes a variety of allergic reactions reported by medical imaging personnel. Symptoms include headaches, skin rashes, shortness of breath, mouth ulcers, unusual heart rhythms, painful joints, runny/stuffy nose and nausea (Spicer & Gordon, 1994). These symptoms are similar to those of individuals exposed to sulphur dioxide (SO_2) fumes in the mining and allied occupations (Smith, *et al*., 1977; Rom, *et al.,* 1986; Kolarzyk, Stepniewski, Zapolska, 2000). According to Chessor and Svirchev (, 1997) no known studies of medical imaging personnel to date have clarified a link between their exposures and these symptoms.

In radiography, x-rays rather than visible light create a latent image on the film surface by reducing the silver halide crystals to elemental silver then the image is amplified and stabilized during the developing process using agents such as hydroquinone (Carlton & Adler, 2001). The image is fixed by agents, which dissolve and remove the unused silver halides (Carlton & Adler, 2001). Automated x-ray film processing machines achieve short development times by using elevated temperatures (28-35°C), by including glutaraldehyde as a hardening agent within the developer solution, and by actively drying the fixed and wash film with heated air (Hewitt, 1993). The process of radiographic film development entails potential exposures to hydroquinone, glutaraldehyde, formaldehyde, glycols, acetic acid, sodium sulphite, SO_2 , ammonium chloride, silver compounds, and other chemicals (Teschke *et al*, 2000).

Processing chemistry may be automixed or manually mixed. Automix chemistry makes use of an automixer in the darkroom. Automixers mix concentrations of developer and fixer with water. The user uncaps the concentrate bottles, places them in proper order in the bottle wells which are labeled, and pushes down to start automixing sequence. A water jet mixes the chemistry, by introducing the right amount of water base on the desired specific gravity of completed mixture. The processor replenishment pumps then draw chemistry from the mixer tanks as required. For a safer working environment in terms of preventing the escape of fumes the mixer must have a lid that fits tightly and there should be a device for piercing and emptying the chemistry replenishment containers automatically

(Teschke *et al*, 2000). The device eliminates the risk of splashes and inhalation of fumes. Whereas liquid chemicals that are not automixed have to be mixed manually and this adds to the problem of possible inhalation of chemistry fumes. Irrespective of the type of chemistry used the composition of the chemicals is the same (Teschke *et al*, 2000). Manual mixing requires the user to make use of open gallons in which the concentrates of fixer and developer respectively are add to water, depending on the amount of the chemistry required. Manual mixing of processing chemistry is achieved by the following steps for fixer and developer solutions according to the manufacturers' instructions:

Fixer and replenisher:

- The user adds the required amount of water into the tank
- The user adds two times part A (fixer) to the water while stirring continuously for 1-2 minutes.
- The user then adds two times part B (replenisher) and stirs for 2 minutes until the solution is well mixed.

Developer and replenisher:

- The user adds the required amount of water into the tank
- The user adds two times part A (fixer) to the water while stirring continuously for one to two minutes.
- The user then adds two times part B (replenisher) and stirs for one to two minutes

- The user then adds two times part C (replenisher) and stirs for two minutes until the solution is well mixed.

Studies of the risks of chemistry fumes have been conducted in some developed countries based on the pioneer work of Gordon, a New Zealand radiographer, who experienced work-related health problems (Spicer & Gordon, 1994; Genton, 1998). Reports in the radiographic literature of occupational risks of SO_2 fumes do not mean all radiographic personnel throughout the world are fully aware of such risks. According to my knowledge, radiographic personnel in Namibia do not work in safe and healthy working environments, as there is a lack of legislation covering occupational health and safety in Namibia. Therefore a study is required to address the awareness of occupational hazards posed by processing chemistry as well as to assist the authorities in control to make necessary decisions for implementation of effective protocols on handling and measurements of hazardous processing chemicals.

1.2 RATIONALE FOR THE STUDY

There is no known legislation in Namibia covering the risks of occupational related diseases caused by exposure to x-ray processing chemistry fumes. Such exposure occurs on a daily basis to personnel working in medical imaging departments. In the absence of literature statistics on mortality and morbidity are not readily available in Namibia. As the fume levels of x-ray processing chemistry are not known adequate preventative measures are not implemented in

Namibian diagnostic (x-ray) imaging departments. This study should aid or create awareness in:

- Identification of areas in the selected departments that fall short of recommended occupational fume exposure limits according to the International Occupational Safety and Health Information Center (IOSHIC) so that, where necessary preventative measures can be adopted in the respective Namibian x-ray departments.
- Creating awareness of occupational hazards posed by processing chemicals to radiology/radiographic workers.
- Assisting the authorities responsible for controlling occupational hazards to make necessary decisions for implementation of effective protocols on handling of hazardous chemicals and to implement effective protocol on regular measurement of processing chemical fume levels.
- Development of darkroom health and safety checklists for use in Namibian diagnostic x-ray departments.

1.3 AIM OF THE STUDY

The purpose of this study was to:

Evaluate SO_2 fume levels and the prevalence of darkroom disease symptoms amongst medical imaging personnel in Namibia. The specific objectives were:

- To identify areas in the selected departments of Katutura State Hospital and Windhoek Central Hospital that fall short of the recommended 2 parts per million (ppm) occupational fume exposure limits of the IOSHIC.
- To measure the SO_2 fume levels of the x-ray processing chemistry in the selected departments to determine whether the levels comply with exposure levels of threshold limit value (TLV) 2ppm or less as recommended by IOSHIC and to determine whether the SO_2 fume levels are higher in the darkroom surrounds of the respective departments in comparison to other areas in the same departments.
- To determine whether there is a relationship between the SO_2 fume levels and the prevalence rate of darkroom disease symptoms of the medical imaging personnel.
- To compare the prevalence rate of darkroom disease symptoms of the medical imaging personnel (exposed group) to those of the control group (unexposed group).

Further research questions were:

- Are there areas in the selected x-ray departments that fall short of the recommended occupational fume exposure limits of IOSHIC?
- Do the SO_2 fume levels within the selected departments comply with the exposure levels of TLV 2ppm or less as recommended by the IOSHIC?

- Are the SO_2 fume levels higher in the darkroom surrounds of the respective departments in comparison to other areas in the same departments?
- Does a relationship exist between the SO_2 exposure levels and the prevalence rate of darkroom disease symptoms of the medical imaging personnel?
- Is the darkroom disease symptom prevalence rate higher in the medical imaging personnel than those of the control group?
- Did the room temperature and relative humidity comply with the recommended ambient conditions for use of SO_2 fume level measurement instruments?
- Do the darkrooms of Katutura State Hospital and Windhoek Central Hospitals comply with the international recommendations of the darkroom design?
- Does a relationship exist between diminished pulmonary function and exposure to SO_2 fumes?

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter outlines the profile of the literature related to the risks associated with the use of processing chemistry, composition and by-products of processing chemistry, occupational risk of exposure to SO_2, darkroom disease and the importance of health and safety measures related to these.

It then highlights the literature related to symptoms associated with the darkroom disease. A brief review of the pulmonary function testing is provided to facilitate understanding of the effects of SO_2 exposure on the pulmonary function. Finally a review of the questionnaire used in the literature for symptom frequency is discussed in terms of its relevance to the present study.

2.2 RISKS OF PROCESSING CHEMISTRY

Since its inception in 1948, the Word Health Organization (WHO) has focused on factors that impact on the health status of working populations' worldwide. The WHO and collaborative role-players, such as the International Labor Organization (ILO) regularly publish reports on occupational health risks. According to the WHO (2001), the ILO estimated that 160 million new cases of

occupation-related diseases occur worldwide and recommend that exposure levels of SO_2 should be threshold limited value (TLV) 2ppm or less. According to the WHO workplace fatalities, injuries and illnesses remain at unacceptably high levels and causes an unnecessary health burden, suffering, and economic loss amounting to 4-5% of Gross Domestic product (GDP). This study will contribute to development of national occupational health profile in Namibia and action plans as well the creation of the capacity to implement the plans.

Processing chemistry is an integral part of an x-ray department. The risks of x-ray processing chemistry have been brought to the fore in many developed countries (Spicer & Gordon, 1994). By-product gases put personnel at risk in poorly ventilated areas. One such gas is SO_2. Of significance is that chemicals can enter the body by a person inhaling or swallowing the substance and/or by skin contact (NIOSH Pocket Guide, 2005). All three methods of entry are evident in diagnostic imaging departments (NIOSH Pocket Guide, 2005).People working in darkrooms handle chemicals, breathe in the chemistry fumes, and handle hardcopies of radiographs (x-rays). The risks of chemical exposures are not isolated to darkroom personnel but include any person who comes directly or indirectly into contact with the processing chemistry and/or its by-product fumes which travel in the air and therefore can be inhaled by persons in proximity to darkrooms, or even in nearby rooms, wards, and waiting areas. Persons at high risks are those who spend long periods in diagnostic imaging departments (Teschke *et al*., 2000).

2.3 COMPOSITION AND BY-PRODUCTS OF PROCESSING CHEMISTRY

The reagents in the developer and fixer solutions according to various manufacturers' specifications are listed in the Table 2.1 (Eastman Kodak, 1993).

TABLE 2.1: Reagents in developer and fixer solutions

Developer	Fixer
Acetic acid	Acetic acid
Carbonates (potassium, sodium)	Aluminum chloride
Glutaraldehyde (some times as bi-sodium sulphite)	Aluminum sulphate
	Ammonium
Glycols (diethylene, triethylene)	Thiosulphate
Hydroquinone	Boric acid
5-nitroindazole	Citric acid
1-phenyl-3-pyramzolidone	Gluconic acid
Potassium acetate	Sodium acetate
Potassium hydroxide	Sodium bisulphite
Potassium sulphite	Sodium sulphite
Sodium sulphite	Sodium thiosulphite

Based on the work of Teschke *et al*., (2000) SO_2 was selected for this research, because it is a gaseous degradation product of the sulphite compounds when the fixer solution is heated or left standing for long periods of time. Sulphur dioxide is

known as an acid gas, it reacts with water to form sulphurous acid which may react further to form sulphuric acid. These acids are formed when SO_2 comes into contact with moist membranes in the eyes or respiratory tract after inhalation (NIOSH Pocket Guide 2005).

It is important to note that SO_2 is one of a number of hazardous chemicals or chemical byproducts that may be chosen for a study of this nature because of its irritant characteristics. According to Schacter *et al*., (1984) Draeger tube measurement of SO_2 levels is accurate and provides a good indication of the overall hazard presented to personnel working with x-ray processing chemistry. In addition to the above this study was carried out for a postgraduate thesis, therefore, limited by time and finance, only a single parameter was selected to determine the degree of chemical danger in Katutura State Hospital and Windhoek Central Hospital x-ray departments respectively.

2.4 OCCUPATIONAL RISKS OF EXPOSURE TO SULPHUR DIOXIDE

The occupational risks of exposure to SO_2 are reported by several researchers who investigated the health status of workers in copper smelter works in the United States of America and Poland respectively (Smith *et al.,* 1977; Kolarzyk *et al*., 2000). Smith *et al.,*(1977) measured the pulmonary function of 113 copper smelter workers during 1973 and 1974 respectively, to assess the effects of chronic exposure to SO_2 and found no significant interaction between SO_2 and

concurrent exposure to irrespirable particulates on pulmonary function. The study indicated that exposure to 1.0-2,5ppm of SO_2 was associated with excessive loss of one second forced expiratory volume and an increase in respiratory symptoms. Workers with one second forced expiratory volume below normal and initial measurements showed evidence of even greater losses of pulmonary function related to SO_2 exposure.

In contrast to the above finding, Kolarzyk *et al*., 2000 reported during their study in 1994-1998 that more compensation claims for disease related to occupational hazards were registered. They conducted a research where 851 cases from 1396 cases were certified as occupational–related diseases, of this number 481 cases (56,5%) were diagnosed as pulmonary diseases. Chronic bronchitis was diagnosed in patients exposed to industrial dust containing SO_2. It is noted by Kolarzyk *et al*., 2000 that during 1994-1996 chronic bronchitis and silicosis and during 1997-1998 lung cancer and asthma were more frequently diagnosed in the workers. The researchers hypothesised that the diminishing frequency of chronic bronchitis and silicosis was due to the consequence of technological progress and greater concern for hygiene standards. Spicer *et al*., 1986, reported on a survey of 367 New Zealand radiographers' work-place symptoms, which correlated with the time spent in the darkroom.

These cited studies show that repeated exposure to low levels of SO_2 (below 5ppm) has caused pulmonary function impairment. It is reported that this effect

is probably due to repeated episodes of bronchoconstriction. According to Sandstrom *et al*., (1989) with improved safety measures and greater concern for hygiene safety, the frequency of chronic bronchitis diminishes.

Sulphur dioxide is a moderate to strong irritant. Inhaled SO_2 penetrates as far as the nose and throat with only minimal amounts reaching the lung. (NIOSH Pocket Guide 2005). Exposure to SO_2 will cause irritation of the eyes, nose, mouth and other parts of the respiratory tract. High concentrations will cause more severe irritation (Mehlman, 1983). Sensitivity to SO_2 varies among people, however, short exposure of between one to six hours, to concentrations as low as 1ppm may produce a reversible decrease in lung function (Ericsson,1983). According to Trenga *et al*., (1999) people with asthma or other respiratory allergies are more sensitive to SO_2 even at low concentrations thus asthmatic reactions can be triggered with symptoms of wheezing, chest tightness, shortness of breath and coughing.

The effects of SO_2 on humans are divided into short and long term. Exposures to very high levels of SO_2 such as 100ppm can be life threatening. Burning of nose and throat, breathing difficulties, severe airway obstruction may be the results of short term exposure (NIOSH Pocket Guide, 2005). The long-term effects are due to generally low repeated occupational exposure to SO_2 over many years. These effects are:

- Discoloration of teeth in the same way as sulphuric acid does (NIOSH Pocket Guide, 2005).
- Bronchitis and emphysema where SO_2 is at least a contributing cause (NIOSH Pocket Guide, 2005).
- Permanent lung damage (NIOSH Pocket Guide, 2005).

According to *SO_2 Hygienic Guide Series* repeated exposure to low SO_2, below 2ppm, has caused permanent pulmonary impairment. Contrary to the above Smith, *et al*., (1977) found a decrease in lung function in smelter workers exposed for over one year to 1-1.5ppm SO_2 over 20 years or more. No effects were seen in the same study in workers exposed to less than 1ppm. Workers exposed to daily average value of 5 ppm SO_2 had a much higher incidence of chronic bronchitis than control groups (*SO_2 Hygienic Guide Series*), however these workers were also exposed to other chemicals, so their health effects may not have been from SO_2 alone. The respective researchers (Ericsson, 1983, Gunnison, 1987, Melhman, 1983) reported on potential effects of SO_2 as a component of air pollution, but these studies are difficult to interpret because of confounding factors such as concurrent exposures to other chemicals and uncertainty about exposure concentrations.

2. 5 DARKROOM DISEASE

Darkroom disease is a term used to describe unexpected multiple symptoms attributed by medical imaging personnel to their work environment (Tarlo *et al*., 2004). According to (Smedley, Inskip, Weild, 1996) symptoms recorded include:

- Headaches,
- Watery/sore eyes,
- Shortness of breath,
- Lip sores/mouth ulcers,
- Unusual numbness of extremities,
- Unusual heart rhythms,
- Painful joints,
- Irritation of the throat,
- Runny/stuffy nose and nausea.

Medical imaging personnel involved in developing and fixing films have a potential exposure to processing chemicals including sensitizers and irritants, such as glutaraldehyde, formaldehyde, SO_2, and acetic acid (Gordon, 1985; Scobbie *et al*., 1996; Teschke et al., 2000).

Initial information on darkroom disease was brought to the attention of radiology workers due to the work of Majorie Gordon a New Zealand radiographer who was forced to give up her clinical career in 1983 because she became severely

sensitized to x-ray processing chemicals. Her main symptoms were tachycardia, hoarseness and extreme fatigue. While visiting Agfa Gevaert plant in Belgium she learned that if the factory workers suffered any signs of respiratory illness they were immediately transferred away from chemical sources. Gordon devoted herself to raising awareness about the safety use of processing chemicals (Genton, 1998).

Publications from the occupational health field have attempted to correlate environmental factors in processing areas with reported occupational symptoms.

Investigations by Gordon from 1984-1986, and the British Society of Radiographers in 1991, highlighted the potential threat to the health of radiology workers constantly exposed to x-ray processing chemicals. An early article by Gordon (1987) also described chest findings in three radiographers and one radiologist, including chest pain with loss of consciousness, arrhythmia, tachycardia and recurring chest infections and lymphoma.

In addition Fisher (1981) published the first report of allergic contact dermatitis in a radiologist and a technician due to handling films containing glutaraldehyde.

Acting on Fisher`s article, his personal experience and results of survey, Zach, in a 1982 letter published in *American Family Physician* warned that severe contact dermatitis, rhinitis and occupational asthma are much more common than the medical profession now recognizes. Noting the use of glutraldehyde in

cold sterilization, Zach recommended taking necessary steps to address these occupational hazards.

In contrast to the above arguments Frielander *et al*., (1982) performed an epidemiological investigation of a 1964 cohort of 478 photographic processors in nine East Kodak Colour Print and Processing laboratories in the United States of America. The findings of the study showed no significant excess mortality, sickness-absence or cancer incidence in people working in the processing laboratories. However in 1986 Kipen *et al*., researched the respiratory abnormalities among three photographic developers who were responsible for processing the x-ray films and who spent approximately five hours in these laboratories, one whom had worked for two years in a cardiac catheterization laboratory and who experienced headaches, tiredness, nasal hyper secretion, sore throat, nausea and two episodes of severe left pain. Recognizing the individual irritant potential of acetic acid, SO_2, formaldehyde and hydroquinone, the authors suggested that although the air levels of each individual chemical might be below the TLV the influence of exposure to combinations may result in adverse effects at levels that would be tolerable if exposure were only to a single compound.

In 1987 a study by Ide, found that female darkroom technicians had a greater sickness absence than a matched control group, even though the difference did not reach statistical significance. The author concludes that while occupational

hygiene assessments indicated chemical contaminants to be within the limits, further evaluation to determine the cause of sickness absences was recommended.

Furthermore, Norback (1988) compared a group of 39 workers exposed to glutaraldehyde compared to an unexposed group of 68. The investigation revealed irritative skin and airway effects and headache occurring at glutaraldehyde exposure levels that were far below the present Swedish short term occupational exposure limit of 0.05 ppm. Norback advised that those with a history of rhinitis, asthma and allergic dermatitis should avoid contact with the solution or vapor.

The British Society of Radiographers (1991) carried out a survey to which 2,804 of their respondents (almost 25%) responded, with 39% of respondents reporting the following symptoms in descending order of frequency, headaches, sore throat/hoarseness, unexpected fatigue, sore eyes, chemical taste, sinus problems/nasal discharge, persistent cold-like symptoms, catarrh, painful joints, mouth ulcers, skin rash and chest pain/breathing difficulties.

Tarlo *et al*., 2004 reported similar symptoms for their survey. They indicated the following symptoms as most commonly reported in order of frequency, headache, nasal symptoms, eye symptoms and sore throat. In addition during

1993 in a letter to the editor of the *Medical Journal of Australia*, Connaughton described seven patients occupationally exposed to glutaraldehyde who presented with either palpitations or tachycardia. No other causative factors were identified from their history, physical examinations or electrocardiograms. Monitoring during exposure indicated these symptoms and when exposure ceased through a change of job or workplace modification symptoms ceased (Connaughton, 1993).

Hewitt in his subsequent articles *Occupational health problems in processing of x-ray photographic films* (1993) and *Reducing the risk in x-ray film processing* (1994) points to the increasing reports of respiratory and skin problems since the early 1980s and to common faults observed in various sites, including the positioning of extractor fans being such that fumes released from film processing machines pass into darkroom technicians breathing-zone. Hewitt concluded that the number of cases reported and common features of the conditions described cannot be ignored, and that the consequences of this illness are enormously distressing to the persons concerned, and that the current state of knowledge leaves much more to be learned (Hewitt, 1993).

