FREQUENTLY ASKED QUESTIONS
MICROTHERM HEAT STRESS WBGT

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What is heat stress?

Heat Stress is the physiological strain caused by an increase in core body temperature. The human body maintains its core body temperature at 98°F over a wide range of conditions by thermo regulatory means.

The contributing factors that can affect heat stress range from metabolic heat generation, evaporation, convection, radiation and conduction. The evaporation rate is affected by the relative humidity, air velocity and the clothing worn by the individual within that environment. The ambient temperature affects convection; if this is higher that the body's core temperature, the body will gain additional heat. When a person is subjected to working in a hot environment the heat loss by radiation, convection and evaporation will be limited and ultimately the core body temperature will rise. This will result in greater heat stress and higher physiological strain.

What are the medical effects/symptoms of heat stress?

Workers exposed to hot working environments are susceptible to heat stress, when the core body temperature rises to dangerous or hazardous levels. This can result in physiological symptoms like heat cramps, nausea, palpitations, stroke and possibly death. In particular, this is dependant on the production of heat inside the body as a result of the physical activity. It is also dependant on the characteristics of the surrounding environment governing the heat transfer between the atmosphere and the body. This depends on a number of different factors; mainly air temperature, mean radiant temperature, air speed and absolute humidity.

There are a number of medical effects that result if the body is subjected to greater heat stress and greater cardiovascular demands and physiological stress. Symptoms first occur when the bodies core temperature raises above 101.3°F. As changes can occur rapidly it is always important that all workers are supervised. A reduction in work rate is the first sign of heat stress. A range of medical conditions can exist due to heat stress;

Skin burns; caused by direct contact to hot surfaces

Fainting; caused by a reduction in blood pressure to the brain. Muscle cramps can also be a result

Excessive sweating, nausea and vomiting; occur as a result of salt depletion

Heat exhaustion; this itself also has a number of characteristic symptoms; such as tiredness, dizziness and vomiting, breathing difficulties, extreme thirst and cramps.

Swelling of the joints and *heat rash*

Heat Stroke is also a result of Heat Stress. Heat stroke can occur when the body's core temperature is above 104°F, the body loses its ability to sweat and loss of consciousness may occur. Ultimately Heat Stroke can result in death.

What are the applicable Standards?

ISO 7243:1989(E) Hot Environments – Estimations of the heat stress on working man, based on the WBGT-index (wet bulb globe temperature)

ISO 7226; Thermal Environments – Instruments and methods for measuring physical quantities.

ISO 7730, Moderate Thermal Environments – Determination of the PMV and PPD indices and specification of the conditions for thermal comfort.

ISO 7933, Hot Environments – Analytical determination and interpretation of thermal stress using calculation of required sweat rates.

What is the WBGT Index?

This was initially developed by the US Marines and is now widely used within the industry. It is an empirical index representing heat stress to which an individual is exposed. It is based on the exchange of heat between man and the environment. This index combines two parameters; the natural wet bulb temperature (t_{nw}) and the globe temperature (t_g). In some situations the air temperature is also taken into consideration, which is performed by measuring the dry bulb temperature (t_a). The following expressions show the relationship between all of these parameters;

Inside Buildings and outside buildings without solar load:

$$\mathbf{WBGT = 0.7t_{nw} + 0.3t_g}$$

Outside buildings with solar load:

$$\mathbf{WBGT = 0.7\ t_{nw} + 0.2\ t_g + 0.1\ t_a}$$

What are the basic principles of heat transfer?

The basic sensors that are used on the Microtherm Heat Stress WBGT work on the basic principles of Conduction, Convection and Radiation & Evaporation.

Conduction; the flow of energy through matter. In order for energy flow to take place there must be an energy differential between the two points. The Wet Bulb Sensor measures conduction.

Convection; the process of heat flow and transfer that involves the movement of the medium itself. The air temperature sensor measures convection.

Radiation; the energy which is transmitted, emitted or absorbed in the form of particles or waves. The Black Globe sensor measures this parameter.

Evaporation; the loss of energy as liquid changes to the gaseous phase. Evaporative cooling takes place when sweat evaporates from the skin. High humidity effects reduce the rate of evaporation and thus reduce the effectiveness of the body's primary cooling mechanism. This is important as the percentage of liquid in the body is critical to its correct functioning.

What sensors are used?

All sensors used are Platinum Resistance Temperature Detectors (PTRD) which are industry standard and yield the most accurate readings.

Natural wet bulb temperature sensor
This is a temperature sensor covered with a wetted wick, and is ventilated naturally. It is responsible for measuring an evaporation effect from a surface.

