

# Designing Safety Vests to Fit Women

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This paper focuses on the design and construction of safety vests for women, particularly in XS and XXL sizes. Safety vests are an essential piece of protective equipment worn by individuals working in environments requiring high visibility for safety reasons. The American National Standards Institute (ANSI) and the International Safety Equipment Association (ISEA) develop safety vest standards to ensure 360-degree visibility of workers, but these standards create limitations in manufacturer's abilities to create a well-fitted vest for women of smaller stature, particularly in the sizes between XXS and S, as the required square inches of material result in a baggy fit. This project aims to improve the design of safety vests to provide a better fit for women by using a woman-specific bodice block pattern, which addresses the areas of discomfort women have identified with their vests in previous studies. The paper discusses the process of designing and creating a high-visibility safety vest, including the creation of a bodice block, pattern, and vest construction. Both of the resulting vests were measured and compared to ANSI/ISEA standards to determine whether they met the minimum square inch requirements. With more women entering the field of construction, the design of safety vests should be updated to fit their bodies from both a safety and comfort standpoint.

**Key Words:** Safety vest, women's fit, ANSI Standards, Bodice block

## Introduction

Safety vests are a piece of personal protective equipment (PPE) commonly worn by personnel who work in environments that require increased visibility for safety reasons. They come in bright colors, such as yellow or orange, and can have additional reflective tape that shines under direct light in low-light conditions. The American National Standards Institute (ANSI) and International Safety Equipment Association (ISEA) have developed design standards for high visibility safety apparel (ANSI/ISEA 107-2020, "the standard"). The standard has designated three classes of vests that have varying levels of visibility. Each class has a different requirement for minimum area of bright background material and reflective tape, with Class 1 having the least stringent requirements. Class 1 vests are used for workers at the lowest risk, such as low-traffic areas, while Class 2 and Class 3 vests are meant for areas where traffic moves faster or visibility is affected by weather or other conditions. Through its general duty clause, the Occupational Health and Safety Administration (OSHA) requires

employers to take reasonable steps to prevent or abate serious hazards that exist in the workplace (OSHA, 2003). They state that “Road construction traffic poses an obvious and well-recognized hazard” (OSHA, 2023, p. 1), and workers that find themselves on construction sites that have exposure to the danger of being struck by vehicles operating near them must be provided proper PPE to diminish these risks. The majority of construction jobs in the United States require Class 2 vests at a minimum, which need at least 775 inches of safety yellow or orange background material and 201 square inches of reflective striping (ISEA, 2020). This standard creates limitations in the manufacturer’s ability to create a vest that is well fitted for people of smaller stature, including women, particularly in the sizes between extra-extra small (XXS) and small (S), as the required square inches of material result in a baggy fit. In addition to these shortcomings, women of larger sizes also have difficulty finding properly fitting safety vests. According to Lizette Galvez Puentes’s (2020) study of women’s fit safety vests “there is a lack of awareness and proactive integration of properly fitting safety vests to accommodate different body types” (p.1). With more women entering the field of construction than ever before, safety vest designs should be updated to fit their bodies and needs.

This project seeks to improve the existing design of safety vests to provide a better fit to women’s measurements, particularly XS and XXL sizes. The measurements used to design the vests in this project are based on the standards the American Society for Testing and Materials (ASTM) sets in its official women’s sizing chart (ASTM, 2023). Safety vests are often designed for tall and wide frames (Milligan, 2019). With this in mind, it was determined that the sizes that would most be affected by this disproportionality are XS and XXL. These sizes were also those that were near the minimum and maximum range provided by the ASTM sizing chart (ASTM, 2023). The design of these vests deviates from the standard men’s fit vests because the women’s bodice patterns, which informed the design of the new vest, provide a more precise women’s fit. In previous research, it was found that there are specific areas that are the most problematic for women’s PPE, as survey results indicated that “areas at the shoulders, waist, and hips have the least satisfaction and comfort for a majority of the respondents” (Puentes, 2020, p.5). The goal to using a woman specific bodice pattern to create vests is to address these areas of dissatisfaction.

