Kestrel®
4400 Heat Stress Tracker
by NK

INSTRUCTIONAL MANUAL

AVAILABLE WITH Bluetooth® WIRELESS DATA TRANSFER

⚠ CAUTION

Your Kestrel brand Weather Tracker is designed to provide accurate measurement of current conditions only. Depending on your location and environment, conditions may change rapidly.

Rapid temperature and humidity changes (ie moving your meter from indoors to outdoors) may cause inaccurate readings of temperature and humidity as well as all readings which rely on either of these values. Before relying on a Kestrel Weather Weather Tracker readings, use care to either a) force air flow over the sensors by waving or slinging your meter through the air; or b) wait until your unit's readings have stabilized, indicating it has equilibrated to its new environment.

To maximize the accuracy and reliability of your readings:

- ***Ensure that your Kestrel Tracker is in good repair and within factory calibration.***
- ***Take readings frequently and carefully according to the guidelines above.***
- ***Allow your meter's readings to stabilize after significant changes in temperature or humidity (ie changing location from indoors to outdoors).***
- ***Allow a margin of safety for changing conditions and reading errors (2-3% of reading is recommended).***

Use extra care and good judgment when referring to your Kestrel Weather Tracker to make any decisions regarding safety, health or property protection.

⚠ WARNING

To reduce the risk of injury or death to persons, read and follow these guidelines!

The Heat Stress, Wind Chill and Thermal Work Limit indices are published indices developed by the National Weather Service to provide decision guidance based on average human physiological response. Certain individuals, animals, equipment or property may be more susceptible to harm relating to environmental conditions, requiring additional precautions. For example, very young or elderly individuals, individuals with asthma or sickling trait, and individuals who have not become acclimated to hot conditions are likely to be more prone to heat illness, heat exhaustion, heat stroke or death.

- ***Know yourself and the individuals and items you are responsible for.***
- ***Where appropriate, seek the guidance of a medical professional.***
- ***Know what to do in the event of heat illness.***
- ***Be prepared with supplies to treat heat illness.***
- ***Have and practice a heat illness action plan.***

Your Kestrel Weather Tracker is an environmental meter, not a medical device. It is only one source of information and must be employed with care and good judgment.

OVERVIEW

NK, manufacturer of Kestrel Pocket Weather Trackers, is available to answer questions and provide support. Contact NK by phone: 610.447.1555; fax: 610.447.1577; email: info@NKhome.com; or NKhome.com

GUIDELINES FOR USE

The Kestrel 4400 Heat Stress Tracker will only yield accurate measurements using the following guidelines. It is important that the 4400 be fully acclimated to the measurement environment for accurate readings.

Proper Placement

The Kestrel 4400 Heat Stress Tracker should always remain 3 feet from the ground. If the 4400 is laid on the ground, it will compromise the measurements of user's conditions. To ensure proper placement, use the Kestrel Compact Collapsible Tripod and the vane mount (included).

Optimal Acclimating Time

If taken from a cool climate, where the Kestrel 4400 Heat Stress Tracker was stored, to an outside heat stress climate, the unit will need to adjust accordingly. Give the unit a minimum of 7 minutes to adjust to the outside climate if taken from storage (examples: air conditioned building, car glove box, truck gearbox, etc). 10 minutes of acclimatization time is recommended. If worn on the person without the Black Globe exposed, the Kestrel 4400 Heat Stress Tracker will need at least 2 minutes to display accurate measurements (examples: jeans pocket, shirt pocket, etc).

Repeat Measurements

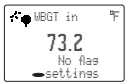
When transporting the 4400 with the intention of taking repeat measurements, such as on a hike or march, try to keep the unit exposed as much as possible. A Kestrel Belt-Clip Carry Pouch or MOLLE-Compatible Tactical Carry Pouch is ideal for this purpose as the Black Globe sensor remains exposed to the air.

Note: the cautions and risks of using the Kestrel 4400 Heat Stress Tracker aforementioned in these instructions. Use other factors such as amount of work being completed or distance of land traveled when making judgments on heat stress and personnel capabilities.

WET BULB GLOBE TEMPERATURE

Measuring

The unit will calculate and display Wet Bulb Globe Temperature based on Globe Temperature, Relative Humidity, Ambient Temperature, Barometric Pressure, and Wind Speed.



