

SOME PERSONAL PROTECTIVE EQUIPMENT ISSUES FOR WOMEN *

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1. Introduction

Women face many of the same problems that men do when it comes to protective equipment and clothing (PPE). The odds of finding something that fits and is comfortable are improving but it's still a problem for many workers. Respirators tend to fit only the "average" white male face, glove fingers are too long for most women and coveralls are too long in the arms or legs for many female, and non-white North American male, workers.

The result: uncomfortable or poorly-fitting clothing often is not worn or used. When it is used, it may cause accidents or near-misses. Protective gear that does not fit, or is not used, does not protect.

But women are also different; they are built differently than men — in obvious and subtle ways. (Male and female shapes and sizes vary for ethnic reasons too.) At the same time, women face a few special problems, often related to attitudes. A (subtle or overt) sexist attitude is not uncommon among PPE manufacturers, suppliers and buyers and employers, since they are mostly men.

Before going further, it is important to put the PPE issue in context. Protective equipment and clothing is not the occupational hygienist's favourite solution to health and safety problems. Hygienists are trained to help prevent people getting sick or hurt at work. Controls at the worker — eg. PPE — are the last resort to reduce or eliminate exposure to hazards from a preventive, public health point of view.

It is acknowledged that certain kinds of protective clothing and equipment are needed on a regular basis in many jobs; some are needed only in particular situations. Unfortunately, protective equipment and clothing are seen as the only solution in many workplaces. Whatever the reason, the net result is that most workers have, or should have, some kind of protective gear to reduce or eliminate their exposure to safety and health hazards.

The Workplace Hazardous Materials Information System (WHMIS) should bring more health hazard information into workplaces, making the need to control these hazards even more obvious. Some WHMIS-related legislation requires controls measures, where necessary (eg. Manitoba's Workplace Health Hazard Regulation). All workers, but particularly women and other workers who do not fit the "average" mold, have a lot at stake in the kind of controls used.

Protective equipment and clothing will be one control measure chosen in many Canadian workplaces, making PPE problems even more acute. The symptoms of

* The original version of this paper was presented at the Conference on Protective Equipment (COPE) 88 Conference, held in Toronto, October, 1988. The current version was prepared in December, 1988.

the problems — limited choices, poor fit, complaints of discomfort, etc. — will remain until the underlying causes are recognised and dealt with.

A major factor behind problems with PPE, I suspect, is a unique feature of the protective clothing and equipment market: for the most part, users do not buy the items or they have little say about what is selected for them. Instead, like children, others buy protective gear and the users are expected to wear/use it. Complicating factors include lack of information about and attention to workforce demographics, a general bias against blue collar workers (and therefore their work clothing) and (in)attention to health and safety issues.

The discussion will focus on some of these, and related, issues, followed by some proposals about where we go from here, rather than trying to cover all the angles. After setting the scene about working women, there is a general discussion of PPE problems, followed by another about specific kinds of PPE. My remarks are based on personal experience, my own "common sense" about the subject, comments from workers and other occupational health professionals, and a general review of the literature on the subject.

2. Women in the Canadian (paid) workforce

2.1 The numbers in the paid workforce

The make-up of the Canadian workforce is changing. The big news from the 1986 census was that more women are working outside the home, compared to 1981. Although there are fewer significant changes in the kind of work they do, women are breaking through some barriers in non-traditional occupations. The ethnic composition of the workforce is changing too, although the extent and the demographics of this change is difficult to determine. The kind of work Canadians do is also shifting, away from primary industries.

The labour force (people working outside the home or unemployed) increased by 8.3 percent from 1981 to 1986. Almost 75 percent of this was the result of women entering the workforce. 56 percent of women now work outside the home. Women with children under the age of six also work in larger numbers than before; for example, 62 percent of married women in this category, with a spouse at home too, worked outside the home, compared to about 50 percent in 1981.(34) For more details, see Table 1.

2.2 What kind of paid work do women do?

More women are able to get "non-traditional" work now, particularly in the primary (industrial) sector where there were 19 percent more women, compared to two percent fewer men. Changes from 1981 to 1986 include:

- o an increase of 61.1 percent to 422,280 women (compared to 919,690 men) in **managerial and administrative** positions;
- o 16.6 per cent more in **medicine and health** to 483,820, so that women are now 78.8 percent of this category;
- o 249,725 (versus 986,155 men), a decrease of 2.7 percent (the same as men) in **machining, fabricating, assembling**;
- o an increase of 19.1 percent (men had a 1.7 percent drop) in **transport equipment operating** to 7.8 percent or 36,390; and
- o a 18.5 percent increase in **construction** to 18,095 (2.4 percent of the category) (compared with a 4.3 percent fewer men).(34)

