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REPORT NO. 71-7424

LONG-DURATION EXERCISE AT MODERATE WORK LOADS

By W. Sanborn, Ph.D., V. B. Dunn,
A. Camacho, and E. C. Wortz, Ph.D.

NASA Contract Monitor: E. L. Michel

May 1971

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Prepared under Contract No. NAS 9-10994 by
AIRESEARCH MANUFACTURING COMPANY

A Division of The Garrett Corporation
Los Angeles, Calif.

for Manned Spacecraft Center
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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SECTION I

INTRODUCTION

This document presents the results of a research program on the metabolic effects of long-duration exercise accomplished by Garrett/AiResearch for the Manned Spacecraft Center, National Aeronautics and Space Administration, under contract NAS 9-10994. Specifically, this document describes the subjects, methods, procedures, apparatus, data, and conclusions drawn from a series of experiments in which the duration of the rest break in each hour, the water intake, the amount of sleep, and the overall duration of exercise were varied.

The contract monitor for this program was Mr. Ed Michel, Chief, Biomedical Laboratories Division, NASA MSC.

The principal exercise mode was an 8-hr walk on a level surface at a velocity of 3.2 mph, which roughly corresponds to an energy expenditure of 1000 Btu/hr.

Balke tests conducted to provide exercise correlative and physical fitness information included pre- and post-experiment tests and two sets of tests utilizing a bicycle ergometer. The Balke tests were conducted by the Performance Physiology Laboratory, University of California, Los Angeles. The main experiment was conducted in the Life Sciences Laboratory at Garrett/AiResearch.

SECTION 2

TEST FACILITY

The long-duration walking exercise test was performed in the Garrett/AiResearch Life Sciences Laboratory located in El Segundo, California.

The test apparatus consisted of two 26-in-wide treadmills having smooth, flat walking surfaces of rubberized fabric. One treadmill provided a 61-in.-long walking surface, the other a 45-in.-long walking surface. Each treadmill was level (zero grade), and had a variable speed control that was adjusted for a walking speed of 3.2 mph.

The treadmill speed was measured by a photoelectric sensor mounted above the treadmill surface. The circumference of each treadmill belt was marked by equally spaced lines of white reflective paint, as shown in Figure 2-1. The photoelectric circuit was triggered by reflections from the white marks. Each pulse (the signal from a marker) was counted electronically, providing a measure of the speed of the belt.

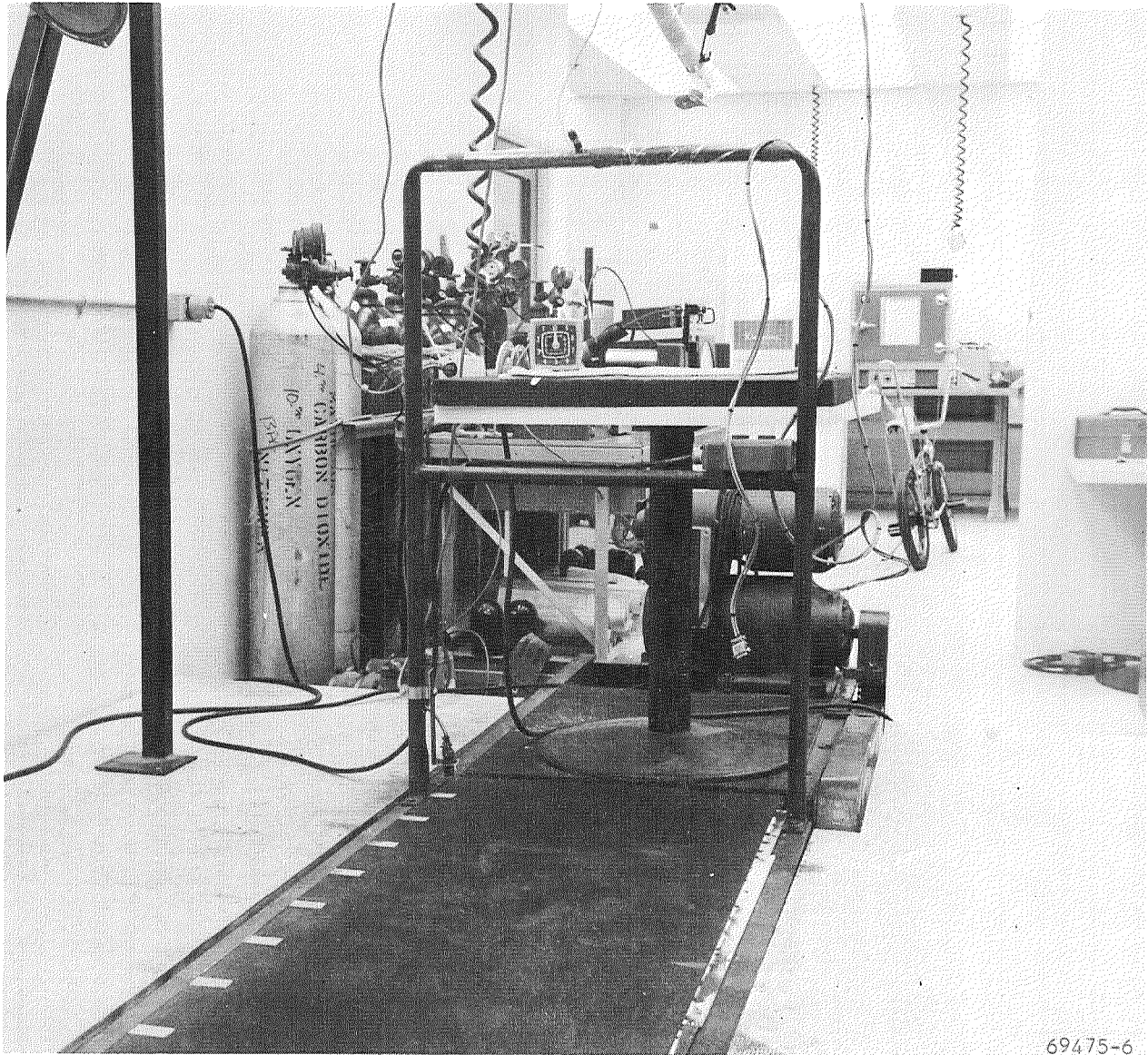


Figure 2-1. Photograph of Treadmill Showing Location of Photoelectric Sensor

SECTION 3

TEST PROGRAM

The experimental design is displayed in Table 3-1. This table, which shows the test sequence, contains a description of the test conditions and defines the independent variables of amount of sleep, rest break period, total test period, and water intake mode. Table 3-2 provides a description of these test conditions in terms of test number (test sequence) and defines the linkages between Tests 3 and 4 and Tests 5 and 6. Test 4 was conducted after Test 3 with a 17-hr nonexercise period between the two tests. Similarly, Test 6 was conducted after Test 5 with a 17-hr nonexercise period intervening.

One test profile involved walking for 8 hr with no rest periods. A second test profile involved walking for 8 hr with 5 min rest each hour. A third test profile, used for 6 tests, provided 10 min rest each hour. The requirement for 10 min rest per hr was fulfilled by two 5-min periods spaced at 1/2-hr intervals.

Ten subjects completed all test conditions.

TABLE 3-1
EXPERIMENTAL DESIGN

Test Conditions			Independent Variables					Total Number of Subjects
Ambient Conditions and Clothing Mode	Treadmill Surface Condition	Gait Mode	Velocity, mph	Sleep Period Prior to Test, hr	Rest Break Period, min/hr	Total Test Period, hr	Water Intake Mode	
Constant-temperature room. Subjects clothed in: (1) undershirt (2) underpants (3) coveralls (4) socks (5) tennis shoes	Smooth rubberized fabric. Slope 0 deg.	Walk	3.2	8	0	8	ad lib	10
				8	5	8	H ₂ O by weight loss	10
				8	10	8	H ₂ O by weight loss	10
				17*	10	8	H ₂ O by weight loss	10
				8	10	6	ad lib	10
				17*	10	8	ad lib	10
				4	10	8	ad lib	10
				0	10	8	ad lib	10

*9 hours of light activity (TV, reading, etc.) followed by a minimum of 8 hr sleep.

TABLE 3-2
TEST DESCRIPTION

Test Number	Hours Sleep in 24 hr Prior to Testing	Water Intake	Test Duration, Frequency, and Duration of Rest Periods
1	8	ad lib	8 hr exercise, no rest
2	8	Weight loss	8 hr exercise, 5 min/hr rest
3	8	Weight loss	8 hr exercise, 10 min/hr rest, followed by 17 hr rest, then
4	8	Weight loss	8 hr exercise, 10 min/hr rest
5	8	ad lib	6 hr exercise, 10 min/hr rest followed by 17 hr rest, then
6	8	ad lib	8 hr exercise, 10 min/hr rest
7	4	ad lib	8 hr exercise, 10 min/hr rest
8	0	ad lib	8 hr exercise, 10 min/hr rest

SECTION 4

TEST SUBJECTS

TEST SUBJECT SELECTION

All prospective subjects were given a thorough medical examination as well as a personal interview. The interview included a visit to the test facility and a detailed description of the severity of the test. Those subjects who expressed a desire to undertake the test were sent to the Performance Physiological Laboratory located on the Los Angeles Campus of the University of California to receive their modified Balke tests. The data obtained from these tests were analyzed by Dr. Gerald Gardner, an associate professor of physical education. Subject fitness was an unexpected hindrance. Although the selection criteria accounted for the usual parameters--medical (physical examination), physiological (modified Balke test), and emotional (personal interview)-- a total of 10 subjects withdrew from the program because of various physical and emotional reasons. The 10 subjects who completed the program were judged to be in acceptable physical condition (all subjects regularly participated in some type of athletic activity). It should be noted that the 10 subjects who could not or would not complete the program were also judged to be physically fit. The anthropomorphic characteristics of these 10 subjects are displayed in Table 4-1.

TRAINING PROGRAM

Each subject completed 4 hr of pretest training (treadmill speed was set at 3.2 mph) one day a week for three consecutive weeks. Clothing for these periods of training consisted of underwear (T-shirt and pants) and a white coverall. Each subject was allowed to choose his own footwear, and the unanimous choice was leather tennis shoes.

PHYSICAL CONDITIONING

The pre- and post-test anthropomorphic and fitness data for the subject population are presented in Tables 4-1, 4-2, and 4-3. Although the means (\bar{X}) of all the parameters changed slightly, none of the differences (δ) was judged to be subjectively significant. Dr. Gardner concluded that physical conditioning during the testing was nonexistent, and therefore the data are not biased by this factor.

TABLE 4-1

PRE-, POST-TEST ANTHROPOMETRIC DATA ON
TEN AIRESEARCH SUBJECTS

Test	Subject	Age, years	Height, cm	Total Body Weight, kg		Lean Body Mass, kg		Body Surface Area, m ²
				Pre	Post	Pre	Post	
1	PA	39	173	73.2	69.5	57.5	52.7	1.86
2	RB	32	180	76.4	73.6	58.5	55.8	1.96
3	DB	26	174	72.7	71.8	54.9	54.0	1.87
4	SD	30	176	74.5	71.8	66.7	57.7	1.90
5	GE	29	171	63.6	62.5	44.9	46.1	1.74
6	PK	32	174	85.0	81.4	59.8	56.8	1.99
7	CN	27	180	73.6	70.9	54.7	52.0	1.92
8	DO	34	177	76.6	77.0	59.7	60.7	1.93
9	GW	29	180	73.9	72.5	54.5	63.2	1.93
10	DW	30	185	83.0	83.0	70.9	74.3	2.06
Mean (\bar{X})		30.8	177.0	75.25	73.3	58.2	57.3	---
Differential (δ)		3.54	4.02	5.57	5.65	6.73	7.24	---

TABLE 4-2

HEART RATE AND
PRE-, POST-TEST OXYGEN CONSUMPTION DATA
ON TEN AIRESEARCH SUBJECTS

Test	Subject	Max Heart Rate, beat/min		Max $\dot{V}O_2$, mls/min/kg		Max $\dot{V}O_2$, mls/min/kg. Lean Body Mass	
		Pre	Post	Pre	Post	Pre	Post
1	PA	185	184	42.3	49.2	53.9	64.9
2	RB	190	190	54.9	52.4	71.6	69.2
3	DB	186	188	49.9	45.4	66.1	60.4
4	SD	173	172	57.7	53.3	64.5	66.3
5	GE	200	197	45.5	43.7	64.4	59.2
6	PK	190	190	41.5	45.0	59.1	64.4
7	CN	194	196	46.9	45.3	63.1	61.8
8	DO	184	183	55.1	53.6	70.7	68.1
9	GW	175	180	55.5	57.4	75.2	65.8
10	DW	187	192	47.3	35.5	55.4	39.7
Mean (\bar{X})		186.4	187.2	49.7	48.1	64.4	62.0
Differential (δ)		7.66	7.24	5.54	6.06	6.57	8.02

TABLE 4-3

PRE-, POST-TEST RESPIRATORY MEASUREMENTS ON
TEN AIRESEARCH SUBJECTS

Test	Subject	Peak Flow, l/min		Max Ventilation, l/min		Max Breathing Rate, breaths/min		Vol/Breath, liters	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	PA	610	650	114.8	111.0	48	35	2.39	3.17
2	RB	630	645	122.4	109.2	41	38	2.98	2.87
3	DB	510	515	111.7	108.5	43	40	2.60	2.71
4	SD	560	555	122.6	106.9	38	44	3.22	2.43
5	GE	460	495	118.9	82.4	44	33	2.70	2.50
6	PK	585	585	123.1	120.0	48	45	2.56	2.67
7	CN	680	655	135.8	112.7	50	39	2.72	2.89
8	DO	570	590	106.3	105.0	31	35	3.43	3.00
9	GW	565	565	133.0	121.6	47	37	2.83	3.29
10	DW	650	690	126.5	130.0	31	29	4.08	4.48
Mean (\bar{X})		582	594	121.5	110.7	42.1	37.5	2.95	3.00
Differential (δ)		61.9	61.0	8.63	12.0	6.52	4.61	0.48	0.56

SECTION 5

TEST AND MEASUREMENTS INSTRUMENTATION

INDEPENDENT VARIABLES

Test facility ambient and surface temperatures were measured and recorded throughout the test period. These data are presented in Appendix A for reference. Test facility wind velocity was also measured during testing. These data are presented in Appendix B.