To Change WBGT settings:

- Press ⬭ while on the Wet Bulb Globe Temperature screen.
- Use ◀ or ▶ to change the "Type" setting between outdoor and indoor, (see glossary for more info).
- Use ⬭ to scroll to "App", then use ◀ or ▶ to change the Application.
- Press ⓘ to exit the WBGT settings screen.

Note: Flags for WBGT are listed in figure 1 (page 6). If red or black flags are displayed, the number will flash to alert the user with the screen contrast inverting. Unless the screen says "No flag", the flag color will flash. See below screenshots for examples of inverting screen contrast. For information on work/rest ratios and water consumption refer to Figure 1.

WET BULB GLOBE TEMPERATURE (CON'T)

Work/Rest and Water Consumption Table

Applies to average sized, heat-acclimated soldier wearing BDU, hot weather. (See TB MED 507 for further guidance.)

Easy Work	Moderate Work	Hard Work
• Weapon Maintenance • Walking Hard Surface at 2.5 mph, < 30 lb Load • Marksmanship Training • Drill and Ceremony • Manual of Arms	• Walking Loose Sand at 2.5 mph, No Load • Walking Hard Surface at 3.5 mph, < 40 lb Load • Calisthenics • Patrolling • Individual Movement Techniques, i.e., Low Crawl or High Crawl • Defensive Position Construction	• Walking Hard Surface at 3.5 mph, ≥ 40 lb Load • Walking Loose Sand at 2.5 mph with Load • Field Assaults

Heat Category	WBGT Index, F°	Easy Work		Moderate Work		Hard Work	
		Work/Rest (min)	*Water Intake (qt/hr)*	*Work/Rest (min)*	*Water Intake (qt/hr)*	*Work/Rest (min)*	*Water Intake (qt/hr)*
1	78° - 81.9°	NL	½	NL	¾	40/20 min	¾
2 (GREEN)	82° - 84.9°	NL	½	50/10 min	¾	30/30 min	1
3 (YELLOW)	85° - 87.9°	NL	¾	40/20 min	¾	30/30 min	1
4 (RED)	88° - 89.9°	NL	¾	30/30 min	¾	20/40 min	1
5 (BLACK)	> 90°	50/10 min	1	20/40 min	1	10/50 min	1

- The work/rest times and fluid replacement volumes will sustain performance and hydration for at least 4 hrs of work in the specified heat category. Fluid needs can vary based on individual differences (± ¼ qt/hr) and exposure to full sun or full shade (± ¼ qt/hr).
- **NL** = no limit to work time per hr.
- **Rest** = minimal physical activity (sitting or standing) accomplished in shade if possible.
- ***CAUTION: Hourly fluid intake should not exceed 1½ qts.***

  Daily fluid intake should not exceed 12 qts.
- If wearing body armor, add **5°F** to WBGT index in humid climates.
- If doing Easy Work and wearing NBC (MOPP 4) clothing, add **10°F** to WBGT index.
- If doing Moderate or Hard Work and wearing NBC (MOPP 4) clothing, add **20°F** to WBGT index.

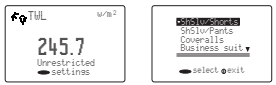
For additional copies, contact: U.S. Army Center for Health Promotion and Preventive Medicine Health Information Operations Division at (800) 222-9698 or CHPPM - Health Information Operations@apg.amedd.army. mil. For electronic versions, see http://chppm-www.apgea.army.mil/heat.

CP-033-0404

Figure 1: Work/Rest ratios and Water Consumption Guidelines. (Source: U.S. Army Center for Health Promotion and Preventive Medicine Health Information Operations Division. URL: http://safety.ucanr.org/files/2091.pdf)

Measuring

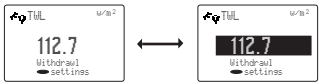
The unit will display Thermal Work Limit based on Globe Temperature, Relative Humidity, Ambient Temperature, Barometric Pressure, Wind Speed, and parameters specific to the population using the Thermal Work Limit measurement. These parameters are the Intrinsic Clothing Insulation Factor (IClo), Vapor Permeation Factor (VPF), Position of the body (Pos), and surface area of the person (Area). See Clothing Ensemble Level Setting Screen below.