TABLE 1

Selected participation rates in the Canadian workforce

<u>Factor</u>	<u>1981 (%)</u>	<u>1986 (%)</u>
Women	51.8	55.9
Men	78.2	77.5
By age and sex		
-- 20 - 24 years - women		+ 81
- men		+ 90
-- 25 - 34 years - women		+ 74
- men		+ 95
-- 55 - 59 years - women		+ 44
- men		+ 81
-- 60 - 64 years - women		+ 27
- men		+ 60
Married women with children		
- at home, living with spouse	52.1	61.2
- and all children < 6 years	49.5	62.1
Single women with children		
- at home	50.1	54.4
- and all children < 6 years	45.3	51.5
Divorced women with children		
- at home	68.7	71.9
- and all children < 6 years	64.8	68.5

Based on Statistics Canada, 1986.(34)

At the same time, the number of women in some non-traditional sectors has decreased for economic and technological reasons. Mining and quarrying is the best example; women's participation decreased by almost 20 percent, compared to a reduction of about 13 percent for men. Although Stats Canada does not provide the exact numbers, they also note that the number of women increased in blue collar occupations such as bus driver, motor vehicle mechanic, cabinet and wood furniture maker and carpenter. Women's participation in white collar traditionally male enclaves has also increased in occupations such as industrial engineer, chemist, lawyer, dentist and agriculturalist.(34)

While these increases are important reflections of small changes in the workforce, the rest of the story does not bode well for women. Most of their increased participation in the workforce is due to more women entering traditional kinds of work in the secondary sector work, particularly service work. The only change is managerial and administrative jobs have taken over fifth position from teaching. (See Table 2.)

These are national statistics. The rates vary from province to province and region to region. It's clear, however, that although more women are working outside the home these days, their numbers in traditionally male (usually blue collar) jobs are still small compared to those in traditional female jobs.

TABLE 2

Women's work in Canada, 1986

<u>Occupation</u>	<u>% of working women</u>
Clerical	31
Services	16
Sales	10
Medicine and health	9
Managerial, administrative	7.5
Teaching	6

Based on Statistics Canada, 1986.(34)86.(34)

2.3 Work-related injuries and illnesses

Work-related injuries and illnesses statistics are also relevant. The only easily-available statistics are for overall time-loss rates.(35) Between 1984 and 1986, these increased by 24 percent for women, compared to a 13 percent increase for men. While the numbers need further analysis, it seems reasonable to assume that reported time-loss injuries for women are increasing. These numbers also under-estimates, based as they are on compensation board reports.

3. Women are not small-scale men (and men are different from each other)

Anthropometry is the study of the stature and size of people. Measurements of the height, length and width of different body parts, and their relationship to each other, are made in specific groups of people (eg. average heights of women and men in the army). In occupational settings, this information is usually used to design processes and equipment. Ergonomics includes the proper application of this information to designing a safe and healthy workplace.

Anthropometric measurements show that women are not smaller versions of men and that there are a range of size and shapes in both sexes.(28,29)

Women are different from men in several categories relevant to protective clothing and equipment. These include smaller length, breadth and circumference of feet, hands and faces. Women's shoulders are also smaller than men's. Hands are a good example of the variation; more than 98 percent of American men have wider hands than the "average" American women and their fingers are usually shorter than men's.(28) While men are larger than women in many body dimensions, they are proportionately smaller in three: chest depth, hip circumference and back curvature at the hip.(30)

There is even a difference in ear sizes. Royster reports that the ear canal diameters of 18 percent of white women and 40 percent of black women in an American study were small enough to need extra-small hearing protectors.(31) Age is another factor. Grandjean cites an American government study showing that people aged 45 to 65 have different average sizes and weights than 20-year-olds. Men and women lose four cm. in body length, while men gain six kg. and women gain 10 kg.(11)

TABLE 3

Comparison of some male body measurements in five countries* (11)

<u>Body measurement</u>	<u>W. Germany</u>	<u>France</u>	<u>Britain</u>	<u>USA</u>	<u>Switz.</u>
Body length	172	170	171	173	169
Body length above seat	90	88	85	86	—
Back to front of knee	59	60	60	59	—
Shoulder breadth	45	—	46	45	44
Breadth of hips	35	35	—	35	34

* measurements are mean values for men in all age groups, in cm.
Swiss measurements include 20% southern Europeans.

Anthropometric data cannot easily be transposed from one country to another because of ethnic characteristics. For example, when Kenney compared facial measurements of Arabs, Asians and Americans, he found variations of up to nine mm. and that Arab facial dimensions are smaller on average than American ones, particularly in terms of width.(19) This kind of information is needed for respirator sizing, along with the type of data produced by McConville and others in the late 1970s.(23)

Most North American literature on the subject seems to rely on measurements of armed forces personnel while European studies more often include working populations. These factors must all be taken into account when comparisons are made between groups from different countries. (See Table 3.)

A recent study of women's hand sizes for machine guarding purposes also shows ethnic differences. Hong Kong women's fingers were shorter than U.K. women's at several points. 11 of 21 measurements were significantly different. Their hands were larger than Japanese women's in all dimensions. Comparisons with American women were interesting: the Hong Kong women's were smaller overall but their finger lengths were similar. Other differences were reported.(6,7)

In a related study, the Hong Kong women were compared with European, Indian (Punjabi) and West Indian women. West Indian women's hands were basically larger than European women's; 25 of 28 measurements were larger. 13 of the measurements made of Indian women were larger than those for European women, three were equal and 12 were smaller.(8)

4. Problems facing PPE users

4.1 General

We all have different criteria when we buy clothing. Colour, comfort, shape or style are common important ones. "Need" may also be a factor. Whatever our shopping habits, most people would likely agree about one thing: the clothing must fit, however we define that. If it doesn't, we either don't buy it or we return it.

