

## Reproductive Hazards in the Workplace: A Case Study of Women Firefighters

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Recent attention has focused on the difficulties of providing equal employment opportunities for women while ensuring reproductive health in the workplace. This paper examines the potential hazards faced by pregnant firefighters and recommends a policy that seeks a reasonable accommodation between employment and fetal and maternal health. The potential hazards faced by firefighters include physical exertion, hyperthermia, and exposure to carbon monoxide and other toxic gases. The ideal policy option for improving reproductive health is to make the workplace safe for all employees. Where this cannot be accomplished and a unique reproductive hazard exists to women during pregnancy, temporary positions should be found that remove the pregnant woman from the hazard while allowing her to continue work.

**Key words:** reproductive health, firefighters, employment policies, pregnancy, disability

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### OVERVIEW

The increased entry of women into the workplace, especially in traditionally male-dominated jobs, has continued to raise a host of difficult, complex, and potentially volatile issues surrounding the question of fetal damage occurring from workplace exposure to chemicals and physical agents. These issues arise from several intersecting and often conflicting trends: the desire for equal employment opportunities for women, social and cultural beliefs about the nature of pregnancy and reproduction, concern over liability for adverse reproductive outcomes in our increasingly litigious society, and the continued introduction of new chemicals into the workplace. Compounding the difficulties of reconciling these trends is the pitifully small fund of scientific knowledge concerning the adverse reproductive effects of currently used chemicals and physical agents. In humans, a small but growing number of chemical substances have been demonstrated to cause birth defects or to affect fertility following occupational or environmental exposures. In experimental animals, thousands of compounds have demonstrable mutagenic, teratogenic, or fetotoxic activity. In reality, the roster of workplace reproductive hazards is undoubtedly longer than the first list and shorter than the second. Evaluation of potential reproductive hazards found in the

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workplace more often than not requires bridging a wide gap of scientific uncertainty, since it is necessary to extrapolate the results of animal studies or high-dose human studies to the typically low-dose, chronic exposures found in the workplace.

It is extraordinarily difficult to make concrete recommendations for workplace exposure limitations that should be followed by pregnant women or women of reproductive age. The problem involves not only the estimation of the actual risks involved—a probabilistic, objective endeavor—but also the determination of the acceptability of those risks—a social and economic decision involving a number of potential tradeoffs. In the face of uncertainty about the actual risks posed by exposure, two polarized positions are possible. The first is that no special provisions should be made for pregnant women in the absence of a “proven risk”—namely, scientific data demonstrating with reasonable certainty that a given exposure is fetotoxic or teratogenic. This position no doubt increases the risks of adverse reproductive outcome in many women. The second approach is to assume that *any* exposure to a known or suspected toxin carries an unacceptable risk of fetal damage and thus all pregnant or even all fertile women must be excluded from work sites where such exposure could occur. It has been charged that this “zero risk” standard denies women equal employment opportunity and applies standards of risk acceptability not applied in other situations, notably that of known male reproductive hazards. The employer’s incentive to apply a “zero risk” or exclusionary policy exists because awards to a fetus are not limited under workers’ compensation statutes, and recovery for prenatal injuries is permitted under common law [Warshaw et al, 1978]. Exclusionary employment policies have been a source of heated controversy. Most recently, a court decision upheld the policies of the American Cyanamid Corporation in excluding reproductive-age women from a job involving lead exposure unless the women could provide evidence of sterilization [Curran, 1985].

Bertin [1982] argues that to provide a bona fide occupational qualification for the exclusion of reproductive-age or pregnant women from a given job, an employer must provide facts demonstrating that women of childbearing capacity and their children are unavoidably exposed to recognized risks that others do not experience. This is not the case in many occupational exclusions, which often ignore the question of mutagenic effects on the male germ cells while concentrating solely on teratogenic effects.

The lack of objective scientific evidence has hampered efforts at setting rational and fair policies that protect both employment rights and reproductive health. As noted by the American Medical Association Council on Scientific Affairs, “The advice given by generations of physicians regarding work during normal pregnancy has historically been more the result of social and cultural beliefs about the nature of pregnancy (and of pregnant women) than the result of any documented medical experience with pregnancy and work” [AMA, 1985].

