
- CONFERENCE ABSTRACTS -

Appleton, Ross

Product manager, Respiratory & hazardous materials handling, New Zealand Safety Pty Ltd

An Evaluation of the Effective Use of Respirators and Local Exhaust Ventilation by Welders.

Welders in New Zealand commonly use very little protection to avoid the health effects associated with welding fumes. They may on occasions when the work is considered to be "dirty" use extraction equipment and/or respirators. This study has involved the survey of 53 welders to compare their health condition with other studies, and obtain information concerning the effective use of respirators by welders. The prevalence of health effects among the study population was similar to other studies and the use of respirators was not effective although wide spread. Less of the welders studied use local exhaust extraction. However, the researcher found that a number of those who reported the use of both local extraction and/or respirators 100% of the time, were observed as experiencing less respiratory disorders. In addition, 3 welders who use respirators 100% of the time but use extraction less than 100% of the time were observed to have no health effects. The researcher concludes that in the New Zealand legislative climate of non-prescriptive health and safety law, welders need to be convinced that the use of both respirators and local extraction equipment has real benefits. Research that demonstrates an improvement in the welders health through the use of control mechanisms should prove invaluable.

Bäckman, Lennart

Safety Equipment Europe AB

ISRP Standard for Respiratory Protective Equipment.

ISRP 2002 ver. 1.0 certified Respiratory Protective Equipment - is this something we will see on respirators in the future?

During the last ISRP in Pittsburgh the question was raised what ISRP could do to work for harmonizing the RPE standards in a shrinking world. Could ISRP create a standard for respirators? The aim should be to provide the user with more information about the performance of a respirator and in the long run to create a global RPE standard. It should also give ISRP a distinct and well known position on the market, resulting in more members and significant business opportunities.

Below is an outline of how such a standard could look. It should be seen as a contribution to the debate and therefor some parts of it can look like pure science fiction, especially to people who have spent some time of their life in various standards committees.

Batterson, Andrew (abstract not available)

Senior Occupational Hygienist, MPL Group

Is Respiratory Protection Adequate — a Customer's Perspective.

The abstract of this paper was not available for publication.

Berndtsson, Goran

President, The S.E.A. Group

Standards: There Is No Such Thing as "Average Breathing."

A standard testing and approval process, by definition, has to be based on some sort of benchmark. It is the setting of this benchmark that comes under scrutiny here.

The criteria used in the testing of respiratory protective equipment are neither realistically set, nor do they in any way reflect actual human breathing. The question can therefore be posed, what is the purpose of the Standard? The physical restrictions that keep testing criteria at an unrealistically low level were discovered around the time of the First World War, and have been scientifically documented since the 1940s. However, with the rising sophistication of both protective devices and the measuring apparatus used to test them, those restrictions no longer exist. Yet, we still use 80-year-old criteria in our testing - criteria that even then were known to be incapable of showing whether a respirator was able to protect a person in a contaminated workplace.

This leaves responsible suppliers of respiratory equipment in a quandary: do we say that a respirator is 'good' because it meets the test requirements? Or do we tell the truth and state that there is no connection whatsoever between Standards approval and human breathing? Manufacturers, suppliers and standards people alike need to address the problem. We all know about it, and how it came about. We must now do something about it. If not, we might one day find ourselves in the same hot-seat as the tobacco producers in regard to liability exposure.

Bien, Ching-tsen

MO Consulting, Inc., Crofton, MD, USA

Cartridge Service Life Data — a Comparison Between Models and Test Data.

The OSHA revised respiratory protection standard requires the employer to develop a cartridge/canister change schedule based on available information and data describing the service life of the sorbent elements against the contaminant present in the employer's workplace, 29 CFR 1910.134 (d)(3)(iii).

As a result of this requirement, many respirator manufacturers have developed computer software that predicts the service life of their own chemical cartridges/canisters against known air contaminants that exist in the workplace. These software programs are based on models developed by Gary Nelson or Gerry Wood. The user provides input parameters, such as contaminant concentration, temperature, humidity, work rate, and the desired breakthrough rate. The software program then calculates the breakthrough time at a given concentration.

Many studies indicate that the humidity, work rate, and boiling point of a chemical can have a significant effect on the service life of cartridges or canisters. This study examines the difference between the experimental breakthrough data and the model-based breakthrough time. Software programs developed by various manufacturers are selected for evaluation. Varying concentrations, humidity levels, and chemicals with low, medium, and high boiling points are selected for comparison.

These comparisons indicate that there are differences among experimental and calculated breakthrough data from different programs, and these differences are more pronounced for low boiling point compounds. Humidity also affects the accuracy of calculated values.

Bromwich, David.

Senior lecturer, School of Environmental Engineering, Griffith University, Qld, AUSTRALIA

Chemical Permeation Through Breathing Lines.

In many tasks using airline respiratory protection, the Breathing Lines run along the ground and in some cases they are contaminated by chemicals these will eventually enter the airline. The question is how much and after what time. The permeation of chemicals through the breathing lines should be unaffected by the air pressure in the lines, but driven by the chemical gradient through the airline. A mathematical model of the process has been developed and a simple test to measure the permeation rate, based on this model, is presented. Experimental data demonstrates that the permeation process can be quite complex with a moving solvent front followed by near constant permeation. The implications of this data in the selection and use of breathing apparatus are explained.

Capon, Andrew

Avon Technical Products, UK

Modification of Avon Military Respirators for Use with Breathing Apparatus in Hostage Retrieval Situations.

In some anti-terrorist operations, such as hostage retrieval, it may be necessary for the security forces to use devices that lead to fire or dense smoke in a confined space. In such situations the atmosphere can become oxygen deficient very rapidly and the NBC, or smaller anti-riot filters normally used with the respirator will not sustain life. A supplied air source is required to enable the snatch squad to complete its mission and evacuate the confined space with the recovered hostages.