Different rules seem to apply for work clothes. To start, in all other clothing markets, except children's, users usually buy their own items. But protective gear is usually purchased by employers and other company officials who often do not wear or use the items; if they do, it is unusual that they wear it for a

full workday, as many workers are expected to do. Workers' lack of control over protective gear purchases inhibits feedback about fit and comfort problems; returns because for fit or comfort problems are less likely. It also means that cost is more likely to be a major consideration in purchases, instead of workers' needs.

The problems of wearing/using PPE facing all workers, but especially women, are fairly basic. Sizing (and the related issue of fit) and comfort are the most obvious. (See section 4.4 for a more detailed discussion of sizing problems.) They are not priorities, especially if hazards and workers' needs are not recognised or taken seriously. Other issues include availability and women's physiology.

We all know the result of these problems: you'd think the only people who need protective equipment/clothing is a young white "average" male blue collar worker. The rest of the workforce is effectively unprotected, either because of a false sense of security or because workers will not use/wear things that are uncomfortable and/or don't fit.

There are particular repercussions for women. It appears that no North American company offers a full range of protective clothing or equipment that fits "real" women. Some small companies specialising in clothing for women have started up recently in the U.S., but they make a limited selection of clothing (eg. welder's garb). (Two sources of information about companies selling PPE for women are references 39 and 40.)

It's "common sense" that the consequences of protective clothing and equipment sizing/fit and comfort problems are more serious than those for ordinary clothing. Accidents have been caused when glove fingers or sleeves that are too long get caught in moving machinery; illnesses follow exposure to hazardous substances when wearing ill-fitting respirators or large gloves. (29,37)

4.2 It depends on who asks the questions and who answers them

It's interesting to look at the literature about protective equipment. Who asks the question and their discipline or viewpoint often determines the answer. And it means some issues are not properly addressed.

4.2.1 Ergonomists

Some ergonomists concentrate on anthropometric sizes for workplace design purposes (eg. hand sizing for machine guarding) and seem to ignore the potential use for other purposes, such as sizing gloves. (6,7,8) Others do important and useful work about protective equipment and clothing for the American or Canadian military, organisations that demand a human factors (a.k.a. ergonomic) approach to the design of their equipment and protective gear. (10,24,29,30)

4.2.2 Governments, standard-setters, manufacturers and suppliers

North American PPE manufacturers, government (and other) standard-setting officials and occupational health specialists seem unaware (for the most part) about this work done for the military. If they know of the work, they must be ignoring it, and civilian workers do not reap the benefits of this publicly-funded research.

An ergonomic approach requires an integrated view of health and safety and PPE issues. These major players in the PPE field rarely take this approach; in

particular, they seem unaware of the demographics of the workforce and the health and safety hazards in Canadian workplaces. As a result, they cannot know what workers -- PPE users -- really need in the way of PPE, whatever their sex, ethnic background or occupation. Even when they have some idea of the hazards requiring PPE control measures, there is no reason to make, purchase or require ergonomically-acceptable PPE if they are not aware of the variety of workers' needs.

The lack of accurate data about the demographics of the Canadian workforce and the hazards facing workers has two other results. First, the size of the PPE market is likely under-estimated. Second, standard-setting organisations and governments do not require use of anthropometric information and standard sizing of PPE.

Instead, they tend to concentrate on safety features (eg. making sure a pair of boots withstands falling objects) and general requirements that workers just wear or use the PPE provided them. (The latter is common in health and safety laws.) In these circles, questions about PPE tend to focus on why workers do not wear/use PPE; it is common to blame the worker, not the equipment/clothing or its manufacturer.

4.2.3 Hygienists

Occupational hygiene literature concentrates on permeability issues (definitely important but not necessarily more important than fit and comfort) for materials. Fit is a subject for respirators but similar studies of other important PPE -- gloves, footwear and coveralls, in particular -- seems to be missing from occupational hygiene journals.

4.2.4 Workers and employers

Workers themselves are rarely asked about their problems with PPE. Canadian workers and/or their representatives usually do not have a real say in PPE purchases, as pointed out earlier, except in Quebec where joint health and safety committees are responsible in some way for PPE selection. Nor are there easily-accessible statistics to find out if workers ever exercise their right to refuse because of unsuitable or badly-fitting PPE.