## WOMEN FIREFIGHTERS

This project arose from a request by the Seattle Firefighters’ Union Local 27 to describe the known or suspected risks to pregnant women that might be sustained as a result of exposure to chemicals or physical agents while performing duties as active firefighters. Further, the union requested advice on work policies for pregnant firefighters. Women have been on the force for 7 years, and 40 of 41 women

firefighters are currently covered by a medical-benefits package that treats pregnancy as a complete disability yet denies pregnant women salary benefits available to firefighters who suffer non-duty-related disabilities. To help those involved in formulating policy changes in medical and disability benefits, we have examined the potential risks to a fetus resulting from maternal participation in active firefighting and have suggested guidelines that strike a reasonable balance between fetal risk and maternal employment.

## POTENTIAL RISKS OF FIREFIGHTING

Firefighting is a hazardous occupation. Statistics from the International Association of Firefighters and the U.S. Department of Labor show that firefighters suffer a high rate of occupational injury and illness and, among private-sector workers, have the highest rate of mortality at work [Schirmer, 1983]. Deaths and injury result from trauma, burns, heat exhaustion, overexertion, and inhalation of toxic gases. Some of these potential injuries hold special concern for the pregnant woman.

### Physical Exertion

The physiologic changes that occur during a normal pregnancy make many types of physical activity difficult. During later pregnancy, the intense and unique physical demands of firefighting pose an increased risk of injury or illness to the pregnant woman, her fetus, and her co-workers. Of particular concern to firefighting are the musculoskeletal and cardiovascular changes that accompany pregnancy.

During the second trimester of pregnancy, a number of significant musculoskeletal changes begin. Weight gain and abdominal protrusion are noticed. There is gradual accentuation of pelvic lordosis and thoracic kyphosis. The symphyseal and sacroiliac joints become more mobile. Toward the end of the second trimester, many pregnant women find that the combined effects of these changes make them subject to unaccustomed muscle pains. Maintaining balance may become more difficult, and some movements become more awkward. Abdominal protrusion and increased susceptibility to falls make activities such as ladder climbing potentially hazardous [ACOG, 1977].

Pregnancy is marked by a number of changes in the cardiovascular system, including increased cardiac output and blood volume, and decreased venous return to the heart owing to peripheral pooling. Pregnant women are more susceptible to dizziness and syncope, especially after prolonged standing or working in hot environments [ACOG, 1977]. This is of obvious concern to pregnant firefighters, since severe injuries could occur from loss of consciousness or equilibrium. In theory, the fetus could be subject to hypoxia during vigorous exercise by the mother owing to shunting of blood away from the placenta [Carney, 1980]. The degree to which this is significant in humans is unknown.

The cardiovascular stresses of firefighting are well recognized. During the first few minutes of active firefighting, firefighters routinely sustain heart rates in the 85–100% maximal range [Manning and Griggs, 1983; Barnard and Duncan, 1975]. Elevated heart rates may be sustained for long periods of time. Barnard and Duncan [1975], who monitored the electrocardiograms of active firefighters, reported one firefighter whose heart rate was sustained at greater than 160 beats per minute for 90

min. Such high levels of exertion could have an adverse effect on the fetus, especially in later pregnancy.

Some animal studies have found that severe exertion during pregnancy is associated with increased fetal mortality and decreased fetal weight [Terada, 1974]. The role of fetal anoxia in adverse reproduction outcomes associated with exposures is suggested by studies finding that uterine blood flow decreases with exercise [Morris et al, 1956; Hohimer et al, 1984; Clapp, 1980]. However, other investigators have found no decrease in uterine blood flow with exercise [Orr et al, 1972]. More significantly, several investigators have described a redistribution of uterine flow during exercise that favors the placenta, such that any decreases in uterine flow are confined to the myometrium, while placental flow is preserved [Hohimer et al, 1984; Curet et al, 1976].