DEPENDENT VARIABLES

Test Parameters

The following physiological parameters were measured directly: rectal temperature, electrocardiogram, heart rate, respiratory frequency, ambient temperature, ambient pressure, and ambient dew point. Metabolic rate, minute volume, oxygen consumption, and carbon dioxide production were not directly recorded parameters, but depended upon certain assumptions and were calculated from additional measurements. These parameters were calculated from data obtained from a paramagnetic oxygen analyzer ($F_{I_{O_2}}$, $F_{E_{O_2}}$), an infrared carbon

dioxide analyzer ($F_{I_{CO_2}}$, $F_{E_{CO_2}}$), and a respirometer ($V_{E(ATP)}$) that was

instrumented for the measurement of temperature and dew point. During the preliminary phases of testing the saturation of the gas in the respirometer was determined. Measurements showed that under the conditions of these tests the expiratory gas could be considered to be saturated; therefore, P_{H_2O} (saturated) was used in the equations for the calculations of gas volume.

Instrumentation of Test Subject

The daily instrumentation of each subject was carefully accomplished by AiResearch personnel who were well qualified to perform this important task. Heart rate was obtained from the EKG signal, and body temperature was recorded from a rectal probe inserted approximately 10 cm past the anal sphincter. Respiratory rate was monitored by frequency circuits located on the respirometer that was used to measure the exhaled gas volume. Metabolic rates (oxygen consumption, carbon dioxide production, and minute volume) were calculated from the primary respiratory parameters measured in the open spirometric circuit.

Measurements and Data Recording

1. Metabolic Rate Measurement

Metabolic rates were measured by indirect calorimetry. The technique utilized a standard 2-way breathing valve, a respirometer, a gas analyzer system, and temperature, pressure, and humidity sensors. Figure 5-1 shows a schematic of the metabolic and physiologic data system.

Dead space of the 2-way breathing valve measured approximately 35 cc. The resistance to the flow of atmospheric gas through this valve and the 6-ft length of hose that connected it with the respirometer was approximately equal to that of the Collins 2-way valves, P-306 and P-307. (See Figure 5-2 for a plot of ΔP versus flow for the 2-way valves and those used in the test.) At a flow of 200 liters/min (STPD), the total pressure drop measured 2 in. H_2O . Figure 5-3 is a photograph showing the subject walking on a treadmill with the counterweighted breathing valve at standby.

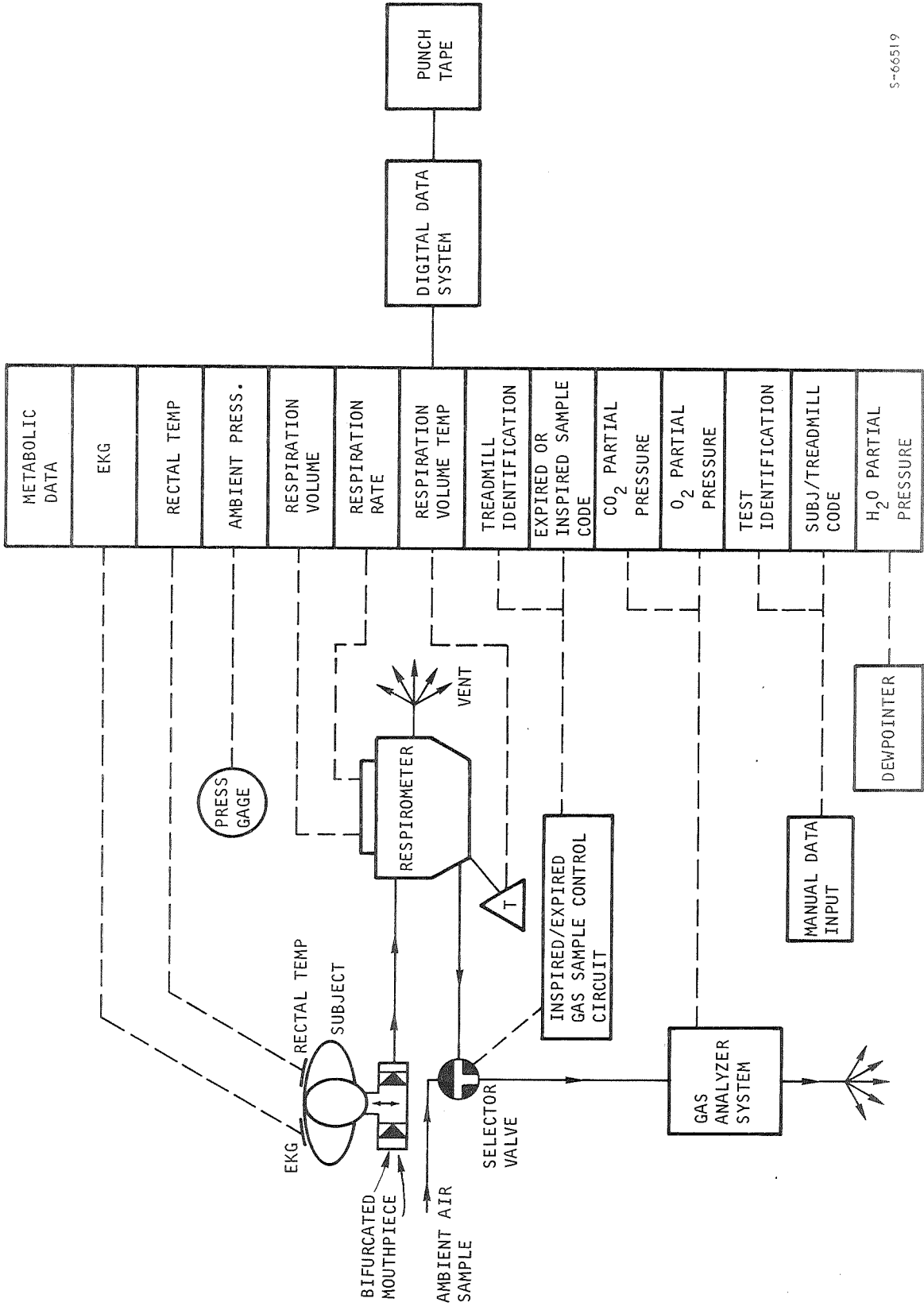
Immediately prior to the measurement of a data point, the subject fitted the mouthpiece into his mouth and placed a noseclip over the bridge of his nose. The weight of the bifurcated mouthpiece and hose assembly was balanced by a pulley and counterweight. The vertical movement provided by this system enabled the subject to hold the mouthpiece comfortably while he walked.

Expiratory volumes were measured by a Franz-Mueller respirometer that was connected to the outlet of the two-way mouthpiece. The respirometer had been modified with electronic sensors to provide signals for the recording of expired volume and breath rate. Figure 5-4 shows the respirometer with the electromagnetic sensor that digitized expired volume into pulses/min. The expired air was vented to the atmosphere.

Inspired and expired air samples were pumped through a Beckman LB-1 infrared carbon dioxide sensor and a Beckman F-3 paramagnetic oxygen sensor and then vented to the atmosphere. Inspired gas samples were taken directly from the inlet area of the mouthpiece. The expired breath sample was taken from the sampling port of the respirometer. A selector valve and electrical timing circuit controlled the sampling sequence of the inspired and expired gas samples. With this control circuit, a single set of oxygen and carbon dioxide sensors was used to monitor both the inspired and expired gas. Since the

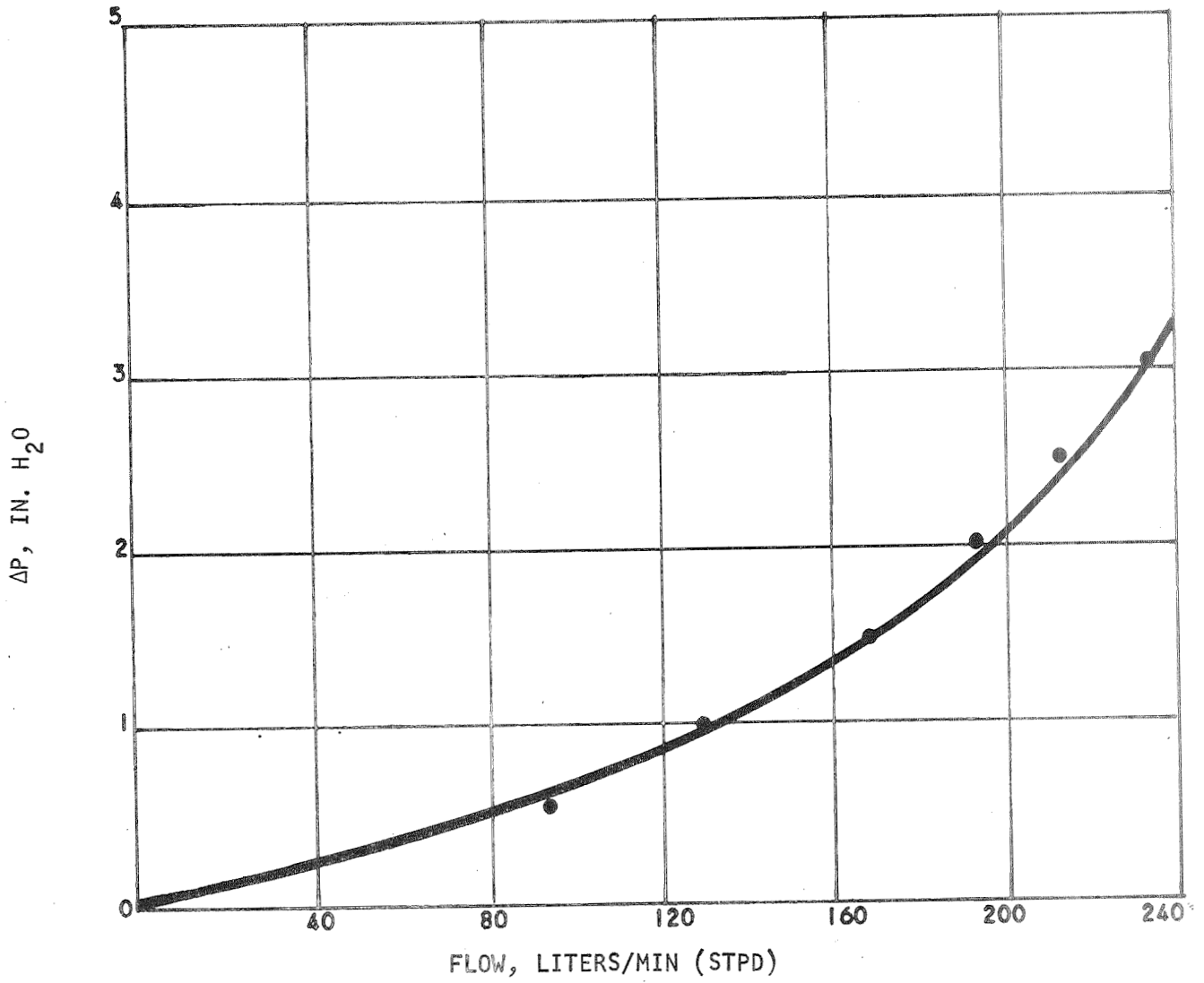
instantaneous values of \dot{V}_{O_2} and \dot{V}_{CO_2} are functions of the differences between $F_{I_{O_2}}$, $F_{E_{O_2}}$ and $F_{I_{CO_2}}$, $F_{E_{CO_2}}$, respectively, the use of one sensor to monitor

each parameter avoids the high errors that could arise if two sensors drifted in opposite directions. Stated another way: the error that arises from the subtraction of two absolute measurements recorded by two separate sensors is greater than the error that arises from the subtraction of two measurements recorded by the same sensor.



