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**STANDARDIZATION OF SYMBOLS AND UNITS
FOR ENVIRONMENTAL RESEARCH**

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**STANDARDIZATION OF SYMBOLS AND UNITS
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W. C. KAUFMAN, Lieutenant Colonel, USAF

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FOREWORD

This report describes a suggested system of symbols and units for use in environmental research. It has been devised over a period of years in the Biothermal Branch, Environmental Medicine Division, Biomedical Laboratory, Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio, under project 7222, "Biophysics of Flight," task 722207, "Biophysics of Flight: Human Thermal Stress."

Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

J. W. HEIM, PhD
Technical Director
Biomedical Laboratory
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ABSTRACT

A logical system of symbols to designate the widely accepted biological variables routinely measured in environmental research is described. Upper case letters are used for three major symbols of temperature, heat quantity, and rate of heat transfer. These are modified by upper case subscripts for physical variables and lower case subscripts for biological variables.

In a meeting called by the National Aeronautics and Space Administration (NASA) and held at NASA Manned Spacecraft Center, Houston, Texas, on 10 March 1966, representatives of the various research centers of NASA and the biological laboratories of the Air Force Systems Command agreed on the desirability of standardizing symbols and units commonly used in environmental research. In line with the system agreed upon many years ago by respiratory physiologists (ref 1) the following set of symbols is recommended.

Three major symbols will be used.

T = temperature

H = rate of heat transfer or production

Q = heat quantity

Upper case subscripts will define physical variables.

A = air

W = wall

R = radiant

E = evaporative

C = convective

D = conductive

DB = dry bulb

WB = wet bulb

Lower case subscripts will define physiological variables.

r = rectal

e = esophageal

t = tympanic

o = oral

s = skin

b = body

m = metabolism

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A dash above any symbol will indicate a mean value and Δ will indicate a change in a variable. Should it be desired, a dot above any symbol will indicate a time derivative.

\bar{s} = mean skin

\bar{b} = mean body

ΔT_r = change in rectal temperature

For metabolic or atmospheric designations those suggested by the Federation of American Societies for Experimental Biology should be used.

\dot{V}_{O_2} = rate of oxygen consumption

P_b = barometric pressure

A second subscript will be used, if necessary, to indicate the time of the observation.

i = initial

f = final

Examples:

$$Q = H_r + H_c + H_b + H_e + H_m$$

Q = quantity of heat

H_r = radiative heat transfer

H_c = convective heat transfer

H_b = conductive heat transfer

H_e = evaporative heat transfer

H_m = metabolic heat production

Q_b = quantity of body heat storage

T_a = air temperature

T_w = wall temperature

T_{wb} = wet bulb temperature

T_r = rectal temperature

T_e = esophageal temperature

T_t = tympanic temperature

T_o = oral temperature

T_{s_i} = initial mean skin temperature

T_{b_f} = final mean body temperature

Less universally accepted terms such as "effective" or "operative" temperature, "index of strain," "heart rate," etc, shall be defined in publication as necessary. Symbols used should be abbreviations or, in any event, clearly distinguished from those such as T_e (esophageal temperature) or T_o (oral temperature).

Units used in publications shall always be in the metric system. The author is well aware of the impact units such as the newton and the joule will have on biologists in general and particularly on those who are clinically oriented. However, in the interest of standardization and uniformity, the Systeme International d'Unites as agreed upon at the 1960 Eleventh General Conference on Weights and Measures (ref 2), is recommended to the courageous.

REFERENCES

1. Federation of American Societies for Experimental Biology, "Standardization of Definitions and Symbols in Respiratory Physiology," Federation Proc. 9:602-605, 1950.
2. Mechtly, E. A., The International System of Units, Physical Constants and Conversion Factors, NASA SP-7012, Scientific and Technical Information Division, National Aeronautics and Space Administration, Washington, D.C., 1964.

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