Smedley and Coggon (1996) examined the health surveillance of employees exposed to respiratory sensitizing agents, including x-ray departments. In another article published the same year, Smedley *et al.,* (1996) determined the

prevalence of symptoms among radiology workers compared with a control group of physiotherapists. They found work-related symptoms suggesting irritation of the eyes and upper airways to be more common in the radiology workers than physiotherapists and that follow-up assessment would be required to assess the prevalence of occupational asthma in the radiology workers.

The respective researchers (Hewitt, 1993, Glass, 1997, Genton, 1998) highlighted that in many departments there were no written safety protocols pertaining to mixing and handling of processing chemistry. Following their studies and the concerns of the WHO regarding health risks most developed countries have addressed health hazard aspects of processing chemistry, such as use of protective clothing and masks when mixing chemistry, installation of high volume extractor fans in darkrooms, and regular service maintenance of equipment. Exposed personnel are developing occupational illness at chemical levels well below the occupational safety levels of 2ppm. According to Genton (1998) several authors while addressing these air level findings have proposed that synergistic effects may be the means by which individual toxins, each within permissible concentration when in combination with others, provide more dangerous mixture. Genton (1998) recommends that there should be ongoing research of the toxicity of chemistry based on air sampling, ventilation, equipment inspection, equipment maintenance, health monitoring, staff training, taking into account the relevant health and safety legislation. There have been

reports of an unexplained medical syndrome darkroom disease amongst imaging personnel, (Gordon, 1989; Hewitt, 1993; Genton, 1998). However, the prevalence of these symptoms and the associated factors are unclear.

Increased ~~ing~~ medical imaging personnel reported symptoms and a growing concern about the safety of their working environment prompted several studies of the risks of chemistry in developed countries (Hewitt, 1993; Glass, 1997; Genton, 1998; Teschke *et al:* 2000). Medical imaging personnel need adequate information in order to make informed decisions concerning possible health risk in their working environment.

Burge *et al.*, (1985) designed a questionnaire which showed 96% repeatability in symptoms reported in building populations when measured one year apart. The questionnaire (Appendix G) was adapted from those used by Smedley *et al*., (1996). Wymer *et al.,* (2000), and Dimich-Ward *et al*., (2003) who undertook studies of radiographers' reactions to exposure to chemical fumes compared to physiotherapists as the control group.

For the purposes of the current study the following questions were included in the questionnaire: general information (participant's age, gender, race and current occupation), exposure to factors which influence health (smoking habits), health and illness information (addressing 12 symptoms such as asthma, chest illness, headaches, nausea, runny nose, irritation of throat, fatigue, pain in the joints,

ringing in the ears, skin rash, lip sores, sores in the mouth, abnormal heart beat, unusual numbness of arms and legs) and exposure to external factors (industrial areas near their homes and burning of incense).

2.6 IMPORTANCE OF HEALTH AND SAFETY MEASURES

Although the hazards of processing chemistry are well documented in the literature and, given the importance that the WHO places on safety in the working environment, safety preventative measures are however not operative in darkrooms in Namibia (Gordon, 1989; Hewitt, 1993; Teschke *et al*., 2000; Tarlo *et al*., 2004). There is a lack of information of darkroom disease amongst Namibian radiographers. Perhaps this is because most of the studies were done in developed countries, among others New Zealand and Britain (Gordon, 1989, Brennan *et al.*, 1996).

Hewitt, (1993) reports that the most common problem is lack of understanding of risk associated with chemical exposures, and slow and often-inappropriate responses to reported problems such as poor ventilation or no extractor fans and protective clothing in the darkroom. According to Teschke *et al*., (2002) preventative measures include adequate ventilation, use of protective gear when handling chemicals, a safe and healthy environment with ongoing monitoring practices.

From the above information, one can conclude that the potential hazards and preventative measures should be an essential part of the radiographers' duty in the workplace. For example, a functioning health and safety committee that conducts regular inspections of processing areas could be of importance to each imaging department. Consequently much emphasis has been placed on reducing the hazards associated with the processing chemicals by the WHO and collaborative role-players, such as ILO and National Institute for Occupational Safety and Health. Manufacturers of chemicals have been constantly searching for less toxic alternatives, lower temperatures are employed for developing and fixer processes (Eastman Kodak, 1993). Chemical packaging and departmental warning notices increasingly detail the dangers of specific chemicals and the necessary treatment following excessive exposure, more regulations is apparent, such as control of substance hazardous to health regulations (COSHH) in the U.K. (Brennan *et al*., 1996). More effective ventilation and extraction systems are being employed as well as proliferation of studies monitoring the levels of chemical fumes in individual imaging departments is evident in most of the developed countries (Genton, 1998; Teschke *et al*., 2003; Tarlo *et al*., 2004).

Eastman Kodak (1993) published several articles in response to alleged adverse health effects. They created worst-case scenarios by disconnecting room ventilation and processor exhaust ducts but found that measured air concentrations remained below permissible exposure limits. They concluded that when used properly, Kodak x-ray processing chemicals should not present a

health or safety risk, but noted that some employees may have specific medical conditions, such as asthma or other respiratory diseases, that may require special consideration (Genton,1998).

2.7 SUMMARY

Medical imaging personnel are exposed to processing chemical fumes but there are no available statistics on morbidity and mortality in Namibia. Neither are there regulations in place to ensure that regular measurements are done of the fume levels of the processing chemistry. This study aims to create an awareness of occupational hazards posed by processing chemical fumes to medical imaging personnel, so that preventative measures can be implemented.

Every department should have protocols on handling of hazardous chemicals to reduce the potential of ever increasing work-related diseases associated with exposure to fumes of SO_2. In order to provide such information requires that the relevant authorities must be made aware of the risks based on well-documented data.

The above literature review offers a cursory look at the complex subject of darkroom disease. Many challenges remain, including the understanding of the biomechanics of commonly reported symptoms. This study aims to provide precise readings of current fume levels and the prevalence of reported darkroom

disease symptoms. The literature underlines one of the dilemmas in qualifying darkroom disease: exposed personnel are developing occupational illness at chemical air concentrations well below occupational safety levels. Chessor and Svirchev (1997) in their occupational health investigation of several Canadian radiology sites where health problems had been reported also found this to be true. Several authors (Glass, 1997, Genton, 1998) while addressing these air level findings have proposed that synergistic effects may be the means by which individual toxins, each within permissible concentration when in combination with others, provide a more dangerous mixture.

Another challenge in darkroom disease is determining a reliable means of qualifying this occupational illness. Bronchial challenge tests may be normal even though the subject experiences work place-related asthma-like symptoms (Genton, 1998). Hayes and Fitzgerald (1994) reported that an association between symptoms and exposure sensitizing agent may not be apparent because asthma caused by low molecular weight chemicals may induce atypical non-specific symptoms such as cough or chest discomfort whereas more classic symptoms such as wheeze and chest tightness may not occur until late in the evening or during the night after exposure (Hayes & Fitzgerald, 1994). The fact that radiology workers involve not only variety of shift and days but also hours will make the task of correlating delayed symptoms with workplace exposure more difficult (Genton.1998).

As noted by Glass (1997) the problems are known internationally and known to general practitioners or hospitals management or user, but it is a long process educating everyone. Although the problems are known internationally, there is a great deal to be done in developing countries in order to educate medical imaging personnel.

CHAPTER THREE

RESEARCH METHODS AND DESIGN

3.1 INTRODUCTION

This study was designed to collect and analyse data in order to evaluate the potential health risks associated with SO_2 fume exposures in two x-ray departments of the Ministry of Health and Social Services in Namibia. The data were collected at Katutura State Hospital and Windhoek Central Hospital x-ray departments respectively. These hospitals were chosen because they employ a large number of medical imaging personnel in Namibia

This chapter describes the way that the research questions were approached and the techniques that were used to address them. Research design, permission for the study, invitation to participants, selection of research population, participant information letter, reasons for research parameters and methods of data collection and organization and ethical consideration are described. In conclusion, consideration is given to data analysis methods used.

3.2 RESEARCH DESIGN

The research approach was a prospective cohort survey. It is a descriptive quantitative research which aims to provide a broad overview of a representative sample of a population.

3.3 PERMISSION TO UNDERTAKE THE RESEARCH

Written permission was obtained from the Permanent Secretary Dr. Kalumbi Shangula at the Ministry of Health and Social Services in Namibia to conduct the study in the state x-ray departments of Katutura State Hospital and Windhoek Central Hospital respectively. X-ray department facilities and personnel were utilized for obtaining data for the research. (Appendix A -letter of application, Appendix B- letter granting permission).

The research proposal for this study was presented to the research committee of the Ministry of Health and Social Services before permission was granted to conduct the research.

3.4 INVITATION TO PARTICIPATE

An invitation letter (Appendix C) which briefly explained the research, was displayed on the notice boards of the following institutions:

- Katutura State Hospital
- Windhoek Central Hospital
- Faculty of Medical and Health Sciences of the University of Namibia.

3.5 SELECTION OF THE RESEARCH POPULATION

An invitation letter (Appendix C) was used to invite interested persons who met the selection criteria to participate in the study. The following two study groups were sampled by means of convenience sampling method:

(i) Exposed Group

This study population consisted of staff members and students in Katutura State Hospital and Windhoek Central Hospital x-ray departments, who were exposed to SO_2 during the study period (n =29).

(ii) Unexposed Group

A control group, who were not exposed to SO_2, consisted of volunteer staff and students from the Faculty of Medical and Health Sciences at the University of Namibia (n=10).

Both the exposed and unexposed Groups completed the self-administered questionnaires (Appendix G) during June 2005 and then underwent pulmonary function testing (PFT) during September 2005.

3.6 PARTICIPANT INFORMATION LETTER, INFORMED CONSENT, DATA COLLECTION SHEET AND SELF-ADMINISTERED QUESTIONNAIRE.

All the participants read the participant information letter (Appendix D) and signed the informed consent form (Appendix E).

The data collection sheet (Appendix F) was designed to record data related to SO_2 fume level measurements and the darkroom environmental measurements of room temperature and humidity. The questionnaire was designed to obtain data associated with the darkroom disease symptom frequency of the participants (Appendix G).

3.7 DATA COLLECTION

The following primary data were collected over a period of four months:

- Symptom frequency related to SO_2.
- SO_2 fume level sampling.
- Biological monitoring by means of (PFT).
- Darkroom environmental measurements of room temperature and relative humidity.
- Darkroom checklist

3.8 RESEARCH PARAMETERS

The test methodologies that were employed for the purpose of this research are described below.

3.8.1 SULPHUR DIOXIDE SYMPTOM FREQUENCY SURVEY

The data relating to symptoms associated with SO_2 fume exposure were obtained from the respective study populations with the aid of self administered questionnaires (Appendix G). This questionnaire was adapted, from those of Burge *et al*., (1987), Smedley *et al*., (1996), Wymer *et al.,* (2000), and Dimich-Ward *et al*., (2003). These

questionnaires were used in previous surveys of radiographers by these authors and also incorporated physiotherapists as the control group. The questionnaire for the current study included questions regarding, demographics, respiratory and symptoms regarding chemical sensitivity and smoking history.

The researcher asked whether participants experienced the listed symptoms on more than two occasions during the past six months

Choices:

- yes,
- no,
- uncertain

If yes have you had this?

Choices:

- most days,
- most months,
- other,
- uncertain

Was this better on days away from work?

Choices:

- yes,
- no

The listed symptoms were as follows: (a) headaches, (b) nausea, (c) runny nose, (d) irritation of the throat, (e) unexpected fatigue, (f) pain in

joints, (g) ringing in the ears, (h) skin rash, (i)lip sores, (j) mouth sores, (k) abnormal heart beat, (l) unusual numb arms and legs.

The questionnaire was pilot tested with 10 medical imaging personnel and the decision not to change any questions was taken as the results indicated that the questionnaire was well understood. The covering letter indicated that this study was to evaluate the SO_2 fume levels in x-ray departments in Katutura State Hospital and Windhoek Central Hospital and did not indicate a focus on darkroom disease or on medical imaging personnel.

The questionnaires were handed out to the two groups and collected four days later. The names of the participants were excluded from the data analyses and data presentation for confidentiality. The data were used in a group data format only. The data entry and analyses conducted with the help of statisticians, Mrs Kaduma and Mrs Muller (2005), employed by the University of Namibia Statistics Department (Appendix H-letter from the statisticians), using the Statistical Package for Social Sciences (SPSS) Program version 12.0. Various statistical tests such as one sample t-test, chi-square and or two sample t-test were applied.

3.8.2 SULPHUR DIOXIDE FUME LEVEL SAMPLING

Chemical monitoring of SO_2 was carried out at the Windhoek Central Hospital and Katutura State Hospital x-ray departments respectively using the following procedure recommended by the manufacturer:

- Draeger diffusion tubes and pumps were used to measure the SO_2 fume levels.
- The tubes were placed at eye level in corresponding locations in each of the x-ray departments by the researcher.
- The areas of measurement were marked as A, B, C and D and this key was used to identify the areas on the SO_2 data sheet (Appendix F).
- The tubes were broken each morning of the study with a tube breaker and left in place for six hours.
- After six hours the researcher assessed the tubes and recorded the reading on the SO_2 data sheet.
- The SO_2 fume level sampling was carried out for two alternate weeks for each x-ray department over a period of four months.
- Total of 35 readings were recorded for each x-ray department respectively.

3.8.3 PULMONARY FUNCTION TESTING

After due consideration of the literature, cost factors and compliance of participants the researcher decided to use pulmonary function testing (PFT), of the two groups, namely those who were exposed to chemical fumes and those who are not exposed as a potential biological

indicator of SO_2 exposure. The PFT was performed by Ms. T. Altmann (2005 -a qualified clinical technologist from JM Bredenkamp technologists office). All of the participants were requested to complete a consent form (Appendix E). Due to cost factors the PFT of each participant was only carried out once, namely at the end of the study. The following method for PFT was used:

- The researcher explained the procedure to the participant in simple terms.
- The participant was then asked to loosen any tight clothing and to stand in front of the apparatus (spirometer).
- The participant was then asked to slightly elevate the chin and slightly extend the neck.
- The participant was then instructed (i) to breathe in very deeply during a normal breathing pattern, and (ii) to blow into the apparatus, without interruption as hard, fast and completely as possible.
- A minimum of three forced expirations were carried out.
- During the maneuvers the researcher noted, by observation, whether the participant followed the breathing instructions.
- The participant's volume of forced expiration/s was checked visually for reproducibility of flow-volume of time tracing or displays.

  The results were obtained from the technologist the same day the PFT was performed and recorded on the self administered questionnaire for each participant.

3.8.4 ENVIRONMENTAL MEASUREMENTS OF TEMPERATURE AND RELATIVE HUMIDITY

The room temperature and the humidity of each darkroom were measured to ascertain whether these readings conformed to the accepted standards for the SO_2 sampling equipment. The room temperature and humidity measurements were recorded on the SO_2 data sheet. Sling psychrometer was used to obtain room temperature and relative humidity. The sling psychrometer consists of three parts, namely the inner frame with wet and dry bulb thermometers, the wet and dry bulb scale on the reverse side of the inner frame, and the outer case with the relative humidity scale. The following steps were used to obtain the room temperature and relative humidity readings:

- The researcher opened the sling psychrometer by withdrawing the inner frame from the case.
- The wet bulb thermometer with a closely fitting wick over the bulb was immersed in distilled water for 30 minutes by the researcher. The researcher ensured that the wick was thoroughly saturated.
- The researcher then placed the pshychrometer at right angles and while holding the case rotated the frame for 30-60 minutes at approximately 2 and 3 revolutions per second.
- The researcher then stopped revolving the instrument and noted the wet and dry bulb temperatures.

- The instrument was closed and the slide rule calculator was used to determine the relative humidity percentage, which is the difference between the wet and dry bulb thermometer readings.
- The room temperature and relative humidity readings were recorded on the SO_2 data collection sheet (Appendix F).

3.8.5 DARKROOM DESIGN CHECKLIST

The darkrooms of the two departments were evaluated by means of a questionnaire, (Appendix I) to ascertain whether they complied with the international recommendations of a darkroom design (Appendix J). The above questionnaire was compiled with input from one of my supervisors.

3.9 ETHICAL CONSIDERATION

The Faculty of Health Sciences Ethics Committee at the Durban University of Technology approved the protocol for this project. The participants were requested to read and understand the information letter in which the participants were notified about the minimal possible risk of the PFT. There is a small risk of collapsed lung in people with certain lung disease. None of the participants did experience any risk or discomfort.

The researcher maintained confidentiality by excluding the identities of the participants from the data analyses and data presentation. Participation in the study was on voluntary basis and did not involve

financial benefit. The participants were free to withdraw from the study at any stage.

3.10 STATISTICAL ANALYSIS

SPSS program version 12.0 was used for data entry and analysis. Bar graphs and histograms were used to assess the assumption of normality. Descriptive statistics were used for the frequency distribution of variables and are displayed by means of tables and graphs as measures of central tendency mean and median values. The measures of variability include standard deviation and range. The t-test was used to ascertain whether there were any relationships between categorical independent variables and dependent variables. The Pearson chi-square was used to describe the relationship between the dependent variables and to test for different proportions of categorical variables.

CHAPTER FOUR

RESULTS

4.1 INTRODUCTION

This chapter reports the results of data analysis. The present study is the first review of medical imaging personnel in Namibia to assess the work-attributed symptom complexes consistent with darkroom disease. The findings of this study, the objectives, and further research questions which arose during the study are presented. One sample t-test was used to determine ambient conditions for sampling instruments, as well as to identify areas, which fall short of the recommended occupational $S0_2$ fume exposure limits. The Pearson chi-square was used to test whether the groups had different proportions, as well as to test the relationship between exposure to SO_2 fume exposure and the prevalence of the darkroom disease symptoms.

The main aim of the research was to establish whether there is a relationship between the symptom prevalence rate and exposure to SO_2 fumes.

The objectives were as follows:

- To identify areas in the selected departments that fall short of the recommended 2ppm occupational fume exposure limits of the Occupational and Safety Information Center (IOSHIC).

- To measure the SO_2 fume levels of the x-ray processing chemistry in the selected departments to determine whether the levels comply with exposure levels of TLV 2ppm or less as recommended by IOSHIC.
- To determine whether the SO_2 fume levels are higher in darkroom surrounds of the respective departments in comparison to other areas in the same departments.
- To determine whether there is a relationship between the SO_2 exposure levels and the prevalence rate of darkroom disease symptoms of the medical imaging personnel.
- To compare the prevalence rate of darkroom disease symptoms of the medical imaging personnel (exposed group) to those of the control group (unexposed group).

Further research questions were:

- Are there areas in the selected x-ray departments that fall short of the recommended occupational fume exposure limits of IOSHIC?
- Do the SO_2 fume levels within the selected departments comply with the exposure levels of TLV 2ppm or less as recommended by the IOSHIC?
- Are the SO_2 fume levels higher in the darkroom surrounds of the respective departments in comparison to other areas in the same departments?

- Does a relationship exist between the SO_2 exposure levels and the prevalence rate of darkroom disease symptoms of the medical imaging personnel?
- Is the darkroom disease symptom prevalence rate higher in the medical imaging personnel than those of the control group?
- Did the room temperature and relative humidity comply with the recommended ambient conditions for use of SO_2 fume level measurement instruments?
- Do the darkrooms of Katutura State Hospital and Windhoek Central Hospitals comply with the international recommendations of the darkroom design?
- Does a relationship exist between diminished pulmonary function and exposure to SO_2 fumes?

4.2 DESCRIPTIVE STATISTICS

Descriptive statistics were used to analyse the data and to summarize and describe the observations of the SO_2 fume level measurements, frequency of symptoms, darkroom temperature and relative humidity of Katutura State Hospital and Windhoek Central Hospital x-ray departments. Measurements are displayed in Appendices L to N. The frequency distribution of variables is presented using bar graphs and histograms. Range and standard deviation are the measures of variability.

4.2.1 DESCRIPTIVE STATISTICS-SULPHUR DIOXIDE FUME LEVELS

SO_2 fumes were measured for four specific areas (A: Automixer, B: Darkroom, C: Tearoom and D: Reception) in the x-ray departments of Katutura State Hospital and Windhoek Central Hospital. Autex RP x-ray fixer and replenisher and Autex RP x-ray developer and resplenisher chemistry supplied by Axim, which were used in the 2 departments during the time of data collection. The measurements were recorded over a period of four months; from August 2005 to November 2005. A total of 35 readings were recorded for each area.