To Change WBGT settings:

- Press ⊖ while on the Thermal Work Limit screen.
- Use ▲ or ▼ to scroll to different ensembles.
- Press ⊖ to select the desired ensemble.
- A bullet indicates the selected ensemble.
- Press ⓘ to exit the WBGT settings screen.
- If Custom is selected, each factor specific to the user can be altered (shown above).
- To view the specifics of an ensemble, press ⊖ after selecting it.
- If viewing the Custom ensemble specs, use ◀ or ▶ to adjust each value, and ▲ or ▼ to scroll to different parameters.
- Press ⓘ to exit the ensemble specs, and once more to exit TWL settings screen.

Note: "Acclim" will blink on the TWL screen when the meter detects that Acclimatization is the current zone. In the Buffer or Withdrawal zones, the number will flash as shown in the screenshots below. For information on TWL interventions, refer to Figure 2. For typical numeric values for each factor, refer to Figure 3.



TWL (W.m^{-2})	> 220	140-220	115-140	< 115
Working Zone	**Unrestricted**	**Acclimatisation**	**Buffer**	**Withdrawal**
Interventions	**No limits on self-paced work** for trained, hydrated workers.	**No restriction for acclimatized workers Workers with uncertain acclimatization status should not work alone in this zone** • Be aware of increased risk of heat illness • Dehydration test for first two shifts back from leave	**Buffer zone exists to identify situations in which environmental conditions may be limiting to work** • Any practicable intervention to reduce heat stress should be implemented e.g. provide shade, improve ventilation etc • Working alone to be avoided if possible • Unacclimatised* workers not to work in this zone • Use the technical information sheets **'Work-rest cycling – sample schedules' and 'Fluid requirements for working in heat'** to prescribe maximum exposure time, work/rest cycling and fluid intakes appropriate for type of work and conditions	**Work limited to essential maintenance or rescue operations** • No person to work alone • No unacclimatised* person to work • Documentation required authorising work in hostile thermal conditions for specific purpose • Specific induction required emphasizing hydration and identifying signs of heat strain • Apply 20 minutes of work – 40 minutes rest schedule • Required fluid intake exceeds 600 ML per 30 minutes • Personal water bottle (2 litre capacity) must be on the job at all times • Mandatory dehydration testing at end of shift

**Unacclimatized workers are defined as new workers who have been off work for more than 14 days due to illness or leave (outside the tropics).*

Figure 2: TWL values, working zones, and interventions.Source: Health Authority, Abu Dhabi. URL: http://haad-safe.ae/index.php?option=com_content&view=article&id=27&Itemid=50

THERMAL WORK LIMIT (TWL) (CON'T)

ENSEMBLE	IClo	VPF
Men's business suit: Long sleeve shirt/ tweed suit jacket & long, loose trousers	1.13	0.37
Short sleeve shirt/denim shorts	0.41	0.43
Work Clothes: Short sleeve shirt/long trousers (denim)	0.50	0.40
Work Clothes & Coveralls	0.96	0.39

POSITION	VALUE
Lying down	0.00
Standing up	1.00

Figure 3: (left/above) Typical values for IClo, VPF, and POS. Typical value for Area of a man is 1.7. Sources: "Heat and Moisture Transfer Through Clothing" (http://www.ibpsa.org/proceedings/BS2009/BS09_1360_1366.pdf), and "A Comprehensive Database for Estimating Clothing Insulation," Institute for Environmental Research, Kansas State University; Elizabeth McCullough and Byron James.

VANE MOUNT

Assembling the Vane Mount

The Vane Mount was designed for extreme light weight and portability, and assembles in seconds. The Portable Vane Mount contains four components: a zippered carry pouch, a cup bracket with incorporated level, a boom and a flight.

Step 1

Assemble the boom. Unfold the two pieces and stretch the bungee gently, then slide the two pieces together (like a tent pole).

Step 2

Attach the flight to the flat end of the boom. Grasp the silver bungee end AND the transparent bungee washer, then pull the bungee out about 1/2 an inch. Drop the bungee into the slot in the center of the flight while slipping the boom end into the opening in the center of the flight.

Step 3

The assembled flight and boom looks like this.

Step 4

Attach the boom to the cup bracket. Locate the arrow on the inside of the cup bracket base. Insert the boom end in the direction of the arrow, all the way through the base of the vane mount. Grasp the silver bungee end AND the transparent bungee washer, then pull the boom back, stretching the bungee. Drop the bungee into the slot and slip the boom end into the opening near the compass. Gently rotate the boom until the angled end "seats" into the base of the opening.