Voluntary exercise is well tolerated by some women during pregnancy. Collings et al [1983] studied women who exercised three times weekly during the second and third trimesters, attaining average heart rates of 152 beats per minute (65–70% maximum). No differences were seen in Apgar scores or fetal growth between the exercising and nonexercising groups, and a trend toward higher birth weight was seen in the fetuses of three exercising mothers. Studies of working mothers, however, have shown that the risk of a preterm or low-birth-weight infant correlated significantly with the degree of standing, heavy lifting, and exposure to extremes of temperature and humidity [Naeye and Peters, 1982; Mamella et al, 1984].

Very strenuous activities must clearly be limited during later pregnancy. Although the amount of work tolerated by pregnant women varies widely, the AMA Advisory Panel on Reproductive Hazards in the Workplace has published general guidelines on limitations of work activities during pregnancy. Recommended guidelines pertinent to active firefighting include the cessation of 1) prolonged standing at 24 weeks' gestation, 2) repeated stooping and bending at 20 weeks, 3) climbing ladders and poles at 20 weeks, and 4) repetitive heavy lifting at 20 weeks. The panel notes that the extent to which pregnancy necessitates alterations in work activity "is variable at best, and presently completely unquantified" [AMA, 1985].

Despite this disclaimer, a prudent recommendation for the pregnant firefighter is to cease active firefighting during the second trimester of pregnancy, preferably by week 20 of gestation. This recommendation, which must be tailored to the individual woman, recognizes that at some time during the second trimester the physical changes of pregnancy make a pregnant woman unable to respond safely to the intense and unpredictable physical exertion of firefighting. There is no convincing evidence that a firefighter with a normal, uncomplicated pregnancy incurs special risks to herself or her fetus during early pregnancy. By the AMA guidelines, a woman with a normal pregnancy who feels well can continue working until term at a desk job or other job involving only light physical duties.

### **Hyperthermia**

Several studies have linked maternal fever (38.9°C or greater) during pregnancy with birth defects, especially those of the neural system [Smith, 1978; Miller et al, 1978; Chance and Smith, 1978; Fischer and Smith, 1981]. It has been suggested that use of a sauna might be associated with neural tube defects [Miller et al, 1978]. In animals, a number of studies have demonstrated that exposure to heat can cause congenital defects [Shepard, 1983]. This raises concern for pregnant firefighters,

since they are routinely exposed to high temperatures. One study found the median temperature to which firefighters are exposed to be 37°C, with some temperatures ranging as high as 80°C [Schirmer, 1983]. Exposure to these high temperatures is exacerbated by the exertion of firefighting while wearing heavy protective gear.

Other data provide evidence that the routine exposures to heat encountered by firefighters would not be expected to lead to an increased risk of congenital malformations. The design of the studies linking maternal fever to birth defects makes it impossible to separate the effects of fever per se from the effects of the etiology of fever, usually infectious agents. A study of Finnish women found that the sauna habits of 302 mothers of children with neural or orofacial defects did not differ from those of a control group [Saxen et al, 1982]. The authors noted that in Finland, which has one of the lowest rates of birth defects, virtually all women use the sauna routinely during pregnancy.

Unlike experimental animals, women can regulate their core temperature by leaving a high heat environment. One study exposed women to a hot tub and sauna while vaginal (core) temperatures were monitored [Harvey et al, 1981]. Using "decidedly conservative" criteria based on data from the most susceptible woman, the authors concluded that women could sustain exposure to a 39°C hot tub for at least 15 min or to a 41.1°C tub for at least 10 min without risk of their core temperatures' reaching a level that might cause problems for the developing fetus or embryo. In the sauna, none of the women in the study were able to tolerate heat exposure for a long enough period of time to raise core temperatures to 38.9°C. Another study found that firefighters who exercised strenuously for 15 min in a 41.8°C sauna had average elevations of only 0.56°C in rectal (core) temperatures, while skin temperatures increased by an average of 5.7°C [Duncan et al, 1979].

