**Introduction**

Wet bulb globe temperature (WBGT) is a constant temperature indicator, calculated using a formula that factors the effect of temperature, humidity, wind speed, and solar radiation on humans. The utilization of WBGT as the key assessment of heat stress on the human body contributes to gain momentum throughout the athletic industry, from the student-athlete up to professional organizations.

Traditionally, organizations measure WBGT with expensive, bulky globe thermometers that provide the temperature indicator at the moment, for the specific location of the sensor, with no visibility to future WBGT readings. Schneider Electric has recently introduced a WBGT forecast technology, utilizing existing weather observation, the integration of advanced meteorological datasets, use-defined alerting on time, and location-based alerting, ultimately providing schools, medical staff, and coaches with flexibility in making operational decisions pertaining to athlete safety.

**Derivation of WBGT Equation**

Schneider Electric recently integrated a fourth degree polynomial equation to define the black globe temperature ($T_b$) estimator for forecast locations worldwide. This equation stems from the research of Derrico, Pizzif, and Ambrao [4] which highlights that $T_b$ can be derived from common atmospheric measurements rather than utilization of an expensive and non-portable black globe thermometer. The approximation equation is defined as the following:

$$ T_b = T_a + 769000 \left( \frac{a}{c + 25600} \right) $$

Where $B$ and $C$ are defined as:

$$ B = \frac{e}{E} \left( \frac{1 + \frac{B}{a}}{\frac{b}{c}} \right) + c \cdot 10^2 $$

$$ C = \frac{E}{0.00566215} $$

Where $a$ is the Stefan-Boltzmann Constant and $b$ is an approximated convective heat transfer coefficient.

$T_a$ = Solar irradiance

$T_d$ = Direct Beam Radiation

$T_e$ = Diffuse Radiation

$T_z$ = Ambient Temperature

$T_w$ = Wind Speed

$T_v$ = Thermal Emissivity, $v$ is defined as:

$$ v = 0.85 \cdot \frac{1}{a^2} $$

$T_{wp}$ = Atmospheric Vapor Pressure can be defined as:

$$ T_{wp} = (P_{Atm} - P_{H_2O}) / P_{H_2O} $$

Knowing Black Globe Temperature ($T_b$), we can now calculate the WBGT ($T_{WBGT}$) as defined by the Occupational Health and Safety Administration (OHA):

$$ T_{WBGT} = (0.7 \cdot T_a + 0.2 \cdot T_b + 0.1 \cdot T_v) $$

$T_e$ = Dew Point Temperature

**Advanced Datasets and functionality for use in WBGT Estimation**

Utilizing the equation to approximate the Global Temperature, Schneider Electric provides its customer base with an hourly forecast plot for 72 hours of WBGT within its software-as-a-service, Mohrson Weather/Safety Online. To ensure the highest quality professional grade weather forecast, the WBGT calculation has been integrated into Schneider Electric’s Advanced Weather Forecast System (A4) to create highly localized, hourly up-date, consistently accurate weather forecasts, suitable for critical business decision support surrounding heat stress.

As illustrated, the approximation requires multiple inputs to calculate the Global Thermometer Temperature used for the final WBGT estimation. Schneider Electric’s Advanced Weather Forecast System takes into account hourly updates of these critical core variables both in observation and forecast formats. Schneider Electric WBGT forecasts are updated hourly, incorporating the most current weather observations and forecast datasets, ensuring that the resultant WBGT forecasts are updated so that they always reflect real-time data. The Mohrson Weather/Safety Online software features one-of-a-kind, customizable tools that you can tailor to your operations.

**Forecast Thresholds** - End users can set forecast thresholds (highlighted in yellow) for over 40 weather parameters, including WBGT. The forecast threshold alerting tool clearly identifies when your specific thresholds will be breached.

**Visualization** - WBGT can also be plotted in real-time within the Mohrson Weather/Safety Online Layer Map. From this setting, users have a spatial view of WBGT in real-time over their territory. By averaging National Weather Service (NWS) weather warnings and information is also an option, including excessive heat warnings, Note in the image to the right how portions of Los Angeles are observing dangerous WBGT values, yet the NWS Excessive Heat Warnings is issued for counties to the East.

**Alerting** - The system’s Alert Manager notifies you of significant weather changes for your specific area. Set custom audio or visual alarms for WBGT and other critical parameters. Additionally, key weather alerts and warnings can be delivered directly to an unlimited number of users via cell phone with our simple set up for critical weather updates anywhere. With forecast lead time warnings of up to 12 hours, those responsible for the safety of athletes can take an proactive measure on high WBGT values.

**Online Consulting Forum** — Should you require further information about WBGT forecast, you can access Schneider Electric’s team of experienced meteorologists via the Mohrson Weather/Safety Online, Consulting Forum. You can access the forum from your phone, your tablet, or your laptop device. Ask a question and receive an answer. This direct, 24/7 access to our forecasting center provides invaluable insight to further mitigate risk.

**Summary**

Wet bulb globe temperature is being adopted by more sports organizations as their standard for identifying possible heat related risks to athletes. It better represents the potential of environmental heat stress than does the traditional heat index indicator, because it factors the wind, direct and sun-angle factors significant when athletes are sweating themselves at a facility with no direct sun.

Schneider Electric’s advanced forecasting technology includes current and forecasted WBGT readings, along with proactive alerting to notify users when their specified thresholds exist or are forecast. This industry-leading functionality provides value far beyond that delivered by dedicated WBGT equipment.

**References**