Step 5

Attach the Vane Mount to your tripod and level your tripod. Spin the Vane Mount knob onto the 1/4-20 mount on your tripod. Slip your Kestrel into the Vane Mount with the display facing the bubble level and the back side of the Kestrel facing the flight and boom. Adjust the flight so it is vertical. Observing the level on the Vane Mount, carefully adjust your tripod so the Vane Mount is level and rotates freely and evenly.

DATA LOGGING AND MIN/MAX/AVERAGE

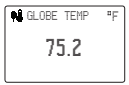
When Autostore is on and the unit is off, the heat stress measurements will not be stored because they use calculations that cannot be performed without power. When reviewing data in the graphical display, the symbol "–" will appear at the top of the display for any points not logged due to the above condition.

In wind-related measurements, a timer will appear at the bottom of the screen after starting the MMA feature – this timer displays the elapsed time. Additionally, for each minute this feature is running a data set will be stored in memory reflecting the instantaneous conditions at that time. This will happen regardless of memory settings.

For additional information on memory options and logging data, please refer to the main Kestrel 4000 series manual.

GLOSSARY

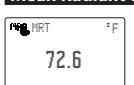
Globe Temperature



The Black Globe on the Kestrel 4400 Heat Stress Tracker is representative of the amount of heat-absorption via the color black. Typically, Globe Temperature is taken using a 6" diameter copper globe painted black with an internal thermometer. However, the Kestrel 4400 Heat Stress Tracker uses a 1" copper globe painted black for its calculations. Globe Temperature is representative of the temperature of the Black Globe itself without accounting for air temperature.

Black Globe temperature will fluctuate between, but always remain near, air temperature and Mean Radiant Temperature. This variability is due to wind speed. The faster the air moves over the globe thermometer, the closer Globe Temperature approaches air temperature. Inversely if there is zero movement of air, Globe Temperature equals Mean Radiant Temperature.

Mean Radiant Temperature

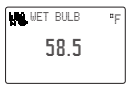


Much like Globe Temperature, the Kestrel 4400 Heat Stress Tracker defines Mean Radiant Temperature as the effects of the environment on the Black Globe. However, Mean Radiant Temperature accounts for the dry air temperature and surface temperature of the Black Globe, whereas Globe Temperature is concentrated on temperature of the Black Globe itself.

GLOSSARY (CON'T)

Mean Radiant Temperature is primarily used to define the comfort of an individual in a defined, closed space (four walls and a ceiling). It is regarded as the most important measurement governing indoors comfort.

Naturally Aspirated Wet Bulb Temperature



The Kestrel 4400 Heat Stress Tracker's Naturally Aspirated Wet Bulb Temperature function accounts for the effects of humidity on the human body. By combining relative humidity and wind speed, the temperature displayed is indicative of the evaporative cooling happening to the Kestrel 4400.

Wet Bulb Globe Temperature (WBGT)

The WBGT is a composite measurement of Naturally Aspirated Wet Bulb, Globe Temperature & Dry Bulb Temperature. This environment data combines temperature, humidity, wind speed and thermal radiation to access heat stress.

Outdoor WBGT

$$= 0.7\ T_{NWB} + 0.2\ T_G + 0.1\ T_D$$

Indoor WBGT

$$= 0.7\ T_{NWB} + 0.3\ T_G$$

Where = T_{NWB} **= Naturally Aspirated Wet Bulb Temperature**

T_G **= Globe Temperature**

T_D **= Dry Bulb Temperature**

Thermal Work Limit (TWL)

Like WBGT, TWL uses environmental measurements, including thermal radiation, to predict work limits for people exposed to heat stress. Different attributes of clothing (such as its ability to insulate and allow water vapor to pass through it) are also used to calculate TWL.

Acclimatization (Acclimatize)

Defined as the process of gradually adjusting to a change in environment (such as a change in temperature, humidity, etc). During TWL mode "Acclim" will flash when the value being displayed falls within the acclimation zone. For example, people who have not worked in such conditions should not be left alone until they have acclimated, a process requiring at least several days.

