REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(LEAVE BLANK)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	3 August 1999	Professional Paper

4. TITLE AND SUBTITLE

Nasal Heat Probe to Measure Nasal Cavity Heat and Water Vapor Transport

5. FUNDING NUMBERS

6. AUTHOR(S)

Kambiz Farahmand, Ph.D, P.E.
Jonathan Kaufman, Ph.D.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Naval Air Warfare Center Aircraft Division
22347 Cedar Point Road, Unit #6
Patuxent River, Maryland 20670-1161

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Naval Air Systems Command
47123 Buse Road, Unit IPT
Patuxent River, Maryland 20670-1547

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

A Nasal-Heat probe was developed to measure intra-airway heat and vapor transfer. The changes in the intra-airway temperature, respiration rate, respiratory heat and water vapor exchange as a result of environmental conditions were easily determined using this device. The humidity profiles generated were closely related to the heat and water vapor exchange. Heat and mass transfer coefficients in the airways were determined from air stream and wall temperatures inside the nasal cavity.

14. SUBJECT TERMS

Nasal heat probe Heat and water vapor transport

15. NUMBER OF PAGES

5

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

Aviation, Space, and Environmental Medicine Science and Technology Watch article

Nasal Heat Probe To Measure Nasal Cavity Heat and Water Vapor Transport

Kambiz Farahmand, Ph.D., P.E. and Jonathan W. Kaufman, Ph.D.

A Nasal-Heat probe was developed to measure intra-airway heat and vapor transfer. The changes in the intra-airway temperature, respiration rate, respiratory heat and water vapor exchange as a result of environmental conditions were easily determined using this device. The humidity profiles generated were closely related to the heat and water vapor exchange. Heat and mass transfer coefficients in the airways were determined from air stream and wall temperatures inside the nasal cavity.

NASAL PROBE

Eight dry-bulb thermocouples are used to measure surface temperatures 5 cm inside the nasal cavity. Four wet-bulb thermocouples (two wet-bulb thermocouples are used at each location for verification purposes) are employed to measure relative humidity inside the nasal airway at two distinctive locations. The nasal probe apparatus is practical and functional with little down time between measurements for sterilization and maintenance.

Figure 1 shows the schematic diagram of the nasal probe. The outer tube is used to house the thermocouple wires (8 mm total diameter). The inside reciprocating tube is used to properly position the thermocouples after insertion. The forward movement of the inside tube is restricted when the stopper reaches the outer tubing and the backward movement is restricted by both support wires attached to its tip and the stopper. The wiring at the tip is safely encapsulated and secured using heated Teflon. The surface is smooth preventing scratching or other health hazards. Four capillary tubes are attached to the tubing on the outside to supply distilled water to the wet-bulb thermometers. A total of twelve wires pass through the outer tubing. The wires are connected to female connectors and mounted onto a board to restrict movement.

FIGURE 1 HERE

PROBE OPERATION

The subjects are familiarized with the operation of the nasal probe before the experiment. Each subject must be comfortable with the use and operation of the probe. The probe must be inserted into the nasal cavity in the collapsed mode. After proper placement (5 cm) the subjects must expand the probe by retracting the inside tube while holding the outer tube in place. This will expand the outer wires on the probe where the thermocouples are attached (1.5 cm diameter). The support wires pushing against the nasal cavity wall will assure thermocouples are in place. The larger the nasal cavity, the further out a subject will need to pull the inner tube. This design allows easy insertion and accommodates different nasal cavity sizes. Most subjects agree to use the probe once

they feel comfortable with its operation. In a recent study, only one of eight subjects refused to participate after briefing.

The probe is designed to measure the dry bulb temperature differences along the nasal cavity at two different intervals. Four measurements are made from the surface of the nasal cavity at each interval. Simultaneous measurements of the airway wet bulb temperatures at each interval are also provided. The measurements are used to determine the heat and mass transfer properties of the nasal cavity. The subjects must rest for a short period after insertion to allow for adjustment of the cavity to the foreign object and to relax. Experimenting with various breathing patterns and frequencies are then possible. After the experiment, the subjects must collapse the probe by pushing the reciprocating inside tube back in while pulling the outer tube out from the nasal cavity.