The findings for the SO_2 fume level measurements are presented below:

- Mean SO_2 fume levels at Katutura State Hospital and Windhoek Central Hospital of all SO_2 levels with the international occupational safety and health limit of 2ppm.
- A comparison of the darkroom SO_2 fume levels with the other locations within each x-ray department of Katutura State Hospital and Windhoek Central Hospital respectively.

4.2.1.1 Mean Sulphur dioxide fume levels at Katutura State Hospital and Windhoek Central Hospital of all sulphur dioxide levels with the IOSHIC limit of 2ppm.

Following the examination of the Draeger tubes, SO_2 fume levels were considered to be well below the IOSHIC recommended level

of 2ppm. Mean readings for each hospital per location are presented in Figures 4.1 and 4.2.

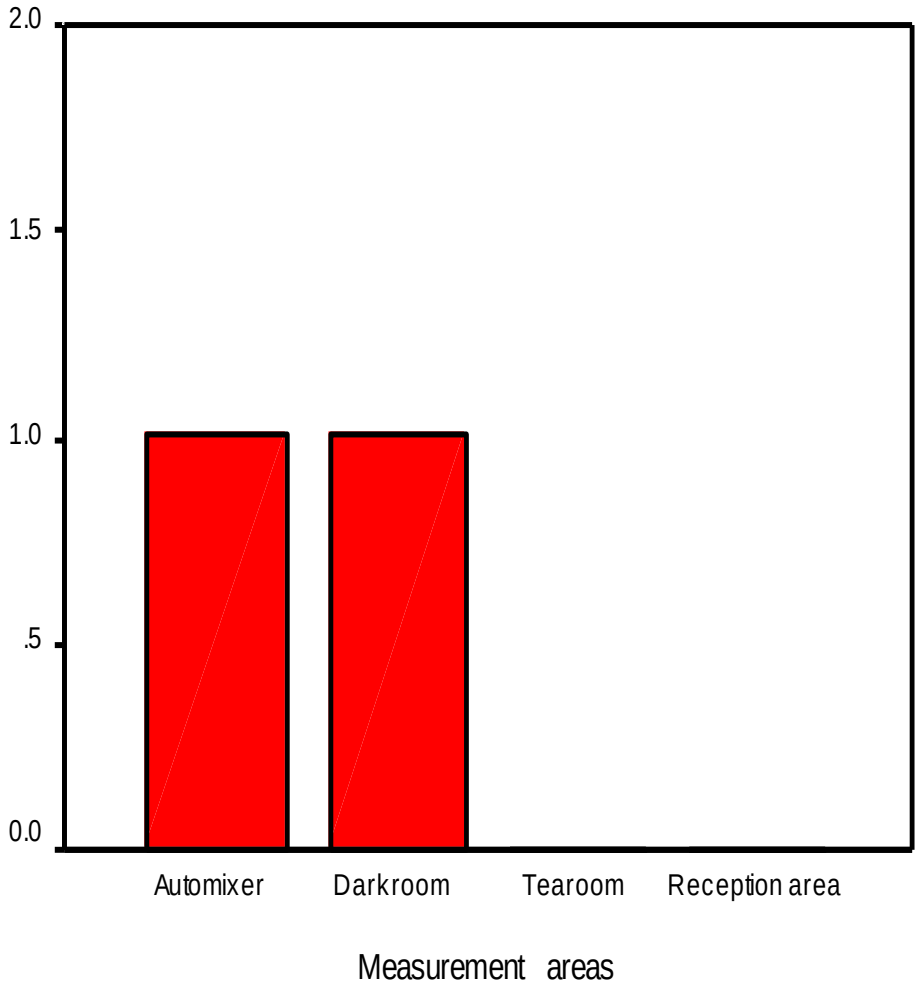

Figure 4.1. Bar graph illustrating the SO_2 fume levels in Katutura State Hospital

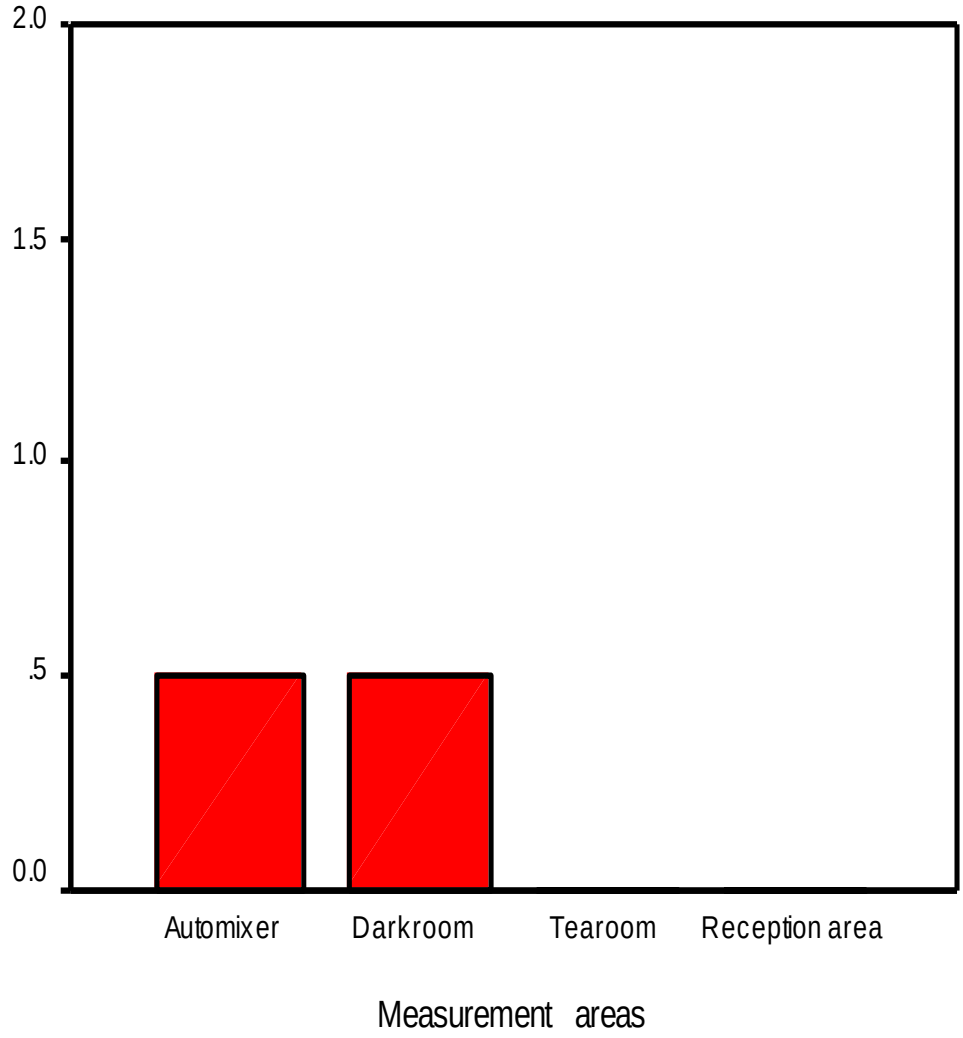

Figure 4.2. Bar graph illustrating the SO_2 fume levels in Windhoek Central Hospital

4.2.1.2 A comparison of the darkroom SO_2 fume levels with the other locations within each x-ray department for Katutura State Hospital and Windhoek Central Hospital.

The results demonstrate a very definite trend where fume levels are greatest close to the auto-mixer of the chemistry and in the darkroom but significantly less than 2ppm (Figure 4.3). For both hospitals the fume levels were greatest for the darkroom and the auto-mixer but significantly less than 2ppm.

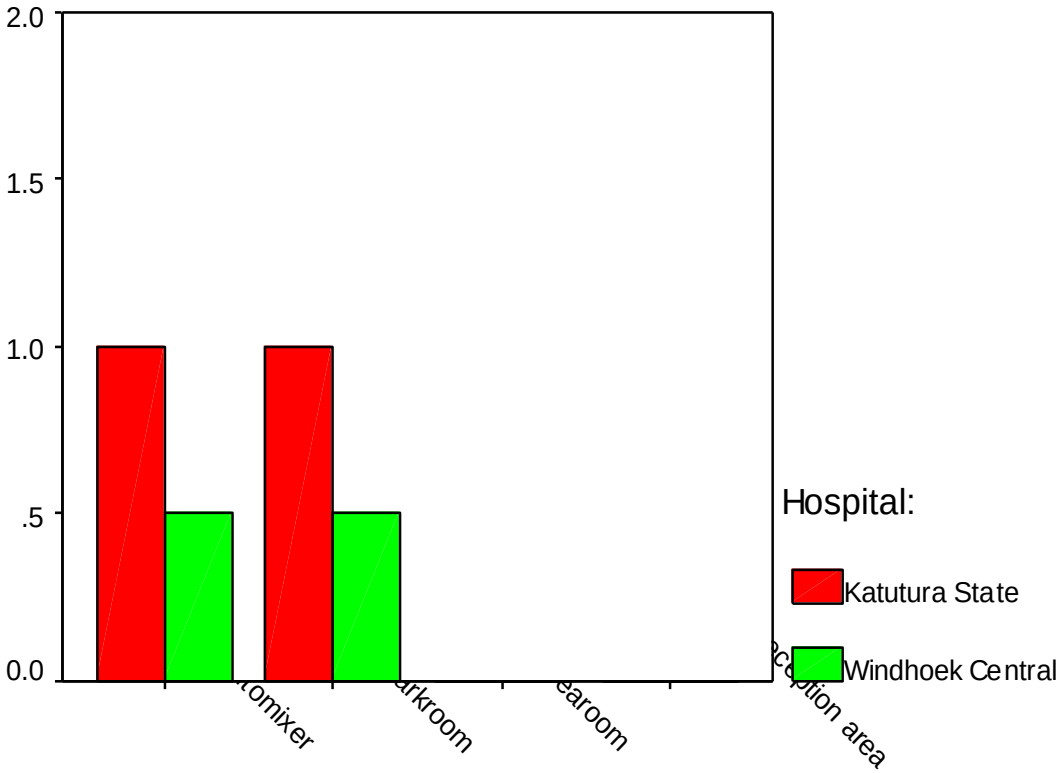

Figure 4.3. Histogram illustrating the SO_2 fume levels in Katutura State Hospital and Windhoek Central Hospital

4.2.2 DESCRIPTIVE STATISTICS-SYMPTOM FREQUENCY SURVEY

The data were collected by using a self-administered questionnaire (Appendix I). The questionnaire included questions to cover 12 different symptoms. The cluster of symptoms used in this study to define dark room disease was the presence of three or more of the following five symptoms:

(i) ear, nose and throat illnesses (runny nose, irritation of throat, ringing in ears),

(ii) headaches and,

(iii) abnormal tiredness (fatigue, numb arms and legs),

(iv) respiratory illnesses (abnormal heart beat), and

(v) skin illnesses (skin rash, lip sore, mouth sores).

Of the 45 and 10 questionnaires distributed to the exposed group and their control group respectively, 29 and 10 questionnaires were returned. The response rate for the exposed group was 64%. On the other hand the control group response rate was 100%.

4.2.3 DESCRIPTIVE STATISTICS-TEMPERATURE AND RELATIVE HUMIDITY OF THE DARKROOMS

The room temperature and relative humidity were measured in order to ensure that the acceptable parameters (temperature limit specified: 15°C to 30°C, relative humidity specified: 80% at 25°C) of the sampling instruments were not exceeded. Room temperature and relative humidity

were measured over a period of four months (August to November 2005) in the respective darkrooms of the x-ray departments. Thirty-five readings were recorded for each darkroom respectively. The descriptive statistics for temperature and relative humidity are presented in Figures 4.4 to 4.7.

As displayed in Figures 4.4 and 4.5 it can be seen that all the readings recorded for both the Katutura State Hospital and Windhoek Central Hospital were within the acceptable limits as specified by the manufacturer for the use of the SO_2 sampling equipment. The average temperature readings for both hospitals were within the specified limits, namely 23.6°C, with standard deviation of 2.60°C for the hospital in Katutura and 24.0°C, with standard deviation of 2.68°C for the hospital in Windhoek. Both readings were lower than 25°C which is the specified temperature for ideal measurements to be taken.

Relative humidity of the two hospitals was much lower than 80% but within the limits specified. Figure 4.6 depicts the median relative humidity for Katutura State Hospital as 33.2%, with standard deviation of 8.90%. Figure 4.7 displays the median relative humidity for Windhoek Central Hospital as 35.4%, with standard deviation of 6.39%. We therefore can see that the SO_2 measurement conditions were optimum.