S-66519

Figure 5-1. Metabolic and Physiological Data System Schematic



S-66503

Figure 5-2. Pressure Drop of Respiratory Valve System

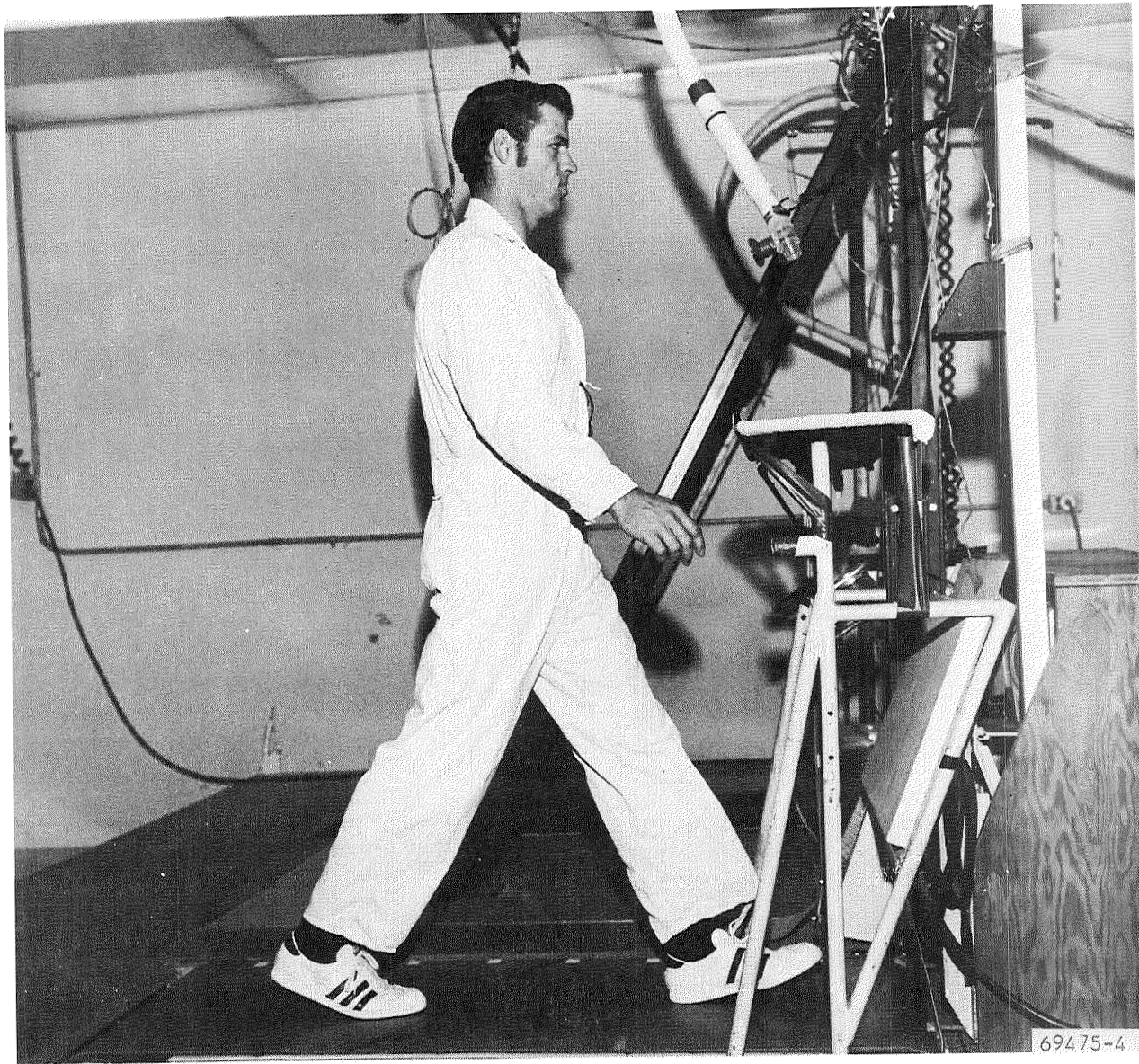


Figure 5-3. Subject Walking on Treadmill

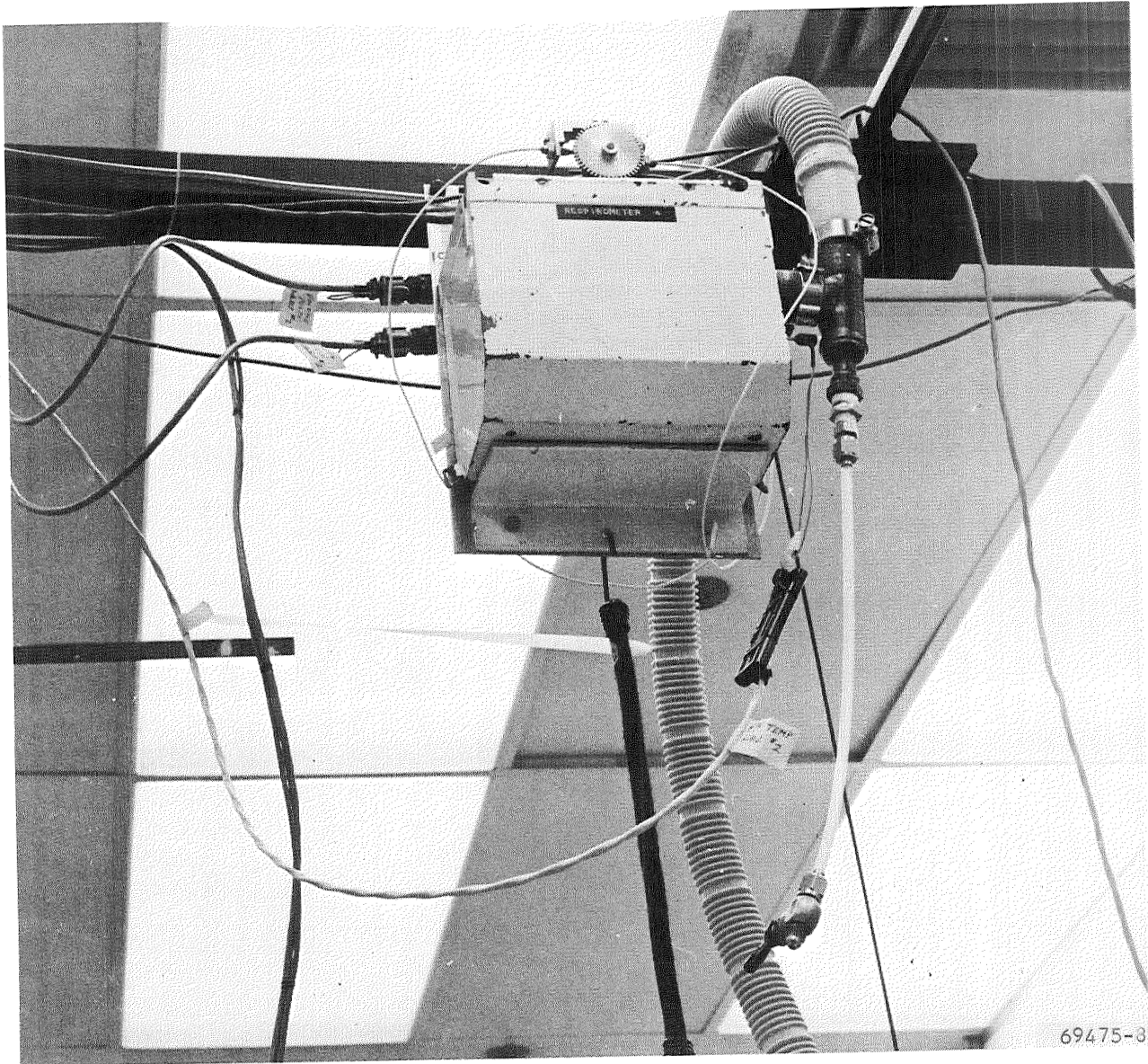


Figure 5-4. Expiratory Volume Measuring Equipment

The gas analyzer calls were located approximately 10 ft from the respirometer, which was approximately 6 ft from the test subject. These dimensions fixed the time required for steady-state measurement of the respiratory gas. Figure 5-5 provides a typical record from the oxygen and carbon dioxide monitors during one experimental session. A calibration gas circuit was connected in parallel to the sampling circuit to allow on-line calibration checks; gas analyzers were calibrated at least 3 times during each 8-hr test period. Power to the gas analyzers was never turned off throughout the test period. Ambient temperature, ambient pressure, and respirometer temperature were measured by temperature and pressure sensors. The dew point of the inspired air sample was measured by a condensation sensor that was designed by AiResearch engineers.

These data were recorded on punch tape and later processed (along with specific hand-recorded data) by computer programs. The final printout included the above specified parameters, which were then tabulated and organized with regard to the independent and dependent variables.

2. Calculation of Metabolic Rate and Related Parameters

The calculation of metabolic rate (units of energy/unit of time) requires knowledge of the oxygen consumption rate (\dot{V}_{O_2}), the carbon dioxide production rate (\dot{V}_{CO_2}), and the energy equivalent associated with given values of the respiratory quotient. The quotient of $\dot{V}_{CO_2}/\dot{V}_{O_2}$ can be considered to equal the respiratory quotient at steady state.

From the measurements of the primary metabolic parameters, the quantities \dot{V}_{O_2} , \dot{V}_{CO_2} , \dot{V}_E (BTPS) or minute volume, and metabolic rate were calculated as described below.

a. Oxygen consumption rate

By definition

$$\dot{V}_{O_2} = \dot{V}_{I_{O_2}} - \dot{V}_{E_{O_2}}$$

$$\dot{V}_{O_2} = \dot{V}_I^F I_{O_2} - \dot{V}_E^F E_{O_2}$$

\dot{V}_I was not measured. However, the equality, $\dot{V}_{I_{N_2}} = \dot{V}_{E_{N_2}}$, can be rearranged and solved for \dot{V}_I .

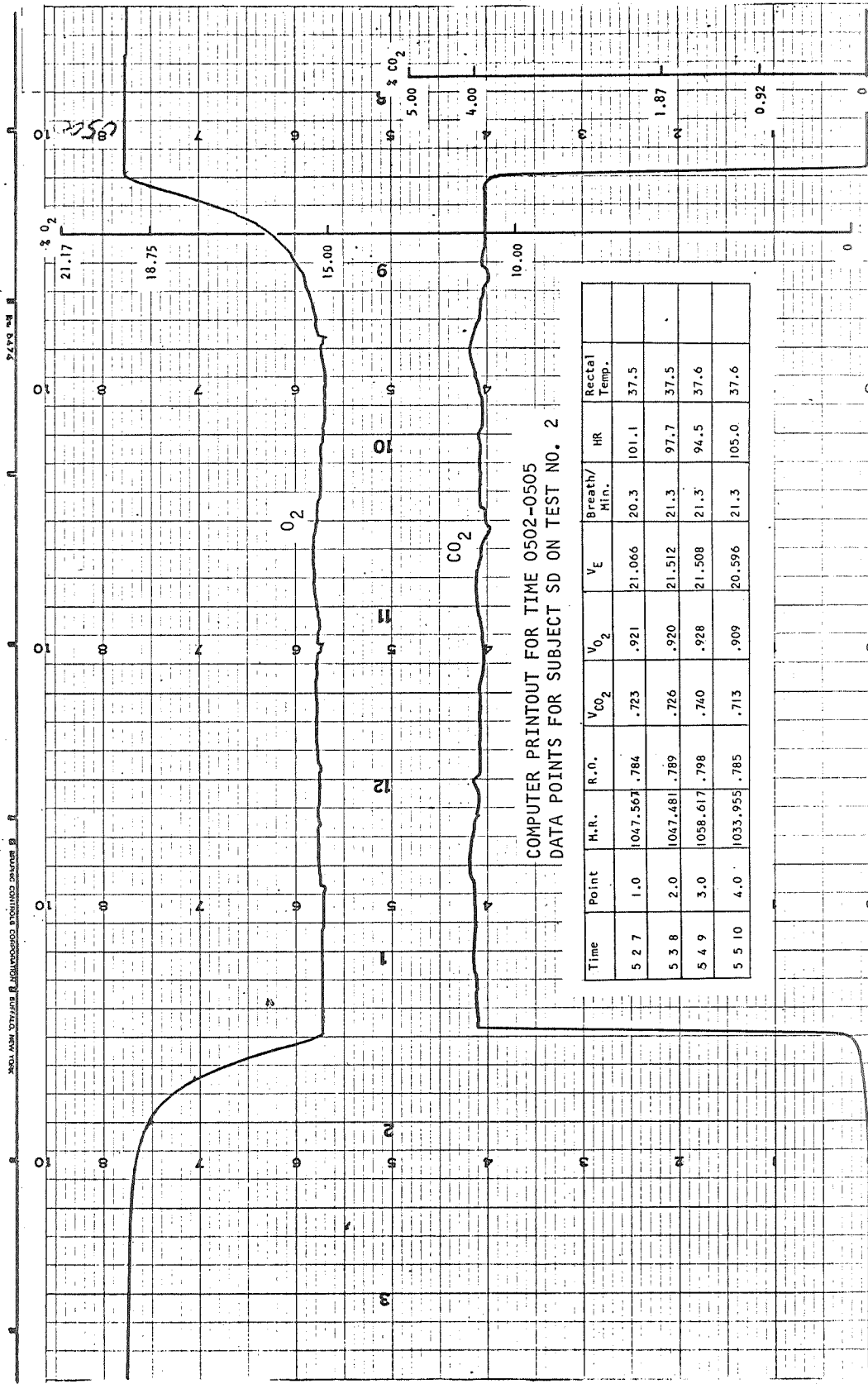


Figure 5-5. CO₂/O₂ Trace and DVM Outputs

$$\dot{V}_{I_{N_2}} = \dot{V}_I F_{I_{N_2}}, \quad \dot{V}_{E_{N_2}} = \dot{V}_E F_{E_{N_2}}$$

therefore

$$\dot{V}_I = \dot{V}_E \frac{F_{E_{N_2}}}{F_{I_{N_2}}}$$

The substitution for \dot{V}_I in the \dot{V}_{O_2} equation yields

$$\dot{V}_{O_2} = \dot{V}_E \left(F_{I_{O_2}} \frac{F_{E_{N_2}}}{F_{I_{N_2}}} - F_{E_{O_2}} \right)$$