Only a few studies report surveys of problems with protective clothing or equipment used in workplaces. They often question purchasers or others in a management role. Feedback from workers (as individuals or in groups) tends to be anecdotal, appearing in popular and worker-oriented magazines and pamphlets. Important exceptions include Kaplan and Knutson's unique study of Wisconsin female workers' ergonomic problems(18) and Kamel et. al.'s survey of Egyptian workers.(15)

In Britain, the Labour Research Department (LRD) included a survey of protective clothing and equipment in its July, 1986 "Bargaining report". The 607 responses from 245 workplaces covering 43,000 employees formed the basis of a useful booklet about problems and remedies. Comfort and fit were important issues, especially for women and others who don't fit the "average" model.(21) General complaints included waterproof clothing being "too sweaty" and clothing itself being too heavy.(21)

A study of 408 male industrial Egyptian workers issued protective gear told basically the same story heard in Britain. The three top reasons the workers gave for not using the gear were: safety staff not telling workers about the

role of the equipment/clothing; discomfort; and feeling that use of the equipment/clothing lowered their prestige with fellow workers. Related factors included lack of awareness of the hazards and ignorance of the role of the equipment/clothing, literacy, skill level and interference with their work.(15)

The results of a recent Canadian survey, conducted by a popular trade magazine, are also interesting. 249 of 1000 randomly-selected subscribers responded to the questionnaire. More than 90 percent were not workers, so the source of their information about the problems was unclear. A fair number also came from larger, often-unionised workplaces, factors that also skew the results.(25)

Figure 1 shows the tabulated results of the question about problems facing PPE purchasers. Size and comfort were obviously important. An interesting sidelight of the survey is who is involved in decisions about PPE and who should be.

FIGURE 1

**Problems facing Canadian
PPE users(25)**

1. None
2. Poor quality
3. Limited sizes
4. Uncomfortable
5. Too costly

About 50 per cent of the committees in the respondents' workplaces were reported to have some kind of input into decisions about buying PPE. Most respondents (including all the hygienists and medical professionals) thought this should be the norm. (The type of input is not specified. If it was consultation with limited choices, or after the fact, it was an inappropriate kind of input.)

4.3 Comfort

Comfort is difficult to quantify, but it and sizing/fit are likely the most important issues for workers. The two issues overlap at times, while size/fit may not be an issue in workplaces dominated by white "average" males.

The Canadian survey reported the main improvement needed is greater comfort for all equipment. For example, about 40 percent of respondents said comfort was an issue when buying respiratory equipment. It was also a big factor -- reported by almost 70 percent of respondents -- in workers' reported reluctance to wear/use PPE. About another 10 percent said the reason was restricted movement, an issue related to comfort and fit. The 50 percent of those reporting reluctance to wear eye protection say it's uncomfortable. Almost half of those reporting problems with hand/arm protection attributed it to discomfort or restricted movement.

The LRD points out comfort is not covered by most legislation. However, the organisation reports that West German and Scandinavian standards include weight restrictions for safety helmets and welding shields, on grounds of comfort.(21) CSA standards do not appear to consider comfort; nor do ANSI or OSHA. The LRD report also cites three cases where industrial tribunals investigating unfair dismissals over protective clothing took comfort into account.

North American manufacturers are finally starting to take comfort seriously, according to Elie. He attributes this partly to employers "at last realising that

if the ppe is uncomfortable or unmanageable, workers won't want to wear it, and if they don't wear it they're going to suffer injuries., And injured employees hurt the bottom line." (9) Unfortunately the costs of occupational illness and disease is less obvious and therefore provides less pressure to remedy hazardous situations.

4.4 Sizing and fit

Work clothing/equipment has no sizing "history" so sizes are not standardised; bad guesses are often the name of the game. The range of sizes available is often insufficient to produce a reasonable fit for almost all workers. In related issues, ease (eg. extra width across the shoulders) is often ignored and differences between sitting and standing positions are not taken into account (see ref. 22 for details).

The results are predictable. One company's "small" is not necessarily the same as another's. Kaplan found that "small" included something fitting people 5'7" to 5'9" in one case and chest sizes varied from 32 to 36.(17) A Canadian author cites other examples: she found one line of pants started at waist size 28 while another started at size 32 and one brand of coveralls starts at size 36.(27) Size was the worst problem for purchasers of hand/arm protection (about 15 percent) in the Canadian survey.(25) The bottom line is that it's difficult for workers to find something that fits them, whether it's coveralls, gloves or respirators.

Those who think they can "fix it so it fits" soon find out that work clothing is not the same as other types of clothing. Making adjustments after buying a larger/smaller size is difficult, especially if the material is synthetic. Reputable manufacturers/suppliers do not guarantee customer-modified products.

Manufacturers approach sizing of clothing from the middle, often using the "Greek God" or "Cinderella" model of "medium".(29) But no one is "average" in all body dimensions, much less like a Greek god or Cinderella. We all have our peculiarities; some of our dimensions are "average" while others are not.

The typical approach is for manufacturers to go from the mythical "medium" to "small" and "large" by scaling their items. Proportional scaling (the proportions stay constant) or constant scaling (dimensions increase by equal amounts) both present problems. If one dimension increases/decreases, so do the other two and the "average" concept goes out the door.

