

**Exploration of Firefighter Bunker Gear  
Part 2: Assessing the Needs of the Female Firefighter**

Lynn M Boorady, Associate Professor  
Fashion and Textile Technology  
Department, State University of New York  
Buffalo State

Shu-Hwa Lin, Associate Professor  
Department of Family and Consumer  
Sciences, University of Hawaii at Manoa

Jessica Barker, Assistant Professor  
Department of Apparel, Educational Studies  
and Hospitality Management  
Iowa State University

Eunjoo Cho, Lecturer,  
Department of Apparel, Educational Studies  
and Hospitality Management  
Iowa State University

Young-A Lee, Assistant Professor  
Department of Apparel, Educational Studies  
and Hospitality Management  
Iowa State University

Susan P. Ashdown, Professor  
Department of Fiber Science & Apparel  
Design, Cornell University

**ABSTRACT**

*Female firefighters are a minority in their workplace yet also need the same protective equipment as their male counterparts. This research focused on the problems with their bunker gear that female firefighters themselves have identified. Focus groups were held in around the country and the comments made by female firefighters were analyzed. Data were organized by identifying the most common problems areas. Five gear factors (i.e. garment design features, sizing, fit, mobility, and fabrication) are discussed within two main constructs; function and comfort. Suggestions on improving bunker gear for female firefighters include altering the fit and sizing, as well as changing the location of pockets and enhancing the functionality of the suspenders.*

*Keywords: firefighter, protective clothing, sizing*

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**INTRODUCTION**

There are more than 1.1 million firefighters in the United States, of which approximately 800,000 are volunteers (United States Fire Administration, 2012). Among the 342,000 career firefighters in the United States today, the United States Department of Labor (2010) reports there are slightly more than 12,000 (3.6%) women. In 2008, a questionnaire study was

conducted of 675 firefighters in 48 states, approximately half of which were female. Follow up interviews were conducted with 175 women either individually or in focus groups. Problems with ill-fitting equipment were reported by 79.7% of the women from this study, nearly four times higher than the 20.9% reported by men (Hulett, Bendick, Thomas & Moccio, 2008).

Research of protective clothing for firefighters is ongoing, yet there have been few studies focused on female firefighters. Standards exist for fabric performance, design aspects of the garment (e. g., location of reflective tape) and performance of associated equipment, such as helmets, hoods, gloves and boots. The National Fire Protection Association (NFPA) publishes required standards for structural firefighting (NFPA, 2007). Standards specific to bunker gear can be found in NFPA publication 1971. Firefighters need to be comfortable in a garment that is fully functional so that they can perform their duties without additional risk or worry, yet no study has focused on female user perceptions of and problems with their gear. As first responders to an emergency situation, their gear is critical and their protection is paramount.

The purpose of this study was to evaluate bunker gear currently worn by female firefighters and determine areas needing improvement, as exploration for further design development. Firefighters need protection from multiple hazards, and perform a variety of job functions. Their clothing systems must protect from thermal and chemical hazards, without affecting their mobility or work performance. Clothing systems must be compatible with other equipment, such as helmets, masks, gloves and footwear. Provisions must be made for additional equipment that the firefighter might carry, such as an axe, oxygen tank, ladder or hose. Resolving these complex issues for the firefighting community requires knowledge of current equipment and garment performance, current fit and safety issues, design analysis of the current garment, prototype development, testing, design and redesign in order to find the optimal system.

In this research Rosenblad-Wallin's (1985) user-oriented approach to functional clothing design is employed, beginning with analysis of the demands that the product (clothing) must meet in the use-situation as described by the person who uses (wears) the protective clothing. These demands can be functional (protection and comfort) or

symbolic (self-esteem, confidence and group membership) among others. The most important step in this process is to acquire detailed knowledge of the user, their capacity and limitations, problems, wishes and needs (Rosenblad-Wallin, 1985). Therefore an extensive literature review, focus group interviews with female firefighters, and in-depth analysis to identify critical areas needing improvement were completed.

## **BACKGROUND**

Prior to 1989, firefighters wore long coats and hip boots for protection (LaBar, 1997). However as fires became more dangerous firefighters needed to be more aggressive (LaBar, 1997). Bunker gear, a coat and pants combination, was developed for better protection. The transition to combination bunker gear was slow, with the last department (Chicago, IL) adopting it in 2006 (Dudek, 2006).