In any given example of inspired and expired gas (dry), respectively:

$$F_{I_{O_2}} + F_{I_{CO_2}} + F_{I_{N_2}} = 1$$

and

$$F_{E_{O_2}} + F_{E_{CO_2}} + F_{E_{N_2}} = 1$$

After solving for $F_{I_{N_2}}$ and $F_{E_{N_2}}$

$$F_{I_{N_2}} = 1 - F_{I_{O_2}} - F_{I_{CO_2}}$$

and

$$F_{E_{N_2}} = 1 - F_{E_{O_2}} - F_{E_{CO_2}}$$

The ratio of $F_{E_{N_2}}/F_{I_{N_2}}$ can be substituted into the equation for \dot{V}_{O_2} to give:

$$\dot{V}_{O_2} = \dot{V}_E \left[F_{I_{O_2}} \left(\frac{1 - F_{E_{O_2}} - F_{E_{CO_2}}}{1 - F_{I_{O_2}} - F_{I_{CO_2}}} \right) - F_{E_{O_2}} \right]$$

Since it is customary to report \dot{V}_{O_2} in STPD, \dot{V}_E (which was measured at ATP) must be corrected:

$$\dot{V}_{O_2}(\text{STPD}) = \dot{V}_E(\text{ATP}) \left[F_{I_{O_2}} \left(\frac{1 - F_{E_{O_2}} - F_{E_{CO_2}}}{1 - F_{I_{O_2}} - F_{I_{CO_2}}} \right) - F_{E_{O_2}} \right] \left[\frac{P_E - P_{E_{H_2O}}}{P_E} \right] \left[\frac{273.16}{273.16 + T_E} \right]$$

b. Carbon dioxide production rate

By definition, $\dot{V}_{CO_2} = \dot{V}_{E_{CO_2}} - \dot{V}_{I_{CO_2}}$. The calculation is methodologically identical to that for \dot{V}_{O_2} .

$$\dot{V}_{CO_2}(\text{STPD}) = \dot{V}_E(\text{ATP}) \left[F_{E_{CO_2}} - F_{I_{CO_2}} \left(\frac{1 - F_{E_{O_2}} - F_{E_{CO_2}}}{1 - F_{I_{O_2}} - F_{I_{CO_2}}} \right) \right] \left[\frac{P_E - P_{E_{H_2O}}}{P_E} \right] \left[\frac{273.16}{273.16 + T_E} \right]$$

c. Minute volume

Minute volume is defined as \dot{V}_E at BTPS. Thus $\dot{V}_E(\text{ATP})$ corrected for temperature and pressure yields:

$$\dot{V}_E(\text{BTPS}) = \dot{V}_E(\text{ATP}) \left(\frac{P_E - P_{E_{H_2O}}}{760 - 47} \right) \left(\frac{310.16}{273.16 + T_E} \right)$$

The parameters P_E , $P_{E_{H_2O}}$, and T_E are the total pressure, the vapor pressure, and the temperature of the expired gas.

e. Metabolic rate

Simply,

$$\text{metabolic rate} = C\dot{V}_{O_2}$$

where C equals the energy equivalent at a given $\dot{V}_{CO_2}/\dot{V}_{O_2}$ ratio.

SECTION 6

TEST PROCEDURE

DAILY TEST PROTOCOL

The subject(s) and test crew arrived at the test facility at the beginning of the work day, generally 8:00 a.m. After a subject completed a daily questionnaire designed to disclose his nutritional, physical, and emotional and rest status (see Figure 6-1), he was instrumented for EKG and rectal temperature and weighed unclothed (except for underpants and undershirt) to an accuracy of ± 10 gm. His bioinstrumentation was checked for continuity, and he then donned his white coveralls (approximately 1 clo). Subsequent hourly weighings were made with the coverall garment removed. This ensured that succeeding weights were comparable with the one obtained in the morning.

During the preparation of the subjects, the test personnel calibrated and checked the instrumentation and apparatus to ensure its readiness. After all circuits had been checked, the subject stepped upon the treadmill platform.

When the test conductor was satisfied that the subject, test personnel, and instrumentation were ready, he signaled the start of the test. Data monitoring began at this time. Data were recorded the last 5 min of each consecutive 15-min interval throughout the test. Traces of oxygen and carbon dioxide consumption, showing the relationship between the attainment of steady-state oxygen and carbon dioxide readings and the 4-min data sampling sequence are presented in Figure 5-5. Figure 6-2 shows the hourly timing of the scheduled rest and data periods for a typical test. During these scheduled rest periods the subject was weighed and allowed to imbibe water (as delineated for the given test), and to urinate (subjects were not restricted from urinating at other times). The consumption of food was not permitted. Dependent upon the conditions of the subject, each test was continued until completion. After the subject had completed his day's testing, he returned to the preparation room and recorded his subjective comments.

REJECTION CRITERION FOR CESSATION OF TESTING

A given test was to be terminated if any subject issued a voluntary request, if his heart rate exceeded 180 beats/min for a 5-min interval, or if his rectal temperature exceeded 102°F. Both the analog of heart rate and the direct EKG waveform were displayed on a direct-writing oscillograph.

One subject voluntarily quit Test 1 after 5-1/2 hr and Test 4 after 6 hr. All other tests were completed as scheduled.

SUBJECT QUESTIONNAIRE
(TO BE FILLED OUT EACH DAY)

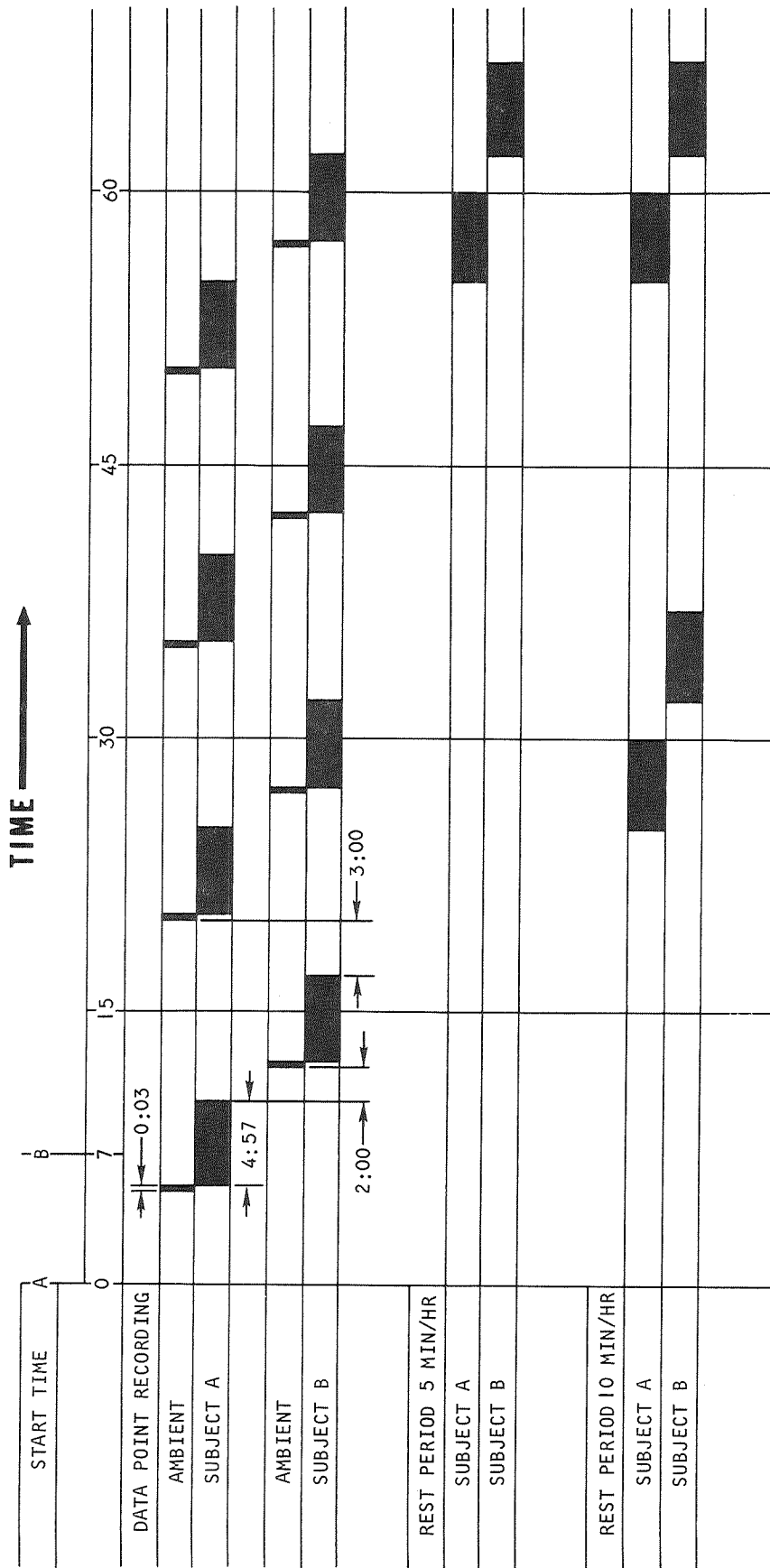
1. Name: _____ Nude Wt: _____ Height _____
2. How did you sleep last night? Soundly: ___ Light: ___ Fitfully: ___ (Check one)
If fitfully, how many times did you awaken? _____ times.
3. How many hours did you sleep? _____ hr.
4. Although directed not to imbibe alcohol, did you indulge? ___ What Kinds? ___
How many? _____
5. What were the basic components and time of last night's dinner and today's breakfast?

