

Choosing Between Orange and Yellow High Visibility Apparel—Which is Safer?

An exclusive whitepaper



VS.



**NATIONAL
SAFETY APPAREL®**

Contents

| | |
|---------------------------------------|----|
| Introduction | 3 |
| The Science of Fluorescence | 4 |
| How Our Eyes See Orange & Yellow..... | 5 |
| Hazard Risk Assessment | 6 |
| Workzone Backgrounds..... | 7 |
| Recognition | 9 |
| What About Nighttime? | 11 |
| Conclusion | 12 |
| Tools & Resources | 13 |

INTRODUCTION

“Struck by Object or Equipment” ranks number two in Construction’s “Fatal Four.” According to the Bureau of Labor Statistics, there were 519 fatalities in this category in 2015. Of the fatalities, 104 were caused by highway vehicles and 54 were caused by construction, logging and mining machinery. Additionally, there were 157,490 non-fatal injuries with lost time in the “Struck By Object” category, with the incident rate increasing from 13.4 cases per 10,000 workers to 14.2. This leaves much room for improvement in the category of protecting workers on roadway and construction sites.

HVSA (High-Visibility Safety Apparel) is designed to make workers more visible to drivers of vehicles and moving equipment on roadways, construction sites, railways, warehouses and manufacturing facilities. HVSA incorporates fluorescent background fabrics with retro- reflective striping to make workers more visible than the background in the work zone. “Struck By” accidents are the number two leading cause of workplace injuries. Proper selection and use of HVSA can reduce these injuries.

THE SCIENCE OF FLUORESCENCE

Fluorescence is the phenomenon in which light energy that is normally invisible is made visible. This is done by converting short wavelengths to a longer wavelength. This ceases almost immediately when the light energy stops. Fluorescent colors are 2-4 times brighter than other colors due to this phenomenon. They are also more visible during low light, dusk, dawn, fog and haze when normal colors experience a graying effect.

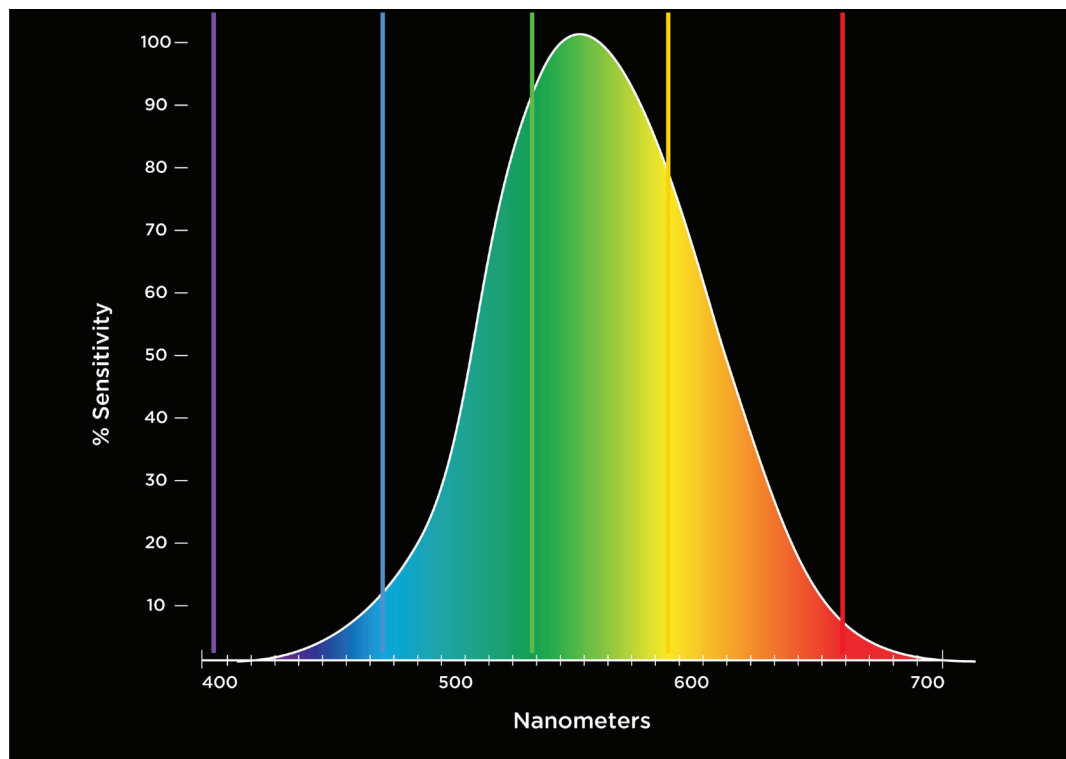
ANSI/ISEA 107 specifies three fluorescent colors that comply with the luminosity requirements of the standard. These colors are fluorescent yellow-green, orange-red and red. Currently the use of red in the United States is very limited. This could be due to fluorescent red not emitting as much radiated light as its counterparts yellow and orange. It could also be the lack of supply chain options in the US. For the sake of this article, we will stick with the comparison of the more common fluorescent orange-red to fluorescent yellow-green as defined by the ANSI/ISEA 107 standard.