Female firefighters, with few exceptions, currently wear bunker gear designed and sized for men. Expecting this gear to fit women is unrealistic due to sexually dimorphic body proportions. Eiser (1988) states that there is an ongoing need to develop protective equipment to ensure proper fit and comfort and that safety issues become more hazardous when the clothing is too loose or ill-fitting.

Women firefighters are underrepresented even in large fire departments. As recent as 2005, Garden Grove, CA with a population of almost 175,000 residents had no female firefighters on their force (Hulett, et. al., 2008). In 2012, New York City had 10,000 firefighters and only 28 of them are female (Gardiner, 2012). Most of the research on women in the field of firefighting focuses on their physicality, and lack of acceptance in a male dominated field. Only three studies were found addressing female firefighters and their gear specifically: Hulett, et al. (2008), Schuster (2000) and Chetkovich, (1997). Hulett et. al (2008) surveyed 114 departments nationwide and held in-depth

interviews with 175 female firefighters to determine their acceptance in the field. One of the issues they found was a lack of support to purchase female-specific protective gear even when available on the market.

Schuster (2000) stated that the lack of appropriately sized protective equipment is a source of stress for the smaller frames of the female firefighters. Indeed, Chetkovich (1997) states that “firefighting gear and equipment (are) designed for a single sex work force” and “ill-fitting uniforms, gloves, boots and masks continue to make the work not only more uncomfortable but more difficult and dangerous” (p. 176). Gender specific bunker gear was available by 1997, however departments even now are hesitant to purchase the gear as “it would not fit anyone else if the female left the department” (Gary Woodson, personal communication).

The physical differences between men and women have been well documented. In Tilley’s 2002 book on anthropometrics “The measures of a man and a woman”, the 50<sup>th</sup> percentile male is 69.1” tall and weighs 172 lbs. Heights and weights for men (98<sup>th</sup> percentile) range from 62.6” to 75.6” in height and from 100.3 lbs. to 244 pounds. A female at the 50<sup>th</sup> percentile is 64” tall and 137.5 lbs., and the 98<sup>th</sup> percentile range is between 58.1” to 69.8” in height and 93 to 217.6 lbs. in weight.

Data analysis from SizeUSA (Textile Clothing Technology Corporation, 2003), shows a difference in waist to hip variation of men and women. A total of 359 women had waist circumferences between 27.5 inches and 28.49 inches. Within this subset, hip circumference varied from 32.91 inches to 45.25 inches. This is a 12.34 inch difference in hip circumference when the waists varied only by one inch. By contrast,

32 men within SizeUSA with waist circumferences between 27.5 inches and 28.49 inches had hip variations of only 5.08 inches.

In the study by Gordon (1984), it was found that female body dimensions must be considered in the sizing and fit of Army field uniforms. U.S. Army women wore field uniforms designed for male dimensions but scaled down for the women. The result was unsatisfactory fit for the women. Therefore a new sizing system was developed to fit the needs for both populations.

## **METHOD**

Semi-structured focus group interviews were conducted to capture user perceptions and group dynamics (Krueger, 1988). Qualitative methodologies, such as focus group interviews, provide a deep understanding of the problem by obtaining substantial data from participants (Esterberg, 2002). In focus group interviews, participants are often stimulated by the comments of others and speak more in depth about issues of concern to them, but are still able to relay their individual user perceptions.

### **Focus Group Questions**

Questions addressed the design of firefighter gear and required work actions of the user. Participants were also asked to identify what they like and dislike about their current and past gear. Table 1 presents the initial interview questions. An interview protocol was followed to minimize interviewer bias (Kvale, 1996). Additional questions were asked when responses from the initial questions needed clarification or expansion.

**Table 1: Focus Group Questions**

1. What do you like best about your gear?
2. What do you dislike most about your gear?
3. Can you tell me a real situation in which your gear kept you from moving in a way you needed to move? What were you doing at the time?
4. What would you change about your gear if you could?
5. What kind of adjustments do you make to your gear to improve your wearing experience?
6. What activities or movements are you doing when you make the adjustments?
7. Are there any features of your previous gear that you miss?
8. What elements of the ensemble as a whole are in need of the most improvement?
9. What would you like to see in your next set of bunker gear?