Meal/Time	Type of Food	Quantity
Dinner		
Time		
Breakfast		
Time		

6. How do you feel generally? Excellent ___ Good ___ Fair ___ Poor ___ (Check one)
7. Do you have significant symptoms to report? _____
e.g., cold, aches, pains, etc. _____
8. Do you think you will have any difficulty in completing today's task? _____

9. Personal remarks (if any) regarding today's test: _____

Figure 6-1. Subject Questionnaire



S-66518

Figure 6-2. Hourly Timing of Scheduled Rest and Data Recording Periods for Typical Test

SECTION 7

TEST RESULTS

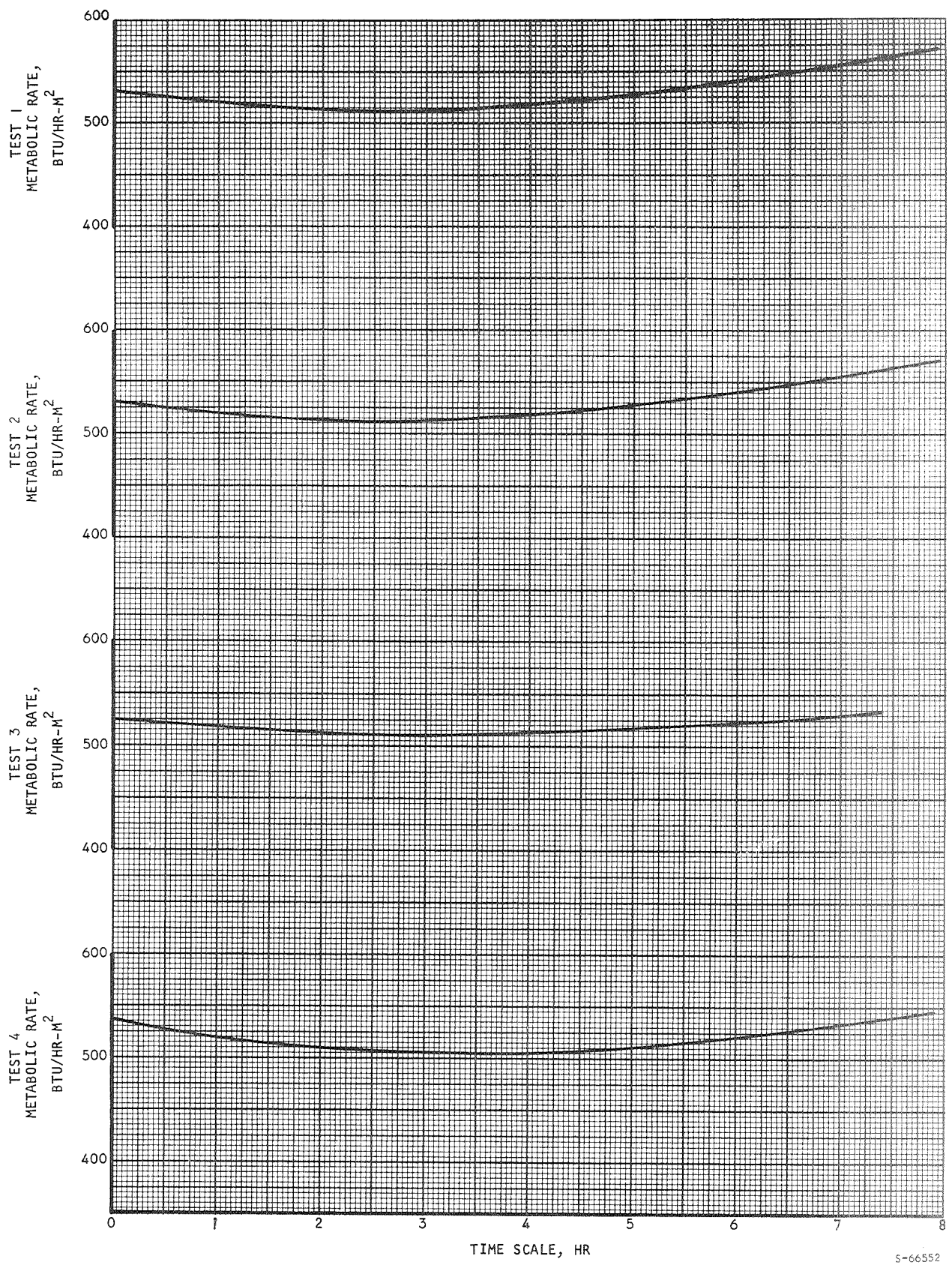
METABOLIC RATE

Figures 7-1 and 7-2 present the metabolic rates as a function of time for all of the eight walking tests. It is clear from these graphs and from statistical tests that no significant differences in the energy cost of walking 3.2 mph for 6 to 8 hr are evident either among tests or from hour-to-hour during the tests. At the end of the first 45 min of walking, the mean metabolic rate for the 8 tests was 527 Btu/hr/m². The maximum deviation from this rate was no greater than ± 16 Btu/hr/m² for any test. After 5 hr, 45 min, the mean value for all tests was 528 Btu/hr/m², and still the extreme values were not more than ± 16 Btu/hr/m². Although the mean values at 3 hr, 45 min and at 7 hr, 45 min (517 and 542 Btu/hr/m², respectively) are not significantly different from the 45 min and the 5 hr, 45 min values, a curvilinear trend is evident in every test. Test 1 shows this tendency to the greatest degree. The means of the data about the 45-min, the 3-hr, 45-min, and the 7-hr, 45-min data points are approximately 512, 514, and 585 Btu/hr/m², respectively. The change in metabolic rate across the duration of this test varied from a decrease of 1 percent to an increase of as much as 22 percent, with an average increase of 14 percent.

In general, then, the data support the conclusion that the energy cost of walking continuously at 3.2 mph, with brief 5- to 10-min/hr rest periods, declined by approximately 2 percent at the midpoint of the test (4 hr) and then increased by approximately 3 percent at the conclusion of the 8-hr test (both percentage values being relative to the initial value). These changes are not statistically significant but are striking in their consistency.

It is clear from the data that no significant differences in the energetic cost of walking 3.2 mph for 6 to 8 hr are evident, either among tests or from hour-to-hour. There is, however, a trend that appears related to the distance walked. Consider that the 8 hr of continuous walking and the 8 hr of walking with 5 min of rest/hr both result in more miles/8 hr than for tests with 8 hr of walking with 10 min of rest per hour. These tests are all compared at equivalent hours-walked. The mean energy values shown in Table 7-1 result.

The data of Table 7-1 show that after approximately 3 to 4 hr of walking during each test, the metabolic rates declined by approximately 3 percent. At the conclusion of the tests, however, the metabolic rates for the tests were different. Whereas the metabolic rates for Tests 3 through 8 returned to the initial values at the end of the tests, the rate for Test 1 was 6 percent greater than the initial value, and the rate for Test 2 was 3 percent greater than the initial value.



S-66552

Figure 7-1. Mean Normalized Metabolic Rates Versus Test Time, Tests 1 through 4

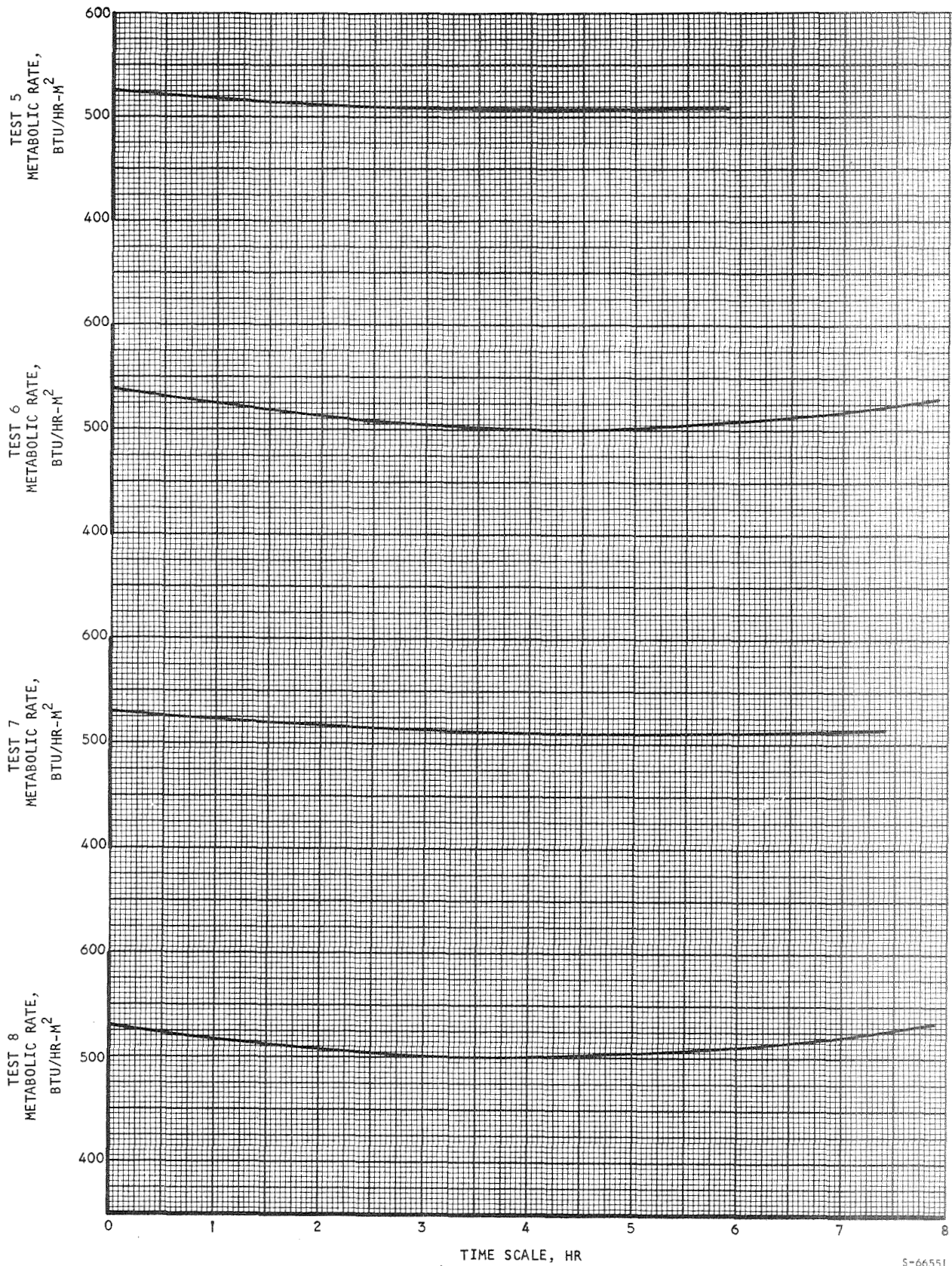


Figure 7-2. Mean Normalized Metabolic Rates Versus Test Time, Tests 5 through 8

TABLE 7-1

METABOLIC RATES AT EQUIVALENT DURATIONS OF WALKING

Time of Observation	Mean Energy Value During Inclusive Interval, Btu/hr-m ²		
	Tests 3 Through 8 (10 min/hr Rest)	Test 1 (No Rest)	Test 2 (5 min/hr Rest)
0:15 to 1:00	526	514	526
3:00 to 3:45	511	512	516
5:00 to 5:45	518	526	538
7:00 to 7:45	527	545	541

At the end of 8 hr of continuous walking at 3.2 mph, however, the mean increase in the energetic cost experienced by the subjects was 14 percent (relative to the initial value) and the range was from a 1 percent decrease to a 22 percent increase.

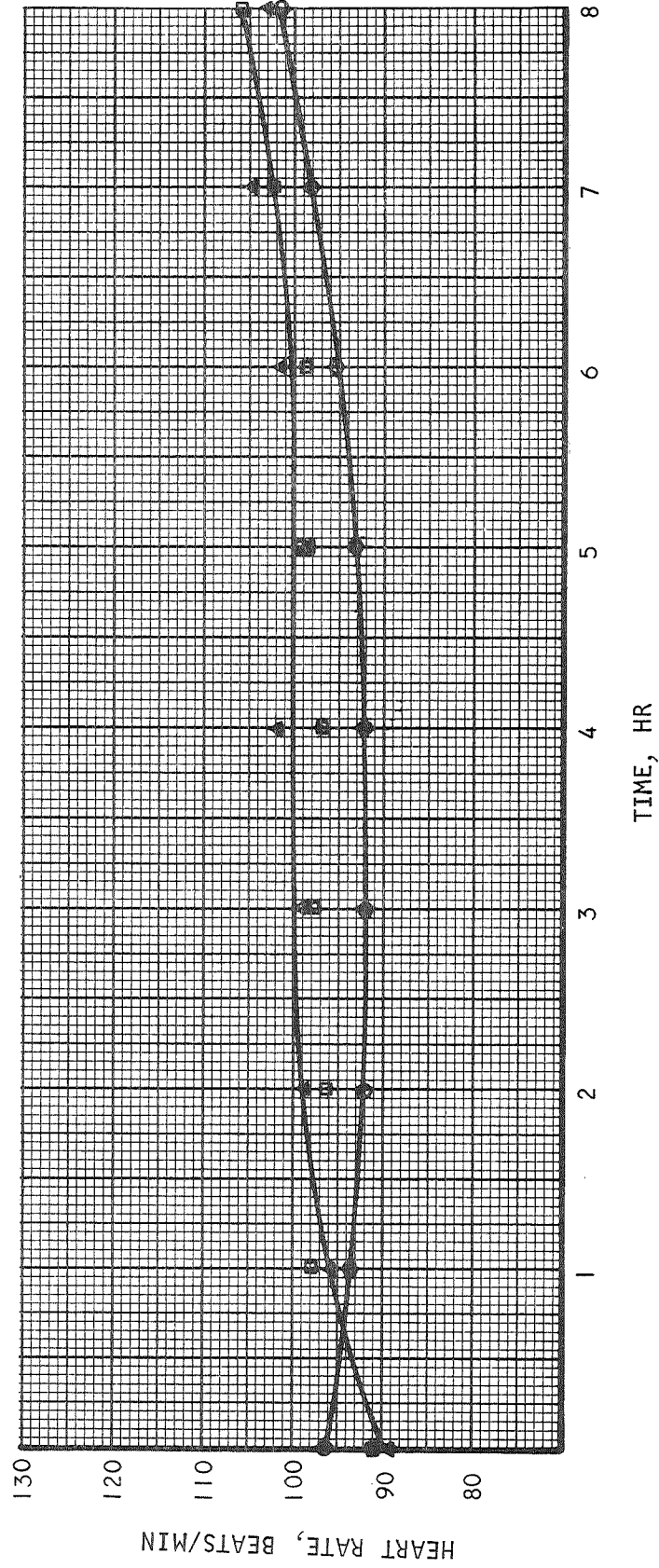
In general, the data for the energetic cost of walking 3.2 mph for a duration of 6 to 8 hr show that after the first 3 to 4 hr the metabolic rate declined by a few percent, and by the end of the walk the metabolic rate had attained the starting value (in the case of Tests 3 through 8) and had exceeded the starting value by a few percent in the case of Tests 1 and 2. These changes, however, are not statistically significant. Appendix C includes mean metabolic rates by test and subject for these experiments.

