CASELLA
CEL

INDOOR AIR QUALITY

NOTES

CONTENTS

01 BACKGROUND & HISTORY

Regent House Circa 1920's

Finishing Shop

200 YEARS OF CASELLA HISTORY

Cesare Tagilabue established the company in Holborn, London in 1799 during the reign of George III. Within just a few years Louis Pascal Casella joined Cesare in a partnership and the new Casella name was born.

In the early years the product ranges being exported around the world included exploration, navigation, photographic, meteorological and medical research instruments. Our early customers included Charles Darwin and Dr. Livingstone.

During the 19th century, the product range continued to grow and Casella exhibited instruments including theodolites and surveying equipment at the first 'Great Exhibition' held in the Crystal Palace, Hyde Park London in 1851.

As the two World Wars of the last century raged, our expertise in optics, compasses and photogrammetry equipment was put to good use by the military. By the 1950's Casella had designed and built a significant amount of dust monitoring equipment for the deep mining industry, including a number of industry standard products.

Show Room

CEL HISTORY

CEL Instruments have been manufacturing high quality instrumentation for the measurement of noise and vibration since the early 1970's. Originally formed from the company Computer Engineering Limited, a British company specialising in the design and manufacture of computer related equipment, CEL rapidly became well known for designing state of the art noise products in the UK.

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Instrumentation
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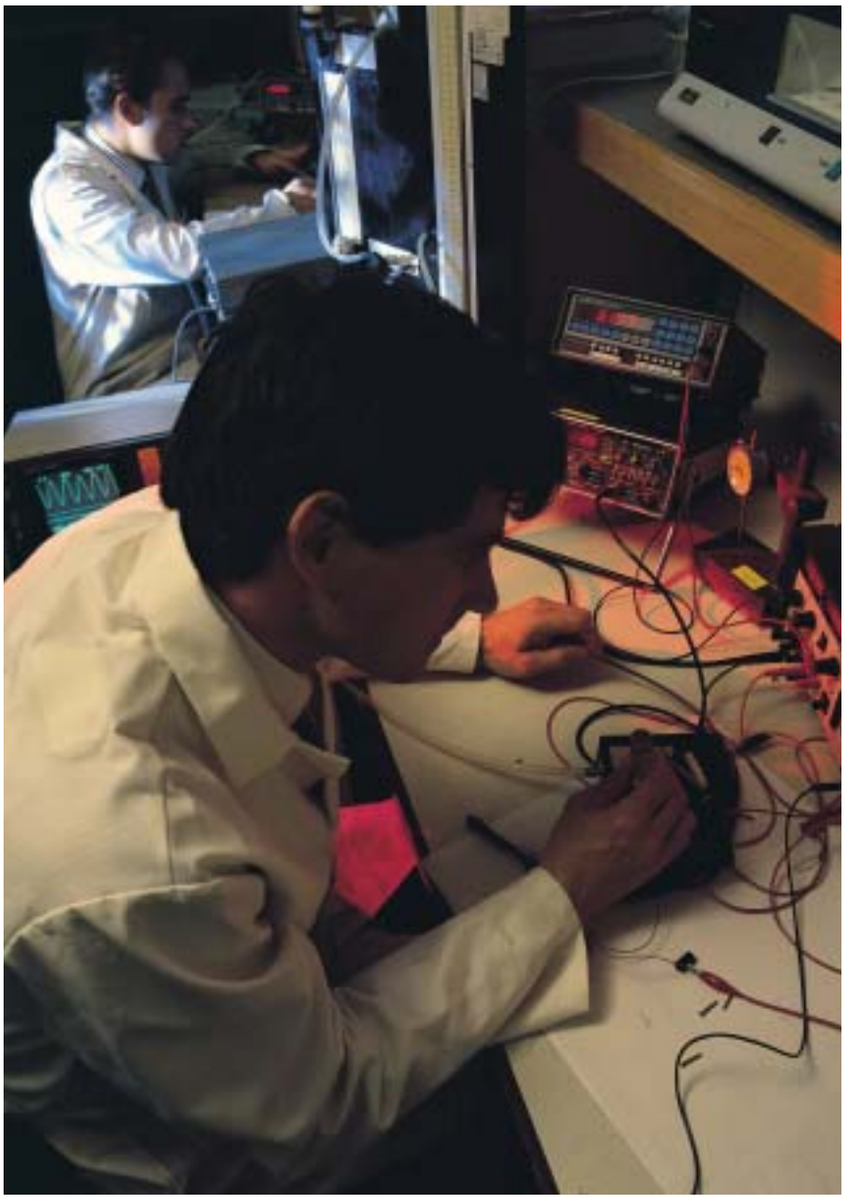

In 1998, Casella acquired CEL Instruments, manufacturers of innovative noise monitoring equipment. The natural synergy formed from this integration allows Casella CEL to offer a broader and more comprehensive product range to both the occupational and environmental market sectors.

To keep one step ahead of an ever-changing market, Casella CEL is committed to an extensive programme of ongoing research and product development. The development programme involves considerable integration with Industry and Research bodies, to ensure the utilisation of the latest techniques and technologies available. It is this commitment that has enabled us to build an impressive product portfolio, allowing us to focus on the following areas:

Air Quality

Indoor Air Quality

Professional Meteorology

Recreational Meteorology

Noise

From our modern facilities in the UK we work continuously to improve and expand our business. Our products are now exported world-wide through an extensive network of distributors and agents. With measurement division offices in both America and Spain, and with further expansion planned, this confirms Casella CEL as a truly International organisation.

Casella CEL is part of Casella Measurement - A division of the Casella Group.

‘We have a commitment to you the customer to provide a ‘total’ service, which exceeds your expectations’

MICROTHERM INDOOR AIR QUALITY

The Casella CEL Microtherm Indoor Air Quality instrument is designed to monitor and record the indoor environment of storage facilities, factories, office or general workplace environments.

The overall instrument is compact and portable, allowing it to be transported and operated by a single person. Power is supplied from the mains, re-chargeable battery pack (option) or a combination of both. The fully integrated comprehensive software enables the user to archive data and generate reports automatically.

We spend over 90% of our time indoors, therefore indoor air quality is important if we are to maintain a healthy, safe and efficient working environment. The adverse publicity, absenteeism and reduced productivity associated with Sick Building Syndrome (SBS) have focused attention on improving air quality. The current annual cost of SBS in the UK is estimated at £500 million.

By carrying out simple, regular monitoring of the thermal and gaseous environments in their workplaces using the Microtherm Indoor Air Quality unit, employers can help identify problem areas, reduce their employees' symptoms, increase productivity and morale and help comply with the relevant legislation. Other users can ensure that perishable or valuable stock is kept in optimum conditions.

Principles Of Operation

The Microtherm Indoor Air Quality unit consists of a central control and logging unit, to which a selection of probes can be attached via DIN type connectors.
Up to 11 parameters may be monitored simultaneously. Standard Sensor capabilities are:

- Temperature and % Relative Humidity (%RH)
- Air velocity
- Globe temperature (40 or 150mm)

A range of other sensors can be supplied for special monitoring applications that require the measurement of particulate and gaseous pollutants, which may be introduced into the building from internal or external sources such as vehicle emissions and tobacco smoke.

- Wet bulb temperature
- Carbon dioxide (ppm)
- Carbon monoxide (ppm)
- Ozone (ppm)
- Particulate/Aerosols
  (these very important pollutants can be monitored by connection to a Casella CEL Microdust Pro unit)
- Light Intensity
- Noise

The instrument may be configured as an integrated desk-top/local monitoring unit with the sensors and control unit combined as one assembly, or for general area monitoring with the sensors remote from the control unit and are linked together via an extension cable. The remote sensor arrangement includes a tripod to support the sensor assembly. The central unit is pre-programmed to log the inputs and store data to the internal memory (13,000 readings). A PCMCIA card option allows memory expansion to 81,000 readings. Results can also be viewed directly, via the LCD display.

In addition to recording basic sensor readings, certain calculated parameters can also be selected for recording. These parameters are calculated using the average reading for each sensor based on one-second intervals taken during the logging period. These values are calculated in accordance with the equations defined in the appropriate ISO standards.

Parameters calculated (to appropriate ISO standards)

- Predicted Mean Vote (PMV)
- Predicted Percent Dissatisfied (PPD)
- Mean Radiant Temperature (MRT)
- Wet Bulb Globe Temperature Index - WBGT (indoor and outdoor)
- Velocity Turbulence Intensity
- Draught Risk
- Relative Air Velocity

Data is then kept on board until analysed using the WinIAQ based software package.

The programme operates under a Windows™ environment (3.1 or later). All aspects and functions are easily accessed from drop-down menus and comprehensive help files are provided within the package to offer a full glossary of terms and details of the relevant legislation/standards.

Basic operating parameters of the unit are maintained in profiles that are user-defined. These include:

- Sensor Allocation:
  Which channels are activated/selected
- Parameter Selection:
  Which calculations you require
- Constant Selection:
  In order to calculate certain parameters, constants often have to be entered. These typically include what clothes are being worn (CLO values) and values of Metabolic Rate to give indication of level of manual labour involved
- Logging Interval:
  Variable between 5 - 3,600 seconds

Profiles can be recalled at any time to allow repetition of previous monitoring regimes.

Once a survey has been completed, data can be retrieved, either directly via serial port, or via modem and is then stored in data files for analysis. The application makes data collection as simple and automated as possible. Full colour graphs are automatically generated and a zoom facility allows individual time events within the sample time frame to be analysed in more detail. Tables of file data are also generated and a summary screen option displays maximum, minimum and average information. All graphs and summary reports can be readily transferred to other word processor and spreadsheet applications as bitmaps or text, via the clipboard. Data files created by the application are saved as comma delimited ASCII text. This allows files to be imported into many commercial spreadsheet

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applications. Reports can then be generated quickly and easily.