The routine heat exposures encountered by firefighters are probably safe for the developing fetus. However, firefighters are not always able to regulate their exposures to heat. The International Association of Firefighters reports that 2.1% of fire scene injuries are due to heat exhaustion [International Association of Firefighters, 1980]. Such an excessive exposure to heat and exertion may increase the risk of an adverse fetal outcome. The pregnant firefighter should be especially careful to heed the warning signs of overexposure to heat. Her fetus could be endangered, and she may be endangered as well, since pregnancy decreases heat tolerance. Thus, a woman may be overcome by an exposure she could have tolerated before pregnancy.

### **Toxic Agents**

Attention has recently been focused on toxins found in fire gases [Terrill et al, 1978; Hartzell et al, 1983]. The pyrolysis and combustion products of fires contain hundreds of compounds, some of which are common to all fires and others of which are formed to a varying degree depending on such factors as the composition of the materials burned, the temperature, and the amount of oxygen present. Combustion toxicology is a complicated and as yet poorly characterized field. The toxic gases found in the fire environment can be categorized as irritants, asphyxiants, or other gases, with a wide array of effects that may include carcinogenesis, mutagenesis, and teratogenesis.

### **Irritant Gases**

A large number of irritant gases are found in the fire environment, including hydrogen chloride, ammonia, acrolein, sulfur dioxide, isocyanates, halogen acids,

and nitrogen oxides [Terrill et al, 1978; Hartzell et al, 1983]. These compounds act primarily by damaging the epithelial surfaces of the respiratory tract and are absorbed peripherally to a varying degree. Though acrolein has teratogenic potential when ingested or injected into experimental animals [Shepard, 1983], the chief known danger to the fetus posed by this group of compounds is the potentially life-threatening maternal chemical pneumonitis that may follow acute exposure.

### Asphyxiant Gases

The most common toxic hazard faced by firefighters is carbon monoxide [Treitman et al, 1980]. After inhalation, carbon monoxide (CO) combines with hemoglobin to produce carboxyhemoglobin (COHb), thus blocking the normal transport of oxygen. Sampling studies have shown elevated levels of CO in virtually all fire environments. A study in which personal monitors were placed on firefighters showed a mean CO concentration of 110 ppm in the 200 fire environments sampled [Gold et al, 1978]. Peak levels of CO in a fire may reach 3,000 ppm [Barnard and Weber, 1979] and are often highest in parts of a structure not involved in the fire. CO levels remain significantly elevated during the "knockdown" or "overhaul" phase of firefighting, when the structure is still smoldering.

These levels of CO pose an immediate health hazard to any unprotected woman firefighter and her fetus. CO levels in the fire environment far exceed safe working levels and are often in the lethal range. Acute exposure to CO has been associated with fetal loss in a few human mothers [Cramer, 1982]. A more difficult problem is the assessment of risks to the fetus of a mother chronically exposed to lower levels of CO.

The few animal studies that have examined chronic low-dose exposure to CO have had mixed results, although continuous exposures to CO resulting in carboxyhemoglobin levels of as low as 9–10% have been associated with low birth weights and increased neonatal mortality in some animal models [Astrup et al, 1972; Schwetz et al, 1979; Longo, 1977]. Higher levels of exposure have been associated with behavioral effects and with low birth weights and increased perinatal mortality in a variety of animal models [Shepard, 1983; Longo, 1977].

The only data concerning chronic low-dose CO exposure in human mothers come from studies of mothers who smoked tobacco during pregnancy. Smoking has been shown to raise the level of COHb in both the fetus and the mother [Longo, 1977]. Smoking during pregnancy is associated with increased incidences of preterm births, low birth weights, increased neonatal mortality, retarded intrauterine growth, spontaneous abortions, and bleeding disorders [Longo, 1980]. Carbon monoxide is one of several thousand constituents of tobacco smoke, and it is undoubtedly not the sole agent responsible for the effects listed above. However, a number of authorities agree that CO exposure from tobacco smoke plays a causal role in the low birth weights and other disorders seen in the offspring of smoking mothers [Longo, 1977; NAS, 1977]. Other important constituents of cigarette smoke include nitrogen oxides, polycyclic aromatic hydrocarbons, hydrogen cyanide, vinyl chloride, and nicotine. With the exception of nicotine, all these compounds are also found in the fire environment, raising the concern that the offspring of firefighting mothers are subject to the same outcomes seen in the infants of cigarette smokers.