Robinette's research for the U.S. Armed Forces provided a model four-step anthropometric sizing system to solve this problem.(29) After deciding what dimensions are essential, sub-groups of the user population are measured for these and other relevant dimensions. (She warns that 5th and 95th percentile values for a dimension will not always produce something fitting 90 percent of the population.) The differences are noted for each sub-group and design values are set to account for them.

At least two dimensions are usually required -- one for vertical factors (heights and lengths) and the other for horizontal factors (breadths, circumferences and depths). For example, stature and weight are important factors in coverall design, while face length and breadth are important for respirators.

The key to this approach is not to scale up or down from one size to another, but to change dimensions according to information from smaller sample groups.

The result is shown in Figure 2. Better fit is only one advantage. It is also easier to know how many coveralls, etc. to make or buy in each size and for users to choose which size garment to wear.

FIGURE 2 **An anthropometric sizing system**

Sample of boxes (ie. types of people)

Size forms

Based on a "Greek God" medium size

Based on a three-size anthropometric system

Adapted from Robinette, 1986.(29)

Claire Gordon used a similar approach to design a single battledress for men and women in the U.S. armed forces.(10) This two-piece uniform was originally designed and sized for men and then scaled down to shorter and smaller sizes for women. Shirts based on chest measurements did not fit the women's hips and those based on hip measurements were usually too big in the shoulders for women. Trousers big enough for their hips were often too big in the inseam and around the waist.

Gordon chose three pairs of key dimensions. After measuring male and female forces members, she ended up with three master patterns, avoiding the problems of a single one that does not account for different sizing patterns. Many dimensions traditionally used by designers were discarded because they were inconsistent with measurements; new ones were used.

The size range goes from extra-small to extra-extra-large for shirts, with subdivisions of extra-short, short, regular and long or extra-long depending on the basic size. 20 sizes are available under this system. Similar size ranges were set up for trousers, with another set of 20 sizes ranging from small short to extra-extra-large extra-long.

This kind of information is now available to those who ask. Robinette's integrated male-female sizing system is available from the Aerospace Medical Research Laboratory in Ohio and the Texas Tech Textile Research Center has developed a women's protective clothing sizing chart.(28,37)

4.5 Availability

Availability is an important issue in terms of information and PPE itself. Manufacturers and standard-setting agencies (including governments) need information about anthropometric sizing and the hazards and demographic make-up of Canadian workplaces. Suppliers, employers and workers need information about manufacturers with wide ranges of sizes and styles, and those specialising in particular markets. And the range of products has to get into workplaces across the country, not just those in major centres.

This issue is also rarely studied or reported in professional journals. Even the expensive and detailed American PPE industry report from Frost and Sullivan does not review the types of equipment available for women, for example. Three useful reports have been done by or with the help of organisations with direct links to workers.(2,17,26)

Kaplan says many of the respondents in one survey report problems finding a supplier and knowing what to buy, whether or not they purchased the items themselves. The WOHRG results are listed in Table 4. The Canadian situation is probably worse, particularly when many items are imported.

Economic choices are part of this issue. It is less expensive for manufacturers to use single "mold" rather than several patterns. Anthropometric studies, proper test panels and a variety of master patterns add to the cost. For individual employers, ordering "special" sizes is usually more expensive, unless large numbers are involved. Special orders are also more time-consuming and problematic and items from specialist manufacturers also tend to cost more.

Even though it is an employer's legal duty to protect workers' (including providing PPE), workers sometimes end up making a choice between having nothing and buying something themselves. This is unacceptable in most cases; individual purchases are expensive and the right equipment is not easy to find, especially for individuals. If they can't afford the correct item, the worker's safety or health may be at risk.

TABLE 4

Results of a U.S. manufacturers' and suppliers' survey (26)

<u>Category</u>	<u>No. of co. providing items</u>	<u>No of co. providing items with women's sizes</u>	<u>% of co. providing items with women's sizes</u>
Ear protection	34	5	14.7
Eye protection	32	10	31.2
Head/face	35	5	14.3
Hand	38	22	57.9
Respirators	28	5	17.9
Work equipment	24	7	29.2
Body protection	46	23	50.0
Foot protection	27	16	59.2

4.6 Other issues for women

There are other issues for women. The ones listed are some of the most obvious; there are others.

Pictures of women wearing protective equipment — relatively uncommon as they are — do not guarantee the company actually has items that will fit women. Items advertised as being "for women" or as "women's sizes" may simply be "small" men's sizes.

hospital workers.(4)) Lab technicians --
protect themselves from exposure to infectious samples --
Arts and crafts workers may need respirators, gloves, coveralls/clothing --
footwear. Meat wrappers need gloves, thermal clothing and safety footwear to
deal with cold temperatures, rolling carts and other equipment.

5. Problems by types of equipment/clothing

5.1 Introduction

Rather than reviewing problems with every possible type of protective gear, I want to concentrate on issues relevant to women and on several commonly-used items: body protection, gloves, eyewear and footwear. These are used by a wide variety of workers, whether their jobs are considered "white collar" or "blue collar".