The removable PCMCIA memory card, not only increases the storage capacity of the Microtherm Indoor Air Quality unit, but also provides a convenient and reliable medium to transport the data. All information saved onto the card may be extracted either via the designated slot in the control unit or separate card reader. PCMCIA cards are therefore ideally suited to applications that require greater memory capacity for longer term monitoring. This option allows data to be viewed 'real-time' from the controller onto a PC monitor screen; an ideal feature for the commissioning of new buildings.

Features

- Robust, small, lightweight unit
- User-configured to suit application
- Integral (desk-top) or remote sensing
- Calculates to appropriate ISO standard parameters
- Comprehensive sensor range
- Direct reading of parameters
- Versatile analysis software
- Battery back-up for data storage
- Modem operation feature
- PCMCIA memory expansion option

Applications

- Indoor air quality studies
- Thermal comfort analyses
- New building commissioning
- Storage of goods/produce monitoring
- Assessment of HVAC efficiency
- COSHH surveys in the workplace
- Building energy management
- Theatre/exhibitions and conference venues
- Life sciences research
- Schools, colleges and Universities

Applicable Standards

BS 1339	Definitions, formulae and constants relating to humidity of the air
BS EN60751	Platinum Resistance Thermometer (PRT) sensors
BS EN8207	Energy efficiency in buildings
ISO 7243	Hot environment WBGT index
BS EN7730	Moderate thermal environments
ISO 7726	Hot thermal environments
ISO/DIN 9920	Ergonomics of the thermal environment 1974

Health and Safety at Work Regulations (UK)1992

Workplace (HSW) Regulations (UK) 1994

Control of Substances Hazardous to Health Regulations (UK)

Specification	MICROTHERM INDOOR AIR QUALITY
Control and display panel	32 character, backlit LCD with 5 key operation
Data storage	Maximum 13000 readings on internal memory
	Expandable to 81000 readings with 256k PCMCIA card
Recording interval	1 second increments from 5 to 3600 seconds
Outputs	a) 9-way D type socket for RS232 communication
	b) 25-way D type socket for parallel data link to sensor hub
	c) 6-way DIN socket for external alarm
	d) Two jack sockets for external power
Power supply	Mains or external battery pack
Weight	2.1kg- control unit
	3.2kg- control unit and sensor array
	5.7kg- control unit and sensor array mounted on tripod
Size	275 x 250 x 75mm-control unit
	380 x 400 x 430mm-control unit and sensor array

Ordering Information

Microtherm Indoor Air Quality kit including:	141110D

Control unit, control software, power supply, air velocity, 40mm black globe, temperature and relative humidity sensors, tripod, interconnections, instruction manual and attaché style carrying case

Accessories and Spares

Natural wet sensor	141004C
150mm black globe attachment	100940A
MICRODUST attachments/interconnections	141182A
Carbon monoxide sensor	141150C
Ozone sensor	141152C
Interconnections box (used if both CO and O_3 required)	141168B
Carbon dioxide sensor	141026D
Battery pack and charger	141154C
Card reader	-MCI1
PCMCIA card	-CMC29
WIN IAQ Software	141211A

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MICROTHERM HEAT STRESS WBGT

The Microtherm WBGT from Casella CEL is an ergonomically designed, compact, and rugged instrument designed to monitor heat stress potential of personnel in hot working environments in accordance with ISO 7243.

It is the first heat stress meter that offers real-time graphical display of data and also features an audible/visual alarm which allows the operator to make rapid decisions if required. PC software for retrospective data analysis is included.

What is Heat Stress?

Workers exposed to hot working environments can be 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.

An overall estimation of heat stress levels on the body can be measured by utilising the Wet Bulb Globe Temperature Index (WBGT). This combines the measurement of three parameters; natural wet bulb temperature (tnw), globe temperature (tg) and air temperature (ta), applied to the following formulae for both indoor and outdoor environments:

WBGT (Indoor) = 0.7tnw + 0.3tg

WBGT (outdoor) = 0.7tnw+ 0.2tg + 0.1ta.

The data collected for these values are compared to reference values (as defined by the standard and appropriate “work rest” regimes) can then be adopted in the work place or more detailed medical analysis undertaken.

Features

- Large LCD graphics display
- Real time display
- Full data-logging facilities as standard
- Low water level warning
- Audible / visual alarm for WBGT levels
- %RH and dewpoint calculation
- Automatic calculation of work rest regimes via PC software
- Tripod mounting for meter and remote sensor array
- Ergonomic design
- Long battery life
- 10M extension cables available
- PC software included
- Meets requirements of ISO 7243

Applications

- Power Stations
- Foundries
- Steel works
- Bakeries
- Glass manufacturing
- Routine monitoring
- Medical Surveillance testing

Operation

The WBGT meter measures simultaneously from three PRTD sensors for Wet Bulb, Dry Bulb and Globe Temperatures. Sensors are manufactured to high accuracy standards: BS EN60751 and DIN 43760.

Processed data values include:
WBGT (indoor and outdoor)
1 Hour (TWA) WBGT values
Relative Humidity (%)
Dewpoint

Sensors can be used either attached directly on the body of the unit (figure 1), or remotely via 10m extension cables (figure 2). Both the electronic unit and sensor array can be tripod mounted (tripod not included).

Display

The Microtherm WBGT incorporates a large 128 x 64 pixel graphics LCD with backlight, capable of displaying data in two modes;

- Graphical Representation

  The Microtherm WBGT is the first area heat stress instrument to offer a real-time scrolling graph of the temperature parameters being measured.

  This display can be shown over variable time bases of 15, 30, 60 & 120 minutes. This allows the user to assess how the environment is changing over time, without having to download to a PC.

- Numerical Values

  Instantaneous values for all parameters are displayed, combined with the hourly rolling average values.

figure 1

figure 2

Sensor array

Alarm

An adjustable alarm threshold may be defined for one selected data channel: WBGTtwa, WBGT, Ta or OFF.

An audible alarm and flashing visual message on the display screen provides warning of excedence of the threshold.

Graphical Display

Numerical Real-Time Display

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Simple Keypad Operation

The Microtherm WBGT has been designed with a simple, easy to use menu structure for the displaying of information, instrument configuration and retrieval of data. The access of this menu via the touch keypad and screen prompts, ensures ease of use for the operator.

Software

Windows 32-bit PC software package (Win HSM) provides an interface for data collection to PC for retrospective analysis. It produces graphical and tabular reports which can easily be imported into other applications. Summary and WBGT Heat Stress Index reports can also be generated.

Work rest regimes are calculated, Clothing (Clo) correction factors, and metabolic rates can be entered in accordance with OSHA and ISO 7243.

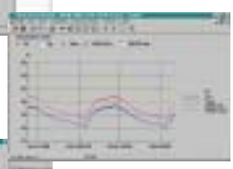
Data can also be viewed “live” by selection of the real-time option whilst connected to the PC.

Calibration

Calibration of the Microtherm WBGT is performed against an internal reference prior to every single measurement. This ensures a high accuracy for each of the temperature sensors and eliminates the need for annual recalibration.

Sensor arrays are also interchangeable without need for recalibration.

Tabular data format/ OSHA calculations



Graphical report format

ISO calculations

Specification	MICROTHERM HEAT STRESS WBGT		
Identity	Sensor specifications		
	Parameter	RANGE	ACCURACY
Ta	Air temperature	10-60˚C	+/- 1˚C
Tg	Globe temperature	20-120˚C	+/- 0.5˚C (20-50) +/-1.0˚C (50-120)
tnw	Natural wet temperature	5 to 40˚C	+/- 0.5˚C
Transducers	PRTD 100 elements 0.1% using 4 wire extension cables available in 10m, lengths up to 30m		
Displayed Data Values			
Ta	Air temperature		
Tg	Globe temperature		
Tnw	Natural wet temperature		
WBGT	Inside and Outside		
Time Weighted WBGT values	Based on a 1 hr rolling average updated every 30 seconds. (During the first hour ‘—-’ is displayed.)		
%RH	Based on”ta” and non aspirated “tnw” sensor		
Dewpoint	Based on “ta” and non aspirated “tnw” sensor		
Data Logger			
Total record capacity	512k memory providing up to 49,100 data records		
Number of runs stored	32		
Logging interval	30 seconds to 1 hour		
Software			
Operating System	MS Windows 95/98 NT compatible. RS232 serial port, 8MB RAM,FDD & HDD,VGA Graphics.		
Power			
Battery Power supply	4 x AA cells Dry cells or Ni Cd (4.8v/950mAh)		
Battery life	30hrs Nicad / 85hrs alkaline. Battery monitoring warning and auto power down. Consumption; 30mA typical		
External power supply	3.5 to 14VDC (12v nominal) 90-260vac Universal input mains power adaptor. Internal fast charge circuitry		
Communications			
RS232 / IRDA future expansion			
Applicable Standards			
ISO 7243/7726, OSHA			
Operating Temperature Range			
Sensors	-5 ˚C to +120˚C		
Electronics	-5 to +60˚C		
Dimensions	Instrument: 245 x 95 x 50mm. Array: 90H x 225 x 65mm. Sensor/carry case (H x W xD): 135 x 490 x 370mm		
Weight	Sensor/carry case 0.97kg. Instrument only 0.75kg		

Ordering Information	
MICROTHERM Heat Stress WBGT meter with kit case	180000A
MICROTHERM Heat Stress WBGT meter with kit case with calibration certificate	180042A
10M Extension Lead for sensor array	180043B
Small Tripod (max height 215mm)	CEL90330
Standard Tripod (max height 1,160mm)	CEL6713

Microtherm Heat Stress WBGT kit includes:

Microtherm Heat Stress WBGT meter
Sensor Array
Pack of spare wicks and screwdriver
Rechargeable batteries (x4)
Universal mains PSU (110/240vAC) with UK, Europe and USA plug adaptors
Distilled water countainer
RS232 communication cable
Windows Win HSM software
Hard carrying case

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THERMOHYGROGRAPHS

Thermohygrographs continuously record both the temperature and the relative humidity of the atmosphere against time by drawing coloured traces onto a chart. There are two models available; the ‘standard’ and the ‘deluxe’. The Thermohygrograph standard model is the more practical instrument and is slightly more accurate on temperature.