Several studies have attempted to quantify exposure to CO among firefighters by measuring blood levels of carboxyhemoglobin. In one study, COHb levels were

drawn at 28-day intervals for 5 months in firefighters and controls matched for age and smoking habits [Sammons and Coleman, 1974]. The mean COHb level in nonsmoking firefighters was 5.0% compared with 2.3% in a nonsmoking control group. The mean COHb among smoking firefighters was 10.0%, compared with 7.6% among smoking controls (authors' calculations). Another study attempted to document the range of acute exposures encountered by firefighters [Radford and Levine, 1976]. The mean COHb levels in firefighters immediately after leaving the fire environment were 2.45% in nonsmokers and 6.82% in smokers (>1 pack per day). Values in nonexposed controls were 0.48% in nonsmokers and 5.64% among smokers (>1 pack per day). The upper recorded limits of COHb following acute exposure were 19% in smokers and approximately 11% among nonsmokers.

In both these studies, the COHb levels of nonsmoking firefighters were lower than those of smokers who were not exposed to the fire atmosphere. Another finding of note is that firefighters who reported continuous use of self-contained breathing apparatus (SCBA) had significantly lower COHb levels than those who reported intermittent or no use of SCBA [Radford and Levine, 1976]. Immediately after leaving the fire environment, the mean COHb levels for firefighters using SCBA was 1.42% for nonsmokers and 2.84% overall (upper limit <10%). These levels can be compared to 1) the average level of 1.4% reported for nonsmoking industrial workers in an urban environment and 2) an average level of 5.1% found in nonsmokers who drove on Los Angeles freeways for 90 min.

It is difficult to assess the fetal risk accruing from maternal exposure to CO encountered during firefighting. The exposure of a firefighter is different from that of a smoker; the firefighter is exposed less often than the smoker but is exposed to higher levels of CO. The delay between exposure to CO and the appearance of steady-state levels of COHb is much longer in the fetus than in the mother. Following an acute exposure to CO, fetal levels of COHb will not rise as high as maternal levels because of this slower physiologic response in the fetus [Longo, 1977]. However, the fetal levels of COHb will take longer to decline than the maternal levels. Also, once steady-state levels of CO have been achieved (at least 8 h after exposure commences), the fetal COHb is 10–15% greater than the maternal COHb [Longo, 1977]. Thus, a maternal COHb level measured when the mother is at a relatively steady state of CO exposure (as in a smoker) represents a higher fetal CO exposure than that same level measured in a mother who has been acutely exposed to CO.

In summary, firefighters are sometimes exposed to levels of CO that could lead to acute anoxic damage to the fetus of an unprotected mother. The fetus of an active firefighter is also at increased risk of chronic anoxia because of elevated COHb levels. The fetus of an active firefighter who smokes is at special risk, since the effects of smoking and CO exposure are additive. The risk of chronic anoxia in the fetus of a firefighter is certainly greater than the risk in the fetus of a nonsmoking mother who is not routinely exposed to CO. The risk to the fetus of a nonsmoking firefighter who consistently uses SCBA is probably less than the risk to a fetus of a smoker who is not otherwise exposed to CO.

But although a firefighter can significantly reduce the risk of CO exposure to her fetus by wearing SCBA, its use increases the work of firefighting [Duncan et al, 1979; Raven et al, 1977] and in some situations may increase the risks that heat and exertion pose to mother and fetus.