HEART RATE

The data for heart rate are presented in Figure 7-3 and Appendix D.

The data for heart rate closely parallel those for metabolic rate. Again there are no significant differences with regard either to test duration or test design. There are, however, discernible trends. The construction of a table of equivalent durations of walking (Table 7-2) shows that there is a slight lowering of heart rate at the midpoint of the test, and thereafter heart rate increases to a value 2 percent greater than the starting values for Tests 3 through 8, 9 percent greater for Test 1, and 7 percent greater for Test 2. These figures are in qualitative agreement with data for metabolic rate. The most marked observation on heart rate is the lack of statistically significant change across the 8-hr test period.

- ▲ TEST 1
- TEST 2
- MEAN VALUE, TESTS 3 THROUGH 8



S-66565

Figure 7-3. Heart Rates During Testing

TABLE 7-2

HEART RATES AT EQUIVALENT DURATIONS OF WALKING

Time of Observation	Mean Heart Rate During Inclusive Interval, Beats/Min		
	Test 3 Through 8 10 min/hr Rest	Test 1 No Rest	Test 2 5 min/hr Rest
0:15 to 1:00	93.3	95.0	96.3
3:00 to 3:45	90.0	98.6	95.6
5:00 to 5:45	92.0	97.9	97.8
7:00 to 7:45	95.5	104	103

RECTAL TEMPERATURE

In general, it will be observed from Figure 7-4 and the data of Appendix E that the starting temperature was approximately 37.2°C, while the temperature at the end of 8 hr of walking was approximately 37.4°C. Thus, under the ambient conditions of these tests (air temperature of approximately 20°C, wind velocity of less than 0.5 mph, and clothing equal to approximately 1 clo), the subjects were in relatively stable thermal equilibrium. There is a consistent trend observable that shows a slight amount of heat storage for all tests, particularly during the last 2 hr of testing.

MINUTE VOLUME

Values for minute volume in reference literature indicate that, at the expected work loads, the anticipated figure would be approximately 20 liters/min. The test data presented in Figure 7-5 and Table 7-3 confirm this expectation.

This parameter, like metabolic rate and heart rate, did not change significantly over the duration of testing or with test design. The trend, however, is qualitatively similar to those reported for metabolic rate and heart rate. With the data normalized for equivalent deviations of walking, each test group shows a slight decline in minute volume at approximately the midpoint of the test, with a recovery to the initial value or a slight increase by the end of the test period.

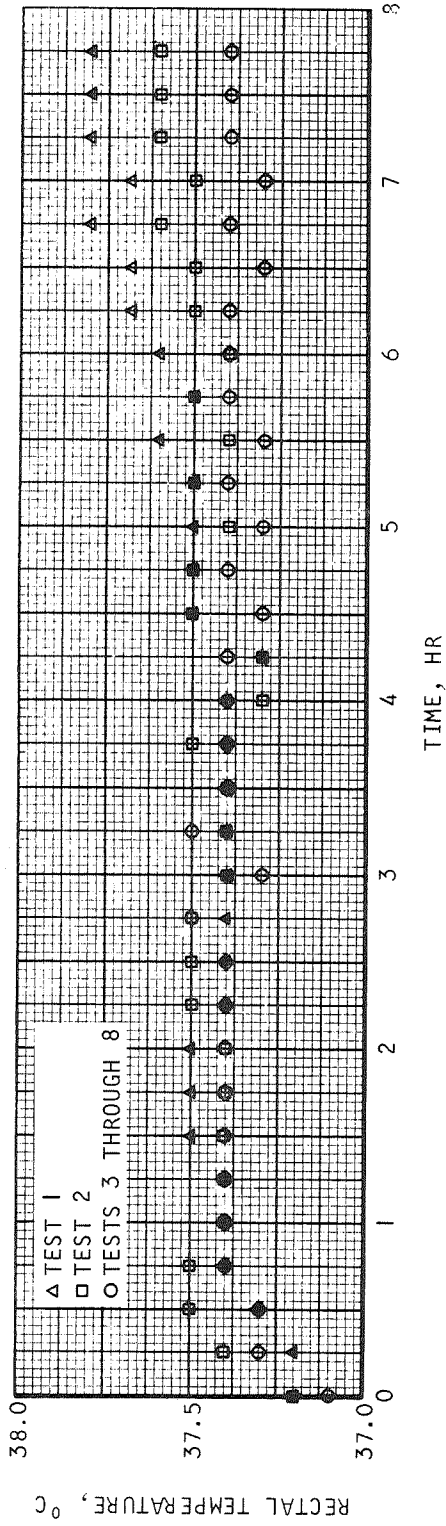


Figure 7-4. Mean Rectal Temperature Versus Time

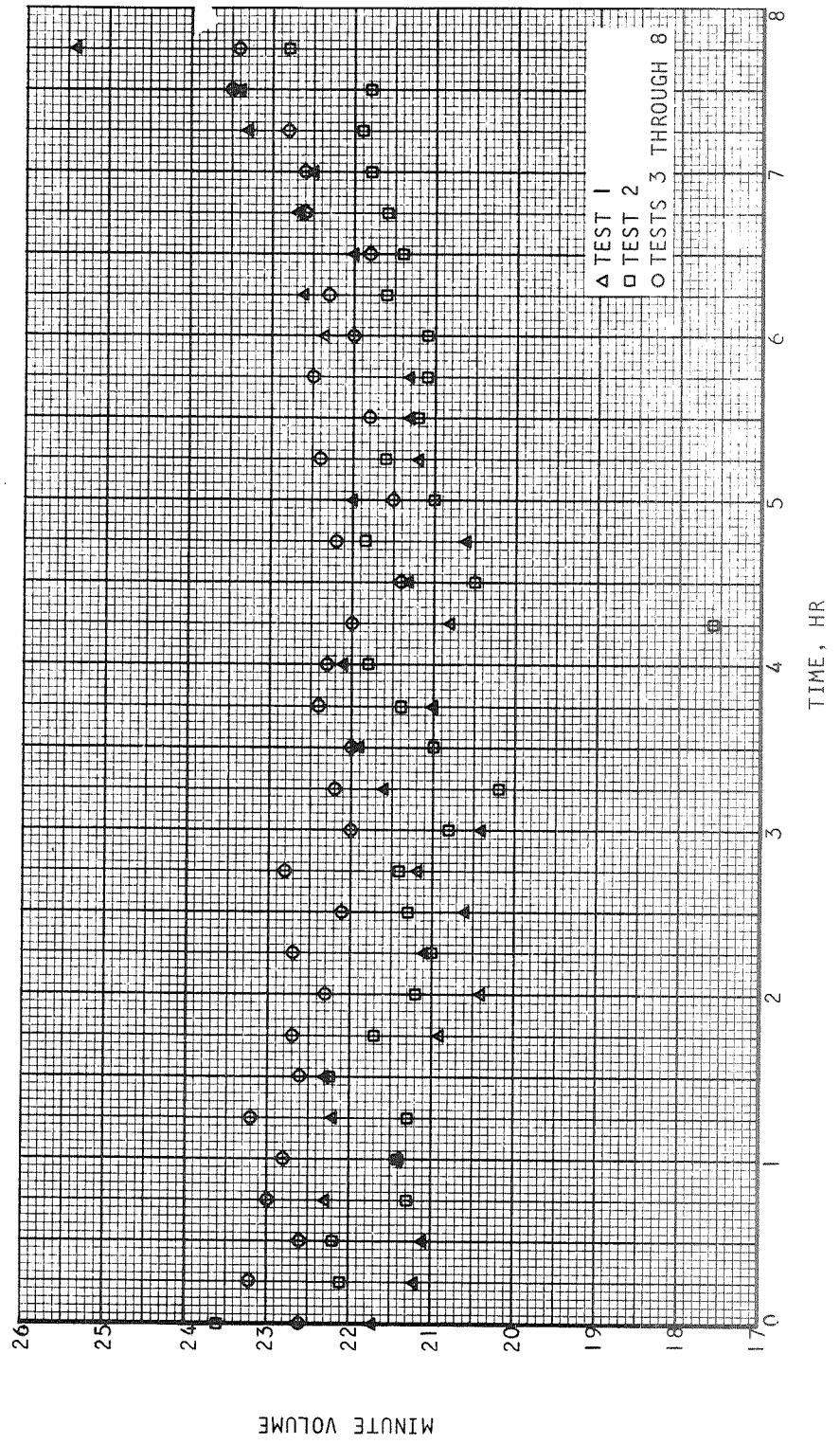


Figure 7-5. Mean Minute Volume Versus Time

TABLE 7-3

MINUTE VOLUME AT EQUIVALENT DURATIONS OF WALKING

Time of Observation	Mean Minute Volume During Inclusive Interval, liters/min		
	Tests 3 through 8 10 min/hr Rest	Test 1 No Rest	Test 2 5 min/hr Rest
0:15 to 1:00	22.9	21.5	21.8
3:00 to 3:45	22.2	21.0	20.8
5:00 to 5:45	22.0	21.4	21.4
7:00 to 7:45	23.1	22.1	21.7

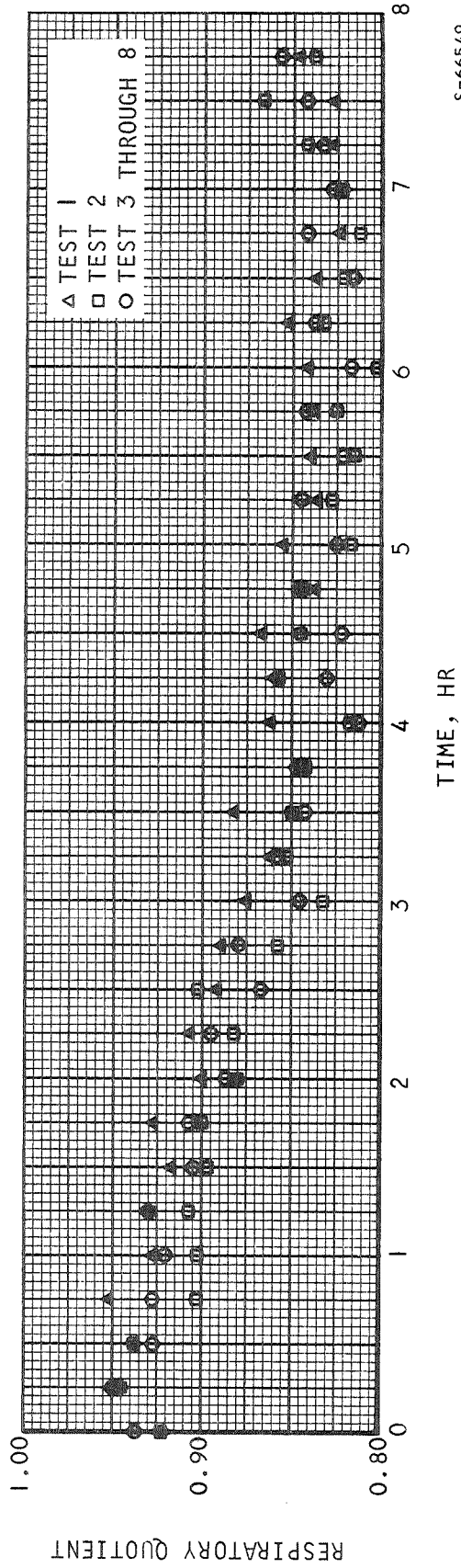
RESPIRATORY QUOTIENT

Both oxygen and carbon dioxide production were calculated for each data point recorded during this test program. The respiratory quotient (RQ) values are reported in Appendix G. Mean RQ values are plotted in Figure 7-6. Figure 7-7 presents plots of oxygen consumption, respiratory quotient, and metabolic rate for Test 6 for direct comparison. Table 7-4 presents a tabulation of the oxygen consumption for this test.

The test data show that the RQ declines steadily from a value of approximately 0.930 at the start of the test to a value of approximately 0.815 after 3 hr, 15 min of testing. Thereafter, the value is relatively constant for the duration of the test.

If the early RQ values do not represent a true steady state with regard to the oxidation of energy stores, the initial values for metabolic rate will be greater than the true values. At most, however, the error would be less than 3 percent (the energy per liter of oxygen at an RQ of 0.930 compared with the energy per liter of oxygen at an RQ of 0.815).

