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LEGAL BASIS, STANDARDS AND CRITERIA FOR EVALUATING THERMAL CONDITIONS IN FOREST WORK

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Abstract

In this discourse, the Slovene legal basis for thermal conditions at work, together with three international standards for studying thermal conditions SIST EN ISO 7730 (Thermal comfort), SIST EN 27243 (hot environments) and SIST EN ISO 11079 (cold environments), are presented. All three international standards list the criteria for evaluation of thermal conditions and represent the scientific research basis for studying work in practice. For efficient work safety, knowledge of the national legislation is implicit.

Key words: international standards, working conditions, thermal conditions, legislation

PRAVNE PODLAGE, STANDARDI IN KRITERIJI ZA OCENJEVANJE TOPLOTNIH RAZMER PRI DELU V GOZDU

Izvleček

V članku so predstavljene pravne podlage za urejanje toplotnih razmer na delovnem mestu v slovenski zakonodaji ter trije mednarodni standardi za preučevanje toplotnih razmer SIST EN ISO 7730 (toplotno udobje), SIST EN 27243 (vroča okolja) in SIST EN ISO 11079 (hladna okolja). Vsi trije mednarodni standardi podajajo kriterije za ocenjevanje toplotnih razmer in so osnova za znanstveno preučevanje in delo v praksi. Za učinkovito varstvo pri delu je nujno potrebno tudi poznavanje nacionalne zakonodaje.

Ključne besede: mednarodni standardi, delovne razmere, toplotne razmere, zakonodaja

INTRODUCTION
UVOD

Modern times are characterized with forecasts realization that due to human interference the climate changes reflect themselves in frequent weather extremes, which have influence on traditional way of living, management and work (ARSO, Kajfež-Bogataj 2005). The extremely hot climates will mostly influence outdoor works, considering that the possibilities of thermal conditions regulation are relatively small. Thus, it can be expected with certainty that with unchanged work technology the already difficult forest work, especially cutting and skidding, will become even harder due to temperature rise. For it has been proved that higher air temperature indicated through the pulse increases the work difficulty (Hunter et al. 2002, Pontén). When researching the complexity of thermal conditions influence on worker, first it is necessary to know the existing standards and criteria for evaluating the thermal conditions at work, whereas in order to provide for appropriate safety of workers the legal basis in Slovene legislation has to be known as well.

LEGAL BASIS IN SLOVENE LEGISLATION
PRAVNE PODLAGE V SLOVENSKI ZAKONODAJI

The right for safe and healthy living environment, including working environment, is defined in Chapter III of the Constitution of Republic of Slovenia (1991), whereby the state provides for healthy environment and thus defines with the law the conditions for performing economic and other activities. The field of safe and healthy work is settled with Safety and Health at Work Act (1999), which, as its basic principle, defines that the employer is the one who must provide for work safety and health. The Act, by which the employer defines safety measures, is the safety statement, based upon defining all kinds of dangers and perniciousness at work, and also the evaluating of risk for injury and health damages.

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One of the important background documents for elaborating safety statement is monitoring of the working environment. This can be done by a practitioner authorized by an employer or practitioner outworker or service with work permission, for conducting the expertise assignments of work safety. The obligation of employer for providing for periodic studies of the working environment is specified in Article 15 of ZVZD (Safety and Health at Work Act). Under work environment the Act classifies chemical, physical and biological hazards, but it does not explicitly mention thermal conditions. The fact that the legislator places thermal conditions to physical conditions can be seen from the Regulation on conditions and procedure for acquiring work permission for conducting safety at work scientific instructions (2003), where the technical equipment for thermal conditions measurement is stated in Appendix 1.