## **Process**

In the following sections, the process of designing a high visibility safety vest will be discussed, including the creation of a bodice block, pattern, and the vest construction. In addition, the size XS safety vest will be measured and compared to ANSI standards for background material and required retroreflective materials.

### *Bodice Block*

The making of each woman-sized safety vest started with the typical starting point for custom-fitted clothing – a bodice block. Bodice blocks represent the torso section of a garment and include a front and back piece, as well as the neckline and armhole. A bodice block uses measurements from the wearer’s body to create a pattern that fits the body closely to ensure a perfect fit. Once the bodice block is created, it can be manipulated in a variety of ways, such as adding darts, changing the neckline, and adjusting the length in order to create the desired garment.

The instructions for creating the bodice blocks for these vests were taken from the textbook “Metric Pattern Cutting” by Winifred Aldrich (2004). Aldrich outlines four different types of bodice blocks: (1) the close-fitting bodice block, (2) the easy fitting bodice block, (3) the tailored jacket blocks, and (4) the classic coat blocks. The easy fitting bodice block was chosen for this project as it provided a looser fit than the other blocks, which would allow for varying underlayers to be worn and allow for increased movement by the wearer (see Figures 1 and 2).

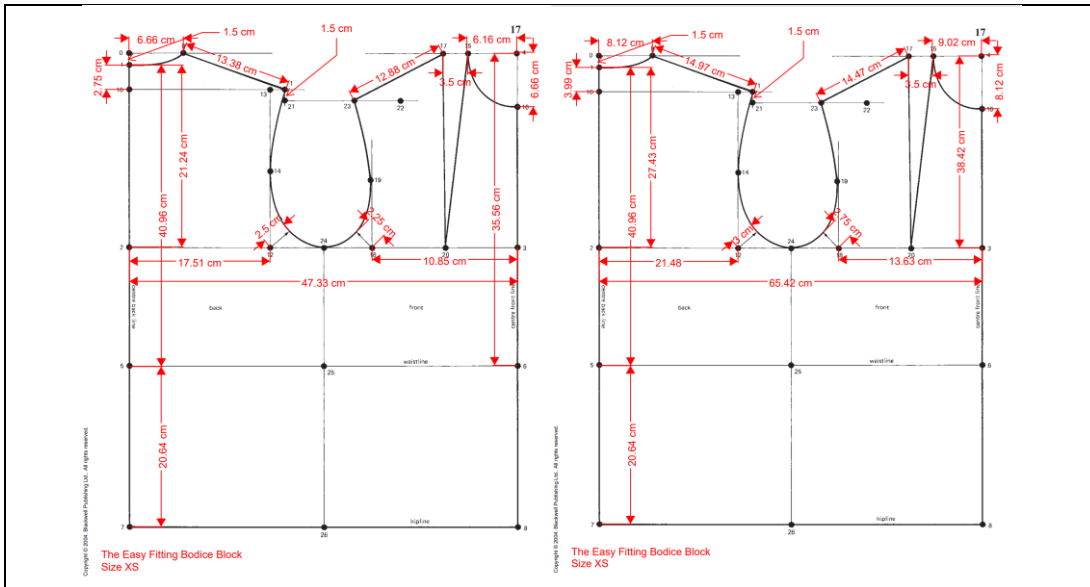


Figure 1. Bodice block patterns (Aldrich, 2004)