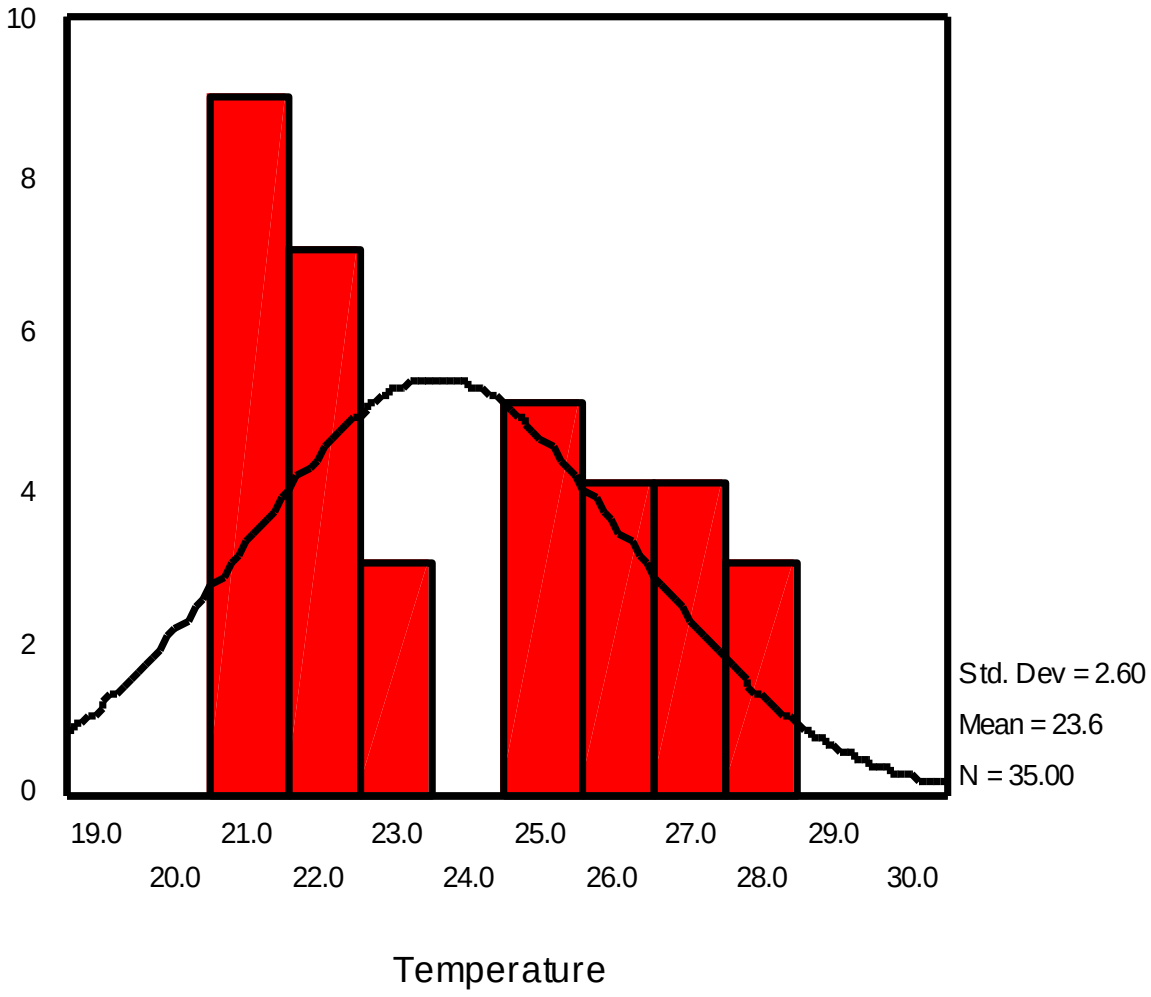

Figure 4.4: Temperature measurements for Katutura State Hospital

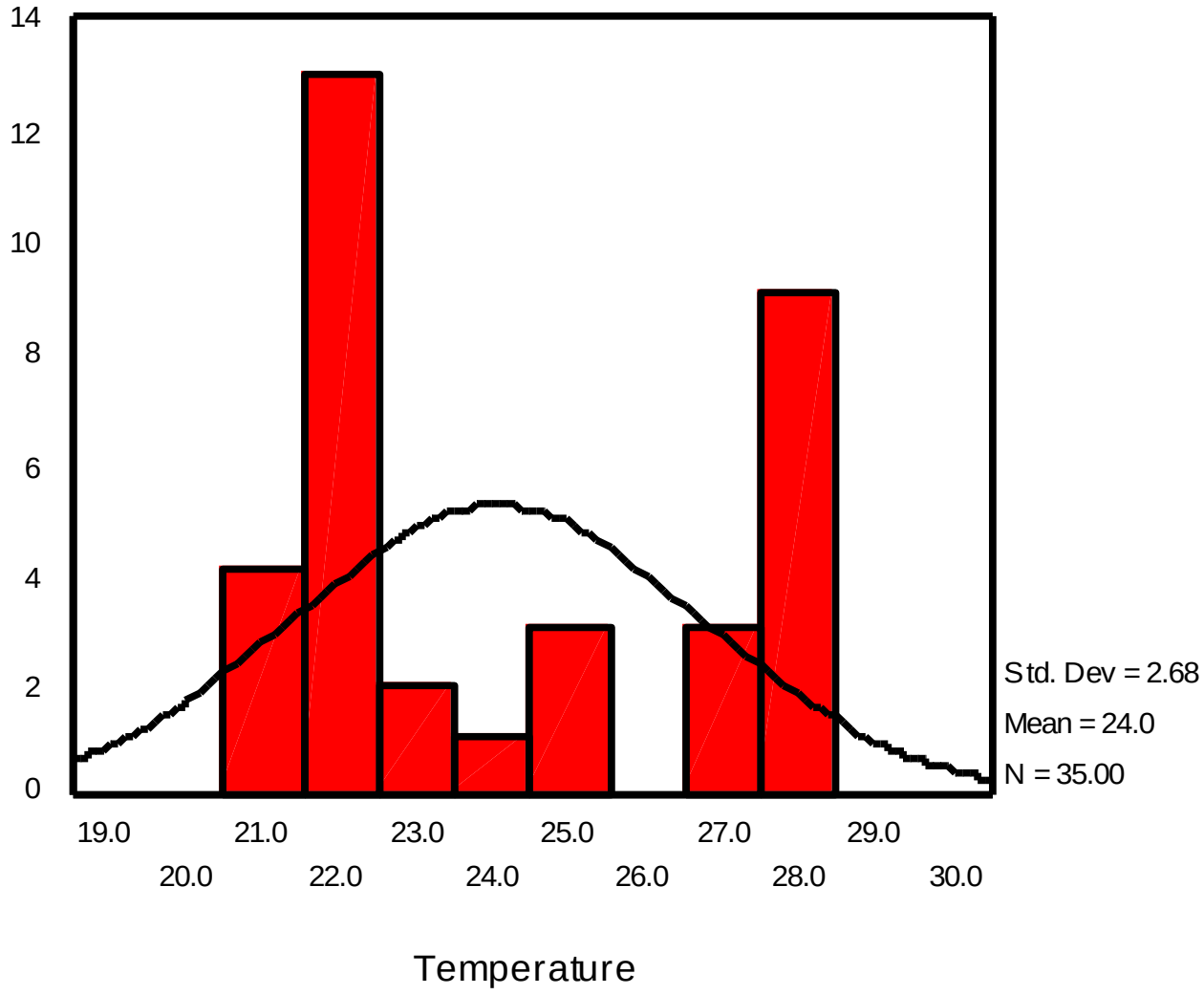

Figure 4.5: Temperature measurements for Windhoek Central Hospital

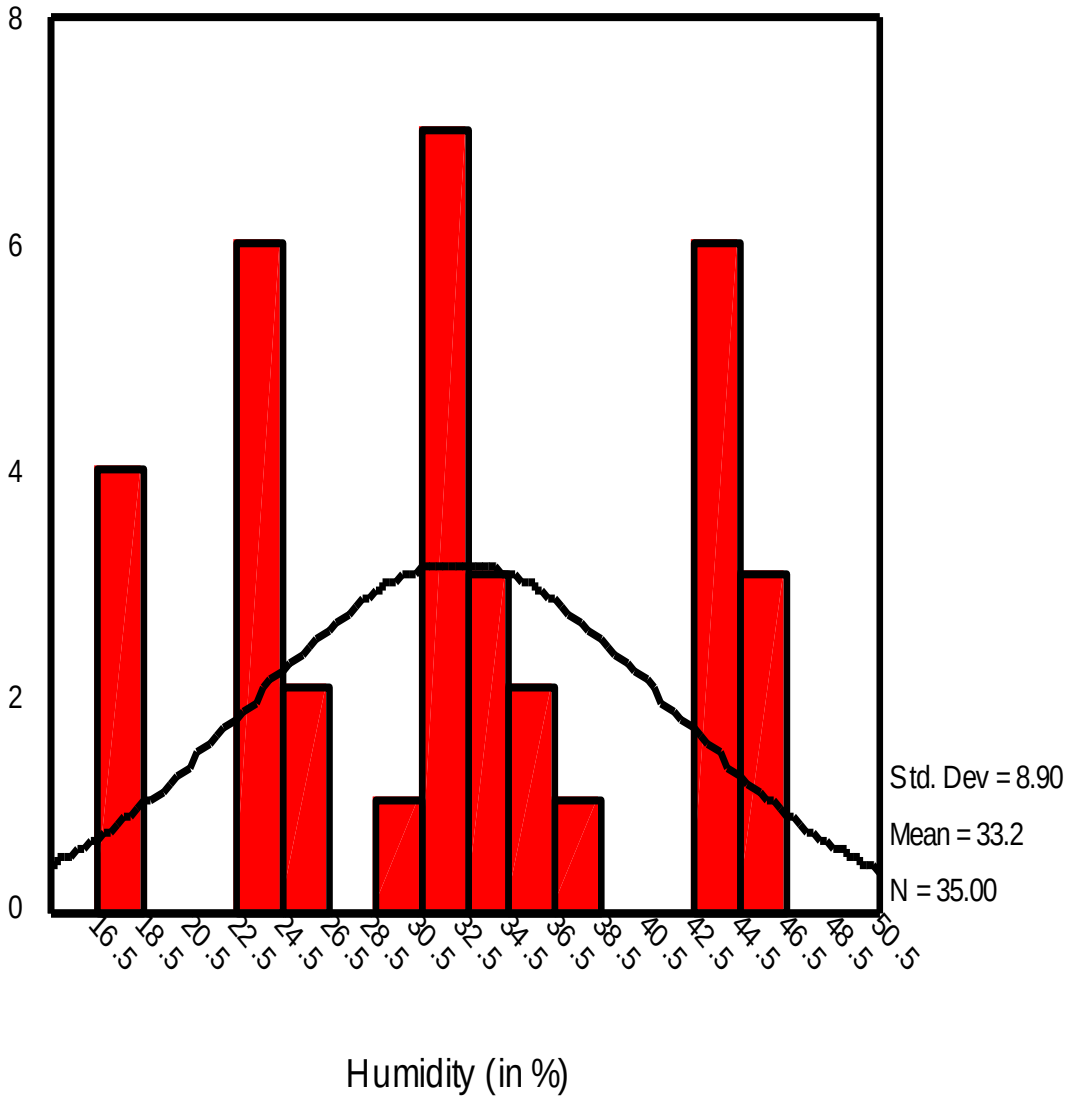

Figure 4.6: Relative humidity measurements for Katutura State Hospital

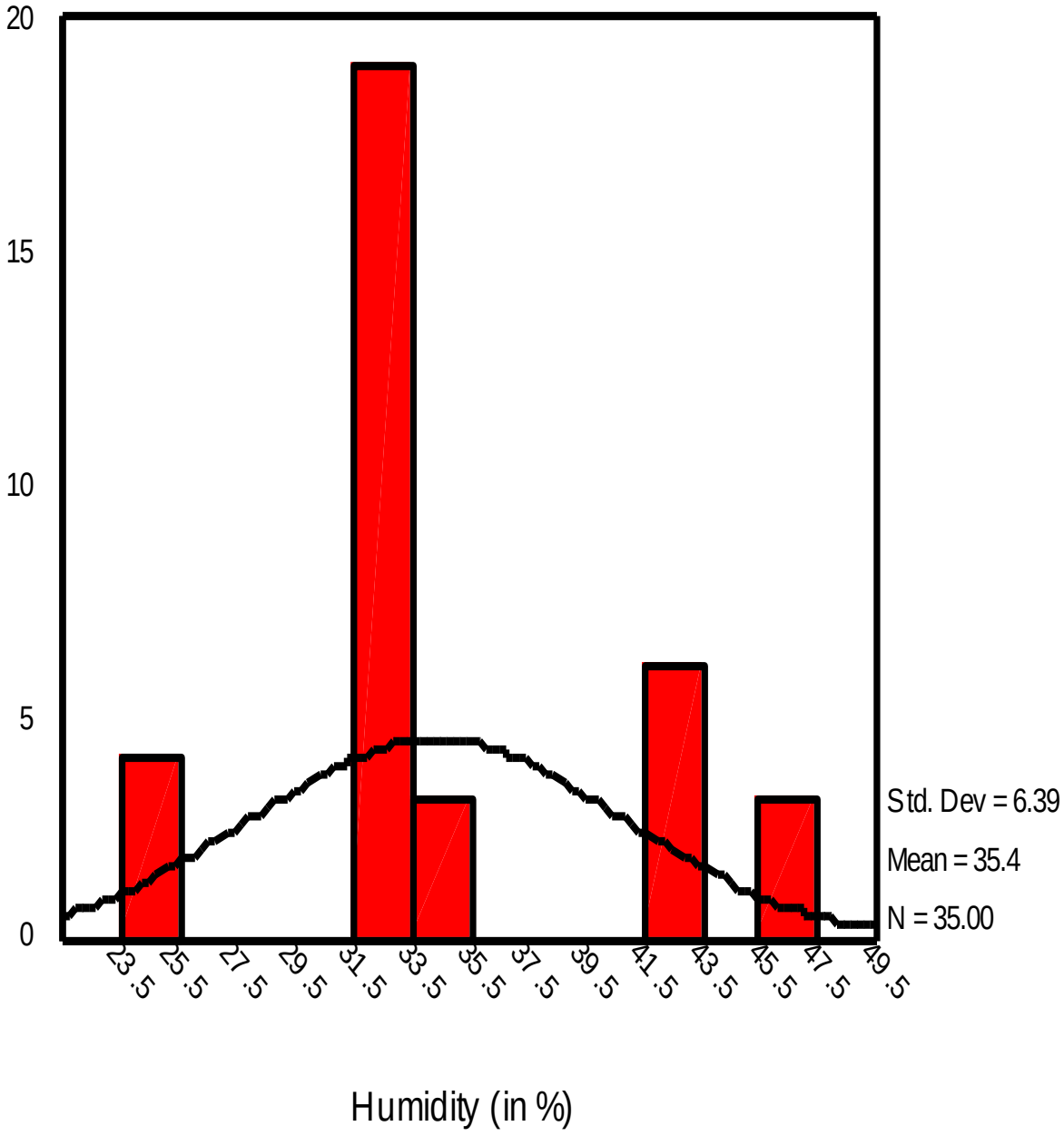

Figure 4.7: Relative humidity measurements for Windhoek Central Hospital

4.2.4 DARKROOM CHECK LIST

Prior to air sampling, information pertaining to unvarying characteristics of the each darkroom was recorded. This included noting where the darkroom is situated in relation to the main passage, x-ray rooms, offices and the external walls of the building.

Information on the type of entrance of the dark room, measurements of the size of the darkroom as well as the measurements of the distance between the waiting area, main passage, x-ray rooms, offices and toilets were obtained to determine whether the darkrooms complied with the international darkroom design criteria.

The following information was also recorded: presence of windows, extractor fans, blow fans, type of floor material, and the make and the model of the film processing machine. The film processing chemistry used, the position of the replenishment tanks and the storage of the new chemistry were noted. Table 4.1 gives the summary of the characteristics of the darkrooms that housed film processing machines.

Table 4.1: Characteristics of the darkrooms housing film processing machines.

Characteristics	**Katutura State Hospital**	**Windhoek Central Hospital**
Location of the dark room		
Entrance leads into a main passage	√	√
Entrance leads into a x-ray room		
Entrance leads into offices		
Entrance leads to external walls of building		
The type of entrance to darkroom		
Single door system		
Double door system		
Labyrinth door system	√	√
Rotating door system		
The size of the darkroom?		
Height	2.5M	2.5M
Width	$5M^2$	$10M^2$
Length	2,5M	2M
Distance in meters that the darkroom is in relation to:		
Patient waiting area	3.5M	3M
Main passage	1.5M	1M

X-ray room/s	1.5M	1.5M
Offices	2M	1.5M
Toilets	2.5M	2M
Are there windows in the darkroom?		
Yes		
No	x	x
If yes, Can it/they be opened?		
Yes		
No		
Are the windows sealed properly?		
Yes		
No		
Is there any light coming through?		
Yes		
No		
Is there an extractor fan in darkroom?		
Yes		
No	x	x
If Yes, is it working?		
Yes		
No		
How often is it cleaned?		

How often is it serviced?		
Where is the blow fan situated in relation to the extractor fan?		
Is there a blow fan present?		
Yes	√	√
No		
If Yes, is it working?		
Yes		
No	x	√
How often is it cleaned?	monthly	monthly
How often is it serviced?	yearly	yearly
Is there an air conditioner present?		
Yes		
No	x	x
If yes, is it working?		
Yes		
No		
How often is it cleaned?		
How often is it serviced?		
What is the temperature set at?	35°C	35°C
The type of floor material	Vinyl	Vinyl
Are there any chemical stains on the floor?		
Yes	√	√

No		
Type of processor present	Konica SRX-701	Alphatek AX 700 LE
Is it working?		
Yes	√	√
No		
How often is it cleaned?	weekly	weekly
How often is it serviced?	monthly	monthly
Are there any leakage areas in the processor/s?		
Yes	√	√
No		
The brand of developer and fixer used:		
Axim	√	√
Kodak		
Agfa		
Picker		
Fuji		
Autex		
Varix		
Dupont		
White mountain		
The position of the replenishment tanks		
Inside the darkroom		

Outside the darkroom	√	√
Location of the storeroom for new chemistry		
Nearby the patient waiting area		
In the main passage	√	√
In the x-ray room/s		
In the offices		
Nearby the toilets		
Number of people working at the same time in the darkroom?	2	3

√: indicates yes and X: indicates no

4.2.5 DESCRIPTIVE STATISTICS-PULMONARY FUNTION TESTING (PFT)

The PFT was obtained from a total of 39 participants. This study found no association between reduced pulmonary function and changes in the ambient concentration of SO_2 as depicted in Table 4.2. The number of participants in this study with normal pulmonary function was 87.2% for the exposed group and 100% for the control group. One participant resigned before the PFT was performed on him. The measurements for restrictive pulmonary functions were 13.8% for the exposed group and 0.0% for the control. The mean values for PFT for both study groups are presented in Table 4.2.

Table 4.2: Pulmonary function measurements for both study groups.

Variable	Exposed group	Control group
Normal PFT	87,2%	100%
Resigned	3.4%	0.0%
Restrictive PFT	13.8%	0.0%

4.3 INFERENTIAL STATISTICS- SYMPTOM FREQUENCY SURVEY

The proportions for categorical variables were compared between the two groups (exposed group and the control group) with χ^2 –test (Appendix N). The percentages of reported symptoms are presented in Table 4.3.

The most commonly reported of these symptoms were ear nose and throat illnesses, 38.5% of the exposed group and 10% of the control group (χ^2 =2.757; pf=1.P=0.097), followed in frequency by abnormal heart beat, headache, abnormal tiredness and skin illnesses.

Table 4.3 The symptom response rate for of the study groups.

Symptoms	**Exposed group (n=29)**	**Control group (n=10)**	**P-Values**
Ear, nose and throat illness	38.5%	10.0%	0.097
Headache	27.6%	0.0%	0.176
Abnormal tiredness	17.2%	0.0%	0.230
Abnormal heart beat	32.1%	0.0%	0.044
Skin illnesses	7.4%	0.0%	0.428

CHAPTER FIVE

DISCUSSION OF RESULTS

5.1 INTRODUCTION

The data collected were presented in Chapter 4 in the form of text, tables and figures. In this chapter the significance of the findings is discussed with reference to the main aim and further research questions.

5.2 THE RESEARCH QUESTIONS ADDRESSED IN THIS STUDY

The purpose of this study was to evaluate SO_2 fume levels and the prevalence of darkroom disease symptoms amongst medical imaging personnel in two diagnostic imaging departments in Namibia.

The specific objectives were

(i) To determine if there were areas in the selected departments that fall short of the recommended 2ppm occupational fume exposure limits.

(ii) To measure the SO_2 fume levels in the selected departments to determine whether the levels comply with exposure levels of TLV 2ppm or less as recommended.

(iii) To determine whether the SO_2 fume levels are higher in darkroom surrounds of the respective departments in comparison to other areas in the same departments.

(iv) To determine whether there is a relationship between SO_2 exposure levels and the prevalence rate of darkroom disease symptoms of the medical imaging personnel.

(v) To compare the prevalence rate of darkroom disease symptoms of the medical imaging personnel to those of the control group.

Further questions explored

(i) Whether the room temperature and relative humidity of the selected departments were ambient for the SO_2 sampling instrument.

(ii) Whether the designs of darkrooms of the selected x-ray departments complied with the international recommendation for the construction of a darkroom.

(iii) Finally to analyze whether any significant relationship existed between diminished pulmonary functions of the participants and their exposure to SO_2.

5.3 SULPHUR DIOXIDE FUME LEVELS

The recorded SO_2 fume levels were lower than the recommended limit of 2ppm for both x-ray departments, compared with the findings of Brennan, *et al*., (1996) where it is reported that the mean fume levels reached 2,92ppm. Teschke *et a*l., (2000) measured mean exposure to be less compared to existing occupational exposure standard. Geometric means for this study for SO_2 was P=0.001.The measurements for the reception area and tearoom for both hospitals were below detection limits. None of

the measurements exceeded the recommended occupational exposure limit. Even though Tarlo *et al*., (2004) in their study did not assess exposure to chemicals in the workplace they indicated an association between self-reported indicators of increased exposure to workplace chemicals and symptoms among medical radiation technologists.

The findings of this study indicate that medical imaging personnel in the two state hospitals in Namibia selected for this study had exposures to SO_2 at levels well below the current NIOSH recommended exposure limits. The fact that the two sites use auto-mixers could have contributed to low SO_2 levels however in places where manual mixing of chemistry takes place the readings could be higher. Despite the low SO_2 levels, exposed personnel are developing illness, thus making it difficult to qualify the darkroom disease.

5.4 SYMPTOM FREQUENCY SURVEY

The response rate for the exposed group and unexposed group was 64% and 100% respectively. The possible reasons which could have contributed to a lower response rate for the exposed group are scheduling of radiographic examinations, vacation leave, sick leave, resignation and scheduling of work shifts.

On analysis of the questionnaire data on symptoms prevalence it was found that the exposed group for both hospitals suffered from ear, nose and throat illnesses, headaches, abnormal tiredness, abnormal heart beat and skin illnesses which are normally associated with exposure to SO_2 fumes. The most significant symptoms measured in both exposed group and the control group was ear, nose and throat illnesses. In addition to these common symptoms the exposed group also reported headache, chest illness, nausea, painful joints, ringing ears, skin rash, lip sores, mouth sores, abnormal heart beat and numbness of arms and legs.

The American Industrial Hygiene Association (1987) reported in their hygiene guides series for SO_2 that there were two cases of individuals who developed skin eruptions after repeated inhalation of high concentrations. In a later test by the American Industrial Hygiene Association it was found that a 30 minute exposure to 10 ppm SO_2 or an one hour exposure to 4ppm SO_2 could produce skin eruption. According to Sandstrom *et al.,* (1989a) a 20 minute exposure to 8 ppm gas produced reddening of the throat and mild nose and throat irritation. The current study did not however have any reports of skin eruptions. It is postulated that this could be due to low air concentrations of SO_2 as reported in Chapter 4.

These symptom clusters were more common among exposed groups compared to their control groups. According to Hewitt, 1993 these symptom clusters were selected as being representative of the symptoms previously reported among those workers with darkroom disease. Similarly Genton, 1998 findings do not differ from previous reports of darkroom disease. The darkroom disease symptom clusters reported by the control group for the current study were not due to exposure to SO_2. However the findings indicate an association between exposure to SO_2 and symptoms among the exposed group. A survey carried out by the Society of Radiographers in Britain also reported an increase in nose and eyes symptoms and are similar to those of persons exposed to SO_2 in mining and allied occupations (Kolarzyk, *et al.*,2000; Rom *et al.*, 1986; Smith *et al.*, 1977).

The symptoms reported for the current study were also noted as being less of a problem on days away from work. This could suggest that these symptoms may be related to exposure to the Autex RP x-ray fixer and replenisher and Autex RP x-ray developer and resplenisher chemistry supplied by Axim, which were used in the 2 department during the time of data collection. The researcher's definition of darkroom disease was met by the exposed group because they experienced all five symptoms included in the cluster defining darkroom disease, while on the other hand

the control group only reported one of the five symptom cluster namely ear, nose and throat illness.

The findings of this study compare favorably with those of Tarlo *et al*., (2004). They performed a study on 2,761 medical radiation technologist and found, as was the case in this study, that sore throat, headache, sore or itchy eyes, abnormal tiredness and runny nose were significant symptoms of SO_2 exposure. They also noted several of the darkroom disease symptoms, namely nose and eyes symptoms could potentially be triggered by mucous membrane irritant effects.

5.5 TEMPERATURE AND RELATIVE HUMIDITY

The results presented in 4.2.3 show that the room temperature and relative humidity measured were within the acceptable parameters of the SO_2 sampling instruments for both x-ray departments. The average temperature readings for both the Katutura State Hospital and the Windhoek Central Hospital were 23.6ºC, standard deviation 2.60ºC and 24.0ºC, with standard deviation of 2.68ºC respectively. As depicted in Figure 4.6 median relative humidity for Katutura State Hospital was 33.2% with standard deviation of 8.90%. Mean relative humidity for the Windhoek Central Hospital was 35.4%, with standard deviation of 6.39% as displayed in Figure 4.7. The above findings indicate that SO_2 measurement conditions were optimum.

5.6 DARKROOM CHECKLIST

In the facilities studied, there were two automatic film processing machines housed in each darkroom. None of the darkrooms had windows, extraction fans, blow fans or air conditioners, thereby presenting occupational hazard of chemical exposure to the medical imaging personnel. The characteristics of facilities studied are summarized in Table 4.1.

Usage of low odor fixer replenisher chemistry in the two study sites could be the contributing factor for low SO_2 fume levels measured around the auto-mixer and the processors. According to Autex chemistry manufacturers low odor fixer replenisher chemistry is a fixer that seeks to mask odors with perfumes or fragrances (email communication with P.Mostert on 29 June 2006). Material safety data sheets as well as specifications on x-ray chemistry for Autex chemistry is provided for information on the chemistry used at the selected hospitals in the current study (Appendix O to Q). A special formulation reduces emissions of odor-causing acetic acid and SO_2 to significantly improved processing. To determine how representative the sampled sites were, the respective measurements of SO_2 for the four designated areas where compared in Figure 4.3. The results demonstrate a very definite trend where fume

levels are greatest close to the auto-mixer of the chemistry and in the darkroom but significantly less than 2ppm for both hospitals.

The data indicate that the darkrooms in this study are cramped and poorly ventilated. Automatic processors can generate considerable heat to hasten the film development process, thus it is imperative that the darkroom ventilation meets current international guidelines of a minimum rate of 10 room air changes per hour (ACH), measured as exhausted air. The primary purpose of general ventilation in the darkroom is the removal of excessive heat, moisture, trace amounts of vapors and gases. If there are significant amounts of toxic chemicals in the room (e.g. any SO_2 fume above 2ppm), local exhaust ventilation is needed, however in this study the darkroom checklist data indicates that neither of the darkrooms in the study complies with the recommended guidelines in terms of ventilation. The installation of equipment should comply with the manufacturer's specifications. In both departments the replenishment tanks are located outside the darkroom, thus the supplier's specifications were met in this regard. These tanks are potential sources of vapor release and may require a local exhaust hood.