Avon Technical Products has developed a simple modification for the S10 and FM12 families of military respirator that enables the masks to be used with either a conventional filter or a positive pressure demand valve, instantly switching from one to the other.

The Avon respirators are designed with side entry ports for the filter and secondary speech transmitter. The ports are interchangeable, left to right, either by hand (FM12) or with the aid of special tools (S10). When used with breathing apparatus the demand valve replaces the secondary speech transmitter.

Positive pressure demand valves require a positively biased exhalation valve. In the Avon respirators the unique folded acoustic horn-shaped primary speech module (PSM) houses the normal exhalation valve within a cone. The outer edge of the cone forms an ideal seat for a second spring-loaded exhalation valve, giving a positively biased exhalation pressure. The front cover of the PSM, suitably modified, provides a simple means of holding the positive pressure exhalation valve in place.

This paper describes the components that make the Avon respirators into interchangeable air filtration/air supplied masks. It discusses possible novel air containers for use with the system and indicates that the concept has wider applications, such as in NBC fire-fighting or in combined protective equipment for

chemical demilitarization or chemical weapons inspection.

D. Caretti, David

Research physiologist, US Army Edgewood CB Center, Aberdeen Proving Ground, MD, USA

Quantifying the Heat Stress Attributable to Respirator Wear.

There are many possible criteria to use for respirator design. For the U.S. military, recent development efforts advocate, among others, designing for a reduced respirator thermal load. However, quantitative data that defines the thermal load attributable to a respirator in and of itself is limited. Respirator designers need to know the amount of heat load due to a respirator under various conditions of work and environmental exposures before the issue can be addressed in the development of next generation respirator systems, whether they be for military or commercial applications. Therefore, a study was performed to quantify the effects of respirator wear on the physiological responses during heat stress. Five subjects aged 36.0 ± 2.9 years completed 120 min trials consisting of treadmill walking, flight simulation, and performance of cognitive tasks in a warm environment (33.9 ± 0.2 °C dry bulb and 24.3 ± 3.4 °C wet bulb temperatures) under one condition of respirator wear and one condition without a respirator. The respirator trial involved wear of a tight-fitting, powered air-purifying respirator (PAPR). Subjects wore one-piece cotton coveralls over shorts and a T-shirt for both test trials. In general, core temperatures (T_c) increased throughout heat exposure trials. However, both T_c and mean weighted skin temperatures (mean T_{sk}) were statistically similar between the masked and unmasked conditions at each minute for the entire measurement period. At the end of heat exposure sessions, no differences in average core temperatures, heart rates, mean T_{sk} , sweat rates, or heat storage rates were observed between the unmasked and masked conditions. Self-reported subjective scores for thermal sensation of the face and overall body comfort differed significantly between conditions, indicating that subjects' faces felt warmer and they experienced greater discomfort during respirator wear. Collectively, these findings suggest that there is no measurable thermal load attributable to a respirator alone other than subjective feelings of warmth and comfort.

Clifford, Frank

Squadron Leader (NBC Policy), UK Ministry of Defense

Respiratory Protection - a UK Prospective.

The Strategic Defense Review assumed that UK forces must anticipate a range of threats across the spectrum of conflict and acknowledges that the possibility of use of NBC weapons is increasing. It has been assessed that the threat of use of NBC weapons is likely to be greatest in deployments where UK forces are operating as part of a multi-national force beyond NATO's traditional area of interest.

NBC Defense Policy for the protection of UK Forces identifies 5 interdependent components each of which plays a major part in allowing operations to continue and for personnel to survive. The maintenance of individual protection of all personnel is a basic requirement for the continuation of operations in the face of an NBC hazard. Furthermore, the protection afforded by a respirator to an individual's respiratory route has been acknowledged as the most critical area.

The Chemical and Biological agents that may pose a threat to personnel deployed on operations requires that individuals have the necessary protective equipment available. However, degradation effects that personnel experience while wearing protective equipment will severely affect the war fighting ability of

the Armed Force. NBC Protection has to be balance against the threat and the actual hazard. This presentation will outline the NBC threats and hazards that personnel may encounter on the battle field and describe how a combination of risk management and protective measures would be used to ensure that personnel survive and are able to continue with the operation.

Cloonan, Terrence K.

Domestic preparedness & occupational hygiene specialist, Scott Health and Safety, Monroe, NC, USA
Law Enforcement Personnel — Are They Protected in a Chemical, Biological, Radiological And/or Nuclear (CBRN) Weapon of Mass Destruction (WMD) Terrorism Incident?

This paper was a recipient of the Sydney 2000 ISRP Conference's "Best Papers Award" (\$1,500).

(The full text is provided elsewhere with this Issue of the Journal)

Law enforcement personnel in the United States routinely respond to unknown situation 911 emergency calls at a higher rate than other emergency first responders. Are they threatened by Chemical, Toxic industrial, Biological, Radiological and/or Nuclear (CTBRN) terrorism? Since CTBRN dangers can be elusive, nondescript, seemingly routine, invisible or outright mass casualty producing a new approach toward reacting to routine emergency calls must be implemented. The traditional law enforcement "can do" focus works well in most police actions but with the threat of CTBRN a possibility this focus can be a dual edged sword and thus present an unknown lethal situation for law enforcement responding to any emergency event. When they respond, how are they currently protected from toxic aerosol, vapor, liquid and/or solid CTBRN contamination/etiological exposure?