The other asphyxiant gas of concern is hydrogen cyanide (HCN), which is present at low levels in fire atmospheres [Gold et al, 1978]. Firefighters were found

to have significantly higher levels of serum SCN<sup>-</sup> (a metabolite of HCN) than were control subjects not exposed to fire atmospheres [Levin and Radford, 1978]. Exposure to HCN occurs much less frequently than CO exposure, and although still controversial, HCN exposures are generally thought not to pose an acute health hazard to firefighters [Treitman et al, 1980]. The risks of HCN to a fetus are not quantified, but HCN exposure would be expected to exacerbate the asphyxiant effects of CO exposure.

### Other Toxins

The growing use of plastics and other synthetic substances in buildings and homes has increased the uncertainties of assessing the risks posed by toxic exposures to firefighters. A number of pyrolysis and combustion products are known or suspected carcinogens, mutagens, or teratogens. Few data are available to document the levels of these exposures.

Several commonly used plastics release acrylonitrile when heated or burned [Bendix, 1983]. This substance, a suspected carcinogen, has been shown to cause teratogenic effects in rodents when inhaled in high doses over a number of days [Shepard, 1983]. The level of acrylonitrile to which firefighters are exposed is unknown.

The pyrolysis and combustion products of polyvinyl chloride (PVC), used as a wiring insulator, may include vinyl chloride monomer, toluene, benzopyrenes, chlorinated hydrocarbons, and possibly dioxins and dibenzofurans [Wallace et al, 1982]. Vinyl chloride is fetotoxic in high doses, and in humans has been associated with increased incidences of fetal loss following paternal exposure. Toluene may be teratogenic in high doses, and one human study found an increased incidence of fetal asphyxia and low birth weights among the offspring of women working with varnish that contained large amounts of toluene [Shepard, 1983]. Benzo[a]pyrene is teratogenic in some animal models.

Polychlorinated biphenyl compounds (PCBs) are found in old transformers and in some lighting fixtures. Ingestion of PCBs is known to cause increased infant mortality and reproductive failures in monkeys. Women in Japan who ate oil contaminated with high levels of PCBs as well as traces of other chlorinated compounds gave birth to infants with a variety of congenital defects. Of perhaps greater concern are the combustion products of PCBs. Soot from a fire involving a PCB-contaminated transformer contained 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) as well as high concentrations of numerous other polychlorinated dibenzofurans and dibenzodioxins [Silkworth et al, 1982]. TCDD ("dioxin") is a potent teratogen in animals, including primates. TCDD is a contaminant of the herbicide 2,4,5-T, which a 1979 EPA study linked to an increased rate of spontaneous abortion in the women of Alsea, Oregon [Brix, 1982; Longo, 1980]. It has been suggested, but not well documented, that women exposed to TCDD (as a contaminant of the herbicide 2,4,5-T) show an increased rate of spontaneous abortions and birth defects [Brix, 1982; Longo, 1980; EPA, 1979].

Firefighters are exposed to heavy metals that are volatilized in a fire atmosphere owing to their incorporation into paints and synthetic polymers. Analysis of the soot deposited in the lungs of fire victims showed measurable amounts of lead in 50/94 cases and cadmium in 66/94 cases [Birky and Clarke, 1981]. Lead is a well-known reproductive hazard, capable of affecting male and female fertility as well as acting



as a teratogen. Cadmium is a known embryotoxin in rodents [Longo, 1980], although there is conflicting evidence of its effects on human reproduction [Shepard, 1983]. It is not known whether chronic exposures to fires can raise a firefighter's body burden of heavy metals to a level sufficient to cause adverse reproductive effects.

Although some of the compounds listed above have teratogenic effects, it is important to note that lead, cadmium, vinyl chloride monomer, PCBs, and other compounds to which firefighters may be exposed have gametotoxic or mutagenic effects on male reproduction as well. These exposures need to be better characterized before the hazards posed to both male and female reproduction can be assessed. At this time, it is not felt possible to make policy recommendations for unique protection of the pregnant firefighter from exposures in unusual situations.