According to technical handbook for environmental health and engineering of Indian Health Services there are reports indicating that silver recovery units may be a source of exposure to the processing chemicals if the lid to

the recovery unit is not tightly applied and or if the unit is not properly installed, and the solution backs up or floods the floor.

The findings of the current investigation emphasize the need for every medical imaging department to set up a program to ensure effective and regular monitoring of fume levels in all departments which employ automatic x-ray processors.

5.7 PULMONARY FUNCTION TESTING

Several human studies show that repeated exposure to low levels of SO_2 caused permanent pulmonary impairment. This effect is probably due to repeated episodes of bronchoconstriction. According to Smith *et al.*, (1977) decreased lung function was found in smelter workers who had been exposed for over one year to 1-2.5ppm SO_2. No effects were seen in the same study in workers exposed to less than 1ppm. In a study by Sandstorm *et al*., (1989b), a high incidence of respiratory symptoms was reported in workers exposed to 20-30ppm for an average of four years. Workers exposed to a daily average of 5ppm SO_2, with occasional peaks of 53ppm, had a much higher incidence of chronic bronchitis than their control groups.

Ericsson (1983) argued that sensitivity varies amongst people, however, short exposure, of one to six hours, to concentrations as low as 1 ppm

may produce a reversible decrease in lung function. Galea (1964) and Charan *et al.,*(1979) reported severe cases when very high concentrations of SO_2 were produced in closed spaces, the SO_2 caused severe airway obstruction, hypoxemia, pulmonary edema and death in minutes. In their opinion permanent lung injury may occur as a result of severe exposure.

The results of this study are consistent with the finding of Aekplakorn *et al*., 2003 which showed a modest negative association between pulmonary function and SO_2 fume levels. No significant changes in the pulmonary functions of the participants were observed by the researcher, this could be due to low levels of SO_2 fumes measured for the current study.

APPENDIX A

Enquires:Ms.C.Damases
Tel: (09264-61: 2063474)

Ms.C.Damases
P.O Box 2888
Windhoek
Namibia

28 JUNE 2002

University of Namibia
Private bag 13301
Windhoek
Namibia

Dear Prof.Van Dyk

RE: PERMISSION TO CONDUCT RESEARCH

I, Damases Christine would hereby like to request permission to conduct research within the faculty of Medical and health Sciences.

The title of the study is as follows: **An evaluation of sulphur dioxide fume levels and the prevalence of darkroom disease amongst radiology workers in Namibia.**

If permission is granted the staff and students of the faculty will be used as her control group. The participants will have to take part in the study on voluntary basis. Each of them will receive a participant information sheet and will have to sign an informed consent form. Attached please find my research proposal as requested by the research committee.

Your consideration of the above matter will be highly appreciated.

Yours sincerely,

_____
Ms.C.Damases

APPENDIX B

Enquires:Ms.C.Damases
Tel: (09264-61: 2063474)

University of Namibia
Private bag 13301
Windhoek
Namibia

30 JUNE 2002

Durban Institute of Technology
P.O. Box 953
Durban
4000

Dear Ms. Moodley

RE: PERMISSION GRANTED TO Ms.C.DAMASES TO CONDUCT RESEARCH

Permission is hereby granted to Ms.C.Damases to conduct research in the Faculty of Medical and Health Sciences (radiography). She will be using the students and the staff members of the faculty as her target/control group, provided that they have volunteered to be included in the study and have signed an informed consent form.

A.Van Dyk
Dean: faculty of medical and health sciences

APPENDIX C

UNIVERSITY OF NAMIBIA

FACULTY OF MEDICAL AND HEALTH SCIENCES

RADIOGRAPHY DEPATMENT

You are invited to participate in research conducted by Ms.C.Damases of the radiography departmnet at the university of Namibia, who may be contacted at the details below. The study will evaluate the sulphur dioxide fume levels in the x-ray processingchemistry and it's effects on the health of the radiology workers. In order for the researcher to consider the effects of SO_2 exposure to yourself a standard self-adminstered questionnaire will be given to you to complete.

The questionnaire is compose of written questions about your medical history, occupational history and sypmtom frequency related to sulphur dioxide exposure. You will also be requested to undergo a pulmonary function test. The pulmonary function test will be conducted by a qualified person identified by the researcher. The parameters evaluated will be the lung functions.

Contact details:

Ms.C.Damases Tel: 2063474(W) 216767(H)
0812690678(Cell)
Faculty of Medical and Health Sciences Fax: 2063922
Radiography Department
University of Namibia

APPENDIX D

PARTICIPANT INFORMATION LETTER

DURBAN UNIVERSITY OF TECNOLOGY: DEPARTMENT OF RADIOGRAPHY

Title: AN EVALUATION OF SULPUR DIOXIDE FUME LEVELS AND THE PREVALENCE OF DARKROOM DISEASE SYMPTOMS AMONGST RADIOLOGY WORKERS IN NAMIBIA.

Dear participant

I am conducting a survey of various radiography departments in Windhoek. The study will determine the sulphur dioxide (SO_2) levels in the x-ray department and evaluate it's effects on the health of the radiology workers. The aim of the study is to mainly create awareness of occupational hazards posed by processing chemistry to radiology workers.

PROCEDURE:
In order to consider the effects of SO_2 exposure to yourself a standard self-administered questionnaire will be given to you to complete. The questionnaire asks about your geographic location, medical history, occupational history and symptom frequency related to SO_2 exposure. The questionnaire should take about 30 minutes to answer.

A qualified person will also do a pulmonary function test on you. This will be used to determine your lung function. This procedure will take about 10 minutes. The researcher will provide you with the dates, time and place where this test is going to be run on who, as will as with the name of the person who will be performing the test on you.

RISKS / DISCOMFORT

The risk will be minimal for most participants when taking the pulmonary function test. There is a small risk of collapsed lung in people with certain type of lung disease. The test will not be given to participants who have experienced a recent heart attack and in certain other types of heart diseases and lung diseases.

BENEFITS:
The study aims to improve the radiology workers' understanding of the effects of the occupational exposure to SO_2.

CONFIDENTIALITY:
Ethical approval has been obtained from the relevant sources. All information obtained from you will be treated confidentially and will be used for research purposes only. Names will be excluded from data analysis and data presentation. Please be aware that you are free to withdraw at any stage of the project.

COST TO PARTICIPANT:

Participation is at no cost.

PERSON TO CONTACT FOR PROBLEMS OR QUESTIONS:
Ms.C.Damases
Tel: (W) 2063474 (H) 216767
Cell: 0812690678
E-mail: cdamases@unam.na / damasesc@hotmail.com

APPENDIX E

INFORMED CONSENT FORM

I, ……..hereby voluntarily
print name

give consent to participate in the research entitled:

AN EVALUATION OF SULPHUR DI OXIDE FUME LEVELS AND THE PREVALANCE OF DARKROOM DISEASE SYMPTOMS AMONGST RADIOLOGY WORKERS IN WINDHOEK

Conducted by:
Name of researcher: Ms Christine Damases

Name of supervisor: Ms Loganee Moodley (DIT – Department of Radiography)

Name of co- supervisor: Ms. M.L.C. Munro (Radiography, King Edward VIII Hospital)

PLEASE CIRCLE THE APPROPRIATE ANSWER:

1	Have you read and understood the research information sheet?	YES / NO
2	Have you had an opportunity to discuss the study?	YES /NO
3	Have you had an opportunity to ask questions regarding this study?	YES /NO
4	Have you received satisfactory answers to your questions?	YES / NO
5	Have you received enough information about the study?	YES / NO
6	Do you understand that you are free to withdraw from this study: a) at any time and;	
	b) without having to give reason for withdrawing?	YES / NO
7	Do you agree to voluntarily participate in this study?	YES / NO

If you have answered NO to any of the above questions, please obtain the appropriate information BEFORE signing.
Please print clearly in block letters:

Subject Name:_____ signature

Witness Name _____signature

Date:_ -

APPENDIX F

SO_2 DATA SHEET

Key:
A: Automixer
B: Darkroom
C: Tearoom
D: Reception area

Location	Katutura Hospital Week 1					Windhoek Central Hospital Week2					Katutura Hospital Week 3					Windhoek Central Hospital Week 4				
Month 1: Date	08\08-12/08					15/08-19/08					22/08-26/08					29/08-02/09				
A																				
B																				
C																				
D																				
Temperature																				
Humidity																				
Month 2: Date	05/09-09/09					12/09-16/09					19/09-23/09					26/09-30/09				
A																				
B																				
C																				
D																				
Temperature																				
Humidity																				
Month 3: Date	03/10-07/10					10/10-14/10					17/10-21/10					24/10-28/10				
A																				
B																				
C																				
D																				
Temperature																				
Humidity																				
Month 4: Date	31/10-04/11					7/11-11/11														
A																				
B																				
C																				
D																				
Temperature																				
Humidity																				

APPENDIX G

Participant no	
PFT results	

STRICTLY CONFIDENTIAL

DURBAN UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF RADIOGRAPHY: QUESTIONNAIRE

AN EVALUATION OF SULPHUR DIOXIDE FUME LEVELS IN X-RAY DEPARTMENTS IN WINDHOEK

A survey is being conducted in order to evaluate the sulphur dioxide fume levels at the University of Namibia in Faculty of Medical and Health Sciences. As part of the study it is necessary to establish a symptom profile of the population and to compare this with a control matched for age and gender. It would be appreciated if you could complete this questionnaire.

IDENTIFICATION INFORMATION

Name:……

Section 1: General information

		For office use
How old are you?		
a) Under 18	□	1
b) Between 18-25	□	2
c) Between 26-32	□	3
d) Between 32-40	□	4
e) Between 40-50	□	5
f) Above 50	□	6
specify:	……..	

1.2.2 What gender are you?

a) Female □ 1

b) Male □ 2

1.2.3 Race

(information required to match our sample and control)

a) Black □ 1

b) Colored □ 2

C) Asian □ 3

c) White □ 4

d) Other 5

specify: ……..

1.1.4 Current occupation: ……..

1.1.5 How long have you been in your current occupation at this hospital?

a) Less than 1 year □ 1

b) 1-10 years □ 2

c) 11-20 years □ 3

d) 21-30 years □ 4

e) Over 30 years □ 5

specify: ……..

Section 2: Exposure to factors which influence health

2.2.1 Are you:

a) A current smoker □ 1

b) A former smoker □ 2

c) A non-smoker □ 3

2.2.2 If a current or former smoker how many cigarettes do/did you smoke each day?

a) 6-10 □ 1

b) 11-20 □ 2

c) 21-30 □ 3

d) 31-40 □ 4

e) Above 40 □ 5

specify: ……

f) Pipe □ 6

2.2.3 Have you ever been knowingly exposed to sulphur dioxide in the course of your work?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

2.2.4 If you answered, “yes” to 2.2.3, for how long have you been exposed?

a) 1-10 years □ 1

b) 11-20 years □ 2

c) 21-30 years □ 3

d) Over 30 years □ 4

specify: ……..

Section 3: Health and illness information

3.3.1 Have you ever been diagnosed as asthmatic?

a) Yes □ 1

If yes, what symptoms that you had/have? …… 2

……

b) No □ 3
c) Uncertain □

3.3.2 Have you ever suffered from other chest illness?

a) Yes □ 1

specify: ……

b) No □ 2
c) Uncertain □ 3

3.3.3 In the past 6 months have you had more than two episodes of headaches?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.3.1 If yes, do you have this on

a) Most days □ 1

b) Most weeks □ 2

c) Most months □ 3

d) Other □ 4

specify: ……

e) Uncertain □ 5

3.3.3.2 Was this better on days away from work?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.4 In the past 6 months have you had more than two episodes of nausea?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.4.1 If yes, do you have this on

a) Most days □ 1

b) Most weeks □ 2

c) Most months □ 3

d) Other □ 4

specify: ……

e) Uncertain □ 5

3.3.4.2 Was this better on days away from work?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.5 In the past 6 months have you had more than two episodes of runny nose?

a) Yes	□	1
b) No	□	2
c) Uncertain	□	3

3.3.6.1 If yes, do you have this on

a) Most days	□	1
b) Most weeks	□	2
c) Most months	□	3
d) Other	□	4
specify:	…….	
e) Uncertain	□	5

3.3.6.2 Was this better on days away from work?

a) Yes	□	1
b) No	□	2
c) Uncertain	□	3

3.3.7 In the past 6 months have you had more than two episodes of irritation of the throat?

a) Yes	□	1
b) No	□	2
c) Uncertain	□	3

3.3.7.1 If yes, do you have this on

a) Most days □ 1

b) Most weeks □ 2

c) Most months □ 3

d) Other □ 4

specify: …….

e) Uncertain □ 5

3.3.7.2 Was this better on days away from work?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.7 In the past 6 months have you had more than two episodes of feelings of unexpected fatigue?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.7.1 If yes, do you have this on

a) Most days □ 1

b) Most weeks □ 2

c) Most months □ 3

d) Other □ 4

specify: …….

e) Uncertain □ 5

3.3.9 In the past 6 months have you had more than two episodes of ringing in the ears?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.10.1 If yes, do you have this on

a) Most days □ 1

b) Most weeks □ 2

c) Most months □ 3

d) Other □ 4

specify: …….

e) Uncertain □ 5

3.3.10.2 Was this better on days away from work?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.10 In the past 6 months have you had more than two episodes of skin rash?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.11.1 If yes, do you have this on

a) Most days □ 1

b) Most weeks □ 2

c) Most months □ 3

d) Other □ 4

specify: …….

e) Uncertain □ 5

3.3.11.2 Was this better on days away from work?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.12 In the past 6 months, have you had more than two episodes of lip sores?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.12.1 If yes, do you have this on

a) Most days □ 1

b) Most weeks □ 2

c) Most months □ 3

d) Other □ 4

specify: …….

e) Uncertain □ 5

3.3.12.2 Was this better on days away from work?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.13 In the past 6 months have you had more than two episodes of Sores in the mouth?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.13.1 If yes, do you have this on

a) Most days □ 1

b) Most weeks □ 2

c) Most months □ 3

d) Other □ 4

specify: …….

e) Uncertain □ 5

3.3.13.2 Was this better on days away from work?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

3.3.14 In the past 6 months have you felt you heart beating abnormally on more than two occasions?

a) Yes □ 1

b) No □ 2

c) Uncertain	□	3
3.3.14.1 If yes, do you have this on		
-a) Most days	□	1
b) Most weeks	□	2
c) Most months	□	3
d) Other specify: …….	□	4
e) Uncertain	□	5
3.3.14.2 Was this better on days away from work?		
a) Yes	□	1
b) No	□	2
c) Uncertain	□	3
3.3.15 In the past 6 months have you had more than two episodes of unusual numb arms and legs?		
a) Yes	□	1
b) No	□	2
c) Uncertain	□	3
3.3.15.1 If yes, do you have this on		
a) Most days	□	1
b) Most weeks	□	2
c) Most months	□	3
d) Other specify: …….	□	4
e) Uncertain	□	5
3.3.15.2 Was this better on days away from work?		
a) Yes	□	1
b) No	□	2
c) Uncertain	□	3

Section 4: Exposure to external factors

4.4.1 Do you live in an industrial area?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

4.4.1.1 If yes, for how long have you been living there?

a) Less than 1 year □ 1

b) 1-10 years □ 2

c) 11-20 years □ 3

d) 21-30 years □ 4

e) More than 30 years □ 5

specify: ……

4.4.2 Do you share your home with people that smoke?

a) Yes □ 1

b) No □ 2

c) Uncertain □ 3

4.4.2.1 If your response to question 4.4.2 was yes, how many cigarettes are smoked inside your home every day?

a) Less than 5 □ 1

b) 6-10 □ 2

c)11-20 □ 3

d) 21-30 □ 4

e) Above 30 □ 5

specify: ……..

f) Uncertain □ 6

4.4.3 Do you or your family burn any of the following at home?

a) Incense	□	1
b) Wood	□	2
c) Paraffin	□	3
d) Coal	□	4
e) Gas	□	5

4.4.3.1 If yes, how often? …….

On completion of the questionnaire please hand it in at the office of your respective supervisor.

Thank you for your assistance.

If you have further questions or can provide more information about this problem, please call:

Ms. Damases. C
Faculty of medical and health sciences
Radiography Department
University of Namibia
Tel: 2063474(w) 216767(h) Cell: 0812531388
Fax: 2063922
e-mail: cdamases@unam.na/damasesc@hotmail.com

APPENDIX H

5th June 2006

Head of Department: Ms.S.Naidoo
Durban Institute of Technology
Faculty of Health Sciences-Radiography
P.O Box 953
Durban

Dear Ms. Naidoo,

RE: STATISTICAL CONSULTATIONS

This is to confirm that Christine Damases (Student No.: 20000583) consulted the following people to receive help in statistical analysis needed for her study:

1) Dr. MAE Muller – during the initial stages of her study where help received included study design and analysis of data from the pilot study,
2) Ms. AG Kaduma – during the final stages of her study where help received included analysis of data from the actual study as well as presentation of the results from the analysis.

We, the above-mentioned, are lecturers in the Statistics Department, Faculty of Science, University of Namibia.

Dr. MAE Muller
Lecturer
Statistics Department
University of Namibia
Tel.: (+264 61) 206 3958
Email: mmuller@unam.na
akaduma@unam.na

Ms. AG Kaduma
Lecturer
Statistics Department
University of Namibia
Tel.: (+264 61) 206 3411
Email:

APPENDIX I

Darkroom Questionnaire

CODE: _____ Date: _____

1. Where is the darkroom situated?

   a) Does it's entrance lead into a main passage
   b) Does it's entrance lead into a x-ray room
   c) Does it's entrance lead into offices
   d) Does its entrance lead to external walls of building

2. What type of entrance does the darkroom have?

   a) Single door system
   b) Double door system
   c) Labyrinth door system
   d) Rotating door system

3. What is the size of the darkroom? _____
   3.1 Height _____
   3.2 Width _____
   3.3 Length _____

4. Indicate distance in meters that the darkroom is in relation to:

   4.1 Patient waiting area _____
   4.2 Main passage _____

   4.3 X-ray room/s
   4.4 Offices _____
   4.5 Toilets _____

5. Are there any windows in the darkroom? Yes No

If yes,
   5.1 Can it/they be opened? Yes No
   5.2 Are they sealed properly? Yes No
   5.3 Is there any light coming through? Yes No

6. Is there an extractor fan present? Yes No

If Yes,
   6.1 Is it working? Yes No
   6.2 How often is it cleaned? _____

6.3 How often is it serviced? _____

6.4 Where is the blow fan situated in relation to the extractor fan? _____

7. Is there a blow fan present? Yes No

If Yes,

7.1 Is it working? Yes No

7.2 How often is it cleaned? _____

7.3 How often is it serviced? _____

8. Is there an air conditioner present? Yes No

If yes,

8.1 Is it working? Yes No

8.2 How often is it cleaned? _____

8.3 How often is it serviced? _____

8.4 What is the temperature set at? _____

9. What material is the floor covered with? _____

9.1 Are there any chemical stains on the floor? Yes No

10. What type of processor is present? _____

10.1 Is it working? Yes No

10.2 How often is it cleaned? Yes No

10.3 How often is it serviced? Yes No

10.4 Is there any leakage areas in the processor/s? Yes No

10.5 Which chemicals constitute the developer and fixer solutions?

_____ _____

_____

_____

_____

10.6 Which brand of developer and fixer is used ? Kodak
Agfa
Picker
Fuji
Autex
Dupont
Varix
White mountain
Axim

11. Where are the replenishment tanks situated? _____

12. Where are the stocks of new chemistry situated?
    a) Nearby the patient waiting area
    b) In the main passage
    c) In the x-ray room/s
    d) In the offices
    e) Nearby the toilets

13. How many people work are usually working at the same time in the darkroom?

COMMENTS:

TECHNICAL HANDBOOK FOR ENVIRONMENTAL HEALTH AND ENGINEERING
VOLUME III - HEALTH CARE FACILITIES DESIGN AND CONSTRUCTION
PART 21 - DESIGN CRITERIA AND STANDARDS
April 9, 1997 (21-4) 10 TN - 5
CHAPTER 21-4 MECHANICAL GUIDELINES

21-4.8 DARKROOM VENTILATION

A. Purpose

To provide guidelines for Indian Health Service (IHS) new construction, renovation, and operation of existing health care facilities in designing and equipping medical imaging darkrooms to control exposure to toxic chemicals.