The United States Department of Justice (DOJ) has mandated the Louisiana State University (LSU) Academy of Counter Terrorism under the National Domestic Preparedness Consortium to train law enforcement personnel in effective response to WMD incidents. The LSU acronym known as TRACEM outlines the spectrum of harm that a Law Enforcement Responder (LER) can expect in a WMD/CTBRN incident. Thermal, Radiological, Asphyxiation, Chemical Etiological and Mechanical (TRACEM) is a concept of harm. Understanding the types of Harm that a LER may encounter allows protective measures to be designed, taught and trained. What are the roles of LER in a local CTBRN incident? Recent US Federal exercises (Top Off etc...) prove that LERs are significantly in need of personal protection equipment and detection instrumentation under the following situations:

- Downwind Agent Per-Cutaneous Exposure
- Agent Miotic Effects Exposure
- No-Notice Agent Exposure
- Primary Device Multiple Effectiveness Agent Exposure
- Secondary Device Persistent Agent Contamination Effects
- Liquid CTBRN agent Exposure

What are their options for protection? The following options are in various stages of utilization within the United States:

- Tight Fitting Full Facepiece "Gas" Mask with Canister
- Loose Fitting Hood Ensemble with Purified Powered Air Respirator and Canisters
- Military Mission Oriented Protective Posture (MOPP) 3 or 4
- Civilian Field Expedient Protection (CFEP)
- US Environmental Protection Agency Levels C, B or A
- One Time Use Disposable Breathing Zone Protection Device

How are these PPE options impacted by United States regulatory guidelines and requirements? Eight different agencies publish guidelines for the LER. OSHA jurisdiction, NIOSH approvals, NFPA acceptance, NIJ/NIST ratings, DOD Military Specifications, DOE acceptance, EPA acceptance and Joint DOD/DOJ Inter Agency Board Standardized Equipment Listing (SEL) acceptance. A Law Enforcement Responder requires some reliability testing of the CTBRN PPE prior to its use in a tactical situation. What agency does a law enforcement executive rely on to ensure that reliable equipment is being used in responding to a "nuclear, biological, chemical (NBC)/chemical, toxic industrial, biological, radiological and/or nuclear (CTBRN) incident?

Equipment that lowers the acceptable casualty ratio to its lowest denominator provides the law executive with the most cost and mission effective item. Once a device and regulatory guidelines are mandated, they require integration into local, adjacent and higher Standard Operating Procedures (SOPs), standardized training, compatibility training, law and fire responder procedures analysis, incident command adaptability, Federal Response Plan (FRP) integration and training after action reports. The integration supports standardization procedures between the most critical first responders (law, fire and EMS).

Currently, the average law enforcement officer is in the equivalent EPA Level D protection. US Army studies show that this protection is no more than the average citizen. Technology improvements that provide required protection are forthcoming. The law enforcement priorities of life safety, incident stabilization and local property/environmental concerns mandate that LERs protect themselves as a first priority in order to conduct law priorities for a municipality. With the addition of individual protective facepieces, shrouds and NBC canisters, law responders can survive CTBRN incidents that are non-persistent toxic chemical warfare agents, pathogenic/toxic biological particulates and radiological particulates - the first step in escaping a Chemical/Biological agent attack. The levels/options for protection need improved in the areas of semi-persistent and persistent chemical and industrial toxic agents, biological virus, change out criteria for canisters and SOPs on command and control between different municipal/state and federal responders.

US national SWAT teams from Houston, TX, Phoenix, AZ, Springfield, IL, and Buffalo, NY have developed internal equipment needs based on credible threat assessments and are designing response plans in support of mitigating the effects of CTBRN incidents. Special Weapons and Tactics (SWAT) Teams are the most aggressive in the area of CTBRN defense. Conversely, the routine patrol officer on routine patrol in the local metropolis or municipality is in dire need of escape/egress breathing zone and skin protection under CTBRN conditions. Training is the immediate answer coupled with rated equipment that provides Initial Civilian Field Expedient Protection (CFEP) to all deployed law enforcement personnel. These factors will ensure that a patrol officer, a SWAT team member or a command post tactician has the minimum breathing zone and skin protection required to survive being contaminated by toxic lethal Chemical, Biological and/or Radiological agents in multiple environmental/tactical conditions.

Daniel, Bruce

Engineering manager, S.E.A. Group, Sydney, Australia

Effects of Ventilation of Protective Suits in Reducing Heat Strain.

Humans generate heat at all times, and the rate of heat generation increases with activity. To maintain a constant body temperature around 37°C this heat must be dissipated.

A chemical protective suit, being impermeable to harmful gases, fluids and particles, is inherently a very good insulator of heat. In addition, to achieve good protection, the suit must be sealed to the wearer's

body. It therefore offers a formidable barrier to heat transfer by convection, conduction, radiation and evaporation. A protective suit generally restricts the loss of the metabolic heat with the result that the wearer's body temperature never reaches equilibrium. The temperature of the body therefore rises until, in extreme cases, the wearer either collapses or is forced to stop working and remove the suit.

A study has been undertaken to investigate the potential to improve heat dissipation from a chemical protective suit by using a ventilation system which bleeds filtered air from an FPBR (Fan-supplied Positive-pressure Breath-responsive air-purifying Respirator). The FPBR has the inherent ability to provide ventilating air at a rate approximately proportional to the exertion of the wearer because its blower fan speed responds to the breathing pattern of the wearer.

This paper describes the initial theoretical study which models the heat flow conditions of a person wearing a chemical suit, and estimates the effect on core body temperature of ventilating the suit at various flow rates.

Future research will include tests to determine the practical effects of such ventilation. The ultimate aim of the research project is to develop an integrated ventilation system which would provide heat dissipation close to optimum. This in turn would result in great improvements in both work efficiency and well-being of employees.

Dower, J. M.

Senior research industrial hygienist, NIOSH, Division of Respiratory Disease Studies

Metzler, R. W.

Branch Chief, NIOSH, Division of Respiratory Disease Studies, and ISRP President

NIOSH Respirator Standards Development Project for Certification of Respirators to Protect Emergency Responders from Terrorist Threats.