Thermal conditions at work are directly mentioned in Rules on the requirements for providing safety and health of workers at work (1999). In its 25th Article, it is defined that the air temperature should correspond to physiological needs of workers according to the work characteristics and physical demands placed on workers at work, and it is also stated that the employer should fulfil these requirements, follow the standards for thermal comfort, whereas in cold stores the criteria of work in cold environments should be followed. Permitted air temperature should not exceed 28ºC, except on the so-called hot working premises. With regard to composition and content of the Rules, the above mentioned criteria are in force mainly for indoor working premises, but the Rules, especially in Articles 93 and 94, deal with working conditions and requirements for outdoor work or permanent outdoor work sites. Although this regulations deal also with outdoor work, it is explicitly stated in Article 3 that it does not hold true for forest work. The air quality and thermal conditions in buildings are more precisely dealt with in the Rules on the ventilation and air-conditioning of buildings (2002), which is specifically based on the international standard SIST ISO 7730 when determining thermal comfort, and which with different parameters determines thermal comfort of a sitting person in intervals. Thus, the air temperature in resident zone should vary between 22 and 26ºC or 19 and 24ºC in the heating up period; the maximal vertical temperature difference between head and feet of a sitting person is 3K, in other cases it should not exceed 4K; ground temperature should be between 17 and 26ºC, with ground heating 29ºC, and air velocity in the period of heating up or cooling down 0.15 m/s^2, otherwise 0.2 m/s^2.

From all things stated above, it can be concluded that except from general legal frame presented in the Constitution, the law (ZVZD) and implementing regulations, there is no obligatory method or criteria for evaluation of thermal conditions, which will be in force for forest workers, in Slovenian legislation. Therefore, it is reasonable to use international standards to meet the general requirements.

INTERNATIONAL STANDARDS AND CRITERIA FOR EVALUATING THERMAL CONDITIONS
MEDNARODNI STANDARDI IN KRITERIJI ZA OCENJEVANJE TOPLOTNIH RAZMER

For evaluating thermal conditions, the standards distinguish: thermal comfort evaluation (SIST EN ISO 7730), thermal stress in hot environments (SIST EN 27243), and the required clothing isolation in cool environments (SIST ENV ISO 11079).

EVALUATION OF THERMAL COMFORT
OCENJEVANJE TOPLOTNEGA UDOBJA

The standard for analytical determination and interpretation of thermal comfort (SIST EN ISO 7730) is used for evaluation of temperate thermal environment. The reason for discontent of workers with thermal environment could be in local overheating or cooling down of the whole body. The human thermal feeling is related to thermal balance of the whole body, which is under the influence of physical activity and clothing, and also environmental parameters (air temperature, radiation temperature, air velocity, air humidity). The standard is in force for men and women that are exposed to indoor environment, where temperate thermal comfort is desired. Where there are moderate deviances from thermal environment, the standard is used for forming and evaluating the new or existent working environments.

There are two indices used for evaluating thermal conditions for the whole body: MNV (predicted Mean Vote) and PPD (Predicted Percentage Dissatisfied). First index tells us how the majority of workers will determine the environment state by applying 7-levelled scale (Table 1), whereas the other index shows us the percentage of dissatisfied workers. Both indices are in reciprocal analytical relation (Equation 1).

$$PPD = 100 - 95 \times e^{(-0,03353 \times PMV^4 - 0,2179 \times PMV^2)} \quad ... (1)$$

Table 1: 7-levelled scale for evaluating thermal comfort according to PMV index

Preglednica 1: Sedemstopenjska lestvica za ocenjevanje toplotnega udobja po indeksu PMV

PMV	-3	-2	-1	0	+1	+2	+3
Description/ Opis	Hot/ Vroče	Warm/ Toplo	Temperate/ Zmerno toplo	Neutral/ Nevtralno	Cool/ Hladno	Cold/ Mrzlo	Freezing/ Zelo mrzlo

To calculate PMV, data on the working environment (air temperature, radiation temperature, air velocity, relative air humidity), work effort (metabolic level – the energy release due to digestion, energy necessary for managing work effort, 1met = 58.2 W/m^2) and work clothing (clothing isolation or thermal permeability, 1 clo = 0.133 m^{2}K/W) are needed. The working environment data are measured, whereas the work effort and clothing isolation are evaluated by using the described standard or additional standards (SIST EN ISO 8996, SIST EN 9920). Clothing isolation values are true when worker does not move, therefore the adjustment should be considered in cases, when worker is moving or wind is blowing. The PMV calculation is possible through equations or a program, all being in accordance with the standard, or through simplified evaluations, for which we need operative temperature and diagrams, without the standard. Operative temperature is defined as the constant temperature of imaginary black space, in which an individual exchanges as much warmth with radiation and convection as in the real, thermally inconsistent environment. When applying PMV measurement, we have to be careful about its validity, because it is used for evaluating thermal comfort between -2 and +2, meaning that it is not suitable for evaluating hot and cold environments. The validity of measure is also limited with intervals for all parameters used for calculation (e.g. metabolism: 0.8 – 4 met, clothing isolation: 0 – 2 clo, etc.).