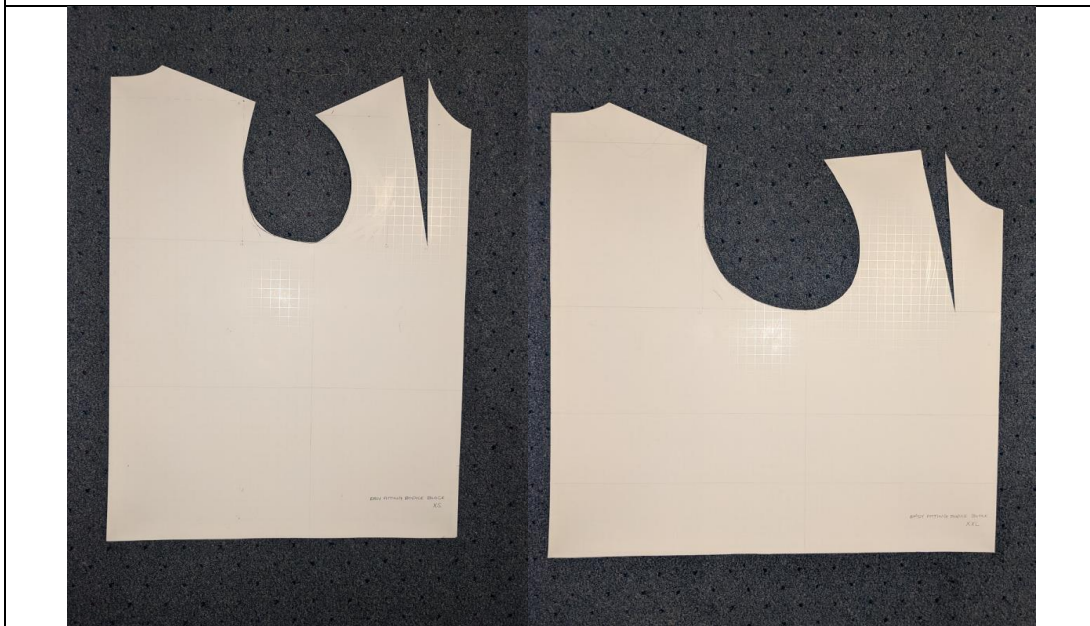


Figure 2. Bodice blocks created from bodice block pattern

## *Pattern*

With the two bodice blocks traced and cut to size, the first version of a vest pattern was created (see Figure 3). Few changes from the bodice were made, but the hemline was set at halfway between the waist and the hip lines, and the neckline was modified for a more vest-like fit. A straight line was drawn from the top point of the dart to the bottom of the dart, but where that point intersected with the farthest right side of the bodice block. The results were sizes XS and XXL front and back pattern pieces. A one-half inch seam allowance was added for all hems except for the bottom, where an inch was allowed.