Globe temperature sensor
This is a temperature sensor placed in the centre of a black globe, which is designed to absorb the available heat energy within the measuring environment. This sensor measures the conduction and radiation effect within the working environment.

Air Temperature
This is a standard PTRD sensor which is shielded from direct solar load.

Metabolic Energy
This is the quantity of heat produced inside the body which produces an element of heat stress. It is therefore essential to determine metabolic energy in order to evaluate heat stress. Metabolic energy, which presents the total quantity of energy consumed inside the body, is a good estimation of this for most industrial situations.

How do I interpret the WBGT values?

The WBGT value is obtained in order to be able to compare the level to a reference value. This value is used in order to evaluate the heat stress within the work place. If the value is too high some action may need to be taken. The action required may be to reduce directly the heat stress or strain at the workplace, or to carry out more detailed medical monitoring of the personnel.

There are also other factors that are responsible for the way in which the body gains and loses heat within its surroundings. These are such factors as the metabolic rate, the type of clothing worn and the duration of the exposure to the heat or the cold. Typical metabolic rates can be seen below.

What are Work Rest Regimes (WRR)?

The Work Rest Regime (**WRR**) minimizes the effect of heat stress upon a worker. Different regimes of work and rest are adopted at specific levels of WBGT. The regime is also dependant upon the levels of work and the metabolic rate of the worker. Workloads are defined as follows;

Light is a metabolic rate of 230W

Moderate is a metabolic rate of 230 to 400W

Heavy is a metabolic rate of between 400 and 580W

	Workload (total)		
	Light	**Moderate**	**Heavy**
Continuous	30.0	26.7	25.0
75% work, 25% rest each hour	30.6	28.0	25.9
50% work, 50% rest each hour	31.4	29.4	27.9
25% work, 75% rest per hour	32.2	31.1	30.0

By performing a heat stress survey, a **WRR** is calculated. This determines how long the worker can work within those conditions and how long a rest period the worker requires. The Microtherm Heat Stress WBGT is capable of indicating (via the software) the appropriate **WRR** required for an entered level of activity on any particular worker (see WinHSM in the software section).

What effect does clothing have on heat stress level?

The amount of heat gained or lost by a body is governed by the type of clothing worn. Standard tables of values for these are available (**Clo**). Clothing Assemblies have varying resistances to heat flow, expressed by the unit 'Clo', where 1 Clo = $0.155°cm^{-2}W^{-1}$. Typical **Clo** values can be seen as follows:

Clothing Assembly	**Clo**
Naked	0
Shorts	0.1
Light summer clothing	0.5
Typical indoor clothing	1.0
Heavy Suit and underclothes	1.5
Polar Clothing	3-4
Practical Maximum	5

Having gained the WBGT values, the work rest regime matrix can again be corrected by the clothing worn within the working environment. The corrections that can be made are as follows;

Light summer clothing, 0

Cotton overalls, -2

Winter clothing, -4

Water barrier (permeable), -6

For example, in cotton overalls, the point at which a worker under heavy workload would be subjected to 75% work and 25% rest would start at 25.9 –2 = 23.9°C. The appropriate clothing correction factor can then be inserted into the WinHSM software and the regimes are re-calculated accordingly (see the following software section).

How do I calculate the metabolic rate?

Metabolic Rate can be determined in two ways; either by measuring the oxygen consumption of the worker or by estimating it from reference tables. It is sufficient when calculating the WBGT to estimate the metabolic rate according to these reference tables.

Activity	Metabolic Rate (W)
Sitting	95
Standing	115
Walking at 4 km h^{-1}	260
Standing : light hand work	160-210
Standing : heavy hand work	210-260
Standing : light arm work	315
Standing : heavy arm work	420-675
Work with whole body : light	315
Work with whole body : moderate	420
Work with whole body : heavy	560

Again, these values can be entered in via the WinHSM software and reports generated.

Can I measure the temperature at different heights?

If the parameters are not constant within the working environment then it may be necessary to determine the WBGT at three different positions corresponding to the height to the head, abdomen and the ankles in relation to the ground. These positions vary whether the worker is sitting or standing. The heights are:

Standing the measurements are done at 0.1m, 1.1m and 1.7m

Sitting the measurements are at 0.1m, 0.6m and 1.1m above the floor

However, for a rapid determination of the WBGT index, it is sufficient to take one measurement at the level at which the heat stress is at a maximum. Tripods are available to allow the user to position sensors (via remote 10m cable) at different heights if required.

How do you calibrate the Heat Stress Monitor?