It is evident from Figure 7-7 that the metabolic rate declines slightly for the first 4 hr of testing, after which it begins to increase. The trend is similar to that observed for all subjects. The oxygen consumption data display the same trend. The trend toward a rising metabolic rate during the last 4 hr of the test is valid, but is not statistically significant because the oxygen consumption rate is rising in the presence of a constant or slightly declining RQ.



S-66549

Figure 7-6. Mean Respiratory Quotient Versus Time

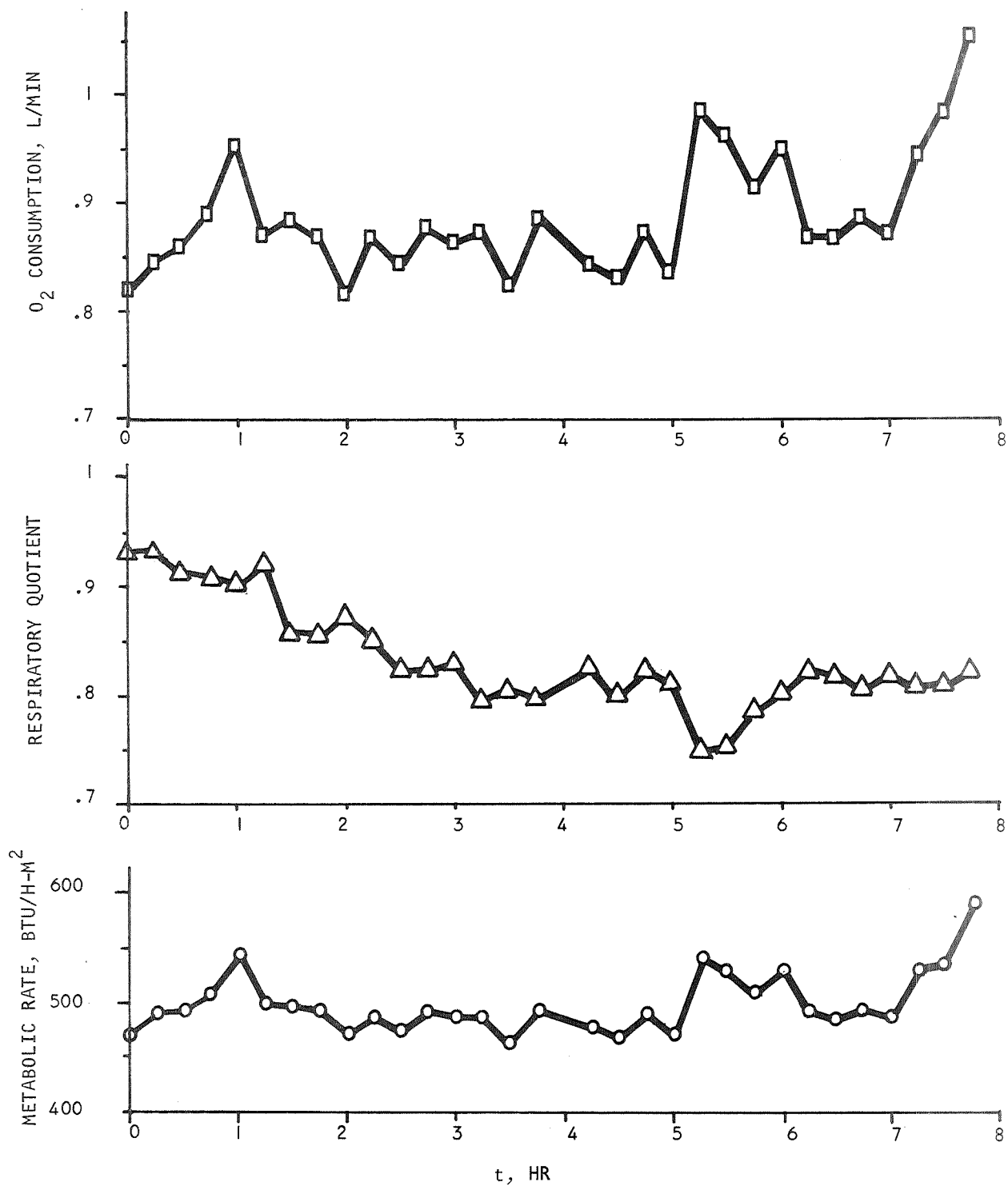


Figure 7-7. Metabolic Rate, Respiratory Quotient, and O₂ Consumption

S-66511

TABLE 7-4

OXYGEN CONSUMPTION, TEST 6 (SUBJECT 10)

Time	\dot{V}_{O_2} (L/min)	Time	\dot{V}_{O_2} (L/min)
0:00	0.824	4:00	--
0:15	0.848	4:15	0.848
0:30	0.858	4:30	0.834
0:45	0.890	4:45	0.872
1:00	0.956	5:00	0.839
1:15	0.870	5:15	0.991
1:30	0.878	5:30	0.964
1:45	0.872	5:45	0.914
2:00	0.828	6:50	0.952
2:15	0.868	6:15	0.868
2:30	0.847	6:30	0.867
2:45	0.878	6:45	0.886
3:00	0.865	7:00	0.870
3:15	0.876	7:15	0.945
3:30	0.825	7:30	0.980
3:45	0.892	7:45	1.058

WATER BALANCE

Subjects were periodically monitored during each test for weight loss, water intake, and urine production. Since weight loss reflects water intake, urine production, perspiration, and catabolism, a simple expression was used to balance these variables:

$$PC = \Delta W + U - I$$

where PC = weight loss due to perspiration + catabolism, gm

ΔW = gross weight change, gm

U = urine output, gm

I = water intake, gm

As long as the variables on the right-hand side of this equation are independent of each other, the values for PC as well as those for U and I can be directly compared for different test conditions. Table 7-5 reports the values of PC, U, and I.

If the subjects had fully compensated for their weight loss by drinking water, the values of water intake (Column 3, Table 7-6) would equal those in Column 2 (perspiration + catabolism). The data show that only approximately one-half the weight loss was compensated for by the intake of water.

Table 7-6 presents this data in a form that is corrected for duration of walking to make the values directly comparable. The data from this table again support the conclusion that Tests 1 and 2 were qualitatively more stressful than Tests 3 through 8. The differences are not statistically significant, but the trend is consistent. Table 7-7 presents the means of the data for Tests 3 through 8 and the values of Tests 1 and 2.

It can be seen from Tables 7-6 and 7-7 that once the data is normalized for actual time spent walking, there is very little difference in the water balance parameters for the various test conditions. Two possible exceptions are evident, the urine production for Test 8 (8 hr of exercise, 10 min/hr rest, following no sleep) and the water consumption of Test 1 (8 hr of walking nonstop).

Substantially more urine was produced in Test 8 than was produced under the other test conditions, while in Test 1, substantially more water was consumed than was consumed during any other test condition. Although neither of these observations is statistically significant, it is relevant to observe that they occur under the two most stressful conditions.

Table 7-8 presents total weight change for each test. This weight change was evaluated using the water balance equation.

TABLE 7-5
WATER BALANCE DATA

Average Values

Test No.	Perspiration + Catabolism,* gm	Water Intake, gm	Urine Output, gm
1	$\bar{X}_8 = 1648$	$\bar{X}_9 = 967$	$\bar{X}_9 = 212$
2	$\bar{X}_9 = 1497$	$\bar{X}_9 = 683$	$\bar{X}_9 = 313$
3	$\bar{X}_{10} = 1245$	$\bar{X}_{10} = 474$	$\bar{X}_{10} = 320$
4	$\bar{X}_{10} = 1246$	$\bar{X}_{10} = 611$	$\bar{X}_{10} = 379$
5	$\bar{X}_{10} = 908$	$\bar{X}_{10} = 319$	$\bar{X}_{10} = 239$
6	$\bar{X}_{10} = 1233$	$\bar{X}_{10} = 551$	$\bar{X}_{10} = 445$
7	$\bar{X}_{10} = 1244$	$\bar{X}_{10} = 662$	$\bar{X}_{10} = 420$
8	$\bar{X}_{10} = 1188$	$\bar{X}_{10} = 580$	$\bar{X}_{10} = 602$

Mean of All Tests \pm Standard Deviation
Weightless from perspiration and catabolism, gm = 1276 \pm 219
Water intake, gm = 600 \pm 188
Urine output, gm = 366 \pm 125

*Weight loss from perspiration + catabolism = change in gross weight + urine output - water intake.

TABLE 7-6

WATER BALANCE CORRECTED FOR WALKING DURATION

Test No.	Perspiration + Catabolism, gm	Water Intake, gm	Urine Output, gm
1	$\bar{X}_8 = 1648$ (1382)*	$\bar{X}_9 = 967$ (811)*	$\bar{X}_9 = 212$
2	$\bar{X}_9 = 1497$ (1384)*	$\bar{X}_9 = 683$ (632)*	$\bar{X}_9 = 313$
3	$\bar{X}_{10} = 1245$	$\bar{X}_{10} = 474$	$\bar{X}_{10} = 320$
4	$\bar{X}_{10} = 1246$	$\bar{X}_{10} = 611$	$\bar{X}_{10} = 379$
5	$\bar{X}_{10} = 908$ (1224)*	$\bar{X}_{10} = 319$ (430)*	$\bar{X}_{10} = 239$
6	$\bar{X}_{10} = 1233$	$\bar{X}_{10} = 551$	$\bar{X}_{10} = 445$
7	$\bar{X}_{10} = 1244$	$\bar{X}_{10} = 662$	$\bar{X}_{10} = 420$
8	$\bar{X}_{10} = 1188$	$\bar{X}_{10} = 580$	$\bar{X}_{10} = 602$

*Corrected value

TABLE 7-7

MEAN 8-HR WATER BALANCE VALUES,
CORRECTED FOR WALKING DURATION

Test No.	Perspiration + Catabolism, grams	Water Intake, grams
3 through 8	1230	811
1	1382	632
2	1384	551

TABLE 7-8

WEIGHT CHANGE PER TEST

Test No.	Weight Change, gm
1	2899
2	2074
3	1399
4	1478
5	988
6	1339
7	1486
8	1166

SECTION 8

DISCUSSION AND CONCLUSIONS

DISCUSSION

All subjects were in agreement concerning the degree of severity of the test. Aside from occasional joint and foot pains, walking at 3.2 mph for 8 hr was not considered to be severely fatiguing. This is not to say that the subjects were not tired; they were, but they all described the walks as not difficult.

Difficulty in maintenance of interest was the most common subject of comment. To combat the monotony of the long walks, a television set was placed for easy viewing by the subjects, and they were encouraged to bring selected reading material. These two techniques appeared to moderate the monotony of the long walks. Apparently the 6-hr mark was the critical one. Once the subjects had passed that time mark they were confident of their ability to complete the tests.

Subjectively, the most difficult test to complete was Test 8, the one following the night of no sleep. Subjects had difficulty in remaining awake during the rest and weighing periods for this test.

Perhaps the most significant ancillary finding to come of this study is the uniformity of the behavior of the RQ parameter.

Each parameter in these tests was measured a total of approximately 10,000 times; even when loss of data due to measurement failure (14 percent) and excessive measurement error (2 percent) is considered, some 85 datum points remain. The consistency of the RQ parameter from subject to subject and from test to test is striking.

A review of the literature--Astrand and Rodahl (Ref. 1); Christensen and Hansen, (Ref. 2); Falls (Ref. 3); and Ricci, (Ref. 4)--indicates that until the Garrett/AiResearch tests had been performed, no measurements of RQ had been recorded over such an extended length of time. The studies of Christensen and Hansen (analytically discussed in Astrand and Rodahl) were not carried past 4 hr (because the subjects were exhausted); their data show clearly that RQ declines smoothly and linearly over the first 3 to 4 hr of work. For the same period (first 3 to 4 hr of exercise), the data from the Garrett/AiResearch test are identical. What Christensen and Hansen could not show (because their subjects worked to exhaustion) was that once the RQ reaches a value of from 0.82 to 0.86 it remains constant for at least 8 hr. This is true, apparently, only as long as the subjects eat a balanced or high carbohydrate diet (the questionnaires filled out by each subject prior to each test reflect a normal mixed diet, as would be expected). The high (approximately 0.93) initial value for RQ indicates that the subject's diet contained a higher percentage of carbohydrates than the diets of the subjects in the study by Christensen

and Hansen who also ate a balanced or high-carbohydrate diet. When the subjects in the Christensen and Hansen study ate a high-fat diet, their RQ remained between 0.7 and 0.8 until the time of exhaustion (never more than 90 min). The explanation of this (Astrand and Rodahl) has to do with the ability of the liver to maintain adequate levels of blood sugar and, consequently, muscle glycogen levels.

It is possible to infer from the Garrett/AiResearch test data something about the level of physiological fatigue experienced by the subjects. These data, and the discussions presented in Astrand and Rodahl, support the tentative conclusion presented in the following sentence from Astrand and Rodahl:

"... assuming a glycogen concentration of 1.5 to 2.0 percent (in terms of glycogen/g wet muscle) at the beginning of exercise, the glycogen utilization at a work level of 25 to 30 percent of the individual's maximum aerobic power would be sufficient to allow him to continue for 8 to 10 hours before depletion of the glycogen deposits."