**Procedure**

Focus groups were conducted at eight fire stations. Each focus group took between 60 and 90 minutes to complete. The focus group sizes ranged from two to 11 firefighters, with an average size of nine. All participants were either full- or part-time firefighters, career or volunteer. Each focus group session was audio recorded with participants’ written consent and transcribed for accuracy in data analysis. For some focus groups, it was not possible to hold the focus group interview without male firefighters present. In these instances, any comments made by male firefighters during the focus group interview were removed from the transcript before analysis.

Fire stations were chosen in two ways; first was proximity to the research sites and whether the researchers could obtain approval to conduct the study at that

site. Additional fire stations were added to capture larger focus groups and additional urban stations.

**Study Participants**

The Human Subject Research board at each university granted approval. All participants were volunteers and gave both written and verbal consent. Focus group meetings were conducted in four states. We purposively identified both career and volunteer fire departments in urban and rural settings to ensure a broad representation of the female firefighter population. Fire stations were selected based on the number of female firefighters employed at the station. Table 2 shows the distribution of urban and rural, and the type of station (career firefighters or volunteer) of each focus group site, along with the number of women in each group.

**Table 2: Focus group sites and participant information**

Site	Urban/Rural	Career/ Volunteer	City Pop.	Area of Country	Total # of Firefighters	Total # of Participants	# of Female Participants
1	Urban	Career	40,000	Midwest	75	7	1
2	Urban	Career	350,000	Midwest	850	8	2
3	Urban	Career	27,500	Midwest	82	11	5
4	Urban	Career	650,000	South	900	2	2
5	Urban	Career	900,000	Pacific	1200	6	6
6	Rural	Volunteer	17,300	Midwest	73	3	3
7	Urban	Career	450,000	Midwest	250	3	3

## Data Analysis and Interpretation

The female firefighters' responses from focus group transcriptions were analyzed by two researchers both individually and cooperatively using an iterative part-to-whole interpretive analysis method (Spiggle, 1994). To ensure accurate representation and interpretation of the data, each transcript was read a minimum of three times throughout the process. First, researchers worked independently to identify prominent themes and ideas from the transcripts. Participants' comments centered around five primary gear factors, including design features, sizing, fit, mobility, and fabrication.

The researchers then worked together to evaluate the comments grouped within these themes and, through a back and forth process, examined transcripts and the previously collected lists of recurring themes to identify abstract constructs that emerged from the initial categories. These constructs represented common issues and recurring themes across all the study responses. Two major constructs evolved

from the interpretive process, each of which encompasses a critical requirement of firefighter turnout gear: function and comfort. Data were organized by grouping participants' comments related to each of the five primary factors of the gear and the two critical requirements, allowing researchers to identify the most frequently repeated comments for each area, and therefore the issues of greater concern to participants.

## RESULTS

### Gear Function

The two main constructs that emerged from the data were function and comfort. Function, as we defined it, related to the ability of firefighters to perform their job functions while wearing their gear. This conceptual area received the highest number of comments from participants and was the only area to receive comments related to each of the five gear factors (i.e., garment design features, sizing, fit, mobility, and fabrication). See Figure 1.