HOW OUR EYES SEE ORANGE & YELLOW

Different colors are seen to differing degrees by the human eye. This goes for fluorescent colors, as well.

The human eye responds best to large, contrasting, bright or moving objects. Worker visibility is enhanced by high color contrast between clothing and the work environment against which it is seen. This makes both orange and yellow HVSA useful.

The human eye is more sensitive to some colors than others as shown below. Peak sensitivity is at the yellow-green portion of the visible spectrum. With that in mind, the human eye will be more sensitive to a fluorescent yellow-green garment than a fluorescent orange one just by the nature of how the human eye sees colors. While fluorescent yellow-green is the most visible, fluorescent orange is still on the brighter end of the spectrum making it highly visible as well.



Eye Color Sensitivity

HAZARD RISK ASSESSMENT

So how does one choose between yellow and orange safety vests? Which color provides the best protection? Most people will say when comparing the two colors that yellow appears “brighter.” This is true according to the sensitivity graph alone. In considering whether orange or yellow is safer, we will explore additional factors and their impact on overall conspicuity.

Conspicuity refers to the ability of an object to come to the attention of an observer. This is especially important in complex environments with competing objects. One activity that will help identify risk factors is a hazard risk assessment of the work zone.

SAMPLE HAZARD RISK ASSESSMENT FORM

Work area environment and background:

- | | |
|--|---|
| <input type="checkbox"/> Simple background | <input type="checkbox"/> Complex background |
| <input type="checkbox"/> Urban | <input type="checkbox"/> Rural |
| <input type="checkbox"/> Outdoor | <input type="checkbox"/> Indoor |

Describe workplace conditions:

- | | |
|--|---|
| <input type="checkbox"/> Poor separation from conflicting vehicle traffic. | <input type="checkbox"/> Work activity diverts worker attention from approaching vehicle traffic. |
| <input type="checkbox"/> Work activity does not permit worker full and undivided attention to approaching traffic. | <input type="checkbox"/> Work activity takes place in or near proximity to unimpeded vehicle traffic. |

Vehicle/equipment speed:

- | | |
|--|--|
| <input type="checkbox"/> Below 25 mph (40 kph) | <input type="checkbox"/> Exceeds 25 mph (40 kph) |
|--|--|

Vehicle/equipment volumes:

- | | |
|--------------------------------------|---|
| <input type="checkbox"/> Limited | <input type="checkbox"/> Controlled traffic |
| <input type="checkbox"/> High volume | <input type="checkbox"/> Uncontrolled |

Existing safeguards:

- | | |
|--|--|
| <input type="checkbox"/> Barriers | <input type="checkbox"/> Traffic monitored |
| <input type="checkbox"/> Traffic control plans | Other: _____ |

Notable hazards/exposures:

- | | |
|---|---|
| <input type="checkbox"/> Moving vehicles | <input type="checkbox"/> Electrical arc |
| <input type="checkbox"/> Moving equipment | <input type="checkbox"/> Temperature extremes |
| <input type="checkbox"/> Pedestrian traffic | <input type="checkbox"/> Entanglement |
| <input type="checkbox"/> Night work | <input type="checkbox"/> Limited sight lines |
| <input type="checkbox"/> Low visibility | <input type="checkbox"/> Precipitation |
| <input type="checkbox"/> Low/limited light | <input type="checkbox"/> Blowing dust/smoke |
| <input type="checkbox"/> Flame | <input type="checkbox"/> Fog/steam |
| | <input type="checkbox"/> Other |