The deluxe model is more elegant in appearance and is generally used in public areas such as receptions, public buildings, museums and libraries. Both styles are provided with a daily/weekly/monthly quartz clock, which can be set by the user.

For additional information on measuring temperature and relative humidity using Casella CEL instruments, please see Glossary/Appendix.

Features

- Portable
- Accurate
- Easy to operate

Applications

- Museums
- Libraries
- Storage areas

Applicable Standards

BS 1339 Definitions, formulae and constants relating to the humidity of air

Application story – The National Museum of Science and Industry

Established in 1857 as the South Kensington Museum, the Science Museum in London is a major attraction to all ages of visitor interested in science, medicine, technology and industry and serves over 1.5 million visitors every year.

With such a broad diversity of priceless and often unique exhibits, many of which date back hundreds of years, artefact conservation and protection is a primary concern. Like many museums around the world, the Science Museum in London has used Casella CEL Thermohygrographs for a number of years. The temperature and humidity levels taken from these instruments, are crucial in helping to maintain the correct environment for preservation of the museum’s valuable exhibits.

For a range of Digital Hygrothermometers, please refer to section 6.

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Specification	THERMOHYGROGRAPHS
STANDARD MODEL	
Accuracy	Temperature: ±1% of full scale
	Humidity: ±3% between 20 and 80%RH
Range	Temperature, 50°C span between -10°C and +50°C (see chart range below)
	Humidity, 0 to 100%RH
Time scale	Daily: 25 hrs @ 11.25mm/hr
	Weekly: 168 hours @ 1.6mm/hr
	Monthly: 31 days @ 8mm/day
Sensitivity	1°C = 1.64mm, 1%RH = 0.82mm
Chart size	300 x 90mm
Dimensions	350 x 150 x 160mm
Weight	3.2kg
DELUXE MODEL	
Accuracy	Temperature: ±2% of full scale
	Humidity: ±3% between 20 and 80%RH
Range	Temperature: 50°C span between -10 and +50°C (see chart range below)
	Humidity: 0 - 100%RH
Time scale	Daily: 25 hrs @ 11.25mm/hr
	Weekly: 168 hours @ 1.6mm/hr
	Monthly: 31 days @ 8mm/day
Sensitivity	1°C = 1.64mm, 1%RH = 0.82mm
Chart size	300 x 90mm
Dimensions	300 x 165 x 145mm
Weight	3.62kg

Ordering Information

STANDARD MODEL	
Thermohygrograph with 2 pens each for temperature & humidity	M109014
Thermohygrograph with 2 pens each for temperature & humidity and calibration certificate	M109015
All charts must be ordered separately	
Box of 200 daily charts, 0 to +50°C, 0 to 100%RH (chart ref. no: 449)	M107404
Box of 200 daily charts, -10 to +40°C, 0 to 100%RH (chart ref. no: 450)	M107405
Box of 200 weekly charts, 0 to +50°C, 0 to 100%RH (chart ref. no: 513)	M107408
Box of 200 weekly charts, -10 to +40°C, 0 to 100%RH (chart ref. no: 514)	M107409
Box of 200 monthly charts, 0 to +50°C, 0 to 100%RH (chart ref. no: 617)	M107415
Box of 200 monthly charts, -10 to +40°C, 0 to 100%RH (chart ref. no: 613)	M107414
DELUXE MODEL	
Thermohygrograph with 2 pens each for temperature & humidity	M109016
Thermohygrograph with 2 pens each for temperature & humidity and calibration certificate	M109017
All charts must be ordered separately	
Box of 200 daily charts, 0 to 50°C, 0 to 100%RH (chart ref. no: 700)	M107301
Box of 200 daily charts, -10 to +40°C, 0 to 100%RH (chart ref. no: 705)	M107302
Box of 200 weekly charts, 0 to 50°C, 0 to 100%RH (chart ref. no: 720)	M107304
Box of 200 weekly charts, -10 to +40°C, 0 to 100%RH (chart ref. no: 725)	M107305
Box of 200 monthly charts, 0 to 50°C, 0 to 100%RH (chart ref. no: 755)	M107310
Box of 200 monthly charts, -10 to +40°C, 0 to 100%RH (chart ref. no: 750)	M107309

Accessories and Spares

STANDARD MODEL	
Black (short) temperature pens (pack of 2)	M118004
Red (long) humidity pens (pack of 2)	M119003
1.5V battery	– B131
DELUXE MODEL	
Black (short) humidity pens (pack of 2)	M118004
Red (long) temperature pens (pack of 2)	M119003
1.5V battery	– B131
For spare charts, please see ‘Ordering information’	

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Specification	WHIRLING HYGROMETER
Accuracy	Approximately 2%RH (dependent on temperature, wet bulb depression and correction of thermometer errors)
Thermometers	Scale length approx. 100mm, divided at 0.5°C increments
Range	-15 to +40°C, -5 to +50°C
Dimensions	230 x 145 x 30mm
Weight	200g

Ordering Information	
Whirling Hygrometer -5 to +50°C with simple slide rule and wick	M112022
Whirling Hygrometer -5 to +50°C with simple slide rule, wick and NAMAS calibration certificate for each thermometer	M105334

Accessories and Spares	
Leather carrying case	M112027
Plastic carrying case	M112028
Simple slide rule	M112011
Pack of 100 wicks	M112035
1 replacement thermometer -5 to +50°C	– TM5
1 replacement thermometer -5 to +50°C with NAMAS calibration certificate	M105316

WHIRLING HYGROMETER

This instrument provides a simple and effective way to measure relative humidity in air. The wet and dry bulb thermometers are held in a slotted frame which is whirled at speed around the handle to give a high and reasonably constant rate of air flow.

For additional information on the Whirling Hygrometer, please see Glossary/Appendix.

For further information on temperature and relative humidity measurement using Casella CEL instruments, please see Glossary/Appendix.

Applicable Standards

BS 2842 Specification for Whirling Hygrometer

BS 1339 Definitions, formulae and constants relating to humidity of the air

KATA THERMOMETER

This simple instrument allows accurate measurement of air velocities and the cooling power of the air. Each thermometer has a stem with just two graduations corresponding to a drop of 3°C. The thermometer is heated and then allowed to cool, noting the cooling time. The air velocity is calculated using a formula and a resulting heat loss per unit surface area can be determined. The cooling thermometer is alcohol filled with a plain or silvered bulb. Silvered bulb patterns are used to overcome heat radiation from surrounding surfaces.

GLOBE THERMOMETER

This simple instrument enables the effects of radiant heat from environmental conditions to be accurately assessed. The instrument consists of a hollow metal sphere coated on the outside with matt black paint and a thermometer fitted at the centre. Readings of radiant heat energy may be read from the graduated scale. The instrument has applications in heating and ventilation as well as factories and public health.

Technical Specifications	KATA THERMOMETER
Temperature range	38 to 35°C
Dimensions	225 x (19 x 19mm bulb cylinder only)
Weight	40g

Ordering Information	
Kata thermometer plain bulb 38 to 35°C	M112002
Kata thermometer silvered bulb 38 to 35°C	M112003

Technical Specification	GLOBE THERMOMETER	
	SMALL	LARGE
Sphere size	44mm	146mm
Divisions	0.5°C	0.5°C
Dimensions	185 x 44 x 45mm	375 x 146 x 146mm (approx.)

Ordering Information	
44mm small globe thermometer -5 to 50°C (in transparent tube)	M111008
146mm large globe thermometer 0 to 65°C (in brass tube)	100944B

Accessories and Spares	
Small thermometer -5 to +50°C	-TM5
Large thermometer 0 to +65°C	100946B

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DA30

DA40

DA40H

VANE ANEMOMETER

A comprehensive range of digital vane anemometers and hygrometers provides an accurate yet affordable way of measuring air velocity, volume flow, temperature and relative humidity in a number of different combinations. Air velocity is measured in either metres per second or feet per minute. Readings for average, maximum and minimum velocity can be displayed. Air volume is calculated by entering the size and type of duct being measured and can be displayed in either cubic metres per hour or cubic feet per minute.

Accurate temperature and relative humidity measurements are made using a Resistance Temperature Device (RTD) and capacitive-type sensors respectively. All instruments have long battery life, are compact, easy to use and are extremely reliable.

