

Wet Bulb Globe Temperature Calculator

Technology Brief

- Automates estimates of WBGT
- Improves worker safety
- Reduces cost
- Provides tool for work planning

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Westinghouse Savannah River Company researchers have developed Wet Bulb Globe Temperature (WBGT) Calculator software that calculates outdoor, with solar load, wet bulb globe temperature using standard meteorological measurements. Use of the software reduces cost and expedites the issuance of safety alerts to protect workers in hot weather.

Measuring Environmental Factors

The WBGT Index was developed by the U.S. military to model the stress imposed on humans by hot humid environments. With the WBGT and estimates of workers' metabolic heat load, depending on the type of work activity being performed, industrial hygienists can use the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values to determine the appropriate work/rest regimen, clothing, and equipment to control the heat exposures of workers.

Per guidance published by the Occupational Safety and Health Administration (OSHA), the outdoor, with solar load, WBGT Index is a weighted sum of three component temperatures:

- A globe temperature (T_g), measured by a thermometer inside a black sphere passively exposed to the ambient environment. The globe temperature provides an indication of the mean radiant temperature of the environment and accounts for 20% of the WBGT Index.
- A natural wet bulb temperature (T_n), measured by a thermometer bearing a wetted wick passively exposed to the ambient environment. The wet bulb temperature indicates the amount of cooling provided to the human subject through evaporation and accounts for 70% of the WBGT index.
- A dry bulb temperature (T_a), measured by a standard air thermometer. The dry bulb temperature is the temperature of the ambient air and accounts for 10% of the WBGT Index.

How it Works

The WBGT Calculator uses data collected at a centrally located meteorological tower to simulate the response of the globe and natural wet bulb thermometers, providing estimates of T_g and T_n . Combining these estimates with the T_a measurement provides a calculation of the outdoor WBGT.

Simulations of WBGT using the WBGT Calculator were field tested at the Department of Energy's Savannah River Site for over 5 years, during which time the algorithms were refined to ensure the closest calibration possible compared to standard, manual measurements.

At the Savannah River site, the WBGT calculations are based on direct input of solar radiation

measured by a radiometer. Many meteorological observing stations, such as those operated by the National Weather Service, military, and Federal Aviation Administration, do not measure solar radiation directly but do record cloud cover. The software can be modified to estimate solar radiation based on cloud cover.

Benefits

The WBGT Index is used to determine potential heat stress at the Savannah River Site in Aiken, SC, from April through September. A full-time field technician used to take manual measurements of WBGT every hour. The manual instruments are cumbersome and require special techniques, such as the use of distilled water when wetting the wet bulb globe thermometer, to ensure accurate measurements.

With the WBGT Calculator, real-time readings are taken automatically every minute from the central meteorological tower. The readings are averaged every 15 minutes and appropriate heat stress precautions are published over the site's intranet.

The use of real time measurements enables a quicker reaction to temperature fluctuations and changing weather conditions, thus improving worker safety.

Use of the WBGT Calculator saves the Savannah River Site about \$28,000 per year by reducing the need for a full-time field technician.

Range of Effectiveness

The Savannah River Site comprises 310 square miles of a homogeneous, flat, sandy and arid land mass. Readings taken from the centrally located meteorological tower are used to calculate potential heat stress for all activities within the site boundaries. For activities involving extenuating locale-specific conditions, such as proximity to large, thermal-radiating concrete structures, manual measurements of WBGT may be required to augment the generically derived WBGT.

The range of use of the WBGT Calculator at other sites may be limited by topographical features such as mountains, canyons, and bodies of water.

Many Potential Uses

The WBGT Calculator can be used to monitor a variety of activities in hot outdoor environments such as construction, above-ground mining, highway work, forestry, heavy-lift operations, pipeline maintenance, utility maintenance, military exercises, and athletic events. The software also can be used in a predictive mode to aid in work planning.

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Partnering Opportunity

WSRC operates the Savannah River Site for the U.S. Department of Energy. WSRC scientists and engineers develop technologies designed to improve environmental quality, support international nonproliferation, dispose of legacy wastes, and provide clean energy sources. WSRC is responsible for transferring technologies to the private sector so that these technologies may have the collateral benefit of enhancing U.S. economic competitiveness.

WSRC is seeking companies who would be interested in selling the copyrighted WBGT Calculator program as a commercial product under a license with WSRC.