5.2 Body protection

Body protection -- coveralls, aprons, etc. -- is protective equipment, even though it is not always considered important from a health and safety point of view. But keeping dust, liquids and other "crud" off workers' skin and clothes can help prevent illness and disease.

Unlike "street clothing", there are few standard sizes or ranges of sizes for coveralls or other body protection. There are no certification procedures for this kind of PPE.

A union survey of its members who worked in the British post office shows some of the practical problems workers face. Those in 39 of 42 depots were dissatisfied with the coveralls supplied by a local cleaning company. The main complaints (with the percentage of depots reporting the problem) were: top pocket flap needed (71 percent); poor quality overall (62 percent); extra pockets needed top and back (52 percent); acid resistance very poor (50 percent); and measurement/fitting bad (50 percent).

The survey resulted in meetings that led to an agreement to change the type of material from six-ounce cotton to nine-ounce 65/35 poly cotton, to increase the number of suits provided and to improve the design by adding more pockets and flaps.(21)

Women who want or need body protection face definite difficulties. Men's coveralls or trousers do not fit most women because of the difference in hip sizes. Coveralls that fit women's hips are often too long for their arms and legs and too big for most women's shoulders. This may not be a problem if the gear is to be worn loosely over other clothes but loose clothing is inappropriate for many jobs, and may be dangerous in some.

Coveralls can fit women. Robinette used an anthropometric approach to produce eight sizes of coveralls for U.S. Army women. A variety of sizes based on real people is the key.(29)

Finally, coveralls pose a unique problem for women: how do you go to the bathroom without undressing? 73 percent of women surveyed by the Coal Employment Project in 1981 said they would buy coveralls they didn't have to remove to go to the bathroom. Their wishes have been answered, according to the CEP. The Texas Tech Textile Research Center developed a prototype model that zip from knee to knee. (They also include a padded back area, especially useful to women working in places they must bend over, eg. coal mines and construction sites.)(2,28)

Womanswork, a small company specialising in protective equipment for women, plan to introduce their own design of women's coveralls and overalls in the fall of 1988. They also produce a 15-pocket work apron.(33)

5.3 Gloves

The stories about gloves that don't fit female workers, and the consequences, abound. They include:

- o women putting cotton gloves inside welding gloves or wearing several pairs at once so that the outer one fits;
- o a Wisconsin woman using company-provided gloves too big for her hand was injured when the "finger-tips of the glove were hanging over the edge of the table onto the belt and were drawn by the belt between the roller and the table which, in turn, pulled her fingers into the gap up to the large knuckles";(18)
- o when cloth gloves provided by the company for frozen food workers were clumsy, uncomfortable and too large, the women did not wear them, even when handling frozen foods;(18)
- o when gloves interfere with dexterity, workers remove them;(2)
- o more than one-third of the respondents in the CEL survey of female miners said that even the smallest gloves they found extended one inch beyond their fingertips;(2) and
- o the LRD survey included complaints that gloves aggravate skin problems, leave a strange smell on hands, let chemicals through and the range of sizes available is small.(21)

Like other protective equipment, there are no uniform sizes for gloves, nor are there certification procedures for these important items. Each company uses its own molds so that one company's "small" can be quite different from another company's. Certification would help standardise sizing, fit requirements and information about permeation and break-through rates. One important ingre-

dient in a certification programme already exists. The armed forces is developing standardised sizing protocol for men and women's gloves that could be used by others.(28)

In 1983, more than 30 American companies stocked "women's sizes" gloves in their regular inventory. These should have shorter fingers and be narrower than gloves designed for men. However, she also points out that women's gloves are not usually available in as many lengths, gauges or weights per gloves style as "men's" gloves. Women's gloves may not be all they seem either; improper fit at the thumb and finger crotches causes dexterity difficulties.(28)

5.4 Footwear

Workers in the LRD survey said footwear problems include a limited range of (unattractive) shoes, boots that are too heavy and/or not waterproof, toecaps causing excessive sock wear and toe damage and discomfort when a lot of kneeling is required.(21)

Many authors investigating PPE problems facing women report the results of the 1976 NIOSH survey of women's "safety" shoes. The agency found that these shoes do "not meet even the least stringent requirements of the men's safety toe footwear standard."(5) Things are changing in the footwear industry but it is still difficult for women to find work boots or shoes that fit them.

In 1983, Punski found that most American manufacturers still did not make any performance or durability claims for their women's footwear.(28) The 1978 ANSI standard for women's footwear is still not incorporated in any legislation. (There is a debate about why it requires a 15/32-inch clearance in the toe cap rather than the 1/2-inch required in men's shoes.) The CSA footwear standard makes no distinctions between men's and women's shoes for fitting or testing purposes.(4)

Without a standard for women's footwear, female workers buy what is supposed to fit them or those certified in men's sizes. The result: it is not uncommon for them to stuff material into the toe to make the shoes/ boots fit or to wear extra pairs of socks. But toes that do not extend into the safety cap are not protected; the CSA and ANSI certification is useless to these women.