HTA4200

Specification	VANE ANEMOMETER	AIR VELOCITY PROBES
Sensor	Vane type probe head	–
Ranges	Probe 275: 0.2 - 40m/s (40 - 7800f/m)	Probe 275: 0.2 - 40m/s (40 - 7800f/m)
	Probe 100: 0.3 - 35m/s (60 - 6800f/m)	Probe 100: 0.3 - 35m/s (60 - 6800f/m)
Accuracy	±1% of reading 1 digit	+1% of reading 1 digit
Display	13 and 7mm LCD, 4 digits	–
Operating temperature	0 to 50°C	-30 to +100°C
Power supply	2 x 1.5V alkaline batteries (AA/MN1500)	–
Battery life	Approx. 300hrs	–
Dimensions	127 x 277 x 25mm	Probe 275: 70mm diameter
Weight	250g (with batteries)	Probe 100: 25mm diameter

Ordering Information

Instrument	Temperature	Air Velocity	%RH	Dew Point	Full Datalogging	Average Max. and Min.	Volume Flow	Part Number
HTA4200	■	■	■		■			V102001
DHM200	■		■	■	■			V102002
DH50	■		■	■		■		V102005
DA40T	■	■				■		V102003
DA40V		■				■	■	V102004
DA40H	■	■	■			■		V102006
DA40		■				■		V102007
DA30		■						V102008

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07 BAROMETERS AND BAROGRAPHS

1

1. ANEROID BAROMETER

The Aneroid Barometer is a robust and simple to use, wall-mounting instrument for general purpose atmospheric pressure measurement. The instrument is of traditional design set on a dark wood base. The 95mm diameter dial has scales graduated in both millibars and inches of mercury, a settable pointer and an adjustment screw are also provided. It is an ideal instrument for observing weather related pressure trends.

2. KEW PATTERN BAROMETER

This instrument is made to a British Meteorological Office specification and is the standard type of barometer used in synoptic and climatological weather stations throughout the world. It is also entirely suitable for use in any laboratory or workshop where accurate knowledge of the atmospheric pressure is required.

3. FORTIN BAROMETER

The Fortin Barometer is the most widely used technique for measuring atmospheric pressure in industrial laboratories and workshops as well as in school, college and university laboratories.

Principles Of Operation

The Kew Pattern Barometer consists of a column of mercury supported within a vertical glass tube, the top of which is evacuated and sealed. The lower end of the column fits into a cistern containing mercury. The height of the mercury column supported by atmospheric pressure is measured against a graduated scale and vernier.

2

3

Specification	KEW PATTERN BAROMETER	FORTIN BAROMETER
Effective range	870 to 1060mb	900 to 1060mb
(two ranges per instrument)	650 to 800mmHg/25.7 to 31.2inHg	670 to 800mmHg
	25.7 to 31.2inHg	
Maximum operating altitude	450m	450m
Vernier reads to	0.1mb, 0.05mmHg, 0.002inHg	0.1mb, 0.05mmHg, 0.002inHg
Thermometer range	-10 to +50˚C	-10 to +50˚C
Mercury	Triple distilled and filtered	Triple distilled and filtered
Dimensions	1070 x 65 x 65mm (1090 x 100 x 100mm barometer in case)	1090 x 90 x 90mm barometer on backboard (1250 x 165 x 165mm barometer in case)
Weight	5.89kg (7.25kg barometer in case)	3.62kg (9.5kg barometer in case)
Ordering Information		
Ordinary range, mb and mmHg scales	M101009	M101002
Ordinary range, mb and inHg scales	M101008	
Accessories and Spares		
Carrying case with rubber packings, lock, key and rope handle	M101015	
Carrying case of polished wood with glass front and sides, reflectors, lock and key		M101004

Specification	ANEROID BAROMETER
Dimensions	150 diameter x 40mm depth
Ordering Information	
Aneroid Barometer	M108010

Contact Details

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Service	Tel: +44 (0) 1234 844146	Fax: +44 (0) 1234 841490	e-mail: info@casella.co.uk

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ANEROID BAROGRAPH

Two versions of the Aneroid Barograph are available; the ‘Small Pattern’ and the ‘Display Pattern’. Both have an 8-day clock and are housed in elegant polished wood cases. The Display pattern has all round glass and an additional drawer to house spare charts.

Specification	ANEROID BAROGRAPH	
	DISPLAY PATTERN	SMALL PATTERN
Ranges	950 - 1050mb, 710 - 790mmHg, 28 - 31inHg	950 - 1050mb, 710 - 790mmHg, 28 - 31inHg
Pen travel	75mm	75mm
Sensitivity	1mb = 0.75mm, 1mmHg = 1.0mm, 1inHg = 25.4mm	1mb = 0.75mm, 1mmHg = 1.0mm, 1inHg = 25.4mm
Accuracy	±1mb	±1mb
Time scale	1.66mm/hr, 172 hours total	1.66mm/hr, 172 hours total
Clock	Spring driven, weekly	Spring driven, weekly
Dimensions	370 x 230 x 210mm	310 x 160 x 190mm
Drum size	90 x 93mm (dia)	90 x 93mm (dia)
Chart size	300 x 90mm	300 x 90mm
Weight	5.6kg	3.85kg

Ordering Information		
	DISPLAY PATTERN	SMALL PATTERN
Supplied with weekly clock and 2 pens	M110002	M110004
Supplied with weekly clock, 2 pens and calibration certificate	M110010	M110012
All charts must be ordered separately		

Accessories and Spares		
Pack of 2 pens	M118004	M118004
Box of 200 charts range 28 - 31inHg	M107701	M107701
Box of 200 charts range 950 - 1050mb	M107702	M107702
Box of 200 charts range 710 - 790mmHg	M107703	M107703

Contact Details

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Service Tel: +44 (0) 1234 844146 Fax: +44 (0) 1234 841490 e-mail: info@casella.co.uk

Absolute Humidity
Ratio of the mass of water vapour in the air to the total volume of the air (g/m3).

Acclimatisation
The ability of a body to adapt to its thermal environment.

Accuracy
The numerical difference between an instrument reading and the true value of the quantity being measured. Often expressed as limits that will not be exceeded when the instrument is used within it's stated operational conditions, i.e. ±5°C.

Actual Pressure
The atmospheric pressure at the level of measurement.

Adsorption
The collection of vapours from the atmosphere by condensation on the surface of a porous solid with a high surface area (e.g charcoal). The adsorbed material can be recovered by thermal or solvent desorption.

Advection
The horizontal transport of heat or cold, in the atmosphere, or the oceans. When a warm air mass passes over a cold land or sea surface it causes the air to cool and the water vapour held within it to condense.

Air Temperature
Typically expressed in °C, it is the temperature of the ambient air.

Air Velocity
The magnitude and direction of air flow, typically expressed in metres per second.

Ambient
The surrounding environment atmosphere.

Ambient Monitoring
The monitoring of air quality outside buildings, being representative of the air that the general (or identified) population is breathing.

Ambient Pressure
The pressure of the ambient air sometimes referred to as barometric pressure.

Ambient Temperature – ta
The average temperature of the air surrounding an instrument/sensor or experienced by the operative during the work activity. This parameter forms one of the fundamental input values for the calculation of various derived values related to heat stress.

Anemometer
An instrument for measuring the speed of wind or air.

Aneroid Capsule
A thin semi-evacuated metal capsule, which when used in a barometer deforms with changes in pressure. One end being fixed and the other moves a pen on a chart or a hand on a dial. Aneroid means without air.

Area, Effective Radiating (Ar)
The surface area of a body, that exchanges radiant energy with a radiant source, measured in m^2.

Area, Wetted (Aw)
The area of skin covered in sweat, expressed in m^2.

Asphyxia
Suffocation from a lack of oxygen. Chemical asphyxia is produced by a substance which combines with the blood's haemoglobin to reduce its capacity to transport oxygen. An example of a chemical asphyxiant is carbon monoxide.

Aspirated
Forced air flow over a sensor.

Badge Monitors
A passive sampling method which does not require the use of sampling equipment. The badges are typically used for gas/vapour monitoring and are worn by the user. The sample is collected by diffusion.

Baud Rate
Identifies the speed of serial communication in terms of bits per second.

BIOH
British Institute of Occupational Hygienists Integration of Institute of Occupational Hygienists (IOH) and the British Examing Board of Occupational Hygiene (BEBOH).

Black Globe Temperature
The temperature within a matt black, hollow sphere. It monitors the radiant temperature of the ambient air.

Body Heat Balance
The balance between the body's heat production and its loss to the environment. Expressed as H=M±C±R-E Where:
- H = Body heat content
- M = Metabolism
- C = Convective heat transfer
- R = Radiant heat exchange
- E = Evaporative heat transfer

Body Heat Storage
The change in heat content of the body, either + or -.

Boiling Point
The temperature when a liquid transforms to a gas. For example water boils at 100°C at sea level.

Bronchiole
The finest of the lung's bronchi leading to the alveoli.

BSI
British Standards Institution

Carbon Dioxide
A colourless, odourless, un-reactive gas commonly produced by combustion and decay. It is also an asphyxiant. Formed when carbon is burned in a limited supply of oxygen, resulting in incomplete combustion. It is tasteless, odourless, colourless and extremely toxic.

Carcinogenic
A substance which is able to cause cancer.

CE
A mark to identify conformity to European Standards.

Celsius
Temperature scale where the ice point of water is 0°C and the boiling point of water is 100°C at sea level.

Communication Port (Comms Port)
A serial or parallel connection used to input/output information from a computer or a piece of hardware.

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.

Convection
The process of heat flow and transfer that involves the movement of the medium itself. For example if a liquid is heated from below, the lower part gets warmer and as a result expands. The warmer liquid is now less dense and therefore rises, to be replaced by the cooler liquid from above. This is in turn heated and the cycle continues.

Convective Heat Transfer (C)
The net heat exchange between a body and its environment.

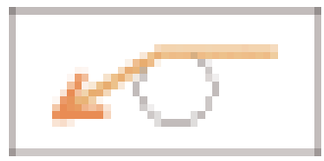
Convective Heat Transfer Coefficient (Hc)
The rate of heat transfer between a body and the ambient air per m^2 of skin exposed, expressed as kcal, Btu, or W.

COSHH
Control Of Substances Hazardous to Health Regulations – UK legislation first implemented in 1989, requiring a suitable and sufficient assessment of both the risk of exposure to hazardous substances in the workplace and what measures may be required to control exposure.

Dew
The formation of moisture droplets on or near the ground. Occurs when an object's temperature has fallen below the dew point temperature of the surrounding air.