Government and military agencies worldwide are addressing respiratory protection for emergency response personnel, civilians, and soldiers against chemical and biological (C/B) agents used for terrorism. Numerous technical issues will be investigated related to employing traditional industrial respirators against C/B agents. In the USA, partnerships have been forged among the National Institute for Occupational Safety and Health, the National Institute for Standards and Technology, the National Fire Protection Association, the Occupational Safety and Health Administration, the Department of Justice, and the U.S. Army Soldier and Biological Chemical Command to jointly address respiratory protection issues and establish appropriate respirator certification standards. The focus of this effort is to develop appropriate performance, quality and reliability standards and test methods for respirator technologies used to protect emergency responders against chemical and biological agents and certain toxic industrial materials. Both air-purifying and supplied-air respirators are expected to be employed for respiratory protection against these agents. Issues associated with adapting respirators approved for hazardous industrial and mining environment protections to responder protection from terrorism agents will be discussed. This information is of interest to those involved in providing C/B respiratory protection equipment and comprehensive respiratory protection programs to protect response workers against C/B terrorist threats.

Eklund, John F.

Sen/or sales and product manager, Trelleborg Protective Products, Ystad, Sweden

Are Hazardous Chemicals More Hazardous in North America than in Europe?

The purpose of this paper is to give a brief historical summary of the development of modern personal protective equipment (PPE) used for protection against hazardous chemicals in various forms, liquid, gaseous, vapor and/or solid. This type of equipment is essential for and in daily use by the rescue services, civil defense forces and by the industry as well as for non-combat application by the MOD forces.

The author will also debate and draw comparisons between the American Standard NFPA 1991 (1994 edition) for chemical (vapor) protective clothing (CPC) and the corresponding European Standard prEN 943.

Other topics of great interest, which are discussed and described in this paper, are the reusable type of CPC versus disposable limited use type of chemical protective suits and also the ongoing problems in conjunction with entries into confined spaces.

Gardner, Jan

Reed, Sue

What are the Most Common Defects of Used Half Facepiece Respirators?

A study was undertaken that assessed 485 used half facepiece, replaceable filter rubber, respirators against 71 visual defect classifications. Less than 15% of the examined respirators had no major defects. The most common defect was extremely dirty exhalation valve(s) due to poor maintenance and cleaning and not part degradation. The most common degradation defect was severely perished face seal areas of the facepiece (8.8%). 6.2% of the respirators had deformed facepieces. Other common defects included: 5.9 % with severely perished head harnesses, 5.9% with at least one missing inhalation valve, 4.5% with modified head harnesses, 2.4% with split, torn or cracked facepieces, 2.3% with missing exhalation valves. An apparent design flaw resulted in 2.2% of inhalation valves being caught in the valve holder. 2.1% had very dirty filter seals. 2.1% had filter media loss on the interior of the respirator (35% did not have filters attached).

The incidences of some defects were low, but the defects was of great concern. This includes damaged threads, improperly inserted valve holders and the use of wrong brand parts. 13 of the defect classifications were not found in the 485 respirators examined.

The results of this study raise serious concerns about the understanding and implementation of respirator maintenance requirements in industry.

Gardner, Paul

Research engineer, US Army Edgewood CB Center, Aberdeen Proving Ground, MD, USA

The Effect of Moisture on the Face Seal Fit of Half-mask Respirators.

A study was conducted to investigate the effect that moisture has on the face seal fit of half-mask

particulate respirators. Respirator fit factor data were obtained while 48 subjects completed two different quantitative fit testing (QNFT) methods under ambient environmental conditions. The two QNFT methods compared were an 8-exercise ambient aerosol protocol, conducted using a commercial condensation nuclei counter fit testing device (Portacount®, TSI, Inc.), and a 10-exercise corn oil aerosol protocol that was performed in an exposure chamber using a forward light-scattering photometer. Four commercial P-100, half-mask, particulate respirators were evaluated. To simulate face sweating, the inside of the respirator facepiece was wetted with water administered from a spray bottle. Fit test trials were performed using dry and wet respirators. Statistical analysis of the dry and wet fit factor results for both QNFT methods showed that respirator fit was not significantly ($p < 0.05$) degraded due to wetting of the facepiece. However, there was a trend for lower fit factors for each of the respirator models evaluated using the photometer/corn oil aerosol QNFT method. Post-hoc analysis of the Portacount® exercise data revealed significantly lower mean fit factors for the talking, grimace, and bending over exercises ($p < 0.02$). The grimace exercise was observed in both QNFT methods to cause the greatest degradation in fit. These findings suggest that facial perspiration can degrade the fit of half-mask respirators and that the effect is most pronounced with exaggerated facial movements. The results of this study support the value of wetting the facepiece prior to fit testing and the use of dynamic exercises to provide a more conservative and discerning measure of fit.

Grantham, David

Occ Health Unit, Div of Workplace Health & Safety Queensland, Australia

Hazardous Substances Legislation vs Respiratory Protection.

Hazardous substances legislation following NOHSC's 1994 National Model Regulations has now been introduced to all states. This legislation generally places respiratory protective equipment (RPE) as a position of last resort in the so called hierarchy of control. Two surveys each of more than 80 users across Queensland industry conducted by the Division of Workplace Health and Safety on the use of respiratory protection review both the reliance on RPE and the competence of its use, both before and after the introduction Hazardous Substance regulation. The surveys used critical elements of the versions of AS/NZS 1715 which were in force at the time. The pattern of reliance on RPE as the major control for hazardous substances did not change with the introduction of legislation, indicating that users (>80%) still resorted to RPE as their principal control option. However, legislative awareness about control obligations rose to from an unlikely maximum of 27% to 39%, and management felt more confident in making decisions about use of RPE (70% and 82%). Major equipment defects were variously found at around 12%. Nonetheless, the capacity of users to select, use and maintain their RPE correctly in accordance with all the elements of AS/NZS 1715, and later the risk assessment requirements of legislation, remain constantly poor at 6% and 5% in the respective surveys. There are clearly pressing requirements for suppliers of RPE and the jurisdictional programs to conjointly act in the interests of their clients so that the RPE, as the de facto primary control strategy, does provide the risk management to the level mandated by modern legislation.