B. Background

The toxic chemicals used in medical imaging darkrooms may cause dermal or respiratory diseases in exposed individuals. In each case where medical imaging staff were affected by occupational chemical exposures, safer work practices were needed and problems were found with the installation of equipment and room ventilation. Appropriate equipment installation and room ventilation are critical elements in the prevention of occupational disease in staff.

There are at least 300 agents known to cause occupational allergy,including several agents used in medical imaging. Also, there are other potentially-hazardous products used in film processing causing such health effects as dermal and respiratory irritation.These products are used in differing concentrations and combinations depending on the product brand and manufacturer.

The potential health effects from chemical mixtures and byproducts are unknown. The mixing of processor chemical components may cause the release of sulfur dioxide, another respiratory toxin. There are reports indicating that silver recovery units may be a significant source of sulfur dioxide if the filters are not changed regularly. This unit can also be a source of exposure to the processing chemicals if the lid to the recovery unit is not tightly applied and/or if the unit is not properly installed, and the solution backs up or floods the floor.

Currently, many IHS medical imaging darkrooms are cramped and poorly ventilated. Automatic processors can generate considerable heat to hasten the film development process. While the processor manufacturers specify minimum space and mechanical requirements, these design criteria are often ignored by the designers and contractors.

Current processor design requires the operator to come in close contact with the chemicals while removing and cleaning cross-over rollers and processor racks. Despite close contact with toxic chemicals, the medical imaging staff are seldom required to use personal protective equipment when performing these tasks.

Many smaller operations do not have automixers, requiring hand mixing of solutions. This increases the potential for exposure to toxic chemicals.

C. Design Criteria

(1) The critical elements to reduce exposure to toxic chemicals in medical imaging are proper equipment installation and adequate room ventilation. IHS staff and the architect/engineering (A/E) staff should review and verify the following design criteria:

a. Review designs and specifications to assure that the darkroom is ventilated at a minimum rate of 10 room air changes per hour (ACH), measured as air exhausted; under negative pressure; and that all air is exhausted directly to the outside. Sufficient make-up air must be allowed to assure proper operation of the system. If there is a possibility of accumulation of toxic vapors, i.e., if chemical tanks are located inside the darkroom, the exhaust blower should be wired to run continuously. The termination of the exhaust duct should discharge at least 8 meters (m) from any supply inlet.

In many locations, the chemical tank for the processor is located outside the darkroom in a small alcove. Unless the area is well ventilated, i.e., at least 10 ACH with no recirculation, a small slot hood exhaust system should be installed in the wall above the tank. While there are no standard designs for venting an automatic processor, the American Conference of Governmental Industrial Hygienists has design criteria for similar applications. One effective method would be to provide a slot hood with dimensions of 50 millimeters (mm) in height and as long as the processor tank in wide. The system should be capable of exhausting at a rate of 75 meters per minute at an effective distance of 150 mm from the hood, e.g., for a 800 mm (30 inches) wide processor and a flanged hood, the exhaust blower should be capable of removing a least 280 liters per second to 420 liters per second (600-900 ft^3/min) of air.

In addition, the chemical replenishment tank is often located outside the darkroom. This tank may also be a source of toxic vapor release and may require a local exhaust hood similar to that described above. Leakage from this tank can be minimized by assuring that the floating lids and tight fitting covers are in place.

b. Provisions will be made for the installation of equipment in compliance with the manufacturer’s specifications. An exhaust duct must be

connected to the film dryer to discharge contaminants directly to the outside. Also, this exhaust duct should be constructed of smooth plastic, aluminum, or galvanized iron materials equipped with an air regulator assembly to attain maximum efficiency. One manufacturer's specifications call for a negative static pressure of 0.75 mm and 1.0 mm of water to be maintained in the vent. Project planning should also include the purchase of a pitot tube and inclined manometer or other appropriate pressure measuring instrument to be used in evaluating static pressures as a part of a preventive maintenance program.

c. Each manufacturer also provides specifications for processor space requirements. These requirements must be followed to assure minimum clearances to maintain and service the unit. Also, space requirements for silver recovery or other critical functions must be considered in the darkroom design. A particular concern is the arrangement of pipes and electrical connections to eliminate tripping hazards. Processor manufacturers may also specify approved materials for waste piping, e.g., one manufacturer prohibits the use of copper piping and recommends only galvanized iron or polyvinyl chloride materials. The Area Institutional Environmental Health staff should be consulted regarding the space and plumbing design of this area.

d. If the project calls for a day-light loading processor, minimum space clearances should be provided per manufacturer's specifications and the room should be ventilated at a rate of at least 10 ACH with no recirculation.

e. The feasibility of specifying a processor using a glutaraldehyde-free fixer should be considered. This would eliminate one chemical that has been demonstrated to cause sensitization; however this process is a new technology that is not suitable for all single emulsion films.

f. The design will include the installation of a utility sink in close proximity to the automatic processor.

g. Provisions will be made to specify the installation of an automixer for replenishment solutions.

h. Provisions will be made to specify the installation of an ANSI approved eyewash station (Z358.1) in the department near the area where chemicals are mixed. An on-the-faucet eyewash unit is not acceptable if it is the same sink used to clean crossover racks because of the potential for contaminating the eyewash unit.

(2) The processor and ventilation systems should be evaluated at least once a year to assure the absence of leaks, and to verify minimum air exchange rates and negative static pressures in the processor vent. Provisions stated in must be considered for existing health care facilities.

The installation of a local exhaust system described in (1)a is required if a new processor is being installed or if the darkroom is being remodeled.

D. Reference Standards

(1) American Institute of Architects 1996-97 Guidelines for Design and Construction of Hospital and Health Care Facilities; and

(2) American Conference of Industrial Hygienists, 1996 Publication #2091 Industrial Ventilation: A Manual of Recommended Practice.

(3) American National Standard Institute Z358.1

APPENDIX K

SEE IMPORTANT INFORMATION ON THE BACK.

IPCS

International Programme on Chemical Safety

SULPHUR DIOXIDE **0074**

October 1994

CAS No: 7446-09-5
RTECS No: WS4550000
UN No: 1079
EC No: 016-011-00-9

Sulfurous oxide
Sulfurous anhydride
Sulfur oxide
(cylinder)
SO2
Molecular mass: 64.1

TYPES OF HAZARD/ EXPOSURE	**ACUTE HAZARDS/SYMPTOMS**	**PREVENTION**	**FIRST AID/FIRE FIGHTING**
FIRE	Not combustible. Heating will cause rise in pressure with risk of bursting.		In case of fire in the surroundings: use appropriate extinguishing media.
EXPLOSION			In case of fire: cool cylinder by spraying with water but avoid contact of the substance with water. Combat fire from a sheltered position.
EXPOSURE		**STRICT HYGIENE!**	**IN ALL CASES CONSULT A DOCTOR!**
Inhalation	Cough. Shortness of breath. Sore throat. Symptoms may be delayed (see	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Half-upright position. Artificial

	Notes).		respiration may be needed. Refer for medical attention. See Notes.
Skin	ON CONTACT WITH LIQUID: FROSTBITE.	Cold-insulating gloves.	ON FROSTBITE: rinse with plenty of water, do NOT remove clothes. Refer for medical attention.
Eyes	Redness. Pain. Severe deep burns.	Safety goggles face shield or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion			
SPILLAGE DISPOSAL		**PACKAGING & LABELLING**	
Evacuate danger area! Consult an expert! Ventilation. NEVER direct water jet on liquid. Personal protection: complete protective clothing including self-contained breathing apparatus		T Symbol R: 23-34 S: (1/2-)9-26-36/37/39-45 UN Hazard Class: 2.3 UN Subsidiary Risks: 8	Do not transport with food and feedstuffs
EMERGENCY RESPONSE		**SAFE STORAGE**	
Transport Emergency Card: TEC (R)-20S1079 NFPA Code: H 3; F 0; R 0		Fireproof if in building. Provision to contain effluent from fire extinguishing. Separated from food and feedstuffs, incompatible materials.	

	See Chemical Dangers. Cool. Dry

IMPORTANT DATA

Physical State; Appearance
COLOURLESS GAS OR COMPRESSED LIQUEFIED GAS, WITH PUNGENT ODOUR.

Physical dangers
The gas is heavier than air.

Chemical dangers
The solution in water is a medium strong acid. Reacts violently with ammonia, acrolein, acetylene, alkali metals, chlorine, ethylene oxide, amines, butadiene. Reacts with water or steam causing corrosion hazard. Attacks many metals including aluminium, iron, steel, brass, copper and nickel in presence of water. Incompatible with halogens. Attacks plastic, rubber and coatings in liquid form.

Occupational exposure limits
TLV: 2 ppm as TWA, 5 ppm as STEL; A4 (not classifiable as a human carcinogen); (ACGIH 2004).
MAK: 0.5 ppm, 1.3 mg/m3; Peak limitation category: I(1); Pregnancy risk group: C; (DFG 2004).

Routes of exposure
The substance can be absorbed into the body by inhalation.

Inhalation risk
A harmful concentration of this gas in the air will be reached very quickly on loss of containment.

Effects of short-term exposure
The substance is severely irritating to the eyes and the respiratory tract. Inhalation of the gas may cause lung oedema (see Notes). Rapid evaporation of the liquid may cause frostbite. The substance may cause effects on the respiratory tract, resulting in asthma-like reactions, reflex spasm of the larynx and respiratory arrest. Exposure may result in death. The effects may be delayed. Medical observation is indicated.

Effects of long-term or repeated exposure
Repeated or prolonged inhalation exposure may cause asthma.

PHYSICAL PROPERTIES

Boiling point: -10/C
Solubility in water, ml/100 ml at 25/C: 8.5
Melting point: -75.5/C
Vapour pressure, kPa at 20/C: 330
Relative density (water = 1): 1.4 at -10/C (liquid)
Relative vapour density (air = 1): 2.25

ENVIRONMENTAL DATA

This substance may be hazardous in the environment; special attention should be given to air quality, water quality and plants.

NOTES

Depending on the degree of exposure, periodic medical examination is suggested.
The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical
effort. Rest and medical observation are therefore essential.
Immediate administration of an appropriate inhalation therapy by a doctor or a person authorized by him/her, should be considered.
Do NOT spray water on leaking cylinder (to prevent corrosion of cylinder).
Turn leaking cylinder with the leak up to prevent escape of gas in liquid state.
Card has been partly updated in April 2005. See sections Occupational Exposure Limits, EU classification.

SULPHUR DIOXIDE MEASUREMENT FREQUENCIES

Automixer
Hospital = Katutura State Hospital

Descriptive Statistics[a]

	N	Mean
Sulphur Dioxide Levels (in ppm)	35	1.000
Valid N (listwise)	35	

a. Hospital = Katutura State Hospital

Hospital = Windhoek Central Hospital

Descriptive Statistics[a]

	N	Mean
Sulphur Dioxide Levels (in ppm)	35	.500
Valid N (listwise)	35	

a. Hospital = Windhoek Central Hospital

Darkroom
Hospital = Katutura State Hospital

Descriptive Statistics[a]

	N	Mean
Sulphur Dioxide Levels (in ppm)	35	1.000
Valid N (listwise)	35	

a. Hospital = Katutura State Hospital

Hospital = Windhoek Central Hospital

Descriptive Statistics[a]

	N	Mean
Sulphur Dioxide Levels (in ppm)	35	.500
Valid N (listwise)	35	

a. Hospital = Windhoek Central Hospital

Tearoom
Hospital = Katutura State Hospital

Descriptive Statistics[a]

	N	Mean
Sulphur Dioxide Levels (in ppm)	35	.000
Valid N (listwise)	35	

a. Hospital = Katutura State Hospital

Hospital = Windhoek Central Hospital

Descriptive Statistics[a]

	N	Mean
Sulphur Dioxide Levels (in ppm)	35	.000
Valid N (listwise)	35	

a. Hospital = Windhoek Central Hospital

Reception Area
Hospital = Katutura State Hospital

Descriptive Statistics[a]

	N	Mean
Sulphur Dioxide Levels (in ppm)	35	.000
Valid N (listwise)	35	

a. Hospital = Katutura State Hospital

Hospital = Windhoek Central Hospital

Descriptive Statistics[a]

	N	Mean
Sulphur Dioxide Levels (in ppm)	35	.000
Valid N (listwise)	35	

a. Hospital = Windhoek Central Hospital

T-Test: SO_2 Fume level measurements
Hospital = Katutura State Hospital

One-Sample Statistics[a]

	N	Mean	Std. Deviation	Std. Error Mean
Sulphur Dioxide Levels (in ppm)	140	.500	.5018	.0424

a. Hospital = Katutura State Hospital

One-Sample Test[a]

	Test Value = 2					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Sulphur Dioxide Levels (in ppm)	-35.369	139	.000	-1.5000	-1.584	-1.416

a. Hospital = Katutura State Hospital

Hospital = Windhoek Central Hospital

One-Sample Statistics[a]

	N	Mean	Std. Deviation	Std. Error Mean
Sulphur Dioxide Levels (in ppm)	140	.250	.2509	.0212

a. Hospital = Windhoek Central Hospital

One-Sample Test[a]

	Test Value = 2					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Sulphur Dioxide Levels (in ppm)	-82.529	139	.000	-1.7500	-1.792	-1.708

a. Hospital = Windhoek Central Hospital

T-Test

Warnings

No statistics are computed for a split file in the Independent Samples table. The split file is: Hospital=Katutura State Hospital.
No statistics are computed for a split file in the Independent Samples table. The split file is: Hospital=Windhoek Central Hospital.

Hospital = Katutura State Hospital

Group Statistics[b]

	Measurement areas	N	Mean	Std. Deviation	Std. Error Mean
Sulphur Dioxide Levels (in ppm)	Darkroom	35	1.000	.0000[a]	.0000
	Automixer	35	1.000	.0000[a]	.0000

a. t cannot be computed because the standard deviations of both groups are 0.

b. Hospital = Katutura State Hospital

Hospital = Windhoek Central Hospital

Group Statistics[b]

	Measurement areas	N	Mean	Std. Deviation	Std. Error Mean
Sulphur Dioxide Levels (in ppm)	Darkroom	35	.500	.0000[a]	.0000
	Automixer	35	.500	.0000[a]	.0000

a. t cannot be computed because the standard deviations of both groups are 0.

b. Hospital = Windhoek Central Hospital

T-Test

Warnings

No statistics are computed for a split file in the Independent Samples table. The split file is: Hospital=Katutura State Hospital.

No statistics are computed for a split file in the Independent Samples table. The split file is: Hospital=Windhoek Central Hospital.

Hospital = Katutura State Hospital

Group Statistics[b]

	Measurement areas	N	Mean	Std. Deviation	Std. Error Mean
Sulphur Dioxide Levels (in ppm)	Darkroom	35	1.000	.0000[a]	.0000
	Tearoom	35	.000	.0000[a]	.0000

a. t cannot be computed because the standard deviations of both groups are 0.

b. Hospital = Katutura State Hospital

Hospital = Windhoek Central Hospital

Group Statistics[b]

	Measurement areas	N	Mean	Std. Deviation	Std. Error Mean
Sulphur Dioxide Levels (in ppm)	Darkroom	35	.500	.0000[a]	.0000
	Tearoom	35	.000	.0000[a]	.0000

a. t cannot be computed because the standard deviations of both groups are 0.

b. Hospital = Windhoek Central Hospital

T-Test

Warnings

No statistics are computed for a split file in the Independent Samples table. The split file is: Hospital=Katutura State Hospital.

No statistics are computed for a split file in the Independent Samples table. The split file is: Hospital=Windhoek Central Hospital.

Hospital = Katutura State Hospital

Group Statistics[b]

	Measurement areas	N	Mean	Std. Deviation	Std. Error Mean
Sulphur Dioxide Levels (in ppm)	Darkroom	35	1.000	.0000[a]	.0000
	Reception area	35	.000	.0000[a]	.0000

a. t cannot be computed because the standard deviations of both groups are 0.

b. Hospital = Katutura State Hospital

Hospital = Windhoek Central Hospital

Group Statistics[b]

	Measurement areas	N	Mean	Std. Deviation	Std. Error Mean
Sulphur Dioxide Levels (in ppm)	Darkroom	35	.500	.0000[a]	.0000
	Reception area	35	.000	.0000[a]	.0000

a. t cannot be computed because the standard deviations of both groups are 0.

b. Hospital = Windhoek Central Hospital

T-Test: SO_2 fume level measurements without regarding departments

Group Statistics

	Measurement areas	N	Mean	Std. Deviation	Std. Error Mean
Sulphur Dioxide Levels (in ppm)	Darkroom	70	.750	.2518	.0301
	Automixer	70	.750	.2518	.0301

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Sulphur Dioxide Levels (in ppm)	Equal variances assumed	.	.	.000	138	1.000	.0000	.0426	-.0842	.0842
	Equal variances not assumed			.000	138.000	1.000	.0000	.0426	-.0842	.0842

T-Test

Group Statistics

	Measurement areas	N	Mean	Std. Deviation	Std. Error Mean
Sulphur Dioxide Levels (in ppm)	Darkroom	70	.750	.2518	.0301
	Tearoom	70	.000	.0000	.0000

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Sulphur Dioxide Levels (in ppm)	Equal variances assumed	.	.	24.920	138	.000	.7500	.0301	.6905	.8095
	Equal variances not assumed			24.920	69.000	.000	.7500	.0301	.6900	.8100

T-Test

Group Statistics

	Measurement areas	N	Mean	Std. Deviation	Std. Error Mean
Sulphur Dioxide Levels (in ppm)	Darkroom	70	.750	.2518	.0301
	Reception area	70	.000	.0000	.0000

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Sulphur Dioxide Levels (in ppm)	Equal variances assumed	.	.	24.920	138	.000	.7500	.0301	.6905	.8095
	Equal variances not assumed			24.920	69.000	.000	.7500	.0301	.6900	.8100

Frequencies: Symptoms
Frequency Table

Group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Exposed	29	74.4	74.4	74.4
	Control	10	25.6	25.6	100.0
	Total	39	100.0	100.0	

How old are you?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Between 18-25	11	28.2	28.2	28.2
	Between 26-32	7	17.9	17.9	46.2
	Between 32-40	10	25.6	25.6	71.8
	Between 40-50	6	15.4	15.4	87.2
	Above 50	5	12.8	12.8	100.0
	Total	39	100.0	100.0	

What gender are you?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	30	76.9	76.9	76.9
	Male	9	23.1	23.1	100.0
	Total	39	100.0	100.0	

Race

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Black	31	79.5	79.5	79.5
	Colored	7	17.9	17.9	97.4
	White	1	2.6	2.6	100.0
	Total	39	100.0	100.0	

How long have you been in your current occupation at this hospital?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	7	17.9	18.9	18.9
	1-10 years	18	46.2	48.6	67.6
	11-20 years	9	23.1	24.3	91.9
	21-30 years	2	5.1	5.4	97.3
	Over 30 years	1	2.6	2.7	100.0
	Total	37	94.9	100.0	
Missing	No answer	2	5.1		
Total		39	100.0		

Smoker status:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A current smoker	3	7.7	7.7	7.7
	A former smoker	4	10.3	10.3	17.9
	A non-smoker	32	82.1	82.1	100.0
	Total	39	100.0	100.0	

current or former smoker, how many cigarettes do/did you smoke each da

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	6-10	7	17.9	100.0	100.0
Missing	Not applicable	32	82.1		
Total		39	100.0		

you ever been knowingly exposed to sulphur dioxide in the course of y work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	15.4	17.1	17.1
	No	13	33.3	37.1	54.3
	Uncertain	16	41.0	45.7	100.0
	Total	35	89.7	100.0	
Missing	No answer	4	10.3		
Total		39	100.0		

If you answered, "yes" to Q3, for how long have you been exposed?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-10 years	5	12.8	83.3	83.3
	21-30 years	1	2.6	16.7	100.0
	Total	6	15.4	100.0	
Missing	Not applicable	29	74.4		
	No answer	4	10.3		
	Total	33	84.6		
Total		39	100.0		