### POLICY OPTIONS

Kotch et al [1984] have analyzed policy alternatives for the protection of working women's reproductive health. They concluded that the optimal policy decision was to improve working conditions for both male and female workers, thereby reducing risk for all and eliminating inequitable treatment. This ideal solution cannot always be achieved. Given the nature of firefighting, some reproductive risks are unavoidable although a number of reproductive risks can be reduced through proper use of self-contained breathing apparatus. The "second best" policy suggested by Kotch et al [1984] is to make the workplace safer for women alone. This "second best" policy should be examined, since with firefighters the ideal solution cannot be achieved. In fact, from a cost-benefit standpoint, Kotch et al [1984] state that the most efficient solution to the problem of women's reproductive health "would be to concentrate resources on reducing those risks which are specific to women, if, *available evidence to the contrary*, there are occupational health risks which uniquely affect women's reproductive health" (emphasis added).

In the above discussion we have shown that some occupational health hazards *do* uniquely affect women's reproductive health. The germ cells of both men and women are affected by mutagens, which exert their effects prior to conception. After conception, however, the embryo or fetus can still be adversely affected by exposure to teratogens. For many compounds, the fetal dose required to produce a teratogenic effect may be much lower than the dose required to produce a mutagenic effect on the paternal or maternal germ cells. There is ample experimental evidence that pregnant women are indeed subject to unique reproductive hazards. The unique reproductive hazards of women firefighters fall into two categories: exposure to toxins and problems associated with physical exertion.

As shown above, there is very little quantification of toxin exposure to known reproductive hazards other than carbon monoxide. From the carbon monoxide data presented, exposure during pregnancy does not seem to constitute an unacceptable reproductive risk if the breathing apparatus is used conscientiously. Carbon monoxide exposure data need to be gathered in women firefighters to see if males and females differ in their physiological response to the fire environment. In the absence of further quantification of potentially teratogenic toxic exposures, we are loath to recommend a policy of exclusion of the pregnant (or especially the "potentially pregnant") firefighter from active firefighting, especially in light of the fact that some potential

exposures are male reproductive hazards as well. Further quantification of the chemical exposures of firefighters is needed.

The second set of unique risks to pregnant firefighters is posed by physical stress and exertion. As noted above, there is evidence that physical exertion late in pregnancy can lead to poor reproductive outcomes. Also, the pregnant firefighter is at an increased risk of injury because of the musculoskeletal and other changes of pregnancy. These risks can be eliminated by switching the pregnant firefighter to a limited-duty position by gestation week 20. This is not the current Seattle Fire Department policy.

Presently, 40 of the 41 female Seattle firefighters are covered under a disability system that treats pregnancy as a non-duty-related disability. To the extent that pregnancy precludes active duty, pregnant firefighters would be given disability leave. Limited-duty jobs are not usually available to firefighters; any temporary disability precluding active firefighting is likely to constitute a total disability. While on disability leave, firefighters must begin to pay their own premiums for medical benefits, which are available for only 6 months after removal from active duty. The firefighters' salaries are maintained, approximately 50% from insurance and 50% from the Seattle Fire Department Relief Association, a fund supported by payments from firefighters but whose administration is separate from both the city and the firefighters' union. However, pregnant women are not eligible for the 50% of salary from the relief association, because the policy of the association is to compensate only those injuries or conditions that could happen to "any firefighter." By this logic, a male firefighter who suffered a genital injury would also be ineligible, although this has not been tested to date.

The present pregnancy compensation is inadequate in at least two respects: the denial of relief benefits and the 6-month expiration of medical benefits. Pregnancy is treated unlike other disabilities by the relief association, so that a pregnant woman receives only half the salary benefits of, say, a firefighter who broke a leg while skiing. The denial of relief association benefits to pregnant firefighters violates at least the spirit of the federal Pregnancy Disability Act, which requires that pregnancy and related conditions be compensated in the same way as other disabilities. Because of the expiration of medical benefits, a woman with a complicated pregnancy who is unable to work during early gestation would not have medical coverage during the most expensive portions of her pregnancy—delivery and postnatal recovery. Two main policy routes are available to rectify the problems of inadequate compensation. First, health benefits for all firefighters could be improved, with pregnancy treated like other non-duty-related disabilities. Second, pregnancy could be treated as a special situation of increased susceptibility, and special employment provisions could be made.