In local thermal discomfort, the working environment is evaluated to exert influence on certain parts of the body. The reasons for local discomfort could be draught, abnormal vertical difference in air temperature, too hot air, too warm ground, or too big radiation temperature differences. For draught, DR measure is calculated – the rate of the felt draught (Draught Rate), whereas for other factors, PD measure is used - the portion of dissatisfied (Percentage Dissatisfied). The workers with sitting activities are more sensitive to local discomfort than those with high energy consumption during work.

According to measure value (PMV, PPD, PD), we classify working environments in classes A, B, and C. There are the criteria given for each class. Thus, for classifying working environment under class A, the percentage of dissatisfied workers (PPD) should be smaller than 6%, under class B smaller than 10%, whereas under class C the percentage should not exceed 15%. The 5-levelled scale of overwork (SO), recommended by Gspan et al. (2002), can also be applied, which determine the quality of working environment in interval from optimal (SO=1) to critical conditions (SO=5), and also the need for safety measures. The Rules on the ventilation and air-conditioning of buildings provide that the thermal environment should have PPD smaller than 15%, thus complying with class C of the described standard.

In the conclusion, the standard defines the evaluation of general thermal comfort, which can be stated as the sum or average value for individual period, or we can use weighted means, where the weights can be formed in accordance to optimal or desired values deviance.

EVALUATION OF HEAT STRESS IN HOT ENVIRONMENTS WITH THE USE OF WBGT INDEX
OCENJEVANJE TOPLOTNEGA STRESA V VROČIH OKOLJIH Z UPORABO KAZALNIKA WBGT

The standard (SIST EN 27243) for evaluating thermal stress on workers in hot environment on the basis of WBGT index (Wet Bulb Globe Temperature) is used for evaluating the heat effect on humans according to their activity. The standard is not used for evaluating thermal stress for very short periods and also not for working environments that are close to thermal comfort range.

To calculate the WBGT index, the standard takes into account two equations. The first (Equation 2) is used for evaluating the thermal stress indoors with no sun radiation, whereas the infrared radiation is very much present; the second equation (Equation 3) is used outdoors, where the sun radiation is present. The last equation is also used indoors, where workers are exposed to sun radiation through windows.

$$WBGT = 0{,}7t_{nw} + 0{,}3t_g \qquad \text{... (2)}$$

$$WBGT = 0{,}7t_{nw} + 0{,}2t_g + 0{,}1t_a \qquad \text{... (3)}$$

The WBGT calculation requires two or three different temperatures, i.e. the temperature of natural wet bulb thermometer (t_{nw}), the temperature of globe thermometer (t_g), and the air temperature (t_a). In this way the index comprises all four basic factors (air temperature, radiation temperature, humidity, and air velocity), which are important for human response to heat. Thus, with the use of natural wet bulb thermometer the cooling down of a worker by perspiration is simulated, which directly depends on air temperature, humidity and air velocity. The natural wet bulb temperature is the most important in the equations (70%), meaning that the equations are true for those environments that are warm enough to cause perspiration. The globe thermometer temperature depends on radiation temperature, air temperature and air velocity. Apart from the presence of sun radiation and inclusion of air temperature, the clothing absorption is also included into WBGT calculation outdoors. Both equations for WBGT calculation are acquired from basic equation (Equation 4), if value 1 is included in calculation for absorption coefficient (α, solar absorptivity). For outdoor evaluation, 0.67 is used, which is true for "normal" (green) clothing (Parson 2006).

$$WBGT = 0,7t_{nw} + 0,3(\alpha(t_g - t_a) + t_a) \quad \text{... (4)}$$

The calculation validity depends to a great extent on the measuring equipment used. That is why the used equipment has to be within standard regulations. The globe thermometer, for example, thus has to be 150 mm in diameter, its emission coefficient 0.95, measuring interval from 20 to 120ºC, and the measuring accuracy ± 0.5ºC to 50ºC and ± 1ºC to 120ºC (Parsons 2006).