Calibration of the Microtherm WBGT is performed internally via the electronics each time the instrument is switched on. This insures a high accuracy for each of the temperature sensors (+/- 0.01%) and eliminates the need for annual recalibration. Sensor arrays are also interchangeable without need for recalibration.

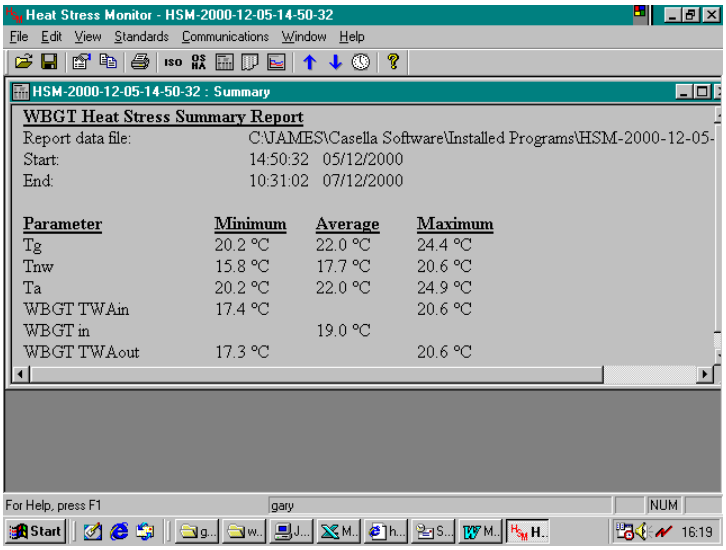
What is the operating temperature range of the unit?

The electronics of the unit are rated for use in the range of –5 to +60°C (23 to 140°F). The sensor array itself can be placed in an area with a temperature range between –5 to +120°C (23 to 248°F).

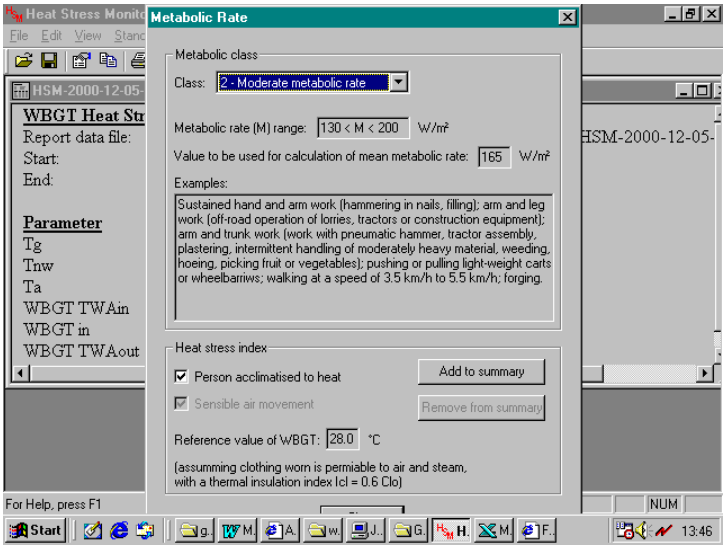
What can the Software do?

The WinHSM Software is compatible with Windows 98 and NT and performs the following:

Generates summary reports of all parameters:

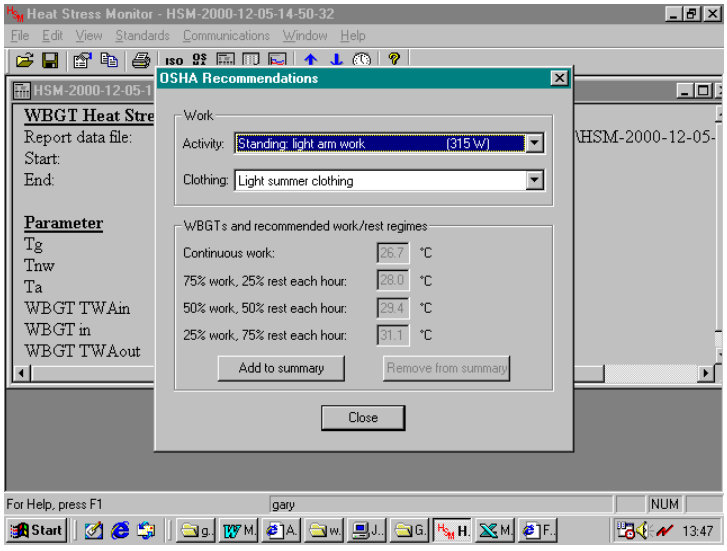


Allows operator to enter ISO Metabolic Class:

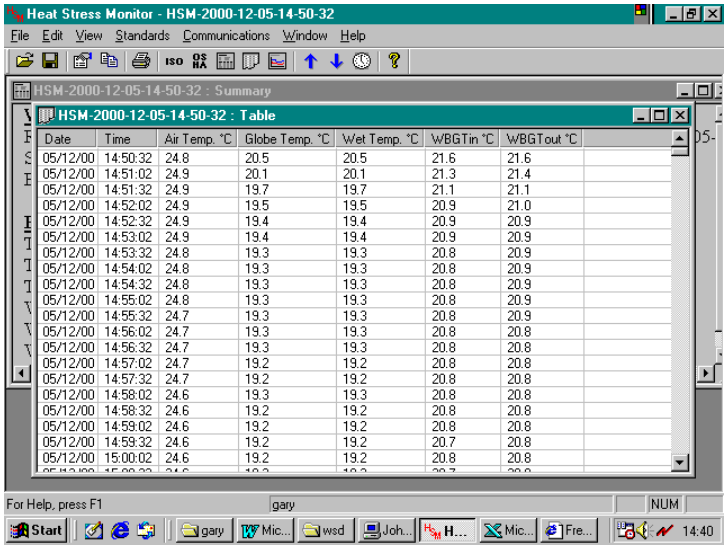


OSHA –recommendations and clothing factors can be entered in and attached to the report, where the WBGT values are corrected accordingly:

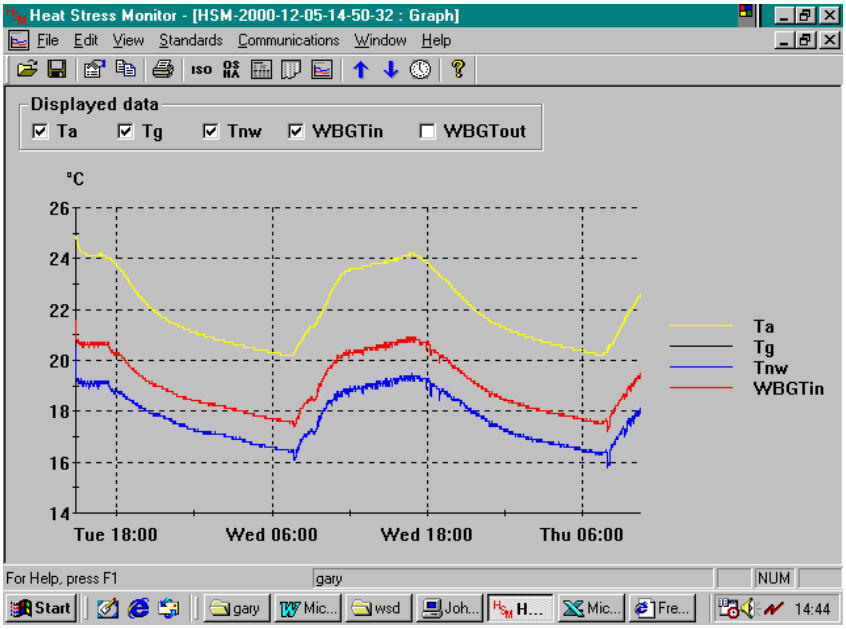
From these amendments, the appropriate work-rest regimes can be adopted.



Tabular reports & Graphical reports:



A real time option is also selectable from a drop down tab menu, which allows monitoring of data direct via the PC.



Practical Considerations

How often do I need to use the Heat Stress Monitor?

The legislation stipulates that employers must reduce risk to employees and external contractors on the site to conditions that cause heat stress. Use the instrument as often as your Health and Safety Policy advises you based on the Risk Assessment previously done at your workplace.

In what applications would I use this instrument?

Use the Microtherm Heat Stress WBGT in any hot environment in order to monitor the effect upon the worker. Such environments are Foundries, Bakeries, Power Stations and Engine Rooms etc.

How do I maintain the instrument?

The main area of maintenance required on the instrument is the renewal of Distilled Water (H_2O) within the Wet Sensor. The sensor arrays on the instrument can be interchanged with no need for individual calibration of each array.

Can I connect the instrument directly to my PC?

The software has a “real time” tab so the instrument can be plugged directly into the PC and the current situation will be able to be monitored continuously.

Can I use the instrument outside?

The instrument can be used in an external environment when required, although it is not designed to be fully weatherproof. When it is necessary to measure $WBGT_{OUT}$ the conditions should be dry.

What are the terms of warranty?

All items are covered under the general Casella CEL Inc. warranty, which is one year in duration.