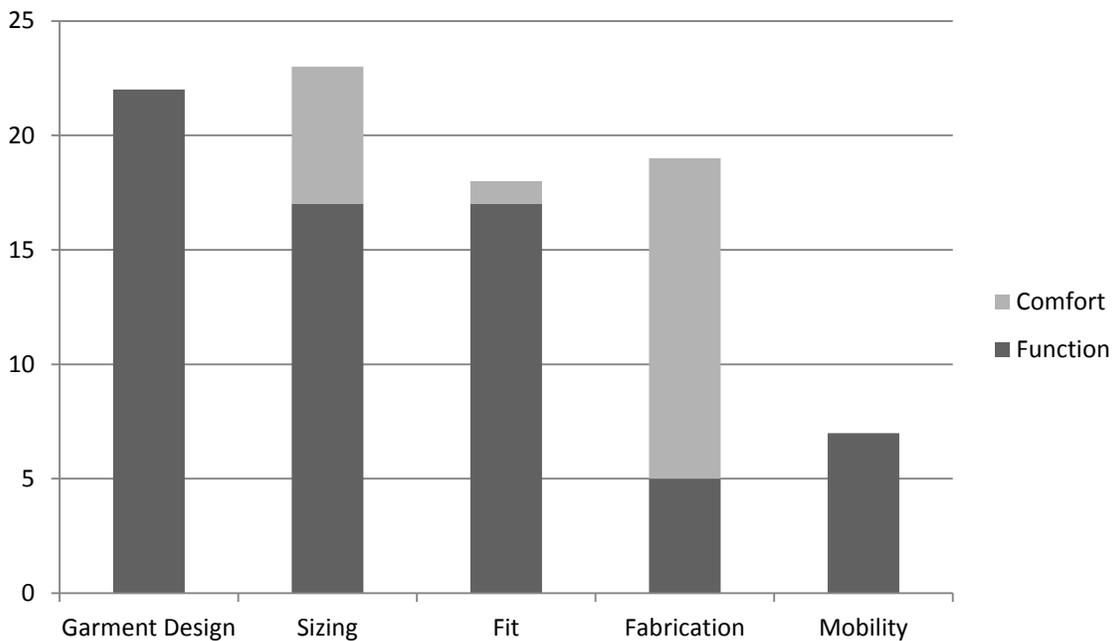


Figure 1. Number of Comments by Category

## Garment Design

Of the five gear factors, participants' comments overwhelmingly focused on garment design features (Figure 1). The majority of remarks centered on design issues that females perceived were more problematic for themselves than for their male counterparts.

Turnout gear normally has a variety of pockets placed on the outside of both the coat and pants to hold items such as hammers and flashlights that were needed when firefighters enter a fire. Firefighters also store their gloves in pockets to be available when donning their gear, and return them to their pockets for storage when removing their gear.

Participants noted that pocket placement was often inconvenient for the female figure. Large, bellows style pockets are often located on the side of the upper leg or hip. Participants indicated that this was a poor location. One female recounted that her hip pockets affected her ability to move through tight spaces or climb.

*I think the pockets are in strange places, too. Maybe it's just a woman's hip consciousness, but having all this stuff like right here seems like a bad idea to me and on my legs, too. I always just feel so totally unwieldy ..... You know, those heavy pockets and you're trying to get up into a truck. It's like, ugh! Heave ho. And somebody push me, please (Site #7).*

Participants also stated that the chest placement of radio pockets on some gear is inconvenient for females.

*...you have so much by the time you put on your pack, by the time you have a flashlight hanging there, a pass device and stuff. So it's kind of not in the greatest place and maybe not for a girl (Site #6).*

The second most common issue for female firefighters related to suspender

design. The suspenders should hold the pants on the body in an optimal position and are available in two configurations – A-style or H-style. The A-style has a strap over each shoulder, fastened on the left and right front of the pants but joined in the back to create a single fastener at center back. The H-style suspenders are separate in the back (fastening on the left and right on both front and back of the pants) with a horizontal strap to hold the straps on the shoulders. Firefighters can purchase different sizes of suspenders in leather or webbing materials and most suspenders are able to be adjusted for length.

Female participants generally agreed that the placement of suspenders was not appropriate for females. One participant stated: *They run right up over your boobs (Site #6).* Another participant agreed, *It rubs, so I've had to wear like my little sports bra underneath (Site #7).* The suspender placement also conflicted with the air pack straps, further complicating the issue for females.

*When you're using a sternum strap on your air pack, you have extra sort of bunching going on in your top half that must be different for them [males] because they're configured differently. ... suspenders and all this end straps and boobs... the whole thing squishing together (Site #4).*

## Sizing

Participants expressed great concern about the sizing and fit issues related to their gear. For this study, comments that dealt with gear that was overall too large or too small were considered a sizing issue, while comments focused on more specific proportions of the gear (e.g. pant waist is too large, coat sleeves are too short) were grouped as fit issues. Equal numbers of comments related to the effects of sizing and fit on firefighters' function.