RISK ASSESSMENT

Based on recognition of hazards, this activity is a:

- | |
|---|
| <input type="checkbox"/> Low risk condition and environment |
| <input type="checkbox"/> Medium (moderate) risk condition and environment |
| <input type="checkbox"/> High risk condition and environment |

WORK ZONE BACKGROUNDS

During this risk assessment, the background colors of the work zone should be taken into consideration. In areas of heavy foliage, orange may provide a greater contrast with the background. A complex background in a work zone may make yellow a better choice. In some work zones it may be helpful to use both colors to identify different work groups. When evaluating contrast, consideration must be given to two things: color sensitivity and color contrast. Color contrast is the difference in an object's color compared with the background. Even though yellow is brighter (higher color sensitivity), color contrast can actually tip the scale in orange's favor.

“ In areas of heavy foliage, orange may provide a better contrast with the background. ”



Both fluorescent yellow and fluorescent orange are known to positively affect conspicuity in daylight conditions, and using both colors is an option for some complex backgrounds. Combined performance 2" wide trim that is retro-reflective and fluorescent will create a color contrast on your HVSA. High contrast reflective wide fluorescent ribbon in orange or yellow with 2" wide silver retro-reflective down the middle. High contrast and combined performance reflective material allows both fluorescent orange and yellow to be utilized in the same design. The vests pictured below are examples of combined performance and high contrast.



▲ Combined performance example

▼ High contrast example



▲ Color blocking example

Currently trending in HVSA are color blocking, or two-tone options, which create a strong visual contrast of fluorescent fabric with darker colors on one garment. An example of this is above. When this hybrid approach to HVSA places dark fabrics in high-dirt areas, it may extend the life of the garment. The fluorescent fabrics will have less staining and abrasion, which can compromise the visibility of the garment. This helps workers to keep their HVSA looking its best, and it provides visual conspicuity against a variety of backgrounds.

RECOGNITION

Also to be considered is recognition. Colors can help drivers and equipment operators recognize workers. While yellow is the brightest fluorescent color and the most widely used, orange has strong recognition as a hazard identifier: orange means “watch out.”

Orange has been widely used in road construction signs, cones, barrels and delineators. Orange is also featured in the auto warning triangle. In road construction, orange may be the color of recognition for a driver.

Orange also has a strong position in identifying humans while hunting. Orange is the required safety color to allow hunters to be recognized by one another in complex backgrounds.

Advocates began promoting wearing orange while hunting in the 1960s, as it was the easiest color to see and recognize outdoors. Because this man-made color does not occur naturally in the forest, it is easier for the human mind to recognize fluorescent orange as marking a human figure.



Reflective patterns can also help with recognition. Wearing a reflective pattern that has an X or Chevron on the back signifies that a worker is facing away from oncoming traffic.

The combination of fluorescent orange and X back reflective designs are commonly preferred in railroad applications. This is because the work zones have heavy foliage and operators can identify if the worker is facing away. The Canadian High Visibility Standard CSA Z96 requires an X on the back.



When all things are equal, a yellow vest will be more conspicuous.



This image depicts the idea that in backgrounds with foliage, orange appears to stand out more than yellow.

WHAT ABOUT NIGHTTIME?

Sometimes work is required when light is at a minimum. Traffic is lighter when the environment is darker. This is why roadwork is often done at night when visibility is poorest. Safety vests are even more vital during these times.

When there is little to no surrounding light, HVSA relies on retro-reflective tape. Headlights from oncoming traffic will hit the reflective tape and the light will “bounce back” before color is discernible. This makes the discussion for orange or yellow vests less relevant when light is minimal.

If nighttime work overlaps with work during the day, the color of the vest will again be an important factor to consider.

CONCLUSION

When color alone is not enough, we can look at additional strategies like body coverage and bio-motion. ANSI has Classes 1, 2 and 3 for different hazard levels.