One application of the nasal probe includes investigating the effects of physical exercise on respiration and heat exchanges. This is due to the fact that the amount of air intake from the nose is increased when the level of physical activity is raised. Other areas of interest include inhalation toxicology through investigation of particle deposition and growth in the airways as a function of intra-airways condition as well as the physical and chemical properties of the particles. Investigating the filtration effect of various respiratory apparatuses and protective masks and face garments on respiration and ventilation is also viable.

The changes in the intra-airway temperature, respiration rate, respiratory heat and water vapor exchange as a result of environmental conditions can easily be observed using the nasal probe and a larger version using in the oral cavity. The nasal probe apparatus is practical, functional, portable, acceptable by subjects, and very economical to build and maintain.

Submitted by:
Kambiz Farahmand, Ph.D., P.E.
Texas A&M University
Department of Mechanical and Industrial Engineering
Kingsville, TX 78363

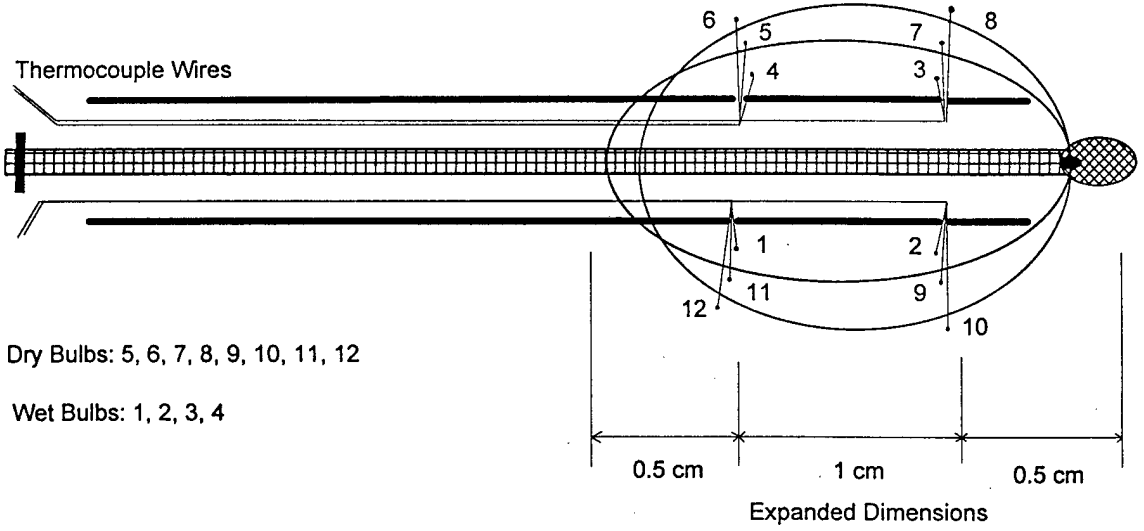
Jonathan W. Kaufman, Ph.D.
Naval Air Warfare Center Aircraft Division
Crew Systems Department
Patuxent River, MD 20670-1906

Editor's Note.
Submissions concerning new technologies and innovative programs and research are encouraged. This column is a service of the AsMA Science and Technology Committee. Please send your articles via e-mail to ShenderBS@navair.navy.mil
or to

Barry S. Shender, Ph.D.
South Engineering Center / Crew Systems Dept.
BLDG 2187 SUITE 2280
Naval Air Warfare Center Aircraft Division
48110 Shaw Road Unit 5
Patuxent River, MD 20670-1906

Figure caption:

Figure 1. Schematic diagram of the Nasal-Heat probe and its placement.



Dry Bulbs: 5, 6, 7, 8, 9, 10, 11, 12

Wet Bulbs: 1, 2, 3, 4

Expanded Dimensions