Dew Point
The temperature at which the water vapour in the air first starts to condense, typically expressed in °C.

Diffraction
Radiation being bent or curved from its original course; for example light being bent as it passes through a narrow slit.



Diffuse Sound Field
A sound field which in a given region has statistically uniform energy density, for which the directions of propagation at any point are randomly distributed.

Diffusion
Movement of matter from a high concentration to a low concentration.

Display Screen Equipment (DSE)
Any graphical or alphanumeric display screen including visual display units (VDU's), microfiche and production control panels.

Draught Risk
Predicts the percentage of people dissatisfied due the Draught sensation. Function of the air temperature, average air velocity and the turbulence intensity.

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Dust
Solid particles, usually produced by a mechanical process, with a range of particle diameters from 0.1µm up to a maximum of 100µm. Dust can also include fumes, which condense from the vapour state, usually from volatilisation of molten metals, high boiling liquids or combustion.

EH
Environmental Hygiene (HSE Guidance Notes)

EN
European standard prefix.

Evaporative Heat Loss (-E)
Heat loss from the body caused by evaporation of sweat from the skin, expressed as kcal, Btu, or W.

Evaporative Heat Transfer (E)
Rate of heat loss by evaporation from the skin or gain by condensation of water on the skin, expressed as kcal, Btu, or W.

Evaporative Heat Transfer Coefficient (h_e)
The rate of heat exchange by evaporation between the body surface and the ambient air as a function of the vapour pressure difference between the two and the air velocity.

Fahrenheit
Temperature scale where the ice point of water is 32°F and the boiling point of water is 212°F at sea level.

Freezing Point
The temperature at which a substance turns from its liquid phase to its solid phase.

Heat Capacity
The ability of a substance to store heat. Defined as the mass multiplied by the specific heat of a body.

Heat Content of a Body
The body mass multiplied by the average specific heat and the absolute mean body temperature.

Heat Cramp
A heat related problem characterised by contractions of the voluntary muscles, usually as the result of restricted salt intake and profuse sweating without significant dehydration.

Heat Exhaustion
A heat related illness characterised by muscular weakness, distress, nausea, vomiting, dizziness, pale clammy skin, and fainting. Associated with lack of heat acclimatisation, poor physical fitness, poor health and an inadequate water intake.

Heat Stress
Physiological strain caused by an increase in core body temperature.
The human body maintains its core temperature at 37ºC over a wide range of conditions by thermo-regulatory means. This equilibrium is affected by:

- Metabolic heat generation
- Evaporation (rate determined by RH%, air velocity, and clothing)
- Convection (if ambient >37°C then body gains heat)
- Radiation
- Conduction

In hot environments heat loss by radiation/convection will be limited and core temperature will rise. Greater heat stress = higher physiological strain.

Heat Stress Index (H.S.I.)
Uses two estimated quantities from environmental and metabolic rate data:

- The required evaporative heat loss by sweating to achieve heat balance (Ereq)
- The maximum evaporative heat loss possible in that environment (Emax)

The ratio of Ereq to Emax is calculated and then related to allowable exposure time.

If Ereq is less than or equal to Emax then the worker can continue to work in that environment without any ill effects.

If Ereq is greater than Emax then heat will build up in the body, therefore limiting the working time allowed in that environment. This is based upon a maximum allowable increase in heat load in the body.

Measurement required:

- Globe temperature
- Air temperature
- Wet-bulb temperature
- Air velocity
- Metabolic work rate

There are several heat stress indices, the choice of which one to use is based upon the clothing indices.

Work rates and clothing indices can be found in the TABLES section of the Glossary.

Heat-Stroke
Medical condition arising from exposure to heat causing an excessive rise in body temperature and a failure of the heat regulating mechanism. Characterised by a sudden and sustained loss of consciousness preceded by vertigo, nausea, headache, cerebral dysfunction, bizarre behaviour, and body temperatures in excess of 41.1°C.

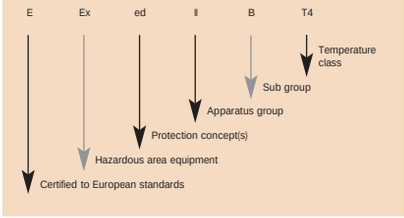
There is a numeric value ranging from 0 to 100, which indicates the heat load on the operative.

Hyperpyrexia
A body core temperature exceeding 40°C (104°F).

Intrinsically Safe (I.S.)
An instrument that will not cause ignition in a specified gas mixture under specific conditions, i.e. can be used in potentially flammable areas subject to individual instrument compliance.

Certification code

Intrinsic safety approval by a European agency.



New ATEX standard certification code to be introduced 2003.

Listed as intrinsically safe by Underwriters Laboratories for use in hazardous locations: Class I, Groups A, B, C, D; Class II Groups E, F, G; and Class III

LUX
The luminescence per square meter, of surface area.

Natural Wet-Bulb Temperature
A temperature sensor covered with a wet wick that measures the cooling effect due to evaporation in ambient air conditions.

NIOSH
National Institute of Occupational Safety and Health – USA.

Occupational Hygiene
The science associated with the anticipation and recognition of workplace hazards and the evaluation and control of subsequent risks to health.

OEL
Occupational Exposure Limits
In the UK, the limits are defined in the HSE's guidance EH40. The limits are in two groups, Table 1 lists Maximum Exposure Limits (MEL) and Table 2 lists Occupational Exposure Standards (OES).

Maximum Exposure Limits
These are statutory limits that should not normally be exceeded. In addition, all efforts should be made to reduce the exposure, as far below the MEL as is reasonably practicable by means other than respiratory protection. These limits apply particularly to substances that are known to be carcinogenic or are respiratory sensitisers, for example.

Occupational Exposure Standards
These are applied to all other materials and, in general, exposures below the standard would be regarded as demonstrating adequate compliance with the statutory requirements. Occasional exposures above the standard would not necessarily be regarded as unacceptable if the reasons for the excursion had been identified and steps were being taken to rectify the situation.

For each material, exposure limits are expressed as an 8-hour time weighted average (TWA) and as a 15-minute short-term exposure limit (STEL). If no STEL is quoted then a level of three times the 8 hour TWA may be assumed but the total duration of excursions above the TWA should not exceed one hour in any 24 hour period.

Omnidirectional Microphone
A microphone for which the sensitivity is largely independent of the direction of sound incidence.

Ozone
Under certain conditions three oxygen atoms combine to form Ozone (O3). It is a highly reactive and toxic gas produced, for example, near electrical equipment containing high voltages.

Parameter
A measured or calculated value.

Particulate
- Aerosol – Liquid or solid particles suspended in air
- Mist or Fog – Liquid aerosol, fog is made up of larger particles than mist
- Dust – Solid particles in the air, produced by an abrasive or mechanical action
- Fumes – Solid particles formed by condensation after volatilisation of welding or flame cutting
- Smokes – Similar size to fumes, produced during combustion

Passive Sampling
Air sampling without the aid of a sample pump. Typically employs diffusion tubes.

PCMCIA
Personal Computer Memory Card International Association. A card interface system, e.g. networks, modems.

Personal Sampling
Occupational sampling of airborne pollutants with sampling equipment worn by the operator. The sample head or collection device must be within the operator's breathing zone (OBZ) which is usually defined as within 200mm of the mouth or nose. For occupational Hygiene purposes, personal sampling is regarded as the normal procedure unless static samples can be shown to be representative of individual exposures.

Photometer/Nephelometer
Optical measurement device based upon the scattering effect of light by particulate. Under clean air conditions all light is prevented from reaching the receiver by a light stop. When dust particles enter the sample volume, the light beam is scattered forward within a narrow angle to the receiver.

The particles scatter the beam by reflection, refraction, and diffraction.

PM_{10}
Particulate matter having a mean aerodynamic diameter of 10 microns, usually relates to ambient particulate monitoring.

PPB
Parts Per Billion

PPM
Parts Per Million

Predicted Mean Vote (PMV)
PMV index predicts the mean value of the thermal votes of a large group of people exposed to the same environment. The index is used to predict the number of people likely to feel uncomfortably warm or cool. It is scaled from -3 to +3, with -3 being cold, +3 being hot and 0 being thermally comfortable.

Predicted Percentage Dissatisfied (PPD)
A qualitative prediction of the number of thermally dissatisfied people for a given steady state condition. The PPD predicts the percentage of a large group of people likely to feel thermally uncomfortable.
See Thermal environment – section 4

Pressure (P), hPa, mb.
Barometric pressure is concerned with measuring the weight of air above the measuring device. Typically, high pressure is associated with good weather and low pressure is associated with poor weather.

Measurement is generally related to a common datum point i.e. mean sea level = QNH, runway elevation = QFE.

Pressure, Atmospheric (p_a)
Pressure exerted by the weight of the air, it is 760mmHg at sea level and decreases with altitude and increases with depth

Pressure Drop (Back Pressure)
The differential pressure across a restriction, such as a filter; normally measured in cm of H_2O.

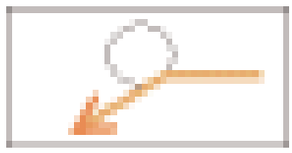
Psychrometer
An aspirated instrument used to measure the water vapour content of the air. Uses a wet bulb and dry bulb thermometer.
See Humidity Measurement – section 2

Radiant Heat Exchange (R)
Heat exchange by two radiant surfaces at different temperatures.

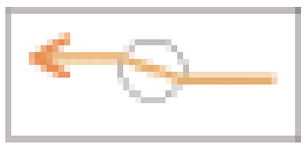
Radiant Heat Transfer Coefficient (h_r)
The rate of heat transfer between two black surfaces, per unit temperature difference.