This "making-do" is unsatisfactory and unnecessary. A large (Canadian?) protective footwear manufacturer says it can provide women with footwear featuring steel toe-caps, metatarsal guards, thermo-insulation, non-slip neoprene soles and built-in and slip-in puncture-resistant soles. Foundry, rubber, conductive and non-conductive boots are also available for women.(27) People with very small or very large feet or other special needs, likely face problems, however. For example, chain saw boots aren't made for women; men's start at size six.

Waitresses and other women who spend much of their work time on their feet know the problems of being expected to wear shoes featuring heels and/or pointed toes. Our big toes don't point to the middle of our foot until after we wear shoes like this. The pressure put on the heel is enormous. A 60-kg. woman wearing heels with a 1.5-square-centimetre base puts pressure of 40 kg/cm² on that little spike, compared to the 7 kg/cm² pressure on an elephant's foot bottom.(38)

Defining the problem properly can lead to solutions. The Swedish Scania airline and its flight attendants attributed their muscle fatigue, sprains, swollen legs, back and shoulder pains and slip-up injuries, to poorly-designed work shoes. Designers came up with shoes that are wider, with a lower, wider heel to distribute body weight over the whole foot. The sole is very slip-resistant rubber and the toe section is lined with a special fabric that can absorb and emit moisture. The ankle strap is adjustable and the heel is lined with an anti-slip surface to keep the foot in the correct position.(38)

This kind of design work is rare for safety boots, particularly those for women and for men with "small" feet.

5.5 Eye protection

Eye protectors are the subject of CSA certification standards. However, these requirements focus on impact and dust and splash protection, not fit or comfort. Standard six-inch-wide goggles may not protect people with smaller-sized faces very well, including women. Punski says five-inch "mini-goggles" may be better for narrower faces but may not have an adequate seal at the temple, cheeks or nose.(28)

Kaplan and Knutson found that faceshields, goggles and sideshields do not fit female workers properly, leaving gaps through which objects or materials could enter. They cite an example of the consequences: a woman got steel particles in her right eye, even though she wore safety glasses with side shields; the glasses were too big for her and would slip down her nose.(18) Some participants in a study of 1400 Air force women cited poor-fitting goggles and straps in which their hair was caught.(16)

5.6 Respiratory protection

Respirators are important emergency and interim devices to prevent illness but they are often purchased and handed out cavalierly. Some employers and workers are aware of the need for a proper face-seal and other fitting requirements. But discussions often focus on fitting procedures and what is being tested, not who is being tested.

Some years ago the U.S. National Institute for Occupational Health and Safety (NIOSH) asked researchers to include women in an anthropometric test panel for respirator fit testing. What they found out is no surprise to women expected to wear respirators: women have generally smaller faces than men, even though there is some overlap.(12) A North Safety Equipment official was quoted recently as saying that a lot of respirator manufacturers now have 12 women on their 25-member test panel to develop and test respirator fit.(32) Hickling discusses related ergonomic fit issues.(13)

Recommendations for a variety of respirator sizes have been around for a while. The 1963 AIHA - ACGIH respiratory protective devices manual recommended half masks come in five sizes based on face length and lip length/mouth width measurements. Hack and McConville ended up deciding to use these same dimensions for their test panel, 15 years later. They also pointed out that the U.S. armed forces design respiratory protective equipment using anthropometry and human factors (ergonomic principles) but this is not done for civilian respirators.(12)

6. Conclusions

6.1 General

As a society, we must make occupational health and safety issues a higher priority. They are linked to the concerns many Canadians have about "the environment", which cannot be separated from the work environment, the source of much pollution. Cleaning up "the environment" means cleaning up workplaces where public health is also at stake. As a public health issue, all workers -- whatever their size, shape, sex or ethnic background -- have the right to PPE that protects them from health and safety hazards.

This will not happen until several conditions change, including the attitude of PPE manufacturers/suppliers and purchasers/employers. They must recognise the presence of women and "visible minorities" in the workplace. Women will continue to work outside the home, probably in increasing numbers. They will continue to make break-throughs in non-traditional jobs, both blue and white collar. So will people from a variety of ethnic backgrounds.

Protective equipment is an important component in a preventive health and safety programme. Its design, use and maintenance must be taken seriously, where its use is appropriate. Workers' needs must be addressed; women are one group of workers whose needs are not being met right now. They cannot continue to be ignored, nor should their differences from men be used to keep them out of new jobs where PPE is required.

The following suggestions for changes are based on the premise that we need **technology-forcing** specification standards and legislation to ensure wider selection of PPE for all workers, including women. Experience shows that a volunteer approach encourages scattered, inconsistent slow change.

6.2 Recommendations

6.2.1 Information sources

A lot of the information needed to solve PPE problems -- PPE requirements, anthropometric sizes and innovative and/or appropriate protective equipment and clothing -- already exists, although it may not be in convenient places. Finding it is the problem, especially in Canada, because most (if not all) of the equipment and studies about it comes from or is done in the U.S. The other main issue is getting information into the hands of those who need it.

