Footwear for cold protection:

Most occupational footwear passes the test according to EN ISO 20344

Kalev Kuklane[1], Satoru Ueno[2], Shin-ichi Sawada[2] and Ingvar Holmér[1]*

[1] *Thermal Environment Laboratory, EAT, Department of Design Sciences, Faculty of Engineering, Lund University, Sweden*
[2] *International Center for Research Promotion and Informatics, Japanese National Institute of Occupational Safety and Health, Japan*
** corresponding author kalev.kuklane@design.lth.se*

Background

The present European (CEN) and international (ISO) standards for safety, protective and occupational footwear EN ISO 20344 – 20347 (2004) classify footwear as cold protective by an allowed 10 °C temperature drop inside the footwear during 30 minutes at an initial suggested temperature gradient of about 40 °C.

It may be argued if a simple pass/fail test is proper for thermal testing – cold is not a certain temperature, but a wide temperature range that depends not only on temperature, but also on air velocity, heat production (activity) etc. However, a standard test on protective properties should certainly assure the intended protection levels.

An earlier study (Kuklane et al., 1999) showed that low insulation footwear may pass the test. This study specifically chose for testing several footwear that can't be considered as cold protective.

Methods

Based on appearance and purpose (not intended for cold) or insulation (thermal model tests) there were chosen out 5 footwear for testing according to EN ISO 20344 (Table 1). The standard allows to increase the upper height with a collar if the uppers are not enough high to support the heat transfer media. This was done with ordinary printer paper for footwear R and S. For footwear S the printer paper was also taped in front of other openings (Figure 1).

In addition, a request came from Cofra, Italy, to test their footwear according to a modified standard at a temperature gradient of 70 °C. For these tests the conditioning temperature was kept the same as in standard +23 °C, while the testing temperature was lowered to -47 °C instead of standard's -17 °C. In all cases air velocity in the chamber stayed at 0.15±0.04 m/s.

Table 1. Footwear from Midori Anzen, Japan (B, F, H, R, S) and Cofra, Italy (C): the effective insulation values (m^2°C/W) of all foot zones and the mid-sole measured on a thermal foot model. During thermal foot tests, a thin sock (effective insulation of the sock I_{cle} = 0.013 m^2°C/W) was used in combination with the footwear.

Code	Upper material	Sole material	Weight (g)	Size	$I_{cle,foot}$	$I_{cle,sole}$
B	Polyvinyl chloride (PVC)	PVC	839	26.5	0.090	0.181
F	Cow chrome leather	One layer of synthesized rubber	737	26.5	0.106	0.219
H	Synthesized leather	Two layers of new foaming polyurethane	332	26.5	0.114	0.225
R	Synthesized leather / mesh	Two layers of new foaming polyurethane	288	26.5	0.105	0.218
S	Synthesized leather	One layer of foaming polyurethane	261	26.5	0.057	0.261
C	PU	PU, Nitrile rubber	1274	42/9	0.202	0.235

Figure 1. a) Footwear S with openings covered; b) Placement of the sensors (footwear H); c) Placement of the footwear (F) in a cold chamber. Figure 2 shows a typical cooling curve.

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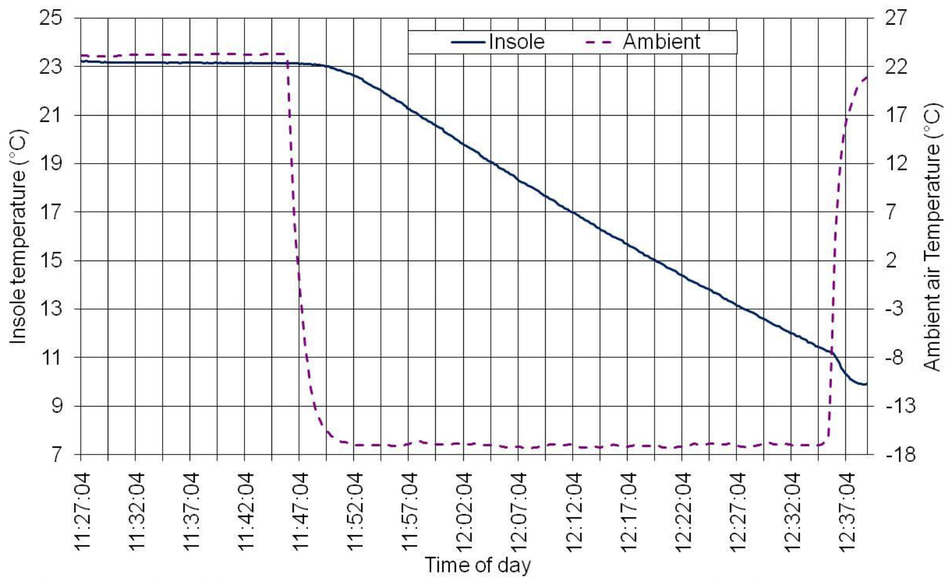

Figure 2. Change in insole temperature during a standard test.

Results and discussion

All footwear passed the test (Table 2). Thus, all tested footwear may be according to the standard classified as cold protective footwear, and as there is no additional classification, then they should possibly protect at any cold temperature from +18 °C to any temperature below -35 °C. By the side of these tests it is not very surprising that a footwear intended for cold did with good margins pass a modified test at much higher temperature gradient.

The main issue is not that a sandal (S), a mesh shoe (R) or a thin textile shoe (H) did pass the test – it is clear for everybody that these are not for protection against cold. The problem is that the footwear (B and F) that has as low insulation as S, R, and H may be classified as cold protective and in this way giving the user a deceiving safety feeling and exposing him/her to higher risks.

Table 2. Conditioning and test temperatures, gradient and footwear ranked by measured temperature drop under 30 minutes in cold.

Code	Conditioning temperature	Mean test temperature	Initial gradient	Temperature drop (°C)
F	23.0	-16.8	39.7	6.2
S	23.0	-17.0	40.1	7.2
B	23.1	-16.8	39.9	7.5
R	23.1	-17.0	40.2	8.5
H	23.0	-16.9	39.9	9.4
C	**22.9**	**-47.8**	**70.7**	**7.3**

Conclusions

- Most occupational footwear would pass the standard test, making it meaningless.
- Such a test may provide a user a deceiving safety feeling and expose him/her to higher risks.
- The present method should be **considerably** improved or replaced with one that is able to consider user requirements, e.g. thermal model method.

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