Radiation – Solar
- Net Radiation – The difference between incoming and outgoing total radiation
- Net Solar Radiation – The difference between solar radiation directed downward and upward
- Solar Radiation – Total electromagnetic radiation emitted by the sun
- Global Radiation – The total of direct solar radiation and diffuse sky radiation received by a units horizontal surface
- Diffuse Solar Radiation – Downward scattered and reflected solar radiation, coming from the whole hemisphere with the exception of the solid angle of the suns disc on a surface perpendicular to the axis of this cone
- Direct Solar Radiation – Radiation coming from the solid angle of the suns disk, opposed to radiation from any other source
- Reflected Solar Radiation – Upward directed solar radiation, reflected by the earth's surface and the atmosphere
- Scattered Radiation – Solar radiation that is scattered by particles in the atmosphere
- Spectral Solar Radiation – Solar radiation of selected wavelengths
- Total Radiation – The sum of Solar and Terrestrial radiation
- Terrestrial Radiation – Total infra-red radiation emitted from the Earth's surface

Reflection
Relates to radiation changing its course after a collision with the surface of an object.



Refraction
The bending effect of light or waves as they pass through a medium of a different density.



Relative Humidity (%RH or U)
This term is the ratio between the partial pressure of water vapour and the water vapour saturation pressure. This value is often expressed as a percentage.

Response Time
The time it takes an instrument to register a designated percentage (usually 90%) of a step change in the variable being measured.

Sick Building Syndrome (SBS)
A widespread occupational health concern that is most commonly associated with air-conditioned buildings. Symptoms are varied but will usually include irritated eyes, nose and throat, headaches and lethargy.

Silicosis
A lung disease caused by excessive inhalation of crystalline silica dust.

Statistical Analysis
The classification of the magnitudes of sound levels into a statistical cumulative distribution from which various statistical levels can be derived.

Statistical Level
A notional sound level value corresponding to a value in the cumulative frequency distribution usually expressed as a percentage of all the classified data points.

Temperature (T)°C
The degree or intensity of heat of a body in relation to others.

Temperature, Core (t_{cr})
Temperature of the tissues and organs of the body, sometimes called Deep Body Temperature.

Thermal Strain
The sum of the physiological responses of an individual to the environmental and metabolic heat load imposed on them.

Thermohygrograph
Device for recording temperature and humidity onto a chart.

Charts available:
- Daily
- Weekly
- Monthly

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Turbulence Intensity
Expressed as a percentage and is calculated from the ratio of the standard deviation to the average measured air flow.

WBGT/I and WBGT/O
The wet bulb globe temperature is an index of the mean temperature effect in °C on a person during a period of time in which they are active. When core temp >38.5°C symptoms begin to appear. Changes can be rapid so workers should be supervised – reduction in work rate is the first sign.

Health and Safety at Work regulations stipulate that employers must reduce risk to employees and external contractors on site to conditions that could cause heat stress. Initially developed by the U.S. Marines, it is now used worldwide. The method is standardised in ISO 7243.

It is an empirical index based on analysis of heat exchange between man and the environment. Transducers have to respond to and measure the same factors as a human being:

- Ambient air temp
- Air movement
- Relative humidity
- Radiant heat

Wet Bulb Depression
The difference between the wet and the dry bulb temperatures of a hygrometer.

Wind
- Anabatic wind – An up-slope wind due to local surface heating, opposite of katabatic wind
- Backing – A change in wind direction in a counter clockwise movement, opposite of veering
- Cross wind– Wind speed perpendicular to a given reference heading, for example a runway heading
- Downdraft – A relatively small scale downward moving current of air.
- Downwind – The direction to which the wind is blowing
- Foehn – A warm, dry wind on the lee side of a mountain range, caused by adiabatic compression on descent
- Gravity wind– A wind directed down a slope caused by a greater air density near the slope than at the same level some distance horizontally from the slope. Sometimes called a Katabatic wind
- Gust – Sudden brief increase in the speed of the wind, followed by a lull
- Head wind – Wind blowing in the opposite direction to the heading of a moving object
- Katabatic wind – Any wind blowing down an incline, if warm it is foehn, if cold it is a gravity wind
- Leeward – Side facing away from the wind
- Local level wind sheer – A local variation in the wind direction or speed, i.e. changes from a head wind to a tail wind
- Lull – A momentary decrease in the speed of the wind
- Monsoon – Seasonal wind with a persistent direction, pronounced change in direction between seasons
- Tail wind – A wind blowing in the same direction as a moving object
- Upwind – In the direction from which the wind is blowing
- Veering – A change in wind direction in a clockwise movement, the opposite of backing
- Wind sheer – Local variation of any kind of wind vector
- Windward – Side facing the wind

Wind Velocity
A vector which includes both the wind speed and direction.

09 APPENDIX

WBGT – 1 – Effects

- Greater heat stress – greater cardiovascular demands and physiological stress
- Burns – caused by direct contact
- Swelling of joints and heat rash
- Fainting – due to reduction in blood pressure to brain
- Muscle cramps
- Nausea, Vomiting – due to salt depletion

2 Heat Exposure, Threshold Limit Values

Higher heat exposures than shown on Table 1 are permissible if the workers have been undergoing medical surveillance and it has been established that they are more tolerant to work in heat than the average worker. Workers should not be permitted to continue their work when their deep body temperature exceeds 38°C.

Permissible Heat Exposure Threshold Limit Values
(values are given in °C W.B.G.T.)

Work Regimen	Work Load		
	Light	Moderate	Heavy
Continuous Work	30.0	27.7	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, Each Hour	32.2	31.1	30.0

3 Calculations

Indoor W.B.G.T.
(without direct solar load) = 0.7 Natural wet bulb (tnw) + 0.3 Globe temp (tg).

Outdoor W.B.G.T. (solar load) =
0.7 tnw + 0.2 tg + 0.1 Air temp (ta)

In direct sunlight black globe over estimates influence of sun so air temp is used.

Heat Stress Index – 1 Work Rates

Activity	Metabolic Rate (W/m^2)
Sitting	10
Standing	25
Walking (4km/hr)	110
Standing: light hand-work	65-130
Standing: heavy arm-work	130-200
Work with whole body	>260

2 Clothing Indices

Clothing	Clothing index
Nude	0
Shorts-only	0.06
Shorts, open-necked short-sleeved shirt, socks and sandals	0.25
Light summer clothing	0.25
Business suit	0.6
Polar weather suit	3-4

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DEW POINT

The following formulae may be used to derive Humidity and Dew point values based upon measured wet and dry temperatures.

The saturated vapour pressures are calculated using the MAGNUS formula (Ref. BS 1339: 1981-Definitions, formulae and constants relating to the humidity of air)

$$\log_{10} e_w = \frac{GT_w}{H + T_w} + I$$

Where:

e_w is the saturation vapour pressure of the air (mb).

T_w is the air temperature (°C).

The remaining constants can have different values depending on the temperature of the wet sensor. If the sensor is below 0°C then it is deemed to be 'Over Ice' else 'Over Water'.

	Over Water	Over Ice
G	7.5	9.5
H	237.3	265.5
I	0.78571	0.78571

The actual Vapour pressure (Regnault and August and Apjohn) is calculated as:

$$e = e_{s(w)} - A \times P (td - tw)$$

Where es(w) is the saturated vapour pressure based on the wet bulb temperature (calculated using the Magnus formula), 'A' is the Ventilation constant and is chosen to suit the instrument type and ventilation rate of the wet sensor.

For unventilated screen type instruments, typically $A=7.99 \times 10^{-4}$

For aspirated instruments with a ventilation rate of about 3m/s, typically $A= 6.67 \times 10^{-4}$

'P' is the air pressure measured in mb, usually this is considered to be a mean value of 1000mb.

Humidity is calculated according to:

$$RH\% = \frac{e}{e_{s(t)}} \times 100$$

Where 'e' is the vapour pressure and '$e_{s(t)}$' is the saturated vapour pressure calculated using the Magnus equation for the dry bulb temperature.

Dew Point

The Magnus formula is used to evaluate the dew point temperature assuming a saturated vapour pressure equal to the actual vapour pressure:

$$\log_{10} e_w = \frac{GT_{dew}}{H + T_{dew}} + I$$

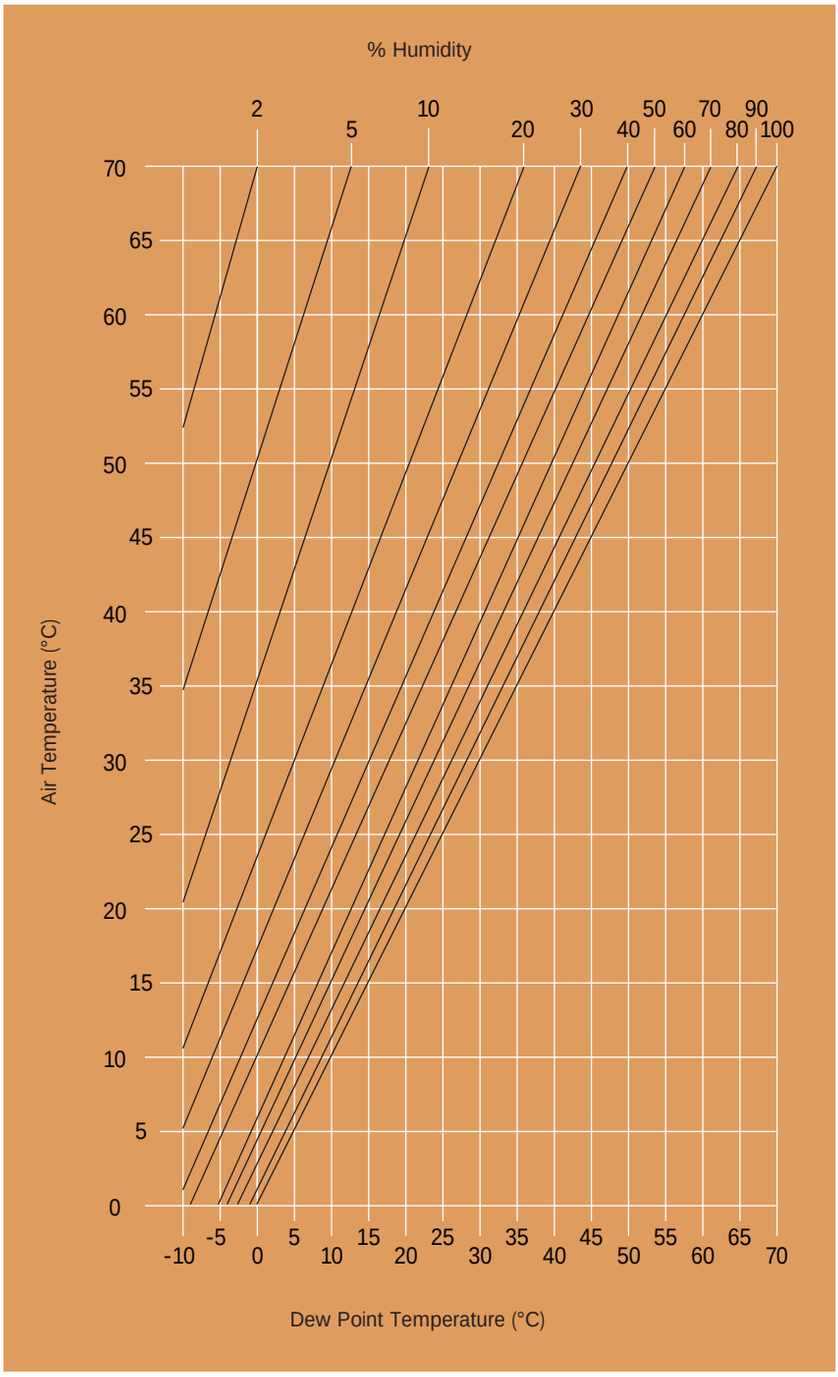
$$\text{DEW Pt°C} = \frac{[\text{LOG10 (Vapour)} \times 237.3] - 186.44898}{[8.2857 - \text{Log10 (Vapour)}]}$$

The dew point can also be calculated by using the following graph. After measuring air temp and relative humidity, draw a horizontal line from the air temperature on the y-axis to the appropriate humidity line and then a vertical line down to the dew point temperature.

Temperature Conversions

Fahrenheit to Celsius tC = 5/9 (tF – 32)

Celsius to Fahrenheit tF = 1.8 tC + 32



NON ASPIRATED HYGROMETER

Depression of Wet Bulb°C

Dry Bulb Reading°C	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5
0	90	81	71	61	52	44	34	25	16	7																									
1	90	81	73	64	55	47	38	29	20	13	4																								
2	91	82	73	64	57	49	41	33	24	17	9	1																							
3	91	83	74	65	57	49	43	36	28	21	14	7																							
4	92	83	75	67	59	51	43	35	32	25	18	11	4																						
5	92	84	76	68	61	53	46	38	31	24	21	15	8	2																					
6	92	85	77	70	62	55	48	41	34	27	20	14	12	6																					
7	93	85	78	71	64	57	50	44	37	30	24	17	11	5																					
8	93	86	79	72	64	59	52	46	39	33	27	21	15	9	3																				
9	93	86	80	73	67	60	54	48	42	36	30	24	18	12	7	1																			
10	93	87	81	74	68	62	56	50	44	38	33	27	21	16	10	5																			
11	94	87	81	75	69	63	58	52	46	41	35	30	24	19	14	9	4																		
12	94	88	82	76	70	65	59	54	48	43	37	32	27	22	17	12	7	2																	
13	94	88	83	77	71	66	60	55	50	45	40	35	30	25	20	15	11	6	1																
14	94	89	83	78	72	67	62	57	52	47	42	37	32	27	23	18	14	9	6	1															
15	94	89	84	78	73	68	63	58	53	48	42	39	34	30	25	21	17	12	8	4															
16	95	89	84	79	74	69	64	59	55	50	43	41	37	32	28	24	19	15	11	7	3														
17	95	90	85	80	75	70	65	61	56	52	47	43	39	34	30	26	22	18	14	10	6	3													
18	95	90	85	80	76	71	66	62	57	53	49	45	40	36	32	28	24	21	17	13	9	6	2												
19	95	90	86	81	76	72	67	63	59	54	50	46	42	38	34	30	27	23	19	16	12	9	5	2											
20	95	91	86	81	77	73	68	64	60	56	52	48	44	40	36	32	29	25	22	18	15	11	8	5	1										
21	95	91	86	82	78	73	69	65	61	57	53	49	45	42	38	34	31	27	24	20	14	14	11	7	4	1									
22	95	91	87	82	78	74	70	66	62	58	54	50	47	43	40	36	33	29	26	23	19	16	13	10	7	4	1								
23	96	91	87	83	79	75	71	67	63	59	55	52	48	45	41	38	34	31	28	25	21	18	15	12	9	6	4	1							
24	96	91	87	83	79	75	71	68	64	60	57	53	49	46	43	39	36	33	30	27	24	20	18	15	12	9	6	3	1						
25	96	92	88	84	80	76	72	68	65	61	58	54	51	47	44	41	38	35	31	28	25	22	20	17	14	11	9	6	3	1					
26	96	92	88	84	80	76	73	69	66	62	59	55	52	49	45	42	39	36	33	30	27	24	22	19	16	13	11	8	6	3	1				
27	96	92	88	84	81	77	73	70	66	63	59	56	53	50	47	44	41	38	35	32	29	26	23	21	18	15	13	10	8	5	3	1			
28	96	92	88	85	81	77	74	70	67	64	60	57	54	51	48	45	42	39	36	33	31	28	25	23	20	17	15	12	10	8	5	3	1		
29	96	92	89	85	81	78	74	71	68	64	61	58	55	52	49	46	43	40	37	35	32	29	27	24	22	19	17	14	12	10	7	5	3	1	
30	96	93	89	85	82	78	75	72	68	65	62	59	56	53	50	47	44	42	39	36	33	31	28	26	23	21	19	16	14	12	9	7	5	3	1
31	96	93	89	86	82	79	75	72	69	66	63	60	57	54	51	48	45	43	40	37	35	32	30	27	25	23	20	18	16	14	11	9	7	5	3
32	96	93	89	86	82	79	76	73	70	67	64	61	58	55	52	49	46	44	41	39	36	34	31	29	26	24	22	20	17	15	13	11	9	7	5
33	96	93	89	86	83	80	76	73	70	67	64	61	58	56	53	50	47	45	42	40	37	35	33	30	28	26	23	21	19	17	15	13	11	9	7
34	96	93	89	86	83	80	77	74	71	68	65	62	59	56	54	51	48	46	43	41	39	36	34	32	29	27	25	23	21	19	17	15	13	11	9
35	96	93	90	87	83	80	77	74	71	68	65	63	60	57	55	52	49	47	44	42	40	37	35	33	31	28	26	24	22	20	18	16	14	12	11
36	96	93	90	87	84	81	78	75	72	69	66	63	61	58	55	53	50	48	45	43	41	38	36	34	32	30	28	26	24	22	20	18	16	14	12
37	96	93	90	87	84	81	78	75	72	69	66	64	61	59	56	54	51	49	46	44	42	39	37	35	33	31	29	27	25	23	21	19	17	15	14
38	96	94	90	87	84	81	78	75	73	70	67	64	62	59	57	54	52	50	47	45	43	40	38	36	34	32	30	28	26	24	22	20	19	17	15
39	96	94	90	87	85	82	79	76	73	70	68	65	62	60	57	55	53	50	48	46	44	41	39	37	35	33	31	29	27	25	24	22	20	18	17
40	96	94	91	88	85	82	79	76	74	71	69	66	63	61	58	56	53	51	49	47	44	42	40	38	36	34	32	30	28	27	25	23	21	20	18
41	96	94	91	88	85	82	79	76	74	71	70	66	64	61	59	56	54	52	50	47	45	43	41	39	37	35	33	31	29	28	26	24	22	21	19
42	97	94	91	88	85	82	80	77	75	72	70	67	65	62	60	57	55	53	50	48	46	44	42	40	38	36	34	32	31	29	27	25	24	22	20
43	97	94	91	88	86	83	80	77	75	72	71	67	65	62	61	58	55	53	51	49	47	45	43	41	39	37	35	33	32	30	28	26	25	23	21
44	97	94	91	88	86	83	80	78	75	72	71	67	65	63	61	58	56	54	52	50	47	46	44	42	40	38	36	34	32	31	29	27	26	24	23
45	97	94	91	89	86	83	80	78	76	73	71	68	66	63	62	59	57	54	52	50	48	46	44	42	41	39	37	35	33	32	30	28	27	25	24

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Pressure Conversion Table

	PSI	in H_2O	in Hg	h Pascal hPa	Millibar mb	cm H_2O	mm Hg
PSI	1.000	27.680	2.036	68.947	68.947	70.308	51.715
in H_2O	3.61247×10^{-2}	1.000	7.3554×10^{-2}	2.491	2.491	2.5400	1.8683
in. Hg	0.4912	13.596	1.000	33.864	33.864	34.532	25.400
h Pascal hPa	0.0145	0.40147	0.02953	1.000	1.000	1.01973	0.75006
Millibar mb	0.01450	0.40147	0.02953	1.000	1.000	1.01973	0.75006
cm H_2O	1.42237×10^{-2}	0.3937	2.8958×10^{-2}	0.9806	0.9806	1.000	0.7355
mm Hg	1.9337×10^{-2}	0.53525	3.9370×10^{-2}	1.3332	1.3332	1.3595	1.000

in H_2O at 39°F
in Hg at 32°F
cm H_2O at 4°C
mm Hg at 0°C

Pressure correction for changes in height, reducing low level stations to mean sea level by adding to the station pressure constant 'C'.

$$C = \frac{p}{29.27} \times \frac{H_p}{T_v} \text{ millibars}$$

where p is the observed station pressure (mb).
H_p is the station elevation in metres.
T_v is the annual normal value of virtual temperature at the station in K.