A fundamental part of any research and information collection or dissemination is the PPE user (ie. workers). However the work is done, high priority must be given to getting information from PPE users about their needs and preferences, and letting them know, in meaningful ways, about the properly-designed equipment/clothing available.

In 1984, Jeanne Mager Stellman recommended the information required to solve PPE problems for women included: how and where to obtain appropriate equipment and clothing; relevant certification and testing information; applicable standards; and proper fitting techniques.(36) To this, should be added:

1. demographic information about the Canadian workforce, linked to information about occupation/industry if possible;
2. anthropometric information about the Canadian workforce;

3. statistics about the sources types and amounts of PPE used in Canadian workplaces;
4. information about the types of occupational accidents and illnesses/diseases, and the role PPE (or lack of it);
5. in conjunction with # 4, hazard surveillance (information about the hazards associated with different types of work, occupations and processes) is a preventive approach whose time has come; and
6. standards, designs and practical approaches used in other countries, translated into English and French where necessary.

The Canadian Centre for Occupational Health and Safety (CCOHS) and COPE should facilitate this work. The CSA Community Advisory Panel on Occupational Health and Safety should also be involved but it needs to expand to get input from other centres. Provincial, territorial and federal departments responsible for occupational health and safety also must play a role in this exchange of information.

The CCOHS should also be the much-needed clearing house for this information, provided decisions about how the material is compiled are made with input from interested and affected parties, including workers and their representatives. Translations of European material, especially from Scandinavia, may be possible through CCOHS's ILO links; if not, the national organisation should get it done itself.

Manufacturers, suppliers and standard-setting agencies should use this information to start the process of designing and certifying PPE that really works and fits Canadian workers. If they are reluctant, or take too long to do it, governments have a responsibility to require changes, on a phased-in basis where appropriate.

6.2.2 Design issues

We won't have protective gear that fits Canadian workers until design concepts change. Preconceptions about "medium" must go. Manufacturers and standard-setting agencies must use anthropometric design methods reported by Robinette and others, to produce patterns for different sizes of workers.

Anthropometric information about the Canadian workforce does not seem to be easily accessible. Standard-setting organisations need to find what information is available, what can be "borrowed" from elsewhere and what is missing. Gaps should then be filled in and the information passed on to manufacturers. COPE could provide the forum for this, as could the CCOHS and government agencies responsible for health and safety. Employers' groups and workers' organisations and representatives need to be involved too.

Workers' needs must also be taken seriously. Issues of fit, comfort and special needs must be addressed if PPE is to be worth buying and using. Test panels must include representatives of the real workforce, including people from a range of sizes and shapes, ethnic backgrounds and both sexes. (As the use of PPE increases — where it is really needed — because of a greater variety of sizes and styles, the market for such equipment and clothing will likely increase.)

The main wrench in the works of this scenario is our economic situation. We need to know more about who designs PPE, and where they come from. Most PPE used in Canada apparently comes from the United States, so efforts must be made to either develop a Canadian industry responsive to Canadian needs or

to persuade or force (with legislative requirements) American companies to change their design and marketing practices.

6.2.3 Certification and standards

Standards and certification procedures would be a big step towards ensuring that workers get the PPE they need and deserve. An ergonomic approach (including anthropometrics and the principle of ability to adjust for a proper fit) should be the basis of these standards and procedures. Comfort and sizing issues must be addressed, along with requirements for adjustability and special needs. Buyers need information about certification and standards, as well as how to select the right PPE. Selection requirements must include real input from workers and/or their representatives.

Pilot projects based on industry and/or occupation would be helpful. These could be funded by government or employer or worker organisations, for example; joint efforts might work best.

Certification is not enough. Monitoring the situation is essential. A performance test of men's safety shoes about 10 years ago shows why. NIOSH found that 57 percent of the shoes in their sample did not meet the OSHA standard of the day, and were unsafe.(5) This should be a government responsibility with assistance from workplace health and safety committees, employers and other (advisory) organisations.

6.4 Availability

Once comfortable PPE that fits real workers is manufactured, it has to get to workplaces. This is a particular problem outside major centres and in small workplaces, where buying in bulk is not always possible. A complication is the lack of complete information in equipment catalogues about a company's stock.

There are several ways to deal with this. They include:

1. Manufacturers' catalogues should list all available stock, and draw attention to equipment/clothing that fits women and others who don't fit the "average" mold.
2. Distribution systems must improve so that geography does not become a discriminating factor.
3. Industry and trade groups must get involved. The best way to do this is to make them part of legally-established occupational health and safety sector associations (as in Quebec) with mandates to tackle health and safety issues, including PPE. Workers and their representatives must be included.
4. Sector associations should prepare codes of practice for minimum standards of selection, use and maintenance of PPE for their industry to increase the uniformity of the types of PPE used.
5. Pilot projects are needed to iron out procedures and set examples for small workplaces in particular. They should include bulk buying on a regional or area basis to small firms.

7.0 Conclusions

All workers — men and women, white and non-white — have the right to working environments that do not adversely affect their health and safety. Use of protective equipment and clothing is sometimes an important method to reduce or eliminate potential health and safety problems. Protective equipment

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