Hallet, Frank

Safety and fire consultant/adviser, The Safety Consultancy, Sth Ockendon, UK

Oxygen Deficiency & Personnel Safety.

During the last few years there has been a considerable amount of legislation imposed or extended in

most developed and developing countries that is focused upon the safety of the worker. Much of the emphasis has been upon ensuring that the worker is working in a safe environment and there have been many International [ISO] and local [EN; NFPA ; AUS] standards and guidance developed with the intent of providing assistance to the employer in this area of safety management.

The definitions of an environment that can be considered acceptably safe for an unprotected worker to work in without respiratory protection are reasonably consistently defined across the world where harmful substances might be inhaled, ingested or absorbed but investigation has identified that the legislative requirements and supporting standards used for defining a minimum level of oxygen in the ambient air are variable and not defined at all in some circumstances.

My presentation will explore the various definitions, principle legal expectations and supporting standards relating to oxygen content in breathable air with the intent of demonstrating a fundamental need to define the criteria either legislatively or in an employers safety documentation.

Hern, J. A.

Research specialist, 3M Canada Co.

Filter Design At The Interface Between Military Specifications And Civil Approval Standards.

Air purifying respirators for first response, domestic preparedness and anti-terrorist personnel should provide broad-spectrum protection encompassing both industrial chemicals and chemical warfare agents.

As the personnel responding to a release incident will most likely include both civil and military organizations, respirators that meet civil approval standards as well as military performance requirements are desirable.

Traditionally, military specifications for air purifying respirator filters refer to chemical warfare agents only and are based on military use doctrines. That includes recognition that use in IDLH environments may be required in certain circumstances. In contrast, civil approval standards for respirators relate to long-term protection of workers in a well-characterized environment. A variety of use limitations are applied as conditions of the approval. A broad-spectrum air purifying filter which meets the requirements of both types of performance standard presents some interesting design challenges. The need to accommodate civil and military standards can impose limitations on filter design and performance. Some of these aspects of filter design will be highlighted and discussed in relation to defining a "First Responder" respirator standard.

Hofacre, Kent

Associate manager, Battelle, Columbus, OH, USA

Assessment of Chemical Vapor Releases in a Model Building.

Release of chemical vapors in a building as the result of evaporation from spills, leaking or venting from a pressurized container, or by spraying can result in a hazardous indoor air quality environment. Whether the release is intentional as that for a terrorist activity or an accident, estimates of the resulting time dependent vapor concentration and distribution throughout the building are important to know and understand to properly assess the hazard. The purpose of this paper is to present an approach used to

predict vapor concentration profile and distribution in a model building to estimate the resulting hazards. Release scenarios of spills, venting from a cylinder, spraying of liquids are presented. The effect of chemical volatility, spill characteristics, release rates, and sinks (active vapor removal by adsorption) on predicted vapor concentration profiles and its distribution throughout the building are presented. Estimated hazard levels associated with the release scenarios are shown to illustrate the dependence on chemical toxicity. The results of such an approach can be useful to guide policy makers regarding appropriate challenge concentrations to test and evaluate respiratory protection equipment.

Hori, Hajime

UOEH, Fukuoka, Japan

Thermal Regeneration Method of a Respirator Cartridge for Organic Vapors.

Respirator cartridges cannot be used beyond their service life, that is, the breakthrough time. However, the breakthrough time of organic vapor cartridges using activated charcoal is short for polar compounds, especially for methanol. Methanol is a popular solvent in the workplaces, and the vapor concentration is easy to exceed the Threshold Limit Values because methanol has high volatility. Therefore, when a worker wears a respirator when he treats materials containing methanol, he must exchange the cartridge several times a day.

We studied the possibility of thermal regeneration of a respirator cartridge that adsorbed methanol or acetone vapor. The vapor introduced into a respirator cartridge (Shigematsu Works, CA-104NII), and the breakthrough curve was obtained. After the cartridge was saturated with the solvent, the cartridge was heated, and the desorption curve was obtained by supplying air continuously. This adsorption-desorption cycle was repeated, and the effect of the cycle on the breakthrough time was investigated.

The desorption rate increased with the increasing desorption temperature. When the desorption temperature was 60°C, desorption of methanol was almost completed within 90 minutes. There was no significant change in the breakthrough time for methanol vapor after the adsorption and desorption cycle was repeated 24 times.

Howie, Robin

Robin Howie Associates, Edinburgh

Collation and Interpretation of Workplace Protection Factor Data.

In collating Workplace Protection Factor (WPF) Data it is necessary to consider the study protocols, sampling methodology and data analysis techniques adopted by the researchers as otherwise the collated data will be difficult to interpret.

For example, if the collated data are for setting Assigned protection Factors (APF) it will be essential that the protocols adopted in the included studies reflect the selection and training protocols which can be reasonably be expected in the workplaces of interest: if the protocols involve more stringent selection and training procedures than likely in the workplace, the data "may overestimate the workplace protection factors which would be achieved by a general worker population that had not been so screened", Lenhart & Campbell (1984)

In-mask sampling methodology is critical. Many published WPF data were generated using the Liu probe. As this probe was effectively flush with the inner surface of the mask it is likely that under-sampling of in-mask contaminants resulted in substantial over-estimation of Protection Factors (PF). For filtering facepieces such under-sampling could have been substantial as the probe was surrounded by an annulus of clean filtered air throughout inhalation. In practice, the probe only collected the exhaled contaminant, i.e. after lung deposition of some substantial fraction of the inhaled contaminant.

In some studies unquantifiable PF were quantified on in-mask contaminant concentrations being at some fraction of the chemical detection limit. Such assumption can slightly increase the geometric mean PF and substantially reduce the geometric standard deviation, so substantially increasing the calculated 95 percentile PF.

The presented paper described the above effects in detail.