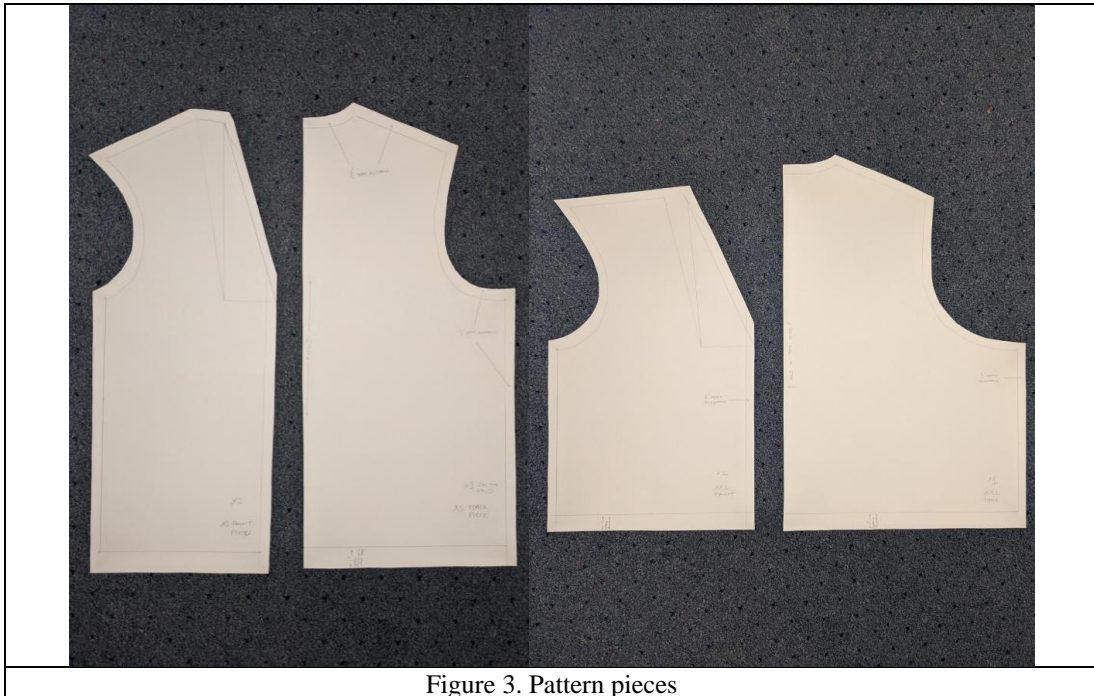


Figure 3. Pattern pieces

## *Vest Construction*

Before construction began, several stitches were tested to see which would provide the neatest finish, as well as stretch with the fabric and prevent breakage. It was determined that a stretch stitch paired with a flatlock stitch would create the best seams for joining two pieces of fabric together, while either just the flatlock or the stretch stitch would work for the hemming (see Figure 4). As seen in Figure 5, for each vest, pattern pieces were cut, taking care to cut the back pieces on the fold and to lay the stretch of the fabric horizontally, and the darts were drawn on the front pieces with tailor's chalk. The front vest pieces were pinned to the back piece, the right sides of the fabric facing each other, and sewn with a straight stitch. The seams were opened and sealed with a flatlock stitch, and excess fabric was trimmed. Next, the dart was sewn with a stretch stitch and extra fabric was folded to the side and secured with a flatlock. The shoulder seams were finished in the same fashion as the sides. The armholes and neck, fronts were finished by rolling in the one-half-inch seam allowance and

stitching with just the flatlock stitch. The hem was folded over one-half inch, then folded once again and secured with a stretch stitch. Zippers were sewn on.