Have you ever been diagnosed as asthmatic?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	5.1	5.3	5.3
	No	35	89.7	92.1	97.4
	Uncertain	1	2.6	2.6	100.0
	Total	38	97.4	100.0	
Missing	No answer	1	2.6		
Total		39	100.0		

Have you ever suffered from other chest illness?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	10.3	10.5	10.5
	No	33	84.6	86.8	97.4
	Uncertain	1	2.6	2.6	100.0
	Total	38	97.4	100.0	
Missing	No answer	1	2.6		
Total		39	100.0		

he past 6 months have you had more than two episodes of headache

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	19	48.7	48.7	48.7
	No	18	46.2	46.2	94.9
	Uncertain	2	5.1	5.1	100.0
	Total	39	100.0	100.0	

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most days	3	7.7	14.3	14.3
	Most weeks	6	15.4	28.6	42.9
	Most months	5	12.8	23.8	66.7
	Other	3	7.7	14.3	81.0
	Uncertain	4	10.3	19.0	100.0
	Total	21	53.8	100.0	
Missing	Not applicable	16	41.0		
	No answer	2	5.1		
	Total	18	46.2		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	17.9	28.0	28.0
	No	8	20.5	32.0	60.0
	Uncertain	10	25.6	40.0	100.0
	Total	25	64.1	100.0	
Missing	Not applicable	14	35.9		
Total		39	100.0		

In the past 6 months have you had more than two episodes of nausea

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	10	25.6	25.6	25.6
	No	27	69.2	69.2	94.9
	Uncertain	2	5.1	5.1	100.0
	Total	39	100.0	100.0	

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most days	1	2.6	11.1	11.1
	Most months	6	15.4	66.7	77.8
	Other	1	2.6	11.1	88.9
	Uncertain	1	2.6	11.1	100.0
	Total	9	23.1	100.0	
Missing	Not applicable	30	76.9		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	7.7	27.3	27.3
	No	1	2.6	9.1	36.4
	Uncertain	7	17.9	63.6	100.0
	Total	11	28.2	100.0	
Missing	Not applicable	28	71.8		
Total		39	100.0		

he past 6 months have you had more than two episodes of runny nos

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	41.0	41.0	41.0
	No	22	56.4	56.4	97.4
	Uncertain	1	2.6	2.6	100.0
	Total	39	100.0	100.0	

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most days	8	20.5	44.4	44.4
	Most weeks	4	10.3	22.2	66.7
	Most months	2	5.1	11.1	77.8
	Other	2	5.1	11.1	88.9
	Uncertain	2	5.1	11.1	100.0
	Total	18	46.2	100.0	
Missing	Not applicable	20	51.3		
	No answer	1	2.6		
	Total	21	53.8		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	17.9	36.8	36.8
	No	6	15.4	31.6	68.4
	Uncertain	6	15.4	31.6	100.0
	Total	19	48.7	100.0	
Missing	Not applicable	19	48.7		
	No answer	1	2.6		
	Total	20	51.3		
Total		39	100.0		

he past 6 months have you had more than two episodes of irritation of t throat?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	15	38.5	39.5	39.5
	No	22	56.4	57.9	97.4
	Uncertain	1	2.6	2.6	100.0
	Total	38	97.4	100.0	
Missing	No answer	1	2.6		
Total		39	100.0		

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most days	5	12.8	31.3	31.3
	Most weeks	2	5.1	12.5	43.8
	Most months	3	7.7	18.8	62.5
	Other	2	5.1	12.5	75.0
	Uncertain	4	10.3	25.0	100.0
	Total	16	41.0	100.0	
Missing	Not applicable	21	53.8		
	No answer	2	5.1		
	Total	23	59.0		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	20.5	50.0	50.0
	No	1	2.6	6.3	56.3
	Uncertain	7	17.9	43.8	100.0
	Total	16	41.0	100.0	
Missing	Not applicable	20	51.3		
	No answer	3	7.7		
	Total	23	59.0		
Total		39	100.0		

the past 6 months have you had more than two episodes of feelings unexpected fatigue?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	43.6	43.6	43.6
	No	20	51.3	51.3	94.9
	Uncertain	2	5.1	5.1	100.0
	Total	39	100.0	100.0	

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most days	5	12.8	27.8	27.8
	Most weeks	5	12.8	27.8	55.6
	Most months	2	5.1	11.1	66.7
	Other	3	7.7	16.7	83.3
	Uncertain	3	7.7	16.7	100.0
	Total	18	46.2	100.0	
Missing	Not applicable	20	51.3		
	No answer	1	2.6		
	Total	21	53.8		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	23.1	50.0	50.0
	No	4	10.3	22.2	72.2
	Uncertain	5	12.8	27.8	100.0
	Total	18	46.2	100.0	
Missing	Not applicable	19	48.7		
	No answer	2	5.1		
	Total	21	53.8		
Total		39	100.0		

ıe past 6 months have you had more than two episodes of having of pai your joints?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	30.8	31.6	31.6
	No	25	64.1	65.8	97.4
	Uncertain	1	2.6	2.6	100.0
	Total	38	97.4	100.0	
Missing	No answer	1	2.6		
Total		39	100.0		

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most days	6	15.4	37.5	37.5
	Most weeks	3	7.7	18.8	56.3
	Most months	1	2.6	6.3	62.5
	Other	3	7.7	18.8	81.3
	Uncertain	3	7.7	18.8	100.0
	Total	16	41.0	100.0	
Missing	Not applicable	22	56.4		
	No answer	1	2.6		
	Total	23	59.0		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	15.4	42.9	42.9
	No	4	10.3	28.6	71.4
	Uncertain	4	10.3	28.6	100.0
	Total	14	35.9	100.0	
Missing	Not applicable	22	56.4		
	No answer	3	7.7		
	Total	25	64.1		
Total		39	100.0		

the past 6 months have you had more than two episodes of ringing in th ears?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	10.3	10.8	10.8
	No	32	82.1	86.5	97.3
	Uncertain	1	2.6	2.7	100.0
	Total	37	94.9	100.0	
Missing	No answer	2	5.1		
Total		39	100.0		

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most days	3	7.7	30.0	30.0
	Most months	1	2.6	10.0	40.0
	Other	2	5.1	20.0	60.0
	Uncertain	4	10.3	40.0	100.0
	Total	10	25.6	100.0	
Missing	Not applicable	28	71.8		
	No answer	1	2.6		
	Total	29	74.4		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	7.7	30.0	30.0
	No	1	2.6	10.0	40.0
	Uncertain	6	15.4	60.0	100.0
	Total	10	25.6	100.0	
Missing	Not applicable	27	69.2		
	No answer	2	5.1		
	Total	29	74.4		
Total		39	100.0		

n the past 6 months have you had more than two episodes of skin rash?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	15.4	17.1	17.1
	No	29	74.4	82.9	100.0
	Total	35	89.7	100.0	
Missing	No answer	4	10.3		
Total		39	100.0		

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most weeks	1	2.6	10.0	10.0
	Most months	2	5.1	20.0	30.0
	Other	3	7.7	30.0	60.0
	Uncertain	4	10.3	40.0	100.0
	Total	10	25.6	100.0	
Missing	Not applicable	25	64.1		
	No answer	4	10.3		
	Total	29	74.4		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	7.7	33.3	33.3
	No	2	5.1	22.2	55.6
	Uncertain	4	10.3	44.4	100.0
	Total	9	23.1	100.0	
Missing	Not applicable	25	64.1		
	No answer	5	12.8		
	Total	30	76.9		
Total		39	100.0		

n the past 6 months, have you had more than two episodes of lip sores?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	12.8	13.2	13.2
	No	33	84.6	86.8	100.0
	Total	38	97.4	100.0	
Missing	No answer	1	2.6		
Total		39	100.0		

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most days	3	7.7	33.3	33.3
	Most months	2	5.1	22.2	55.6
	Other	2	5.1	22.2	77.8
	Uncertain	2	5.1	22.2	100.0
	Total	9	23.1	100.0	
Missing	Not applicable	29	74.4		
	No answer	1	2.6		
	Total	30	76.9		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	5.1	25.0	25.0
	No	2	5.1	25.0	50.0
	Uncertain	4	10.3	50.0	100.0
	Total	8	20.5	100.0	
Missing	Not applicable	29	74.4		
	No answer	2	5.1		
	Total	31	79.5		
Total		39	100.0		

the past 6 months have you had more than two episodes of Sores in th mouth?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	12.8	13.5	13.5
	No	31	79.5	83.8	97.3
	Uncertain	1	2.6	2.7	100.0
	Total	37	94.9	100.0	
Missing	No answer	2	5.1		
Total		39	100.0		

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most days	1	2.6	14.3	14.3
	Most weeks	1	2.6	14.3	28.6
	Most months	1	2.6	14.3	42.9
	Other	4	10.3	57.1	100.0
	Total	7	17.9	100.0	
Missing	Not applicable	30	76.9		
	No answer	2	5.1		
	Total	32	82.1		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	5.1	33.3	33.3
	No	2	5.1	33.3	66.7
	Uncertain	2	5.1	33.3	100.0
	Total	6	15.4	100.0	
Missing	Not applicable	30	76.9		
	No answer	3	7.7		
	Total	33	84.6		
Total		39	100.0		

he past 6 months have you felt you heart beating abnormally on more th two occasions?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	23.1	23.7	23.7
	No	26	66.7	68.4	92.1
	Uncertain	3	7.7	7.9	100.0
	Total	38	97.4	100.0	
Missing	No answer	1	2.6		
Total		39	100.0		

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most days	4	10.3	30.8	30.8
	Most weeks	1	2.6	7.7	38.5
	Most months	2	5.1	15.4	53.8
	Other	3	7.7	23.1	76.9
	Uncertain	3	7.7	23.1	100.0
	Total	13	33.3	100.0	
Missing	Not applicable	26	66.7		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	5.1	16.7	16.7
	No	3	7.7	25.0	41.7
	Uncertain	7	17.9	58.3	100.0
	Total	12	30.8	100.0	
Missing	Not applicable	26	66.7		
	No answer	1	2.6		
	Total	27	69.2		
Total		39	100.0		

:he past 6 months have you had more than two episodes of unus numb arms and legs?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	17.9	17.9	17.9
	No	32	82.1	82.1	100.0
	Total	39	100.0	100.0	

If yes, you have this on:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most days	3	7.7	27.3	27.3
	Most months	1	2.6	9.1	36.4
	Other	5	12.8	45.5	81.8
	Uncertain	2	5.1	18.2	100.0
	Total	11	28.2	100.0	
Missing	Not applicable	28	71.8		
Total		39	100.0		

Was this better on days away from work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	10.3	40.0	40.0
	No	3	7.7	30.0	70.0
	Uncertain	3	7.7	30.0	100.0
	Total	10	25.6	100.0	
Missing	Not applicable	28	71.8		
	No answer	1	2.6		
	Total	29	74.4		
Total		39	100.0		

Do you live in an industrial area?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	20.5	20.5	20.5
	No	29	74.4	74.4	94.9
	Uncertain	2	5.1	5.1	100.0
	Total	39	100.0	100.0	

If yes, for how long have you been living there?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	1	2.6	10.0	10.0
	1-10 years	3	7.7	30.0	40.0
	11-20 years	3	7.7	30.0	70.0
	21-30 years	1	2.6	10.0	80.0
	More than 30 years	2	5.1	20.0	100.0
	Total	10	25.6	100.0	
Missing	Not applicable	29	74.4		
Total		39	100.0		

Do you share your home with people that smoke?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	23.1	23.1	23.1
	No	29	74.4	74.4	97.4
	Uncertain	1	2.6	2.6	100.0
	Total	39	100.0	100.0	

/our response to Q2a was yes, how many cigarettes are smoked inside yo home every day?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 5	5	12.8	62.5	62.5
	6-10	3	7.7	37.5	100.0
	Total	8	20.5	100.0	
Missing	Not applicable	30	76.9		
	No answer	1	2.6		
	Total	31	79.5		
Total		39	100.0		

Do you or your family burn any of the following at home?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Incense	1	2.6	10.0	10.0
	Wood	6	15.4	60.0	70.0
	Coal	1	2.6	10.0	80.0
	Gas	2	5.1	20.0	100.0
	Total	10	25.6	100.0	
Missing	No answer	29	74.4		
Total		39	100.0		

PFT diagnosis

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	normal	34	87.2	87.2	87.2
	resigned	1	2.6	2.6	89.7
	restrictive	4	10.3	10.3	100.0
	Total	39	100.0	100.0	

Symptom tests by groups
Crosstabs

up * In the past 6 months have you had more than two episodes of e nose and throat illnesses? Crosstabulation

			In the past 6 months have you had more than two episodes of ear, nose and throat illnesses?		
			Yes	No	Total
Group	Exposed	Count	10	16	26
		% within Group	38.5%	61.5%	100.0%
	Control	Count	1	9	10
		% within Group	10.0%	90.0%	100.0%
Total		Count	11	25	36
		% within Group	30.6%	69.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.757[b]	1	.097		
Continuity Correction[a]	1.579	1	.209		
Likelihood Ratio	3.168	1	.075		
Fisher's Exact Test				.127	.101
Linear-by-Linear Association	2.681	1	.102		
N of Valid Cases	36				

a. Computed only for a 2x2 table

b. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 3. 06.

Crosstabs

Group * If yes, you have this on: Crosstabulation

			If yes, you have this on:				
			Most weeks	Most months	Other	Uncertain	Total
Group	Exposed	Count	3	1	2	1	7
		% within Group	42.9%	14.3%	28.6%	14.3%	100.0%
Total		Count	3	1	2	1	7
		% within Group	42.9%	14.3%	28.6%	14.3%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	7

a. No statistics are computed because Group is a constant.

Crosstabs

Group * Was this better on days away from work? Crosstabulation

			Was this better on days away from work?			
			Yes	No	Uncertain	Total
Group	Exposed	Count	2	2	3	7
		% within Group	28.6%	28.6%	42.9%	100.0%
Total		Count	2	2	3	7
		% within Group	28.6%	28.6%	42.9%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	7

a. No statistics are computed because Group is a constant.

Crosstabs

oup * In the past 6 months have you had more than two episodes of headache Crosstabulation

			In the past 6 months have you had more than two episodes of headaches?			
			Yes	No	Uncertain	Total
Group	Exposed	Count	8	19	2	29
		% within Group	27.6%	65.5%	6.9%	100.0%
	Control	Count		9	1	10
		% within Group		90.0%	10.0%	100.0%
Total		Count	8	28	3	39
		% within Group	20.5%	71.8%	7.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.473[a]	2	.176
Likelihood Ratio	5.419	2	.067
Linear-by-Linear Association	2.569	1	.109
N of Valid Cases	39		

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .77.

Crosstabs

Group * If yes, you have this on: Crosstabulation

			If yes, you have this on:					
			Most days	Most weeks	Most months	Other	Uncertain	Total
Group	Exposed	Count	1	1	3	2	1	8
		% within Group	12.5%	12.5%	37.5%	25.0%	12.5%	100.0%
Total		Count	1	1	3	2	1	8
		% within Group	12.5%	12.5%	37.5%	25.0%	12.5%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	8

a. No statistics are computed because Group is a constant.

Crosstabs

Group * Was this better on days away from work? Crosstabulation

			Was this better on days away from work?			
			Yes	No	Uncertain	Total
Group	Exposed	Count	2	4	5	11
		% within Group	18.2%	36.4%	45.5%	100.0%
Total		Count	2	4	5	11
		% within Group	18.2%	36.4%	45.5%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	11

a. No statistics are computed because Group is a constant.

Crosstabs

Group * In the past 6 months have you had more than two episodes of abnormal tiredness? Crosstabulation

			In the past 6 months have you had more than two episodes of abnormal tiredness?			
			Yes	No	Uncertain	Total
Group	Exposed	Count	5	22	2	29
		% within Group	17.2%	75.9%	6.9%	100.0%
	Control	Count		10		10
		% within Group		100.0%		100.0%
Total		Count	5	32	2	39
		% within Group	12.8%	82.1%	5.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.942[a]	2	.230
Likelihood Ratio	4.653	2	.098
Linear-by-Linear Association	.447	1	.504
N of Valid Cases	39		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .51.

Crosstabs

Group * If yes, you have this on: Crosstabulation

			If yes, you have this on:				
			Most days	Most months	Other	Uncertain	Total
Group	Exposed	Count	1	3	1	3	8
		% within Group	12.5%	37.5%	12.5%	37.5%	100.0%
	Control	Count			1		1
		% within Group			100.0%		100.0%
Total		Count	1	3	2	3	9
		% within Group	11.1%	33.3%	22.2%	33.3%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.938[a]	3	.268
Likelihood Ratio	3.506	3	.320
Linear-by-Linear Association	.071	1	.789
N of Valid Cases	9		

a. 8 cells (100.0%) have expected count less than 5. The minimum expected count is .11.

Crosstabs

Group * Was this better on days away from work? Crosstabulation

			Was this better on days away from work?			
			Yes	No	Uncertain	Total
Group	Exposed	Count	2	3	2	7
		% within Group	28.6%	42.9%	28.6%	100.0%
	Control	Count			1	1
		% within Group			100.0%	100.0%
Total		Count	2	3	3	8
		% within Group	25.0%	37.5%	37.5%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.905[a]	2	.386
Likelihood Ratio	2.209	2	.331
Linear-by-Linear Association	1.256	1	.262
N of Valid Cases	8		

a. 6 cells (100.0%) have expected count less than 5. The minimum expected count is .25.

Crosstabs

up * In the past 6 months have you felt you heart beating abnormally on more t two occasions? Crosstabulation

			In the past 6 months have you felt you heart beating abnormally on more than two occasions?			
			Yes	No	Uncertain	Total
Group	Exposed	Count	9	16	3	28
		% within Group	32.1%	57.1%	10.7%	100.0%
	Control	Count		10		10
		% within Group		100.0%		100.0%
Total		Count	9	26	3	38
		% within Group	23.7%	68.4%	7.9%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.264[a]	2	.044
Likelihood Ratio	9.155	2	.010
Linear-by-Linear Association	1.133	1	.287
N of Valid Cases	38		

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .79.

Crosstabs

Group * If yes, you have this on: Crosstabulation

			If yes, you have this on:					
			Most days	Most weeks	Most months	Other	Uncertain	Total
Group	Exposed	Count	4	1	2	3	3	13
		% within Group	30.8%	7.7%	15.4%	23.1%	23.1%	100.0%
Total		Count	4	1	2	3	3	13
		% within Group	30.8%	7.7%	15.4%	23.1%	23.1%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	13

a. No statistics are computed because Group is a constant.

Crosstabs

Group * Was this better on days away from work? Crosstabulation

			Was this better on days away from work?			
			Yes	No	Uncertain	Total
Group	Exposed	Count	2	3	7	12
		% within Group	16.7%	25.0%	58.3%	100.0%
Total		Count	2	3	7	12
		% within Group	16.7%	25.0%	58.3%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	12

a. No statistics are computed because Group is a constant.

Crosstabs

ıp * In the past 6 months have you had more than two episodes of s illnesses? Crosstabulation

			In the past 6 months have you had more than two episodes of skin illnesses?		
			Yes	No	Total
Group	Exposed	Count	2	25	27
		% within Group	7.4%	92.6%	100.0%
	Control	Count		8	8
		% within Group		100.0%	100.0%
Total		Count	2	33	35
		% within Group	5.7%	94.3%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.629[b]	1	.428		
Continuity Correction[a]	.000	1	1.000		
Likelihood Ratio	1.073	1	.300		
Fisher's Exact Test				1.000	.590
Linear-by-Linear Association	.611	1	.435		
N of Valid Cases	35				

a. Computed only for a 2x2 table

b. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .46.

Crosstabs

Group * If yes, you have this on: Crosstabulation

			If yes, you have this on:			
			Most days	Most months	Other	Total
Group	Exposed	Count	1	1	3	5
		% within Group	20.0%	20.0%	60.0%	100.0%
Total		Count	1	1	3	5
		% within Group	20.0%	20.0%	60.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	5

a. No statistics are computed because Group is a constant.

Crosstabs

Group * Was this better on days away from work? Crosstabulation

			Was this better on days away from work?			
			Yes	No	Uncertain	Total
Group	Exposed	Count	1	1	2	4
		% within Group	25.0%	25.0%	50.0%	100.0%
Total		Count	1	1	2	4
		% within Group	25.0%	25.0%	50.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	4

a. No statistics are computed because Group is a constant.