Howie, Robin

Robin Howie Associates, Edinburgh

What Do Quantitative Fit Test Results Mean?

Quantitative Fit Tests (QnFT) have been an integral part of RPE programs in the USA for many years, have recently been specified for asbestos workers in the UK and are likely to be specified for all work covered by the revised UK COSHH Regulations. However, notwithstanding the effort expended in such tests, it would appear that those specifying such tests have failed to consider the vital question: What do the test results mean?

Analysis of the available published data clearly demonstrates that there is no significant or useful relationship between Fit Factors and Workplace Protection Factors, an interpretation clearly stated by a number of authors. For example, Colton et al (1989) considered "The quantitative fit factors that were obtained did not predict which workers would have the highest or lowest WPF. . . it appears there was no correlation between WPF and quantitative fit factor". Consequently, the revised BS 4275:1997 stated that "Fitting tests only identify gross misfits and do not guarantee adequacy of fit", BSI (1997).

Detailed analysis of the available data was presented and discussed.

Howie, Robin

Robin Howie Associates, Edinburgh

Selecting RPE for Protection Against Asbestos.

RPE is generally selected to ensure that in-mask contaminant concentrations do not exceed the relevant Occupational Exposure Limits (OEL). For substances where OEL are set to either completely prevent or reduce any adverse health effects to a very low level, controlling in-mask concentration to OEL levels is adequate.

However, at current OEL for asbestos there is significant risk. For example, in the UK it is officially anticipated that exposure to amosite or crocidolite at the current OEL of 0.2 fibres/ml will lead to 5,000 excess of lung cancer deaths plus 2,500 - 5,000 mesothelioma deaths in workers exposed at the limits,

HSE (1993), HSC (1999). That is, exposure at OEL concentrations will result in 7,500-10,000 deaths per million. Reassessment suggests that these official figures substantially underestimate likely deaths at OEL concentrations. This reassessment indicates that 5,000 excess deaths per million will result from exposures to: chrysotile at 0.09 fibres/ml; amosite at 0.016 fibres/ml; or crocidolite at 0.008 fibres/ml. If 5,000 excess deaths per million is unacceptably high it will be necessary to reduce in-mask concentrations approximately pro rata below the above figures to reduce excess deaths to "acceptable" levels.

The derivation of the above required limits was explained and discussed.

Howie, Robin

Robin Howie Associates, Edinburgh

Results of a Workplace Protection Factor Study of a Positive Pressure Demand Respirator.

A Workplace Protection Factor (WPF) Study has been carried out on a new Positive Pressure Demand Respirator* during the removal of asbestos waste containing chrysotile, amosite and crocidolite.

Given the general reduction in in-enclosure airborne fibre levels in the UK to about 2-5 fibres/ml during well conducted asbestos removal operations, it has been necessary to develop new in-mask and ambient sampling techniques.

To permit quantification of individual Protection Factors (PF) up to 500 in ambient fibre concentrations of 1 fibre/ml an in-mask sampling probe incorporating a 7 mm diameter filter has been developed. This sampling probe is fitted directly to a 30 mm disc probe which is placed within about 5 mm of the wearers' lips to ensure effective sampling of inhaled contaminants.

Given current ambient fibre concentrations, it is frequently necessary to change the ambient samplers every c 15 minutes to prevent overloading of the filter.

In many asbestos removal operations the ambient samples are obscured by non-fibrous materials. Previous experience has demonstrated that the Higgins cyclone is suitable for asbestos sampling due to removal of such non-fibrous material. It has been found that cyclone concentrations are generally about 20% higher than conventional cowl concentrations. However, during WPF studies RPE wearers are already encumbered with a sampling pump for the in-mask sampler. The addition of heavy cyclone, an additional pump and associated plumbing can be unpopular!

Given these difficulties, miniature size-selecting samplers able to run for 8 hours in up to 5 fibres/ml have been developed and validated.

The presented paper described the sampling techniques developed and the results obtained.

NOTE: *The study reported will be carried out in August 2000. This abstract therefore describes only the methodology.

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Protection Performance of Activated Carbon Filters Against Methyl Isocyanate.

Polyurethanes are a group of frequently used polymers. If polyurethane-containing objects are heated (higher than about 160°C), a large number of degradation products are formed. Among these are very toxic low molecular weight isocyanates, such as methyl isocyanate. The very low Swedish occupational exposure limit of 0.005 ppm for all types of isocyanates has been found difficult to maintain in quite a few workplaces where polyurethanes and some other nitrogen-containing plastics are heated. The use of individual respiratory protection is therefore necessary in many cases. Although the preferred method of protection is supplied air respirators, in some cases air purifying respirators have been found to be the only practically feasible solution. However, there have been some doubts about the efficiency of gas filters against low molecular weight isocyanates.

In order to check the usefulness of gas filters against low boiling isocyanates we have determined breakthrough curves for methyl isocyanate for a number of gas filters containing various commercially available activated carbons. To be able to determine breakthrough levels lower than 0.001 ppm the effluent gas was absorbed in a series of wash bottles with dibutylamine in toluene. The resulting urea derivative was then analyzed by GC-MS. In this way breakthrough curves for a number of activated carbon filters could be determined. There were large variations in performance for the various carbons. High relative humidity was found to give shorter protection times.

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Anthropometric Dimensions of Koreans and Their Associations with Fit of Quarter-Mask Respirators.