ASPIRATED HYGROMETER

Depression of Wet Bulb°C

T	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0
55	97	95	92	90	87	85	83	81	78	76	74	72	70	68	66	64	62	60	58	56	54	53	51	49	48	46	44	43	41	40	38	37	35	34
54	97	95	92	90	87	85	82	80	78	76	73	71	69	67	65	63	61	59	57	55	54	52	50	48	47	45	43	42	40	39	37	36	34	33
53	97	95	92	90	87	85	82	80	78	76	73	71	69	67	65	63	61	59	57	55	53	52	50	48	46	45	43	41	40	38	37	35	34	32
52	97	95	92	89	87	84	82	80	77	75	73	71	68	66	64	62	60	58	56	54	53	51	49	47	45	44	42	40	39	37	36	34	33	31
51	97	95	92	89	87	84	82	80	77	75	73	71	68	66	64	62	60	58	56	54	52	51	49	47	45	43	42	40	38	37	35	34	32	31
50	97	94	92	89	87	84	82	79	77	74	72	70	68	66	63	61	59	57	55	53	51	50	48	46	44	42	41	39	37	36	34	33	31	30
49	97	94	92	89	86	84	81	79	77	74	72	70	67	65	63	61	59	57	55	53	51	49	47	45	44	42	40	38	37	35	34	32	30	29
48	97	94	92	89	86	84	81	79	76	74	71	69	67	65	62	60	58	56	54	52	50	48	46	45	43	41	39	38	36	34	33	31	30	28
47	97	94	92	89	86	83	81	78	76	73	71	69	66	64	62	60	58	56	54	52	50	48	46	44	42	40	39	37	35	34	32	30	29	27
46	97	94	91	89	86	83	81	78	76	73	71	68	66	64	62	59	57	55	53	51	49	47	45	43	41	40	38	36	34	33	31	29	28	26
45	97	94	91	88	86	83	80	78	75	73	70	68	66	63	61	59	57	54	52	50	48	46	44	42	41	39	37	35	33	32	30	28	27	25
44	97	94	91	88	86	83	80	78	75	72	70	68	65	63	61	58	56	54	52	50	48	46	44	42	40	38	36	34	33	31	29	27	26	24
43	97	94	91	88	85	83	80	77	75	72	70	67	65	62	60	58	55	53	51	49	47	45	43	41	39	37	35	33	32	30	28	26	25	23
42	97	94	91	88	85	82	80	77	74	72	69	67	64	62	59	57	55	53	50	48	46	44	42	40	38	36	34	32	31	29	27	25	24	22
41	97	94	91	88	85	82	79	77	74	71	69	66	64	61	59	56	54	52	50	47	45	43	41	39	37	35	33	31	30	28	26	24	23	21
40	97	94	91	88	85	82	79	76	73	71	68	66	63	61	58	56	53	51	49	47	45	42	40	38	36	34	32	30	29	27	25	23	21	20
39	97	94	91	87	84	82	79	76	73	70	68	65	63	60	58	55	53	50	48	46	44	41	39	37	35	33	31	29	27	26	24	22	20	18
38	97	94	90	87	84	81	78	75	73	70	67	65	62	59	57	54	52	50	47	45	43	41	38	36	34	32	30	28	26	24	22	21	19	17
37	97	93	90	87	84	81	78	75	72	69	67	64	61	59	56	54	51	49	46	44	42	40	37	35	33	31	29	27	25	23	21	19	17	16
36	97	93	90	87	84	81	78	75	72	69	66	63	61	58	55	53	50	48	45	43	41	39	36	34	32	30	28	26	24	22	20	18	16	14
35	97	93	90	87	83	80	77	74	71	68	65	63	60	57	55	52	49	47	45	42	40	37	35	33	31	29	26	24	22	20	18	16	14	13
34	96	93	90	86	83	80	77	74	71	68	65	62	59	56	54	51	49	46	44	41	39	36	34	32	29	27	25	23	21	19	17	15	13	11
33	96	93	89	86	83	80	76	73	70	67	64	61	58	56	53	50	48	45	42	40	37	35	33	30	28	26	24	21	19	17	15	13	11	9
32	96	93	89	86	83	79	76	73	70	67	64	61	58	55	52	49	47	44	41	39	36	34	31	29	27	24	22	20	18	16	13	11	9	7
31	96	93	89	86	82	79	75	72	69	66	63	60	57	54	51	48	46	43	40	38	35	32	30	28	25	23	20	18	16	14	12	9	7	5
30	96	93	89	85	82	78	75	72	68	65	62	59	56	53	50	47	44	42	39	36	34	31	29	26	24	21	19	16	14	12	10	8	5	3
29	96	92	89	85	81	78	74	71	67	65	61	58	55	52	49	46	43	40	38	35	32	30	27	24	22	19	17	15	12	10	8	5	3	1
28	96	92	88	85	81	77	74	70	67	64	60	57	54	51	48	45	42	39	36	33	31	28	25	23	20	18	15	13	10	8	6	3	1	
27	96	92	88	84	81	77	73	70	66	63	60	56	53	50	47	44	41	38	35	32	29	26	24	21	18	16	13	11	8	6	3	1		
26	96	92	88	84	80	76	73	69	66	62	59	55	52	49	46	42	39	36	33	30	27	25	22	19	16	14	11	8	6	3	1			
25	96	92	88	84	80	76	72	68	65	61	58	54	51	47	44	41	38	35	32	29	26	23	20	17	14	11	9	6	3	1				
24	96	91	87	83	79	75	71	68	64	60	57	53	50	46	43	39	36	33	30	27	24	21	18	15	12	9	6	4	1					
23	96	91	87	83	79	75	71	67	63	59	56	52	48	45	41	38	35	31	28	25	22	19	16	13	10	7	4	1						
22	95	91	87	82	78	74	70	66	62	58	54	51	47	43	40	36	33	29	26	23	20	16	13	10	7	4	1							
21	95	91	86	82	78	73	69	64	61	57	53	49	45	42	38	35	31	27	24	21	17	17	11	8	4	1								
20	95	91	86	81	77	73	68	64	60	56	52	48	44	40	36	33	29	25	22	18	15	11	8	5	2									
19	95	90	86	81	76	72	67	63	59	55	50	46	42	38	34	31	27	23	19	16	12	9	5	2										
18	95	90	85	80	76	71	66	62	58	53	49	45	41	36	32	29	25	21	17	13	10	6	2											
17	95	90	85	80	75	70	65	61	56	52	47	43	39	34	30	26	22	18	14	10	7	3												
16	95	89	84	79	74	69	64	60	55	50	46	41	37	32	28	24	20	16	11	7	4													
15	94	89	84	78	73	68	63	58	53	49	44	39	35	30	26	21	17	13	8	4														
14	94	89	83	78	72	67	62	57	52	47	42	37	32	28	23	18	14	10	5	1														
13	94	88	83	77	71	66	61	55	50	45	40	35	30	25	20	16	11	6	2															
12	94	88	82	76	70	65	59	54	48	43	38	32	27	22	17	12	8	3																
11	94	87	81	75	69	63	58	52	46	41	35	30	25	19	14	9	4																	
10	93	87	81	74	68	62	56	50	44	38	33	27	22	16	11	5																		
9	93	86	80	73	67	61	54	48	42	36	30	24	18	13	7	2																		
8	93	86	79	72	66	59	52	46	40	33	27	21	15	9	3																			
7	93	85	78	71	64	57	50	44	37	31	24	18	11	5																				
6	92	85	77	70	63	55	48	41	34	28	21	14																						
5	92	84	76	69	61	53	46	39	31	24																								
4	92	83	75	67	59	51	44	36																										
3	91	83	74	66	57	49																												
2	91	82	73	64																														
1	90	81																																

Dry Bulb Temperature°C

WIND DESCRIPTION

Description	Wind Speed miles/hour	Beaufort Scale Number
Calm	Below 1	0
Light Air	1 to 3	1
Breeze	4 to 31	2 to 6
Light Breeze	4 to 7	2
Gentle Breeze	8 to 12	3
Moderate Breeze	13 to 18	4
Fresh Breeze	19 to 24	5
Strong Breeze	25 to 31	6
Gale	32 to 63	7 to 10
Moderate Gale	32 to 38	7
Fresh Gale	39 to 46	8
Strong Gale	47 to 54	9
Storm	64 to 72	11
Hurricane Force	Above 73	12 to 1

WIND CONVERSION TABLES

	feet/second	knots	metres/second	miles/hour	kilometres/hour
feet/sec	1.00	0.592	0.305	0.682	1.097
knots	1.689	1.00	0.515	1.152	1.853
metres/sec	3.281	1.943	1.00	2.237	3.600
miles/hour	1.467	0.868	0.447	1.00	1.609
kilometres/hour	0.911	0.540	0.278	0.621	1.0

WIND CHILL

Estimated Wind	Actual Thermometer Reading°C											
Speed In MPH	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-124
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-158
Wind >40mph has little added effect	Little Danger				Moderate Danger				Extreme Danger			

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NOTES

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