You can see from this chart as the class increases so does the body coverage. Also designs that mark the arms and legs increase the identity of the human figure through bio-motion. In a high hazard work zone, safety professionals may choose to go beyond the basic requirements and opt for full body coverage in a coverall with both the arms and legs marked by reflective for maximum bio-motion identity and body coverage.

| Garment Type | Type "O" | Type "R" | | Type "P" | | Supplemental Items |
|---|---------------------|------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------------|
| Designation | Off-road | Roadway | | Fire, Police, EMS Personnel | | Garments with Legs, Including Gaiters |
| Performance Class | Class 1 | Class 2 | Class 3 | Class 2 | Class 3 | Class E |
| Background Material Amounts | 217 in ² | 775 in ² | 1240 in ² | 450 in ² | 775 in ² | 465 in ² |
| Retro-reflective Material Amounts | 155 in ² | 201 in ² | 310 in ² | 201 in ² | 310 in ² | 109 in ² |
| Width Minimums of Retro-reflective Material | 1" | 1.38" 1" for split trim designs | 2" 1" for split trim designs | 2" 1" for split trim designs | 2" 1" for split trim designs | 2" 1" for split trim designs |
| Previous Standard and Class | ANSI 107 Class 1 | ANSI 107 Class 2 | ANSI 107 Class 3 | ANSI 207 | NEW! | ANSI 107 Class E |

Orange has been majorly under-represented in the flame-resistant (FR) HVSA category. This is because many FR fibers and fluorescent dyes are inherently incompatible. This means it is difficult and expensive to get FR fabrics dyed fluorescent orange. Since fluorescent yellow is so bright and has been "more popular," the economics of supply and demand have kept fluorescent orange FR choices to a minimum. There is only one fluorescent orange FR/AR fabric

that meets ANSI and ASTM F1506. Other fabrics fall back to the CSA Z96 "Bright Orange" standard which allows for fluorescent oranges that have a minimum total luminance factor of 17% versus ANSI fluorescent orange minimum total luminance factor of 40%.

If orange is the right color for your application and you cannot find the HVSA solutions that you need, talk to your supplier.

ABOUT THE AUTHOR



Dionne Murray Lemer

Sr. Product Manager – High Visibility and Rainwear

National Safety Apparel

dlemer@thinkNSA.com

Starting in the family business, Safety & Supply Company in the 80s, Dionne developed her passion for safety product knowledge and training. She served the industry on the Washington State Construction Safety Council, ASSE and the Washington State Department of Labor & Industries. She has provided training on the proper selection and application of arc rated/flame resistant clothing and rainwear, high visibility safety apparel, ANSI/ISEA 107, and other related safety areas.

Dionne joined National Safety Apparel in 2013, bringing her passion and knowledge for high visibility and FR fabrics to the position of Senior Product Manager for high visibility and rainwear. At NSA, Dionne collaborates with the team to develop new products, provide training, and improve the customer experience by providing solutions to the ever-changing needs in flame resistant and standard high-visibility workwear.

Dionne is a subject matter expert on high visibility safety apparel, and is currently serving on the ISEA High Visibility Products Group (ANSI 107 Committee).



**NATIONAL
SAFETY APPAREL®**

National Safety Apparel is a U.S. manufacturer of protective apparel including flash fire and arc flash, thermal and cut protection, and hi-vis work and foul weather gear. We are proud to be certified to ISO 9001 with design, which allows us to offer product customization and personalization to any of our products, and the ability to develop products to best meet your specific needs and hazards. Our team is ready to provide solutions to your PPE challenges and address your needs, questions and requests. Since 1935, workers across the country have relied on NSA's safety apparel and quality craftsmanship.

TOOLS & RESOURCES

FEMA article

https://www.usfa.fema.gov/downloads/pdf/publications/fa_323.pdf

Bureau of Labor Statistics

<https://www.bls.gov/news.release/cfoi.nr0.htm>

Daylight Fluorescent Color—the color that shouts

<https://trid.trb.org/view.aspx?id=168277>

Human Eye Color Sensitivity & Perception

<http://www.astronomyassociation.org/atlas/at/ot/othcs.html>

CSA Z96-15

ANSI/ISEA 107-2015

FOR MORE TOOLS & RESOURCES, VISIT **THINKNSA.COM**