Historically, majority of respirator research have been focused on White, male subjects. Therefore, little information on respirator performance for Asians does exist. This study was designed to analyze the association between facial dimensions of Koreans and respirator fit factors obtained from three quarter-masks with quantitative fit testing using a PortaCount 8020 (TSI Co. USA). In addition, the performances of the three respirators, two domestic brands (Sejin SK-6 and Youngsung YS-2010) and one imported (3M-7500, medium, USA), were compared. Total 110 students, 70 males and 40 females, from a university located in Pusan were volunteered for the study. One person who was trained for facial dimensions from the Anthropology Research Project, Inc, USA, measured 12 facial dimensions to reduce interpersonal variations. All measurements were made in centimeters to one decimal point using a sliding-, and a spreading caliper and a steel measuring tape. Preliminary results showed that the imported respirator performed better than those of domestic ones ($P < 0.05$, by Friedman nonparametric ANOVA). And males were fitted better than females regardless of respirator brands. A stepwise regression analysis using log-transformed fit factors and facial variables was used to select common prognostic variables. No common variables, however, were found for all three respirators studied. In males, the coefficients of determination (R^2) were less than 5% while they were 21.5% to 60.9% in females. To find the most predictable model, we used the stepwise logistic model with heuristic method

which maximizes the efficiency (E, probability of correct classification) and has the smallest number of facial measurements, using the fit factor of 100 as a pass/fail criterion. For the 3M-7500, predictive facial dimensions were bizygomatic breadth(face width) and menton-subnasale length(lower face length) in males(E=65.2%), and menton-subnasale length and lip width in females (E=67.5%). For the SK-6, those were bigonial breadth and bitragion subnasale arc in males (E=61.4%), and bitragion subnasale arc in females (E=76.9%). For YS-2000, none were found in males while biectoorbitale breadth, subnasale-nasion length, lip width, and bitragion-menton arc were found in females(E=75%).

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Chemical Bed Degradation in Self-contained Self-rescuers Deployed in U.S. Coal Mines.

In the aftermath of a mine fire or explosion, the atmosphere inside a mine may become oxygen deficient or filled with toxic gases. Under these circumstances, escape is nearly impossible unless a miner relies on a self-contained breathing apparatus, called a Self-Contained Self-Rescuer (SCSR).

Since their introduction into U.S. underground coal mines in 1981, failures have been identified with a number of different models of SCSR's. These failures are associated with life support performance, conditions-of-use, or age. All SCSR's, regardless of specific design, have common components. One component, in particular, is a packed chemical bed, which functions either as a stand-alone scrubber, or as both an oxygen supply and carbon dioxide absorber. The life support performance of an SCSR depends on the general integrity of its chemical bed. As its chemical bed degrades, an SCSR's overall life support performance also diminishes, sometimes to the point where it can no longer maintain the protective capacity for which it was approved or even to failure.

This paper discusses case histories of SCSR field failures due to chemical bed degradation in the context how these failures were discovered and what steps were taken to correct the problems and restore in-mine reliability. Failure rates are also estimated and a computer program is used to project what might happen to SCSR reliability if bed degradation in a population of SCSR's goes undiscovered over a period of time.

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An Overview of Particulate Respirators.

The particulate respirators are mainly used as a safety device to filter solid and/or liquid aerosol type contaminants from the air. In the past 15 years, there has been a phenomenal growth in particulate respirator industry mainly due to advancement in meltblowing and other non-woven technologies. There are many types of particulate respirators available in the market today. This paper gives a thorough overview of the particulate respirator industry. This paper covers a variety of topics, such as: markets, manufacturing methods, types and designation, testing and approval standards, and new trends in this industry.

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New Standards and Quality Assurance System for Respirators in Japan.

Government standards for dust respirators and gas masks of Japan have been revised this year, better complying with the standards of the EU and the US. The important changes are (1) the criteria and the test methods of particle filtration efficiency of dust respirators, (2) new classification of gas masks which are combined with dust filters and (3) newly introduction of the test of carbon dioxide concentration in inhalation.

National certification tests had been performed by the National Institute of Industrial Health for the past 40 years. But the certification tests based on the new standards have started by the Technology Institution of Industrial Safety from November 2000. The quality surveillance system of respirators for industrial uses in the market has also started this year as the government policy.

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NIOSH Respirator Standards Development Project for Certification of Respirators to Protect Emergency Responders from Terrorist Threats.

Government and military agencies worldwide are addressing respiratory protection for emergency response personnel, civilians, and soldiers against chemical and biological (C/B) agents used for terrorism. Numerous technical issues will be investigated related to employing traditional industrial respirators against C/B agents. In the USA, partnerships have been forged among the National Institute for Occupational Safety and Health, the National Institute for Standards and Technology, the National Fire Protection Association, the Occupational Safety and Health Administration, the Department of Justice, and the U.S. Army Soldier and Biological Chemical Command to jointly address respiratory protection issues and establish appropriate respirator certification standards. The focus of this effort is to develop appropriate performance, quality and reliability standards and test methods for respirator technologies used to protect emergency responders against chemical and biological agents and certain toxic industrial materials. Both air-purifying and supplied-air respirators are expected to be employed for respiratory protection against these agents. Issues associated with adapting respirators approved for hazardous industrial and mining environment protections to responder protection from terrorism agents will be discussed. This information is of interest to those involved in providing C/B respiratory protection equipment and comprehensive respiratory protection programs to protect response workers against C/B terrorist threats.

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Workplace Protection Factor Study Protocols.

In 1996 the AIHA respirator protection committee sponsored a meeting to identify the scientific and technical issues with WPF studies. The participants in the workshop consisted of people from industry, government, labor, academia and manufacturers. The intent was to develop model protocols that would establish of higher confidence in studies and identify evaluation tools for past work.

Participants were split into three groups and discussed a series of issues dealing with conducting WPF studies and data interpretation independently. There was general agreement among the participants on the key issues that needed to be included in a study design and recommendations for reporting data.

The importance of conducting workplace protection factor studies with minimal adherence to the suggested data elements is illustrated by several recent articles that deal with respirator performance. A study by Myers et al. had the required information and can be used to estimate respirator performance. While a study by Spear et. al. lacks several data elements. The lack of data elements makes the study difficult to interpret, the information from the research cannot be used to estimate respirator performance.

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How Protective are Respirator Assigned Protection Factors?: an Uncertainty Analysis.