Before evaluating thermal stress, it is also necessary to determine the metabolic rate needed for work performance. Then, the calculated WBGT values, regardless of effort, are compared by applying reference values (Table 1) or reference value curves (Fig. 1).

Reference values in Table 2 are formed on the assumption that the maximal rectal temperature of worker is 38ºC and that the worker is "normally" clothed (clothing isolation I_{cl}=0.6 clo; e.g. light trousers and T-shirt), in good physical condition and healthy. Reference values relate to the levels of exposure, to which the individuals can be daily exposed without health consequences under the condition that there are no preceding pathological signs. The purpose of reference values determination is not to decrease work accidents due to altered psychomotoric reactions.

With gradual increasing of thermal stress, body adapts to the conditions within the working environment. Thus the partial acclimatization to heat can be achieved in 7 days. The period of partial acclimatization is the same for heat or cold acclimatization (Glaser and Shephard 1963). The full acclimatization can be achieved after three weeks of exposure and lost approximately in the same time (Sušnik 1992).

The thermal stress evaluation is done by comparing the calculated WBGT values with reference values. If they are exceeded, the measures for decreasing thermal exposures have to be taken, or more detailed analyses have to be conducted (e.g. by using SIST EN ISO 7933 standard). One of the organizational measures when work arrangements are made is adjustment of resting time to the type of work and thermal conditions in the working environment (Fig 1). By increasing the resting time ratio within each hour of work (not for the while day), the reference WBGT values increase for the same work.

Table 2: Reference values of WBGT index according to metabolic rate and acclimatization of workers (source: SIST EN 27243)

Preglednica 2: Referenčne vrednosti kazalnika WBGT glede na napor in aklimatizacijo delavca (vir: SIST EN 27243)

Metabolic rate M/ *Napor med delom M* (W/m^2)	Values for calculation of metabolic rate/ *Vrednosti za izračun napora med delom* (W/m^2)	Reference value WBGT / *Referenčna vrednost WBGT* (° C)	
		Acclimatized worker / *Aklimatiziran delavec*	Non-acclimatized worker / *Neaklimatiziran delavec*
Resting/Počitek M ≤ 65	65	33	32
65<M≤130	100	30	29
130<M≤200	165	28	26
200<M≤260	230	25 / 26*	22 / 23*
M>260	290	23 / 25*	18 / 20*

* - noted air velocity / *zaznavno gibanje zraka*

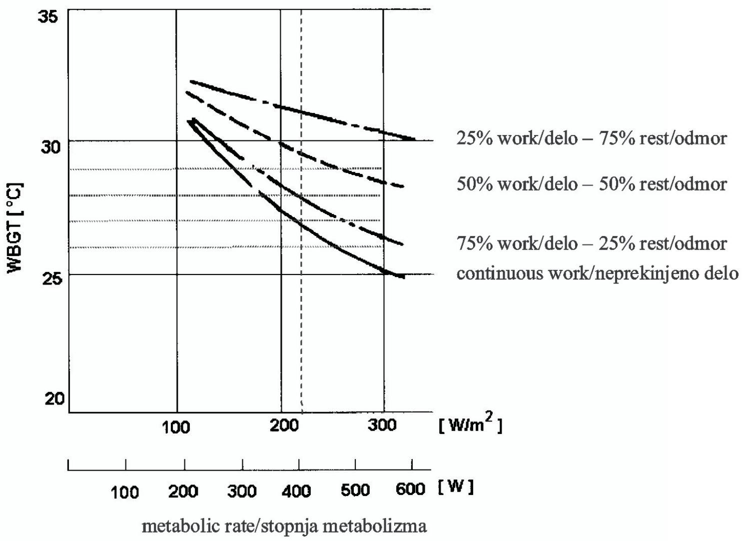

Fig. 1: Reference WBGT values according to effort and conditions during work and rest time duration in each hour of work (source: SIST EN 27243)

Slika 1: Referenčne vrednosti WBGT glede na napor in razmerje med trajanjem dela in počitka v vsaki delovni uri (vir: SIST EN 27243)

The biggest potential source of errors in WBGT evaluation, beside the inappropriate measuring equipment, is metabolic rate evaluation (not observing the individual differences, sex, capabilities, ethnic and other cultural differences), and not considering the influence of clothing on the effort, due to worker movement prevention or the weight of protective personal equipment itself (PPE). Thus, the English standard BS 7963:2000 considers the metabolic rate increase due to PPE. For example, the effort, when using protective shoes at rest, is 0 W/m^2, whereas at hardest work it is 20 W/m^2. The American standards (ACGIH) define the corrections also for reference WBGT values. When using cotton overalls (1 clo), the reference values decrease by 2ºC, when using winter overalls (1.4 clo) by 4ºC, and by for 6 ºC when waterproof clothing is used (Parsons 2006).