The first option, improvement of medical benefits for all firefighters, is a current goal of the Seattle firefighters' union. The union wishes to extend medical coverage to a year or more. This would provide adequate pregnancy coverage, and should therefore be pursued regardless of other changes. Before this policy option could be considered adequate, the relief association would have to agree to provide salary benefits for pregnancy and conditions related to pregnancy on the same basis as other non-duty-related disabilities. Legal action will probably be required before this compensation system is changed. The main disadvantage of this policy option is that it treats pregnancy as a totally disabling illness instead of as a normal life event

that precludes some, but certainly not all, types of work activities. This option is not efficient, since it would deprive the city Fire Department of several months of work during each pregnancy and would increase the cost of disability benefits.

The second policy option considers pregnancy as a work-related partial disability rather than a non-duty-related total disability. Employers are obligated to provide a safe workplace for all employees. Optimally, this would be accomplished by maintaining a work site that is safe even for those workers, such as pregnant women, who are more susceptible to some types of injury and illness. Where this cannot be accomplished for all workers, those workers temporarily at increased susceptibility should have their work site modified so that they can continue to work safely. In the case of the Seattle Fire Department, light-duty positions should be found so that pregnant firefighters can continue to work. This is the policy followed by the Seattle Police Department for all temporary conditions, including pregnancy, which make an officer temporarily unable to perform active patrol duties. The Fire Department, unfortunately, has fewer light-duty positions available, although one might assume that a firefighter in later pregnancy could do useful work for the city in such areas as community outreach and education, fire inspection, or equipment repair and overhaul.

## CONCLUSION

This paper has reviewed an example of the conflicts that arise in attempting to ensure reproductive health while providing equal employment opportunities for women. The ideal solution to these conflicts is to make the work site safe for both sexes, since many, if not most, reproductive hazards affect both men and women. However, some hazards are not common to both sexes, such as some physical activities contraindicated by the physiological changes that accompany pregnancy, and exposures to chemicals that act as teratogens or fetotoxins at levels much lower than those at which they exert mutagenic or gametotoxic activity. Where such a differential effect exists, the ideal solution is still the reduction of risks for all workers. As Kotch et al [1984] have argued, this policy avoids stigmatization of either sex while optimizing vertical and horizontal equity in employment opportunity. In some occupational situations, however, risk cannot practicably be reduced to a level that ensures the reproductive health of all workers. In these situations, the "second best" policy option defined by Kotch et al [1984] should be pursued, and the workplace should be made safe for the sex at higher risk.

At least one state has recognized the special vulnerability of pregnant women to some hazards. The California Pregnancy Disability Act (California Government Code 12900 et seq) mandates the temporary transfer of a pregnant woman, at the advice of her physician, to a less strenuous or hazardous position where such a transfer can be "reasonably accommodated." We believe that other employers, in this case the Seattle Fire Department, should adopt similar policies.

We have shown that pregnant firefighters are at increased risk for injury and should cease active firefighting sometime during the second trimester of pregnancy. Carbon monoxide exposure poses a hazard to the fetus, but conscientious use of SCBA seems to reduce this risk to an acceptable level. With our present knowledge of toxin exposures encountered by firefighters, it is impossible to single out other routine exposures that constitute a unique reproductive hazard to gravid women. Prudence suggests that pregnant women should not be exposed to fire environments

likely to contain unusually high concentrations of known teratogens or fetotoxins. Such a situation could arise, for example, in a fire at a chemical plant or waste site.

For many women today, pregnancy must be integrated into a life that includes work. In some instances, pregnant women will have special needs or restrictions placed on their ability to work. Where accommodation does not pose an unreasonable burden on the employer, every effort should be made to accommodate these special needs.

Neither "proven risk" nor "zero risk" employment strategies achieve an equitable balance between reproductive health and equal employment opportunities. There is a need for careful analysis of occupational reproductive hazards, both those common to all workers and those unique to pregnancy. Only then can a judicious accommodation be found between the employment rights of workers and the health of their children.

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