T-Test: Temperature
Hospital = Katutura State Hospital

One-Sample Statistics[a]

	N	Mean	Std. Deviation	Std. Error Mean
Temperature	35	23.557	2.6031	.4400

a. Hospital = Katutura State Hospital

One-Sample Test[a]

	Test Value = 25					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Temperature	-3.279	34	.002	-1.4429	-2.337	-.549

a. Hospital = Katutura State Hospital

Hospital = Windhoek Central Hospital

One-Sample Statistics[a]

	N	Mean	Std. Deviation	Std. Error Mean
Temperature	35	24.029	2.6815	.4533

a. Hospital = Windhoek Central Hospital

One-Sample Test[a]

	Test Value = 25					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Temperature	-2.143	34	.039	-.9714	-1.893	-.050

a. Hospital = Windhoek Central Hospital

T-Test: Humidity
Hospital = Katutura State Hospital

One-Sample Statistics[a]

	N	Mean	Std. Deviation	Std. Error Mean
Humidity (in %)	35	33.23	8.902	1.505

a. Hospital = Katutura State Hospital

One-Sample Test[a]

	Test Value = 80					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Humidity (in %)	-31.084	34	.000	-46.771	-49.83	-43.71

a. Hospital = Katutura State Hospital

Hospital = Windhoek Central Hospital

One-Sample Statistics[a]

	N	Mean	Std. Deviation	Std. Error Mean
Humidity (in %)	35	35.37	6.385	1.079

a. Hospital = Windhoek Central Hospital

One-Sample Test[a]

	Test Value = 80					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Humidity (in %)	-41.350	34	.000	-44.629	-46.82	-42.44

a. Hospital = Windhoek Central Hospital

P.O. BOX 48431 Hercules 0030, Pretoria SOUTH AFRICA Tel: (27) 012 - 3720671 or 3 Fax: (27) 012 - 720674

SECTION I **- General Information**

Product Name: Autex RP x-ray Developer and Replenisher, Concentrate
Private label Name: AXIM
Catalog No. 9X23011, 9X230112, 9X13011ME, 9X23011NDT, Developer Bulk 800lt.

Chemical Family:
Photographic Developer

Formula:
Aqueous Mixture

Proper D.O.T. Shipping Name:
Acetic Acid Solution

D.O.T. Hazard Classification:
Corrosive Material UN 2790
"Ltd Qty" Pkg. Group II Class 8

Manufacturer:
CPAC Imaging
P.O. Box 48431
Hercules, 0030
South Africa

Manufacturer's Phone Number:
+27 (0)12 372 0671

SECTION II **- Product and Hazardous Ingredients Information**

Item #1503 (Part A)	**CAS#**	**PERCENT**	**PEL (TWA)**	**SARA RQ/TPQ**
Potassium Hydroxide	1310-58-3	1-5	2 mg/m3	1000# N/A
Sodium Sulfite	7757-83-7	5-10	N/A	N/A N/A
Potassium Sulfite	10117-38-1	10-15	N/A	N/A N/A
Sodium Carbonate	497-19-8	1-5	N/A	N/A N/A
Hydroquinone	123-31-9	5-10	2mg/m3	1#-500#
Water	7732-18-5	50-55	N/A	N/A N/A
Item #1603 (Part B)				
Acetic Acid	64-19-7	55-60	10 ppm	5000# N/A
1-Phenyl-3-Pyrazolidone	92-43-3	10-15	N/A	N/A N/A
Water	7732-18-5	20-25	N/A	N/A N/A
Item #1725 (Part C)				
Glutaraldehyde	111-30-8	20-25	0.2 ppm (c)	N/A N/A
Water	7732-18-5	75-80	N/A	N/A N/A

SECTION III **- Physical Data**

Boiling Point: >212^{o} F.-Part A&C; Part B-N/A **Specific Gravity:** Part A-1.29, Part B-1.080; Part C-1.080
Vapor Pressure (mmHg): Part A&C-17.0; Part B-15.0
Vapor Density (mmHg): Part A&C-0.6; Part B-1.83 **Percent Volatile by Weight:** 55%
Solubility in Water: Complete **Evaporation Rate:** N/A
Appearance and Odor: Part A-Pale yellow, odorless; **pH:** Part A-11.40; Part B-2.5; Part C-3.0Part B-Amber color, vinegar odor; Part C-Clear, aldehyde odor

SECTION IV **- Fire and Explosion Hazard Data**

Parts A & C

Flash Point: None
Extinguishing Media: Use method appropriate for surrounding fire.
Special Fire Fighting Procedures: Use protective clothing to prevent contact with skin and eyes.
Unusual Fire and Explosions Hazards: When heated to decomposition, it can emit toxic fumes of SO_2.

Part B

Flash Point: >225^{o}F
Extinguishing Media: Water spray, alcohol foam, dry chemical, carbon dioxide.
Special Fire Fighting Procedures: Use protective clothing to prevent contact with skin and eyes. Use self-contained breathing apparatus.
Unusual Fire and Explosions Hazards: When heated to decomposition, it can emit toxic fumes. Will produce CO_2, and possible CO. Reacts vigorously with oxidizing materials.

SECTION V **- Health Hazard Data**

TLV (ACGIH): Hydroquinone (2mg/m3), Potassium Hydroxide (2 mg/m3)

Effects of Overexposure: (Part A)

Inhalation: Low hazard for ordinary industrial handling.
Eyes: Vapor may cause irritation. Contact may cause burns.
Skin: Repeated and prolonged contact may cause irritation and burns.
Ingestion: Do **Not** take internally. Harmful if swallowed. Drink water to dilute concentration. Induce vomiting only as directed by medical personnel.

Pure Component Toxicology Information

Hydroquinone**:** Moderately toxic by oral ingestion. It is a skin and eye irritant and may cause an allergic reaction in sensitive individuals. Hydroquinone also may cause brown staining of the conjunctiva following prolonged direct eye contact with the solid and may depigment the skin following repeated skin contact under some circumstances.
Hydroquionone is a CNS stimulant based on animal studies. Although hydroquinone is not listed as a human carcinogen, it has caused cancer in some animal studies.

Sodium Carbonate: Slightly toxic by oral ingestion. It is a moderate to strong skin, eye, and respiratory tract irritant.
Potassium Sulfite and Sodium Sulfite: Slightly toxic by oral ingestion. It is a slight to moderate skin, eye, and respiratory tract irritant. Some asthmatics or sulfite-sensitive individuals may experience wheezing, chest tightness, hives, weakness and diarrhea following ingestion.

TLV (ACGIH): Acetic Acid (25 mg/m3)

Effects of Overexposure: (Part B)

Inhalation: Vapor may cause severe irritation to nose and throat. May cause difficulty breathing.
Eyes: Vapor may cause irritation. Contact causes severe burns.
Skin: Repeated and prolonged contact may cause irritation and burns.
Ingestion: Do **Not** take internally. May cause severe burns to upper respiratory tract. Do **Not** induce vomiting. Drink water to dilute.

Pure Component Toxicology Information

Acetic Acid: Acetic acid is a skin and eye corrosive. Vapor irritates the eyes and respiratory system. Ingestion causes internal irritation and damage. The compound has been infrequently associated with skin sensitization in humans.
1-Phenyl-3-Pyrazolidone: This compound is an eye irritant. Ingestion of large doses may cause red blood cell destruction and anemia, and liver, kidney, spleen or testicular abnormalities. May cause adverse reproductive effects – such as infertility based on animal data.

Medical Conditions Aggravated by Exposure: Persons with preexisting eye, skin or respiratory tract disorders may be more susceptible to the effects of this product.
Carcinogenicity Information**:** None of the components present in this material at concentrations equal to or greater than 0.1 % are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

TLV (ACGIH): Glutaraldehyde (0.2 ppm)

Effects of Overexposure: (Part C)

Inhalation: Vapor may cause severe irritation to nose and throat. May cause difficulty breathing.
Eyes: Vapor may cause irritation. Contact may cause irritation and burns.
Skin: Repeated and prolonged contact may cause irritation and burns.
Ingestion: Do **Not** take internally. May cause severe burns to upper respiratory tract. Do **Not** induce vomiting. Drink water to dilute.

Pure Component Toxicology Information

Glutaraldehyde: Acute effects of overexposure: Eye and skin contact with glutaraldehyde causes severe irritation; burns and permanent injury may result. Prolonged or repeated skin contact with glutaraldehyde may result in dermatitis. Inhalation of the mists causes irritation of the respiratory tract and inflammation of the lungs may result. Ingestion may cause moderate to severe gastric irritation. Ulceration or perforation of the gastrointestinal tract may occur. Glutaraldehyde is a strong irritant to the skin, eyes and respiratory tract. Repeated dermal contact may produce sensitization. Allergic dermatitis has been known to occur in humans. Chronic effects of overexposure: Overexposures have been known to produce liver damage in animal studies.

Evidence of Carcinogen: Hydroquinone

Teratogenicity: N/A
Reproductive Toxicity: 1-Phenyl-3-Pyrazolidone
Mutagenicity: N/A
Synergistic Products: N/A

Emergency First Aid Procedures:

Skin: Thoroughly wash exposed area with soap and water. Remove contaminated clothing. Launder contaminated clothing before re-use.
Eyes: Immediately flush with water, lifting upper and lower lids occasionally, get medical attention.
Ingestion: For Part A ONLY - Immediately drink two glasses of water to dilute concentration. Induce vomiting only as directed by medical personnel.
For Parts B & C-Do **Not** induce vomiting. Drink water to dilute concentration. **Get medical attention immediately. Never give anything by mouth to an unconscious person.**
Inhalation: Move to fresh air.
Primary route(s) of entry: Skin contact.

***SECTION VI* - Reactivity Data**

Stability: Stable.
Incompatibility: Strong acids, strong bases.
Hazardous Decomposition Products: When heated to decomposition, it can emit toxic fumes. Will produce CO_2, and possibly CO, SO_2.
Hazardous Polymerization: Will not occur.
Conditions to Avoid: Keep away from heat or flame. Keep away from alkalis, amines, alcohols, and strong oxidizers.

***SECTION VII* - Spill or Leak Procedures**

Steps to be Taken in Case Material is Released or Spilled: Wear protective clothing as specified in Section VIII. Neutralize with sodium

bicarbonate. If federal, state and local laws permit, flush to sewer with large amounts of water.

Waste Disposal: Neutralize with sodium bicarbonate. If federal, state, and/or local laws permit, flush to sewer with large amounts of water. Otherwise, dispose of contaminated product and materials used in cleaning up the spill in a manner approved for this material. Consult proper federal, state and/or local regulatory agencies to ascertain proper disposal procedures.

***SECTION VIII* -Special Protection Information:**

Respiratory Protection (Specify Type): Should not be necessary under normal conditions. If exposed to vapors that exceed TLV or PEL, wear approved organic vapor/ mist respirator or an air supplied respirator as appropriate.

Ventilation: Use local exhaust to control vapors or mists to the PEL.

Protective Equipment:

Gloves: Impervious gloves.

Eyes: Wear protective goggles.

Other: As necessary to prevent skin contact. Eyewash facilities in vicinity of use.

***SECTION IX* -Special Precautions**

Precautions to be Taken in Handling and Storage: Do not store or consume food, drink or tobacco in surrounding area. Do not store near strong acids or bases. Wash thoroughly after use.

The information contained in this material safety data sheet is furnished without warranty of any kind. The user should consider this data a supplement to other information gathered and must make independent determination of suitability and completeness of information from this and other sources to assure proper use and disposal of the materials and the health and safety of employees and customers. This statement is incorporated as part of this Material Safety Data Sheet.

Revised: January 18, 2002

P.O. BOX 48431 Hercules 0030, Pretoria SOUTH AFRICA Tel: (27) 012 - 3720671 or 3 Fax: (27) 012 - 720674

Health	1
Flammability	0
Reactivity	0
Personal Protection	B

April 15, 2001

MATERIAL SAFETY DATA SHEET

SECTION I – General Information

Product Name: Autex RP x-ray Fixer and Replenisher, Concentrate
Private label Name: AXIM

Catalog No. 9X23012, 9X230122, 9X13012FP, 9X23012NDT, Fixer Bulk 1000lt.

Chemical Family:
Photographic Fixers

Formula:
Aqueous Mixture

Proper D.O.T. Shipping Name:
Not Regulated

D.O.T. Hazard Classification:
N/A

Manufacturer:
CPAC Imaging
P.O. Box 48431
Hercules, 0030
South Africa

Manufacturer's Phone Number:
+27 (0)12 372 0671

SECTION II **– Product and*Hazardous Ingredients Information**

SARA ITEM #2301 Part A	**CAS #**	**PERCENT**	**PEL(TWA)**	**RQ / TPQ**
Ammonium Thiosulfate	7783-18-8	8 – 12	N/A	N/A
Sodium Sulfite	7757-83-7	1 – 2	N/A	N/A
Acetic Acid	64-19-7	1 – 2	10 ppm	5000#
Water	7732-18-5	70 – 75	N/A	N/A

ITEM #2101 Part B	CAS #	PERCENT	PEL(TWA)	RQ / TPQ
Aluminium Sulfate	10043-01-3	5 – 6	N/A	N/A N/A

SECTION III – Physical Data

BOILING POINT: >100C **VAPOR PRESSURE (mmHg):** 17.0

VAPOR DENSITY(mmHg): 0.6 **SOLUBILITY IN WATER:** Complete

SPECIFIC GRAVITY: 1.085 **pH: 4.20**

PERCENT VOLATILE BY WEIGHT : 88% **EVAPORATION RATE:** N/A

APPEARANCE AN ODOR: Clear, slight vinegar odor.

SECTION IV – Fire and Explosion Hazard Data

Flash Point: None **Flammable Limits: LEL:** N/A **UEL: N/A**

Extinguishing Media: Use method appropriate for surrounding fire.

Special Fire Fighting Procedures: Use protective clothing to prevent contact with skin and eyes.

Unusual Fire and Explosions Hazards: When heated to decomposition, it can emit toxic fumes of SOx and ammonia.

SECTION V – Health Hazard Data

TLV (ACGIH): Acetic Acid (10 ppm)

Effects of Overexposure:

Inhalation: Low hazard for ordinary industrial handling.

Eyes: Contact may cause irritation.

Skin: Repeated and prolonged contact may cause irritation.

Ingestion: Do not take internally. May be harmful if swallowed.

Carcinogen: * Teratogenicity: N/A *** Reproductive Toxicity: N**/A *** Mutagenicity: NA * Synergistic Products: N**/A

Emergency First Aid Procedures:

Eyes: Flush with large amounts of water for 15 minutes. Seek medical attention.

Skin. Wash skin with soap and water. If irritation occurs, seek medical attention.

Ingestion: Seek medical attention immediately giving full details of amount ingested and toxicity.

Inhalation: Move to fresh air.

SECTION VI – Reactivity Data

Stability: Stable.

Incompatibility: Strong acids, strong bases.

Hazardous Decomposition Products: When heated to decomposition it can emit toxic fumes of SOx and ammonia. Contact with strong acids may release Sulfur Dioxide. Contact with strong bases may release ammonia.

Hazardous Polymerization: Will not occur.

Conditions to Avoid: None known.

SECTION VII – Spill or Leak Procedure

Steps to be taken in Case Material is Released or Spilled: Wear protective clothing as specified in Section VIII. Neutralize with sodium bicarbonate. If federal, state and local laws permit, flush to the sewer with large amount of water.

Waste Disposal: Neutralize with sodium bicarbonate. If federal, state and/or local laws permit, flush to sewer with large amounts of water. Otherwise dispose of contaminated product and materials used in cleaning up the spill in a manner approved for this material. Consult proper federal, state and/or local regulatory agencies to ascertain proper disposal procedures.

SECTION VIII – Special Protection Information

Respiratory Protection (Specify Type): Should not be necessary under normal conditions. If exposed to vapors that exceed TLV or PEL, wear an approver vapor respirator.
Ventilation: Good local mechanical ventilation should be sufficient.

Protective Equipment

Gloves: Impervious gloves.
Eyes: Wear protective goggles.
Other: As necessary to prevent skin contact. Eyewash facilities in vicinity of use.

SECTION IX – Special Precautions

Precautions to be taken in Handling and Storage: Do not store or consume food, drink or tobacco in surrounding area. Do not store near strong acids or bases. Wash thoroughly after use.

The information contained in this material safety data sheet is furnished without warranty of any kind. The user should consider this data a supplement to other information gathered and must make independent determination of suitability and completeness of information from this and other sources to assure proper use and disposal of this materials and the health and safety of employees and customers.
This statement is incorporated as part of this Material Safety Data Sheet.

P.O. BOX 48431 Hercules 0030, Pretoria SOUTH AFRICA Tel: (27) 012 - 3720671 or 3 Fax: (27) 012 - 720674

Specifications on X-ray chemistry:

1. Replenishment Rates and operating temperatures:

Autex x-ray Developer (RTU and Bi-Pak)
Replenisher Specifications: pH at 21ºC = 10.45 – 10
Spg at 21ºC = 1.070 – 1.080

Working Tank Specifications: pH at 21ºC = 10.20 – 10.30
Spg at 21ºC = 1.070 – 1.080
To make a Working Tank Solution: Add 23ml STARTER per litre Replenisher
Repl Rate: Use ONLY : Autex Started Cat# 60-179-007

Film Size Processed	Processor Usage	Average Sheets of Film (per 8 hours) With Standby	NO Standby	Replenishment Rate per 35 cm
Mixed	High	115	225	50 ml
Mixed	Medium	80	175	65 ml
Mixed	Low	40	115	80 ml
35 x 43	High	75	150	80 ml
35 x 43	Medium	50	110	80 ml
35 x 43	Low	25	75	90 ml

*Suggested starting replenishment rates may require adjustment based on processing conditions.

Autex x-ray Fixer (RTU and Bi-Pak)

Replenisher Specifications: pH at 21ºC = 4.10 – 4.20
Spg at 21ºC = 1.080 – 1.09
Working Tank Specifications: pH at 21ºC = 4.10 – 4.20
Spg at 21ºC = 1.080 – 1.090

Repl Rate: To make a Working Tank Solution: Replenisher = Working Solution

Film Size Processed	Processor Usage	Average Sheets of Film (per 8 hours) With Standby	NO Standby	Replenishment Rate per 35 cm
Mixed	High	115	225	70 ml
Mixed	Medium	80	175	85 ml
Mixed	Low	40	115	100 ml
35 x 43	High	75	150	85 ml
35 x 43	Medium	50	110	100 ml
35 x 43	Low	25	75	120 ml

*Suggested starting replenishment rates may require adjustment based on processing conditions.

Autex x-ray Developer (RTU and Bi-Pak)

TIME AND TEMPERATURE

Temperature ºC	Film Type Medical Screen	Industrial	Dental	Cinefluorograph
18	4 – 6 minutes	6 – 10 min	6 – 10 min	2 – 4 minutes
20	3 – 5 minutes	5 – 8 min	5 – 8 min	
22	2.5 – 4 minutes	4 – 6 min	4 – 6 min	
24	2 – 3 minutes	3 – 5.5 min	3 – 5.5 min	
26	1.5 – 2 minutes			

Autex x-ray Fixer (RTU and Bi-Pak)

TIME AND TEMPERATURE

Temperature ºC	Film Type Medical Screen	Industrial	Dental	Cinefluorograph
15 - 20	3 – 5 minutes	5 – 12 min	3 – 6 min	2 – 4 minutes
22 - 27	2.5 – 4 minutes	3 – 8 min	2 – 4 min	

2. Shelf Life

The recommended shelf life for unmixed chemicals i.e. in the 2 x 20 litre Bi-Pack form for both Developer and Fixer is 18 months from date of manufacture. The BATCH number and MANUFACTURE date appear on each package.

The Ready To Use (RTU, or Pre Mixed) Developer and Fixer has a recommended shelf life of 6 months from date of mixing. The BATCH number and USE BY date appear on each package.

3. Recommendations for disposal of the chemistry: Please refer to the MSDS (Material Safety Data Sheets) sheets herewith applicable to each product. This MSDS data conforms to international standards.

4. Safety requirements: Please refer to the MSDS sheets herewith for each product.

Should you require any further information, please do not hesitate to contact us.