Measurement of factors, on the basis of which the WBGT is calculated, should be carried out for at least one hour, having such work and rest duration structure that it is representative for specific work or task. The total WBGT evaluation is calculated as the weighted average. It is recommended that the measures are carried out at the time of greatest effort, i.e. in the middle of the summer day. If greater vertical differences in the values of measured factors exist, the WBGT is calculated by Equation 5.

$$WBGT = \frac{WBGT(glava) + 2 \times WBGT(trebuh) + WBGT(gležnji)}{4} \quad ...\ (5)$$

EVALUATING THE REQUIRED CLOTHING ISOLATION IN COLD ENVIRONMENTS

OCENJEVANJE ZAHTEVANE IZOLACIJE OBLAČIL V HLADNIH OKOLJIH

The standard (SIST ENV ISO 11079) evaluating the required clothing isolation in cold environments is used for permanent and temporary exposure as well as for indoor and outdoor works. It is recommended to evaluate the stress due to cold as an influence on the whole body, and as a local influence on the exposed body parts (e.g. hands, feet, and face).

For the evaluation of cold influence on the whole body, the index IREQ (Required Clothing Insulation) is used, which determines the required clothing isolation. IREQ is a measure for cold stress, where the highest value means the greatest heat exchange between worker and environment. The aim and basis of this method is to keep the body in balance with environment in changeable body and skin temperatures resulting from different effort or level of worker activity. Therefore, the method and calculation IREQ are based on energy balance equation (Equation 6), which presupposes the equality between production and loss of energy.

$$M - W = E_{res} + C_{res} + E + K + R + C + S \quad ...\ (6)$$

The energy produced in metabolism (M) has to be equal to the sum of energy losses due to the energy consumption for mechanic work (W; 0-25% (Gavhed 2003)), evaporation of water through the respiratory organs (E_{res}), exchange of heat with respiration (C_{res}), evaporation of water from the whole body (E), exchange of heat with conduction (K), radiation of the whole body (R), exchange of heat with convection (C) and thermal change in the body (S), if we want to keep the body in the balance temperature condition or to prevent heat accumulation or deficiency. All factors in the equation have dimension W/m^2 of body or clothing surface.

Beside this equation, the standard includes a variety of other equations, on the basis of which the individual equation variables are calculated. Out of all, only the equation of IREQ (Equation 7) and somehow simplified balance equation (Equation 8) are cited. Considering the denominator of IREQ equation, there is a difference between the average skin temperature (t_{sk}) and temperature on the clothing surface (t_{cl}). The IREQ value is acquired form iteration between these two equations.

$$IREQ = \frac{t_{sk} - t_{cl}}{M - W - E_{res} - C_{res} - E} \quad \text{... (7)}$$

$$M - W - E_{res} - C_{res} = R + C \quad \text{... (8)}$$

The calculated IREQ value (m^2 ºC /W = clo) determines what kind of clothing isolation is required by specific physical activity or effort, and thermal conditions, defined by air and radiation temperature, air velocity and air humidity, to keep the thermal balance during work. For IREQ calculation, the same data are required as for thermal comfort calculation or measure PMV and PPD. IREQ can be applied with air temperature below 10ºC (Gavhed 2003).