The majority of participant comments revolved around the lack of female-specific gear for female firefighters. Few of the participants indicated they had gear designed and sized for women. One participant stated, *Pants are too long and coats are too big in general. I feel like I am wearing my dad's, you're a little kid... you're trying to fit into your dad's coat and trying to make the best of it. It's just bunches of material everywhere* (Site #3). Another female firefighter said, *So we just stick with the guy's clothing, even the pants. They think everybody has a waist this big around and hips this wide. They're terrible*" (Site #7). One participant made the simple statement, *Wearing males' gear is a problem* (Site #5).

They also reported their suspenders were too long, even when they adjusted them to the shortest length, and that they did not have gloves and boots that were adequately sized for their smaller hands and feet. One volunteer firefighter was only allowed a choice of male gear owned by the department. Consequently, her boots were much too large for her feet. *It's like the second coming. Yeah, the boots will be left behind. Like if you're climbing away, you'll lose a boot. I've had that happen plenty of times* (Site #6). Another volunteer firefighter indicated that she struggled to find gloves to purchase in smaller sizes.

*Gloves have to be redone because they just always feel so huge and it's, I mean, for me, one of the difficult things is actually finding the right size. ...Almost everything is large, extra-large. And so, you know, it was like lobster claws* (Site #6).

## Fit

Female firefighters reported that their gear was generally too long to fit their bodies, even if the circumference measurements were correct. Participants from two focus groups (Sites #5 and #7) indicated that the coat and coat sleeves were too long. Similarly, three focus group participants related that the pant legs were

too long (Sites #3, #4, #5), and they cinched their suspenders up higher to try to deal with the excess length.

Female firefighters also stated that the crotch on their pants was too low, either due to the pants not fitting properly or because the suspenders would stretch out over time, allowing the pants to drop lower on their bodies. The low crotch posed one of the bigger issues for females, greatly affecting their ability to perform specific tasks that involved squatting or stepping up. One firefighter described the issue, *Literally, the crotch is like clear down almost to my knees, so when you go to step up or do anything. And part of the problem is they fall, they fall down* (Site #7). Another told how she couldn't fully participate in a training drill because of the low crotch. *Pants are real long and they are down. You know? And he said, you all drop to one knee and I couldn't even. I couldn't even get my legs far enough from each other to go on a knee because the crotch was so low* (Site #4).

## Mobility of Wearer

Firefighters must be able to move quickly into a wide variety of body positions. In the course of their job they may climb a ladder or stairs, check for people under objects and reach overhead to take down objects. Above all, they also must be able to leave the building quickly if conditions are too dangerous. Wearing gear that does not allow for mobility endangers the firefighter.

Firefighters related that their mobility is reduced by the weight and bulk of the gear. One urban firefighter said, *I think it's too bulky. Need to kind of do something with that. The weight and the bulkiness of it. You know, you walk around, you can't, you can barely move* (Site #2). Another participant recounted conversations with other firefighters about increased weight of new gear. *See the gear seems a lot thicker. I know it's not my imagination. That other people say it. And at first I didn't know if it was stiffer, stiffer material or thicker.*

*But other people will say, 'Oh, yeah, I like my old gear. It wasn't so heavy' (Site #7). While participants noted that excess weight and bulk would affect male firefighters' ability to move as well, they felt they were at more of a disadvantage than their male co-workers because they were not wearing gear that was properly designed and sized for their female bodies, causing greater problems.*

### **Fabrication**

Participants related issues caused by the materials of their gear, such as difficulty laundering the gear. Bunker gear requires specific laundering methods to ensure it is properly cleaned without diminishing the fire and thermal protection the gear provides. Firefighters commented that the gear is not only difficult to launder, but also difficult to dry after laundering, or when soaked with perspiration or water after use. One participant described how the slow drying time of her gear affected her.

*It doesn't dry quickly. .... we were out training and I got my pants wet. Well, because we keep our pants down around our boots, they're always scrunched up. They don't dry out. Or when you come back three days later, your gear is still wet and it stinks like kitty litter. So my biggest complaint is it takes too long. And like in the wintertime, when your gear gets wet, you're not dry and you have to go back out in wet gear and you become a popsicle. You can't move because everything is frozen (Site #7).*

### **Wearer Comfort**

The second conceptual area that emerged from the data was comfort, which received approximately 20% of the comments in our focus groups (Figure 1). Comfort, as it is defined here, relates to the absence of discomfort while wearing their gear. The female firefighters said that fabrication and sizing of the gear have the biggest impact on comfort.