The assigned protection factor (APF) is operationally defined as the minimum expected workplace level of respiratory protection that would be provided by a properly functioning respirator or class of respirators, to a stated percentage of properly fitted and trained users. The percentage of users is not stated. The 5th percentile of the distribution of workplace protection factor studies has been suggested by NIOSH as being the appropriate statistic to set APFs.

A hazard ratio is defined as the concentration in the workplace divided by the occupational exposure limit (OEL). When a respirator is selected with an APF greater than the hazard ratio, it is assumed the exposure inside the respirator will then be less than the OEL.

For respirator use, several variables effect the person's exposure. These include the performance of the respirator and the concentration of the contaminant in the workplace. A Monte Carlo simulation of respirator use with these variables provides a way to estimate the percentage of time respirator wearers may be exposed above an OEL.

For a half facepiece respirator with an APF of ten, used at the maximum use limit, the average percent of time a worker may be exposed above an OEL is estimated to be 0.2%. On an individual basis, a person who has a geometric mean respirator protection factor at the 5th percentile of respirator users, at the maximum use concentration of the respirator will not be exposed above the OEL for more than 7% of the time. This can be considered a worst case estimate since not all workers use respirators at the maximum use limit.

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Individual Preparedness for Protection against Toxic Agents.

The readiness of our society to respond to major emergencies or terrorist attacks depends on a number of factors including adequate planning, available equipment and appropriate organization and training of rescue forces and their command. Efforts are made to master these situations. However, so far no special efforts have been made to increase the individual preparedness.

In 1981, the Swedish Government decided that all civilians should have access to a protective mask (available equipment) to be distributed in wartime or in special critical situations for protection against chemical warfare agents, biological agents, and radiation fallout. These masks might also be useful to protect our population from accidentally released toxic industrial chemicals (TICS). Today these masks are stockpiled in centrally located stores. The question, which then arises, is whether the stockpiled protective masks instead could be distributed to the population in order to increase the preparedness against exposure to BC-agents or TICS in case of an incident contaminating their neighborhood.

In this paper we describe an investigation aimed at measuring risk perception, knowledge of the function of protective masks and attitudes with respect to possessing and keeping a personal protective mask. Questionnaires were distributed to 1500 persons were 72% of those responded. We found that the majority of the responders had the opinion that their personal security would increase if they had access to a protective mask of their own. Only 16 % thought that it should be a problem to store the mask at home. As many as 41% were willing to participate in a field trial with protective masks, whereas 34% expressed uncertainty.

Based on the result from the opinion poll three field trials in different risk areas are initiated. The field tests are performed in three different 'risk zones'. The village - Hörnefors -, a town with many chemical industries - Landskrona -, and a town where both the railway and the main road are crossing nearby centers with a large population - Jönköping -. More than 500 persons in the age of 10 - 60 years are now engaged in the trial. In this paper we present the initial findings from the field trials. The complete study will be evaluated in the beginning of 2001. Swedish Agency for Emergency Planning (ÖCB) finances the study, and the conclusions drawn from the final results should than be used in the future civil emergency planning processes.

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The Effect of Testing Respirator Components with Real Breather Patterns as Opposed to Constant or Sinusoidal Flow.

Current standards outlining the test methods for both military and industrial respirators require specific components such as canisters and outlet valves to be tested under constant or sinusoidal breathing regimes. Given, (i) the performance of such components is dependent on the test flow conditions, and (ii) the occurrence of high peak flows that are observed during actual breathing cycles, potential exists for component performance to differ markedly when investigated under real breathing patterns compared to other less demanding flow regimes. The advancement of breathing machine technology at DERA Porton Down permits the accurate recording of actual breather flows, which in turn may be reproduced using a

digital breathing machine. Consequently, canisters and outlet valve assemblies can be rigorously tested using a series of "real" breathing patterns representing low, medium and high work rates. In addition, other activities such as talking can be mimicked and incorporated into the test regime.

This paper reports on the performance of canisters as regards (i) aerosol penetration and vapor breakthrough time, and (ii) the dynamic leakage of the outlet valve using various test flow regimes. For each work rating, the minute volume is maintained as a constant so that a true comparison may be made. Methods for deriving actual flow patterns from internal respirator pressures are also discussed. Adopting this approach permits breathing patterns to be easily recorded using a single, miniature pressure transducer as opposed to a complex and cumbersome flow arrangement.

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The Evolution of a Filter Family.

This paper was a recipient of the Sydney 2000 ISRP Conference's "Best Papers Award" (\$1,500) and the European Section's "Bob Bentley Award" (£1,000)

(The full text is provided elsewhere with this Issue of the Journal)

This paper describes the evolution of a filter-family from the early 90s into the new Millennium. Evolution instead of development, because the process to create a filter-family is like an evolution where the most fitted will survive. In the paper the basic information about the filters is presented, the dimensions of the filters and their properties for gas and particle filtration. Also comparison to older filters and filters of other producers are made and the results are discussed. In house test results as well as results from independent test laboratories are presented.

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Development of Biological Protective Ensembles.

Gas tight and non-gas tight protective systems were developed to provide protection from BSL-4/3 and BSL-2/1 biological organisms. End users include agriculture, public health, and emergency response personnel.

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Filtering Efficiency of Particulate Filters Against DOP Particles.

We have studied filtering efficiency of filter media designed for dust respirators. When we tested the filter media against DOP particle loading, we observed three types of phenomenon on the efficiency: (1)

decreasing rapidly, (2) keeping almost constant value and (3) increasing rapidly at the initial stage then approaching a constant value. Electrostatic filters usually show the first phenomenon. Mechanical filters show either of the last two phenomena. Almost all mechanical filters show the second phenomenon. A mechanical filter treated with a water and oil repellent chemical shows the last phenomenon. These phenomena of the efficiency are thought to be related to the surface state. We will discuss on the state of

DOP particles collected by the filter fibers and the effect on the efficiency.
