

Fallacies in BSEN 471, ANSI/ISEA 107, 207 Standards in High Visibility Safety Clothing

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Just as we wish to provide the very best protection for professional users, it is equally important to provide safety for pedestrian and cyclist who travel on the road way. However, under the current specification, the high visibility warning clothing are usually unattractive and uncomfortable. Consequently, occupational workers tend to take it off during their lunch break or when traveling to and from work and therefore, being exposed to danger. In addition, there is a great deal of room for improvement concerning the safety of the design.

The safety effect for the high visibility warning clothing can be improved only when people are inclined to wear it for extended period of time, instead of using it minimally as forced by legislation. For example, workers often throw their safety vests in their truck before going across the road to lunch.

Over specification and misleading specification limit the designer from creating more fashionable and comfortable safety clothing.

In EU, a safety vest is mandated to be put on in the dark road. People normally put the garment in the car-boot/trunk and do not generally wear it. In the event it is needed when the driver gets out of the car to go around to the trunk he/she has already been exposed to danger from passing traffic.

The safety clothing design as specified in the "Standards" is intended visible by vehicle drivers in front of headlight after dark in critical detection distance to avoid accidents. The required Luminous Intensity in this distance shall be no less than 0.3 cd.lx^{-1} at critical detection distance of 140 meters, based on Scandinavian Report, Morkertrafik, Night Traffic Rapport, NR. 5², and The University of Michigan Transportation Research Institute report, UMTRI I-98-50³. The high visibility clothing as specified in the "Standards", is not related to critical detection distance.

In addition, the minimum required the testing observation angles, entrance angles and the corresponding coefficient of retroreflection (R_A) in the "Standards" are not adequate:

1. Observation Angle is the angle between the line from the light source to reflective fabric and the line from the reflective fabric to the driver's eyes. Considering there is a distance from the driver's eye level to the lamp (d), the required (R_A) for each of observation angle (OA) is related to and proportional to the detection distance (D). $OA = \tan^{-1}(d/D)$. In each observation distance, the luminance is corresponding to a specific observation angle. However, the luminance intensity (R_A) as specified in the "Standards" the observation angles are not corresponding to the critical detection distance or cover the luminous intensity observed by drivers in different sizes of vehicles.
2. Entrance Angle is the angle between the incoming light and the line perpendicular to the plane of the reflective fabric surface. The luminance that drivers observe is a collection of light from all entrance angles in each distance.

3. The minimum (R_A) of the four entrance angles as specified in the "Standards" are not evenly distributed. The measured (R_A) in these entrance angles does not represent that of an equal area. Therefore, the value of (R_A) of each observation angles cannot be added together nor be averaged; the required (R_A) cannot be determined.

The minimum values of coefficient of retroreflection (R_A) as specified in the standard are not the actual minimum requirement to achieve necessary conspicuity. Furthermore, the required value of retroreflective index are not included or excluded in the standard. Clothing that meet the standard does not necessarily meet safety requirements, while some clothing that meet all safety requirements are excluded from use

The picture below to the left is an example of a typical Class 2 safety vest as specified in the "Standards". Not visible from the side view, this clothing does not meet the 360° visibility safety requirement. The picture below to the right is a T shirt meeting all the safety requirement, but not suggested in the "Standards".



It is recommended that the retro-reflective functions shall be properly specified for safety purpose. The required minimum coefficient of retroreflective (R_A) should be specified according to the visibility of drivers in vehicles of all types at the critical observation distance. In designing high visibility safety clothing the requirements of the reflective functions shall balance with the other important elements of clothing such as comfort and fashion. After all, the safety effect prevails only if people are wearing it.

References:

1. The University of Michigan Transportation Research Institute Report, UMTRI 2003-29, *High – Visibility Safety Apparel and the Night Time Conspicuity of Pedestrians in Work Zones*, by James R. Sayer & Mary Lynn Mefford, 2003.
2. Scandinavian Report, Morkertrafik, Night Traffic Rapport, NR. 5, 1982, *Pedestrian Retroreflectors, Functional and Technical Requirements*, Sponsor

includes Ministry of Justice, Denmark, Central Organization for Traffic Safety, Finland, VTI, Sweden, EFI, Norway, by Lysteknisk Laboratorium - Danmark, Vejdirektoratet - Danmark, VAG-OCH Vattenbyggnadsstyrelsen - Finland, Elektrisitetsforsyningens Forsknings Institutt –

3. The University of Michigan Transportation Research Institute report, UMTRI I-98-50, *Lane Marking in Night Driving*, by Kare Rumar II & Delbert K. Marsh II, 1998.
4. *Color and shape recognition of reflectorized targets under automobile low-beam illumination at night*. Transportation Research Record, No. 1327, 1-7, by Zwahlen, H. T. & Yu, J. (1991).
5. Fallacies and Myths of Retro-Reflectivity Standards and Its Implications to High-Visibility Safety Clothing By Tom King, Master of Engineering, Professional Engineer, Brian Sagar, BSc, Ph.D, MRSC, Hsin H. Hsu, Ph.D. AATCC Journal forthcoming.