### **Gear Fabrication**

The material properties of turnout gear are problematic for female firefighters. The highest concern to study participants was the overall weight of the gear. Many shared the same sentiment expressed by one urban firefighter: *It would be nice someday if they could come up with something that would be a little lighter, yet still be effective in protecting you (Site #7).* In addition to the coat and pants, firefighters wear fire and heat resistant boots, Nomex® hoods, face shields, a Self-Contained Breathing Apparatus (SCBA), helmet and gloves. The total weight of this equipment is between 50 and 70 pounds; when wet, this weight increases. One female in our study described the difficulty of the additional weight from wet gear for females wearing male gear.

*The suspenders are only there to keep your pants from falling like off; .... So, when they get wet and they get that added weight. So then what happens, you get shoulder aches. So the things dig into your shoulder. (Site #6)*

Female firefighters in this study noted that because their gear is so absorbent and has multiple layers of fabrics, they struggle to get it to dry between wearings. Their gear will develop a foul smell after it has stayed wet for a few days that participants noted bothered female firefighters more than male firefighters. Some participants reported that they laundered their gear at home to try to dry it out or get rid of the smell. One participant said, *You're not supposed to hang it in the sun or dry it. But mine smelled real bad a couple weeks ago. I was like I can't take this. This is stinky (Site #4).*

### **Sizing**

Participants discussed how wearing gear sized for males affected their comfort. The majority of comments were about the gear being too big overall, causing additional bulk beyond what they would experience with properly sized gear. They noted this additional bulk made them

uncomfortable, particularly where it bunched at joints or under the SCBA straps on the shoulders and upper chest area.

## DISCUSSION

This study identified critical issues female firefighters have with their gear that affects their ability to perform their job functions or hinders their comfort. Aspects affecting female firefighter function included garment design features, sizing, fit, mobility, and fabrication. Sizing and fabrication issues impacted the overall comfort of female firefighters.

The two greatest concerns related to garment design for female firefighters were pocket placement and suspender function. Study participants found pocket location to be cumbersome and awkward. Bunker gear manufacturers generally let firefighters specify pocket placement on the right or left side of their body (for the thigh pockets, chest pocket or arm pockets) and the firefighters may have some choice in the placement of pockets when ordering new equipment. There is often choice of pocket design (i.e. or whether the pocket has inside divisions). However, from the comments received, many firefighters are not given these choices. It may be more critical that fire departments allow females to customize pocket placement than males, since common pocket locations caused specific frustration for the female firefighters in this study.

Many of the participants agreed that the suspenders stretched out quickly and this, combined with the weight of the pants, caused the pants to hang too low on the body. Another issue was that the weight of the pants was transferred to the suspenders instead of being partially supported at the waist. Female firefighters struggled to perform their duties with this additional weight hanging on their shoulders, along with the weight of the heavy SCBA unit. Furthermore, participants felt the configuration of suspenders was not appropriate for the female figure. The suspender design should be modified for

females to avoid having the straps cross directly over the bust.

There is much ongoing research of protective clothing for firefighters, yet no studies address sizing and fit of the garments, areas of critical concern for participants in this study. Few participants in our study wore gear sized specifically for women, and those that were able to wear female gear reported that the sizing availability and fit were still problematic. Female firefighters can purchase bunker gear designed for women, however in the Hulett et. al. (2008) study 39.8% of female firefighters reported wearing male bunker gear. The main reason given for not purchasing this type of gear was “the simple lack of departments’ responsiveness” (p. 8). This means that many departments will not invest in female specific bunker gear for their female firefighters. Participants in our study faced this challenge. Some participants were unaware that female gear was available for purchase, while others were told the fire department did not have the resources to purchase personally-sized gear. Female firefighters are often given a choice of gear currently owned by their department, generally not including any female specific gear. Fire departments must be made aware of the greater challenges and impacts of firefighters wearing improperly sized and ill-fitting gear and strongly encouraged to ensure all firefighters are provided good fitting gear.