Black Globe

Typically a 6" copper sphere colored matte black with a thermometer in the center. This thermometer reads the surface temperature of the Black Globe, which indicates the radiant heat exposure of one in sunlight. The Kestrel 4400 Heat Stress Tracker uses a 1" Black Globe which is calibrated to achieve the same measurements as a 6" globe.

MAINTENANCE & SERVICES

Batteries

Kestrel Pocket Weather Trackers require 2 AAA batteries. Average battery life is 300 hours based on typical use.

For the Kestrel 4500, it is important to re-insert the shim along with the new batteries then recalibrate the digital compass to ensure correct wind direction readings.

When using the Kestrel meter in extremely cold weather, it is recommended to use lithium batteries for optimal performance.

Maintenance & Storage

To avoid scratching the window, store the Kestrel Tracker in the soft pouch and/or use the Kestrel lens cleaning kit.

Software

To download the Kestrel Communicator software, visit: www.nkhome.com/kestrel-software.

Calibrations, Certifications & Service

Every NK product is tested and calibrated before it leaves our factory. We warrant that it will perform within specifications when you receive it. The unit may be returned to NK for factory calibration, or you can contact NK for field calibration instructions (RH Calibration Kits are available on our website).

Each Kestrel Meter comes with a Certificate of Conformity, stating the specifications for that product.

If you are concerned your Kestrel is not performing within specifications upon receipt, please contact us and we will review your concerns. If necessary, we will test or recalibrate any unit within 30 days of purchase.

Beyond 30 days, we offer reasonably-priced tests, calibration services, NIST-traceable calibrations, and full Kestrel Meter tune-ups.

We offer full factory service on every product we manufacture for as long as we make the product (and as long after as component availability permits). If we cannot repair a product, we will offer you a replacement under our Loyalty Discount (even for accidental damage and misuse).

Please contact NK if you feel your product is not working properly. We can often solve product issues by phone or e-mail, saving you the time and expense of returning the unit. If we require the product to be returned, you can obtain a Return Authorization to expedite the handling of your return.

Made in the USA

made in USA

Your Kestrel Pocket Weather Meter was designed, developed and built in the USA by Nielsen-Kellerman Co. of US and imported components. We are a lean manufacturing enterprise committed to continuous improvement of our products, processes, people and partners. We strive to conduct our business in a sustainable manner and minimize harm to the environment by actively implementing company-wide plans to conserve energy, reduce waste, and recycle.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

RoHS COMPLIANT

5-YEAR LIMITED PRODUCT WARRANTY

WARRANTY CERTIFICATE

Your Kestrel Pocket Weather Meter is warrantied to be free of defects in materials and workmanship for a period of FIVE YEARS from the date of its first consumer purchase. NK will repair or replace any defective meter or part when notified within the warranty period, and will return the meter via domestic ground shipping or NK's choice of method of international shipping at no charge. The following are excluded from warranty coverage: damage due to improper use or neglect (including corrosion); damage caused by severe or excessive impact, crushing or mechanical harm; modifications or attempted repairs by someone other than an authorized NK repair agent; impeller failure not caused by a manufacturing defect; normal usage wear; failed batteries; and accuracy issues resolvable by recalibration. If no warranty registration or proof of purchase is provided, the warranty period will be measured from the meter's date of manufacture.

Except for the warranties set forth herein, NK disclaims all other warranties, expressed, implied or statutory, including, but not limited to, the implied warranties of merchantability or fitness for a particular purpose. Any implied warranties that may be imposed by applicable law are limited to the term of this warranty. In no event shall NK be liable for any incidental, special or consequential damages, including, but not limited to, loss of business, loss of profits, loss of data or use, whether in an action in contract or tort or based on a warranty, arising out of or in connection with the use or performance of an NK product, even if NK has been advised of the possibility of such damages. You agree that repair, and (upon availability) replacement, as applicable, is your sole and exclusive remedy with respect to any breach of the NK Limited Warranty set forth herein.

All **product liability** and **warranty options** are governed exclusively by the laws of the **Commonwealth of Pennsylvania.**

FIVE-YEAR 5 WARRANTY

NOTES:

NOTES:

By NK

NIELSEN-KELLERMAN
21 Creek Circle, Boothwyn, PA 19061
Phone: (610) 447-1555
Fax: (610) 447-1577
Web: NKhome.com
Email: info@NKhome.com

made in USA

Kestrel® Pocket Weather® Meters are designed and manufactured in the USA