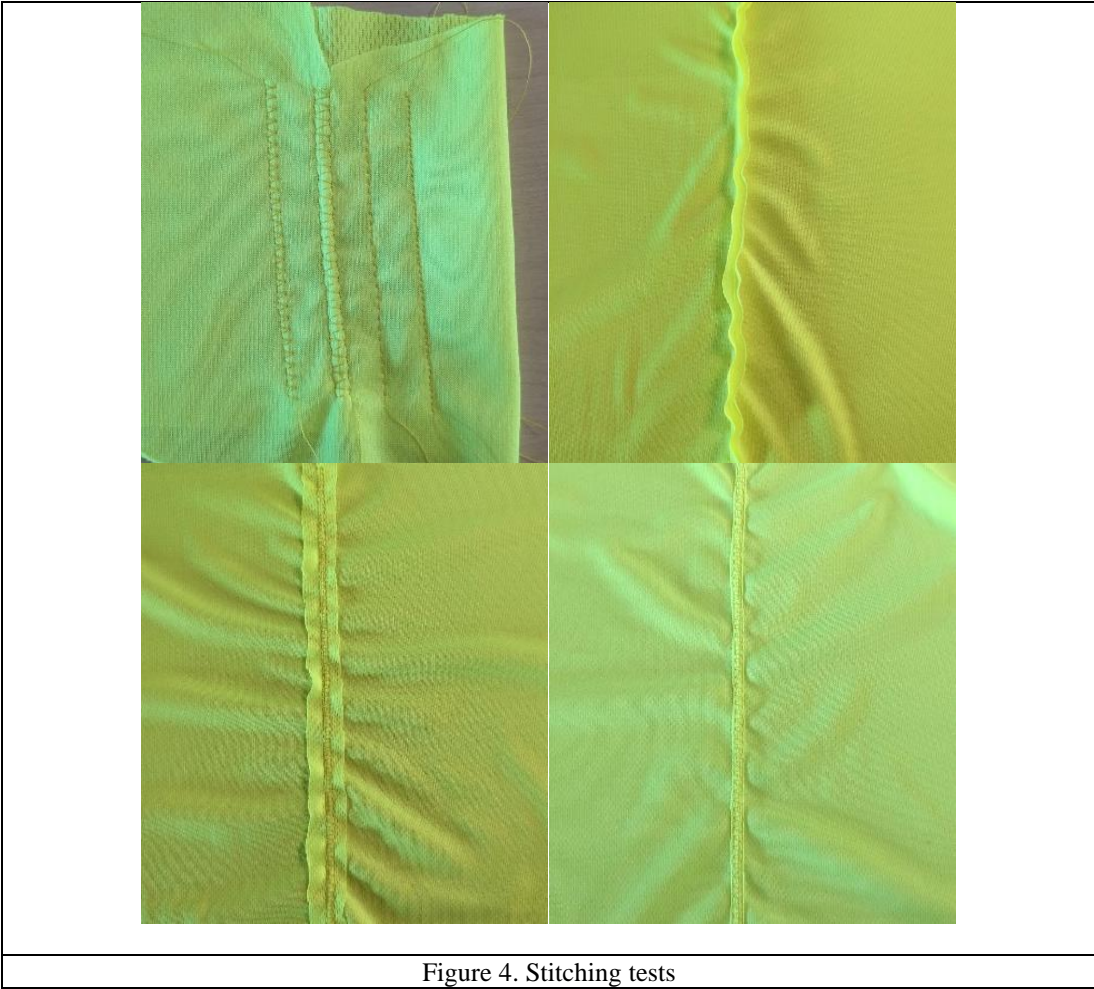


Figure 4. Stitching tests





Figure 5. Vest construction

### *Improvements*

With the first version of the vests created, adjustments were made, and a second version (V2) of the vests were sewn. The fit, length and type of stitching were updated to create a better finished product. The hemline on the V2 vests was lengthened to be three-quarters of the distance between the waistline and the hip on the bodice block for each vest, as opposed to the original half distance. In addition to a stretch stitch, a flatlock stitch was used to create clean seams throughout the garment. The direction of stretch in the fabric was cut to expand horizontally instead of vertically and matching thread color was used for a more seamless look. The reflective tape was sewn on in accordance with the Class 2 vest standard.

### *ANSI Compatibility Comparison*

In order to qualify as a Class 2 safety vest, ANSI requires 775 square inches of background material and 201 square inches of reflective material. With 201 square inches of reflective striping, the size XS vest was found to have 623.84 square inches of background material, which is 151.16 inches shy of the requirement. The size XXL vest was found to have 821.24 square inches of background material.



Figure 5. Size XS vest with reflective striping

### **Lessons Learned**

This project was good way to learn more about bodice patterns and how the clothing industry determines the measurements of their designs in accordance to the typical size ranges of women.

It was also a good opportunity to work with different fabrics and adjust stitches, needles, and techniques to work with the background material, and learn about regulatory standards for PPE. The results found that it's not possible to make XS vests that provide a proper fit for women that also meet ANSI's square inch requirements for background material and reflective material. While the XS vest fell short of ANSI's standards, some women may need an even smaller size to properly fit in their vests. Change in safety vests will not happen until ANSI's standards are revised to be more inclusive for women of smaller sizes. The XXL vest provided enough background material, but many women in larger sizes are dissatisfied with the fit of their vests, which means that the safety vest industry needs to re-examine how they make vests to be more inclusive of the female shape in larger sizes.

## Conclusion

As an essential piece of protective clothing for women and men alike on the job site, a proper fit is important for the comfort and safety of those wearing them. This project's goal was to improve upon the fit of safety vests to better serve the needs of XS and XXL women. The deliverables were an XS and XXL bodice block pattern based on the ASTM women's sizing chart, XS and XXL vest pattern pieces, and the two physical vests with reflective striping that resulted from the patterns. Two versions of patterns were created, V1 and V2. The second version improved upon the first by adjusting the hemline, the style of stitching, and the thread color. The V2 vests were measured to determine how compatible they were with the ANSI square inch requirements for background and retroreflective material, and it was found that the XS vest did not reach the minimum requirements while the XXL vest did.

ANSI has an interest in updating the metrics for their classes of safety vest, and in future testing will be evaluating whether safety vests, such as those in this project, can provide enough visibility despite not meeting the square inch requirements. Future projects can work with ANSI and ISEA to determine how much background fabric and retroreflective tape is required to provide workers with enough visibility on the jobsite, as well as use this information to update their standards.

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