The most recent edition of the National Fire Protection Association’s structural firefighting standards includes required size increments for bunker gear labeled as NFPA compliant (NFPA, [2007], Table 6.1.11, p. 24). It is not required that all sizes be offered by manufacturers to be compliant, just that the size increments be within or at the 2” tolerance level set forth by the NFPA committee. Therefore, manufacturers who offer a limited range of sizes, still meet the requirements of the NFPA standard. Standards do not include information on proportions between measurements. This standard could be more

fully developed to address issues related to gear sized for females.

It is also important that manufacturers that do offer female specific gear reevaluate their fit to make improvements to the fit of the gear by correcting the proportions of length to width. Females in our study reported that even when they could find gear correctly proportioned for their smaller waists and larger hips, the length of sleeves and pant legs was still too long. Pants designed for women are available; however, the only control measurement is the hip. Therefore the pants may be made in a larger hip to waist ratio for the women but with no other body proportions taken in to consideration, for example crotch length, fit remains a significant problem for study participants.

Issues of fit and sizing reported in this study extended beyond the protective coat and pants for most participants, to include other gear. Hulett et al. (2008) reported that 79.7% of women firefighter in their study reported problems with their equipment. Within that total, gloves were the most problematic with 57.8% of the complaints, boots received 46.8%, then bunker coats (38.9%), helmets (28.4%) and breathing masks (25.6%). These findings are confirmed through our focus groups; participants in our study also noted that gloves and boots were most problematic for them, specifically that these items were too large and cumbersome.

Improvements in firefighter protective clothing can decrease the number of firefighters who die in the line of duty, but heat stress remains a major problem (Pye, 2006). According to the U.S. Fire Administration (2008), heart attacks caused by heat stress are the leading cause of death among firefighters. Wearing oversized clothing adds to the weight and bulk of the garment requiring additional physical exertion, leading to additional heat stress (Huck & McCullough, 1988). This also impacts wearer mobility; females in our study described effects of excess bulk in the gear which will increase metabolic heat production when firefighting. It is critical

for the health and safety of firefighters that they wear properly sized clothing.

The women in this study noted that one of the greatest hindrances to their mobility was caused by the low pant crotch. This impacted their ability to crawl through windows and buildings, get down on their knees, and climb ladders. Structural firefighters enter a building on their hand and knees or in a “duck walk” stance in order to be under the smoke and see the layout of the building. It is critical that they are able to crawl, kneel, and climb without restriction caused by poorly fitting gear.

Study participants described frustration with keeping their gear clean and dry. Some participants reported laundering their gear at home. Laundering gear in the home can expose firefighters and their family to toxins and cause deterioration of protective materials used in the gear. Women also struggled to dry their gear between wearings. Because the participants are wearing gear that is already too big for them, they had more issues when the gear was wet and heavy. Improving the drying time of the coat and pants would greatly improve the female firefighters’ comfort and function.

## CONCLUSION

Critical issues for female firefighters identified in this study are primarily caused by women wearing incorrectly sized gear. Female firefighters can purchase female specific bunker gear, however most females in our study reported they were still wearing male gear. Respondents discussed sizing issues with gloves and boots, and fit issues, such as the pants being too large in the waist or too long in the crotch. Participants also reported female specific problems with the design of the gear that negatively impact their comfort, such as suspender placement over the bust and pockets being awkwardly placed on the hips and bust area. The gear is also heavy, weighing as much as 70 pounds or more when wet, diminishing the ability of smaller framed women to move quickly, a necessity for firefighting.

Female firefighter gear should be sized specifically for female wearers. Furthermore, female firefighters could benefit from fit adjustments to the bunker pants to shorten the crotch and/or improvements in suspender function.

To complete the Rosenblad-Wallin (1985) method of functional product design, observations of female firefighters in action are recommended along with collection of ergonomic and anthropometric data on this population. It is recommended that sizing systems be developed specifically for female firefighters, based on anthropometric data obtained from the female firefighter population. Development of lighter, more breathable fabrics for bunker gear is also recommended to reduce bulk and improve drying time. It is recommended that prototypes be developed and tested for improved garment design features, such as pocket and suspender placement.

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