There are two different calculations: $IREQ_{neutral}$ and $IREQ_{min}$. Regarding $IREQ_{neutral,}$ the worker can keep normal body temperature (t_{sk}=35.7-0.0285xM), whereas with $IREQ_{min}$, the worker can only keep sub-normal body temperature (t_{sk}=30ºC). The comparison of $IREQ_{neutral}$ and $IREQ_{min}$ with dynamic clothing isolation (I_{clr}), which also depends on body posture, body movement and wind, and is for 10-20% lower than basic clothing isolation (I_{cl}), can show us the following results:

- if I_{clr} < $IREQ_{min}$, the chosen clothing does not meet the required body protection, and thus the risk for hypothermia is increased,
- if $IREQ_{min}$ < I_{clr} < $IREQ_{neutral}$, the chosen clothing is satisfactory, and
- if I_{clr} > $IREQ_{neutral}$, then the isolation is more than satisfactory; through activity increase, an increased risk of body overheating, strong perspiration and moisture absorption into clothing can also appear, again representing an increased risk of hypothermia.

For evaluating the level of workers physical demands, the scale can be used, suggested by Gspan et al. (2002). The level of physical demand is at the acceptable level, if $IREQ_{min}$ < I_{clr} < $IREQ_{neutral}$. With I_{clr} < $IREQ_{neutral}$, the physical demand is unsatisfactory, while with I_{clr} < $IREQ_{min}$ it is very unsatisfactory.

In cases when it is not possible to select such kind of clothing that will meet minimal thermal requirements ($IREQ_{min}$), the work in such conditions has to be limited. In these instances the standard demands the calculation of the allowed duration to cold exposure or DLE (Duration Limited Exposure), and also the time needed to achieve normal thermal balance or RT (Recovery Rate) according to exposure.

The IREQ index presupposes that the isolation is equally distributed across body surface, meaning that individual parts are always warm (e.g. hands and feet). Therefore, the thermal balance for individual parts and limbs has to be calculated separately. For this purpose, the standard provides for WCI index calculation (Wind-Chill Index), which is defined as the level of heat loss through unprotected skin surface (W/m^2).

$$WCI = 1{,}16 \times (10{,}45 + 10 \times \sqrt{v_{ar}} - v_{ar}) \times (33 - t_a) \quad \text{... (9)}$$

As indicated in Equation 9, the WCI index includes only air temperature ($_{ta}$) and relative air velocity between the person and air (v_{ar}), whereas it does not include the radiation influence and body cooling influence due to perspiration evaporation (Parsons 1998). If a presumption is made in Equation 9 that the relative air velocity equals 1.8 m/s (calm), the result is the equation for calculating the felt temperature (chilling temperature). The chilling temperature (t_{ch}) shows to which air temperature in calm weather the specific combination of real air and wind temperature corresponds.

$$t_{ch} = 33 - \frac{WCI}{25{,}5} \quad \text{... (10)}$$

Physical demands with stress due to cold are valued according to WCI value or t_{ch}. If the value of WCI exceeds 1,600 W/m^2, the physical demands are great, whereas in case of value being below 1,200 W/m^2, the physical demands are small. Similarly, Gspan et al. (2002) suggest that the physical demands with WCI ≥ 1,200 W/m2 are still acceptable, with WCI ≥ 1,400 W/m^2 unacceptable, and with WCI ≥ 1,600 W/m^2 very unacceptable. The Norwegian standards (Norsok Standard) present work limitations outdoors according to WCI measure, which should be under 1,000W/m^2. Otherwise, the work in cold environment is appropriately shortened or is not executed. Thus, the work should not take place with WCI > 1,600 W/m^2, with WCI between 1,600 and 1,500 W/m^2 the exposure is linearly increasing from 0 to 33%, whereas with WCI between 1,500 and 100 W/m^2 the exposure is linearly increasing from 33 to 100%.

The standard does not specify the time and duration of data collecting. If the analogy regarding the work in hot environments is used, it can be assumed that the measures have to be taken in times of greatest cooling. Also the values of other parameters have to be included (e.g. wind).

CONCLUSION
ZAKLJUČKI

The knowledge of standards and criteria is, on the one hand, necessary as basic knowledge, a tool for planning and organization of research, and preparation of efficient safety measures, while on the other hand it enables a reliable comparativeness between data of different research projects and working positions. The need and validity of some international standards, especially technical ones, is confirmed with their implementation in the EU directives and thus in the national legislations (e.g. SIST ISO 1999:1990 – directive 2003/10/ES - Rules on the protection of workers from risk related to exposure to noise at work; SIST EN ISO 5349:2002, ISO 2631:1997 – directive 2002/44/ES - Rules on protection of workers from risks related to exposure to vibration at work).

The presented three standards supplement each other according to the content and method. In terms of the content, the field of thermal comfort as well as the regions, where the workers' health is potentially endangered due to the extreme thermal conditions, is covered. Speaking methodologically, the standard for evaluating thermal comfort for that kind of forest work will be used (SIST ISO EN 7730), and for regions where PMV is greater than 2, the index WBGT (SIST EN 27243) will be calculated, and for the regions where PMV is smaller than 2, the IREQ index will be calculated (SIST ENV ISO 11079). It has to be emphasized that in case of comfort evaluation the validity of standard for indoors will be violated.

The practical use of the described standards demands the application of unusual instruments, which are relatively cheap. The evaluation of indices can be, in general, applied by using diagrams or with the assistance of computer programs added to the standards. "Manual" calculation is practically unsuitable due to the great number of equations and the search for equation system solution with iteration The need for non-standard meteorological data (temperature of globe thermometer), the limits of use and weaknesses (Brake 2002) are the reasons for the development of new indices, i.e. ESI (Environmental Stress Index; Morgan et al. 2001, 2003, 2004, 2005), PSI (Physiological Strain Index; Moran 1998), and TWL (Thermal Work Limit; Brake 2002).

The indices based on the mentioned standards or just their individual components should be included in every research work, for by influencing the energetic balance they also influence psychophysical characteristic of workers (Bates and Miller 2005). Due to the lack of data on climate conditions in the majority of ergonomic research on work in forestry, it is established (Wästerlund 1998) that the connection between human and his/her thermal environment in the past has been overlooked to a great extent.

SUMMARY

Thermal conditions at work, especially in terms of heat, are becoming increasingly significant due to climate change. This is manifested particularly in outdoor work, where the possibilities for thermal regulation are limited. Although our legislation stipulates, with its Constitution, the right to safe and healthy living environment and further specifies, with its Occupational Safety and Health Act, that this right is to be provided for by the employer, it does not define methods and criteria for the evaluation of thermal conditions applying to forest work. Somewhat more accurately, however, the existing regulations stipulate thermal conditions indoors. Thus, for the needs of research work and practice, it would be reasonable to use international standards for the evaluation of thermal environment (SIST EN ISO 7730), evaluation of thermal stress in hot environments by applying the WBGT index (SIST EN 27243), and evaluation of the required clothing isolation in cold environments (SIST ENV ISO 11079). By using them, the areas of thermal comfort and the areas, where extreme

thermal conditions can have negative consequences on the workers' health, could be covered. By applying the standards, their validity has to be taken into account. The indices or just their individual components should be used in any research dealing with work, since the factors influencing thermal regulation indirectly influence the workers' psychophysical capabilities as well.

POVZETEK

Pomen toplotnih razmer na delovnem mestu, predvsem vročine, postaja zaradi podnebnih sprememb vedno večji. Še posebej se to izraža pri delu na prostem, kjer so možnosti za termoregulacijo omejene. Slovenska zakonodaja z ustavo sicer določa pravico do varnega in zdravega življenjskega okolja ter za zagotavljanje te pravice na delovnem mestu z Zakonom o varstvu in zdravju pri delu določi delodajalca, ne določa pa načina in kriterijev za ocenjevanje toplotnih razmer, ki bi veljale za delo v gozdu. Nekoliko natančneje so z podzakonskimi akti opredeljene toplotne razmere v zaprtih prostorih. Za potrebe raziskav in prakse lahko zato smiselno uporabimo mednarodne standarde za ocenjevanje toplotnega okolja (SIST EN ISO 7730), za ocenjevanje toplotnega stresa v vročih okoljih z uporabo kazalnika WBGT (SIST EN 27243) in za ocenjevanje zahtevane izolacije oblačil v hladnih okoljih (SIST ENV ISO 11079). Z njimi vsebinsko pokrijemo področje toplotnega udobja ter področja, kjer imajo ekstremne toplotne razmere lahko negativne posledice za zdravje delavcev. Pri uporabi standardov je treba upoštevati njihovo veljavnost. Kazalniki ali samo njihove posamezne komponente morajo biti uporabljeni v vseh raziskavah dela, saj dejavniki, ki vplivajo na termoregulacijo, posredno vplivajo tudi na psihofizične sposobnosti delavca.

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