CONCLUSIONS

The energetic cost of walking at 3.2 mph for up to 8 hr does not significantly increase or decrease throughout the duration of the walk: at the end of 8 hr of continuous walking at 3.2 mph with no rest periods, the mean increase in the energetic cost experienced by the subjects was 14 percent (relative to the initial value) and the range was from a 1 percent decrease to a 22 percent increase.

The data for heart rate closely parallel those for metabolic rate. There are no significant differences with regard to either test duration or test design.

The respiration quotient declines from an initial value of approximately 0.93 to a value of 0.85 near the midpoint of each test. From the midpoint of the test to the end of the test, the RQ remains approximately constant at 0.84.

Physiological estimates of subjective fatigue at metabolic rates of approximately 1000 Btu/hr cannot be obtained from the parameters measured in this program.

It can be concluded that a walking speed of 3.2 mph on a level surface does not induce exhaustion, but this work load must be relatively close to the limit for an 8-hr duration.

REFERENCES

1. Astrand, P. O. and K. Rodahl, Textbook of Work Physiology, McGraw-Hill, New York, 1970.
2. Christensen, E. H. and O. Hansen, Arbeitsfähigkeit and Ernährung, Skand. Arch. Physiol, 1939, 81:160-171.
3. Falls, H. B., Exercise Physiology, Academic Press, New York, 1968.
4. Ricci, B., Physiological Basis of Human Performance, Lea and Febiger, Philadelphia, Penna. 1967.

APPENDIX A

TEMPERATURE PROFILES OF THE TEST FACILITY

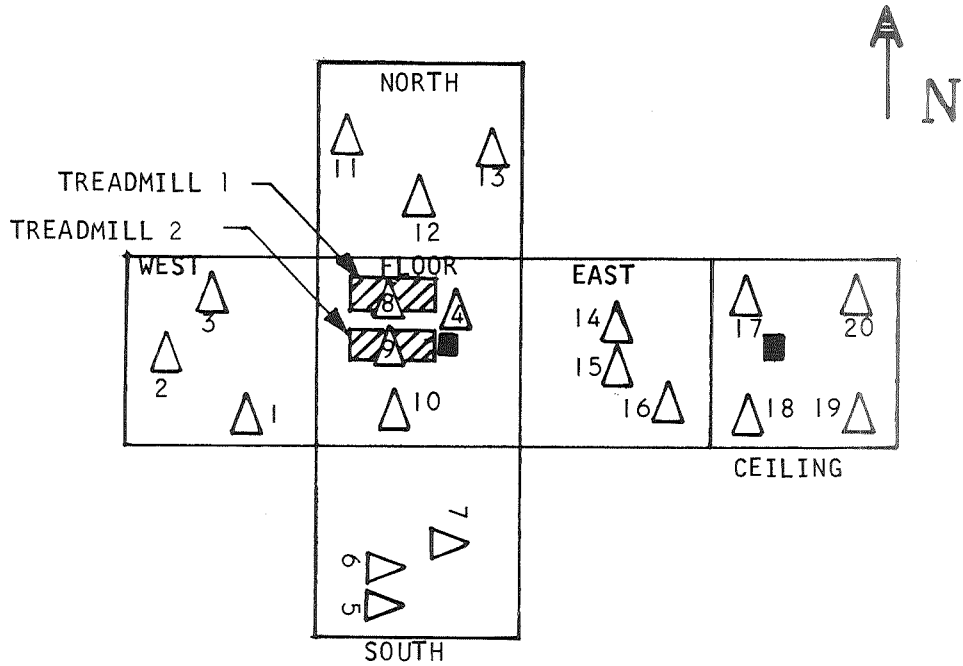
APPENDIX A

TEMPERATURE PROFILES IN THE TEST FACILITY

Temperatures were measured for the test facility using thermocouples in contact with various surfaces and exposed to the ambient air. The location of each of twenty thermocouples attached to the walls, floor, and ceiling are shown in the sketch in Figure A-1. In addition, a thermocouple was located at head height directly over treadmill No. 1. Readings from this thermocouple are designated "ambient air thermocouple" on the accompanying plots of the temperature profiles. Data obtained for six days during the period from Nov. 19 to Dec. 15, 1970 are shown in Figures A-2 through A-7. Rather than plotting all of the temperatures recorded from each thermocouple, a temperature envelope (high and low readings) has been plotted. Zero-hour coincides with the beginning of a day's physiological testing. The temperature of the ambient air is also plotted on each graph.

Note that the maximum temperature rarely exceeded 75°F , while the minimum temperature generally was greater than 66°F . Generally, it was observed that the temperature of the walls of the test facility remained between 68°F and 73°F . Furthermore, the ambient air temperature tended to remain approximately 2°F below the lower border of the surface temperature envelope.

FOLDOUT VIEW OF THE TEST FACILITY SHOWING THE THERMOCOUPLE LOCATION



THERMOCOUPLE IDENTIFICATION Δ

WEST	1, 2, 3
FLOOR	4, 8, 9, 10
SOUTH	5, 6, 7
NORTH	11, 12, 13
EAST	14, 15, 16
CEILING	17, 18, 19, 20

S-66502

Figure A-1. Test Facility Thermocouple Locations

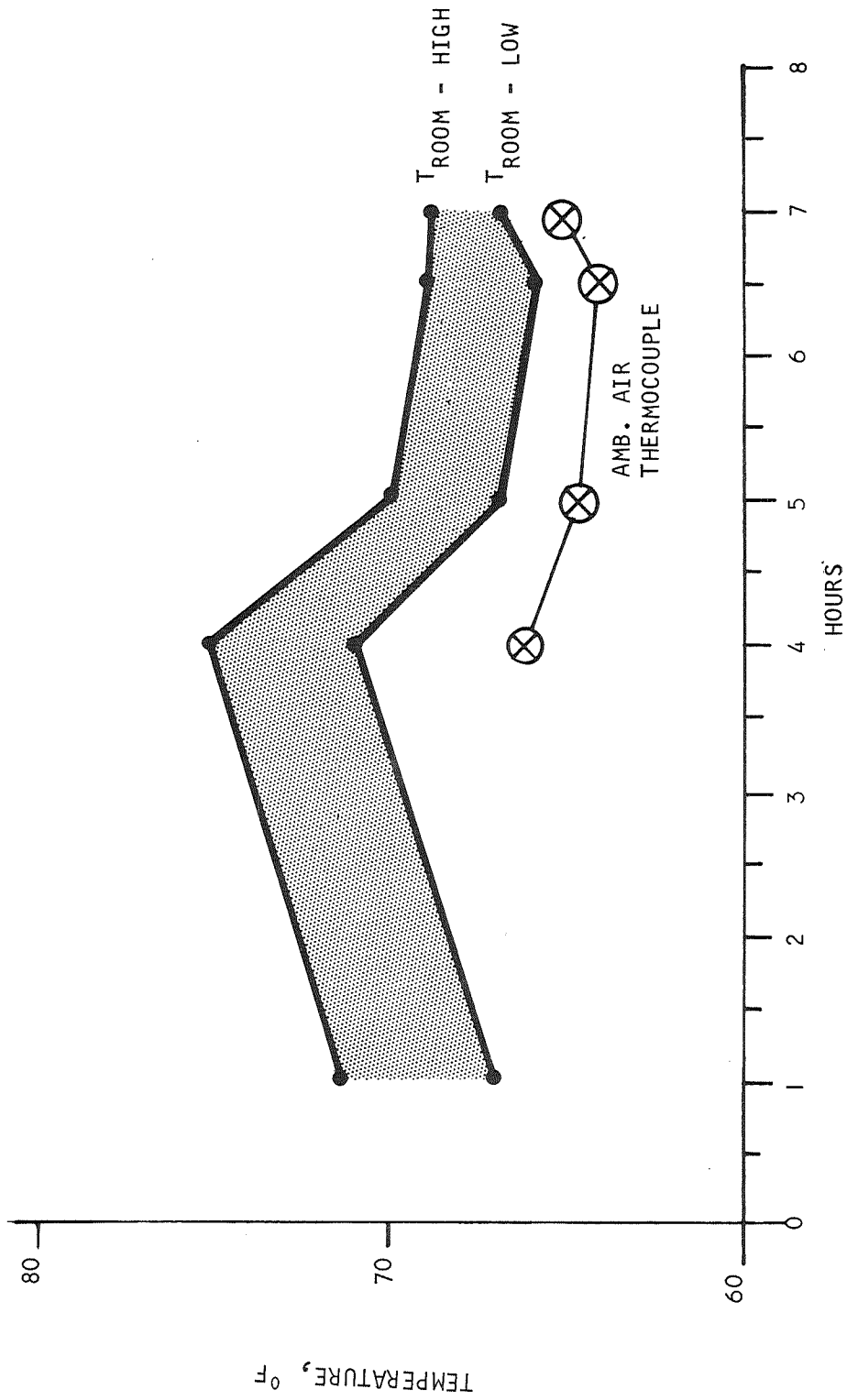


Figure A-2. Fatigue Test Temperature Data

S-66504

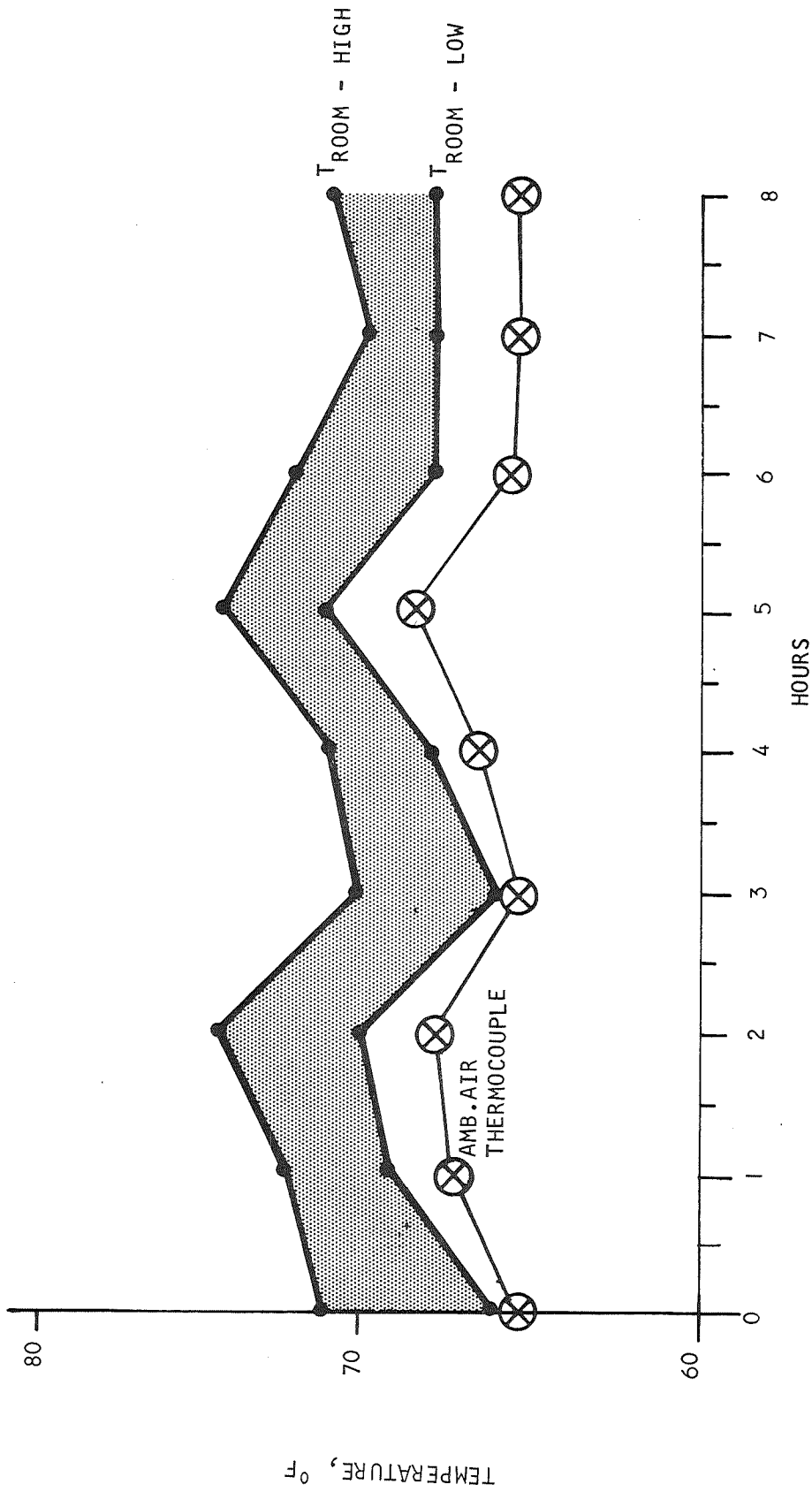
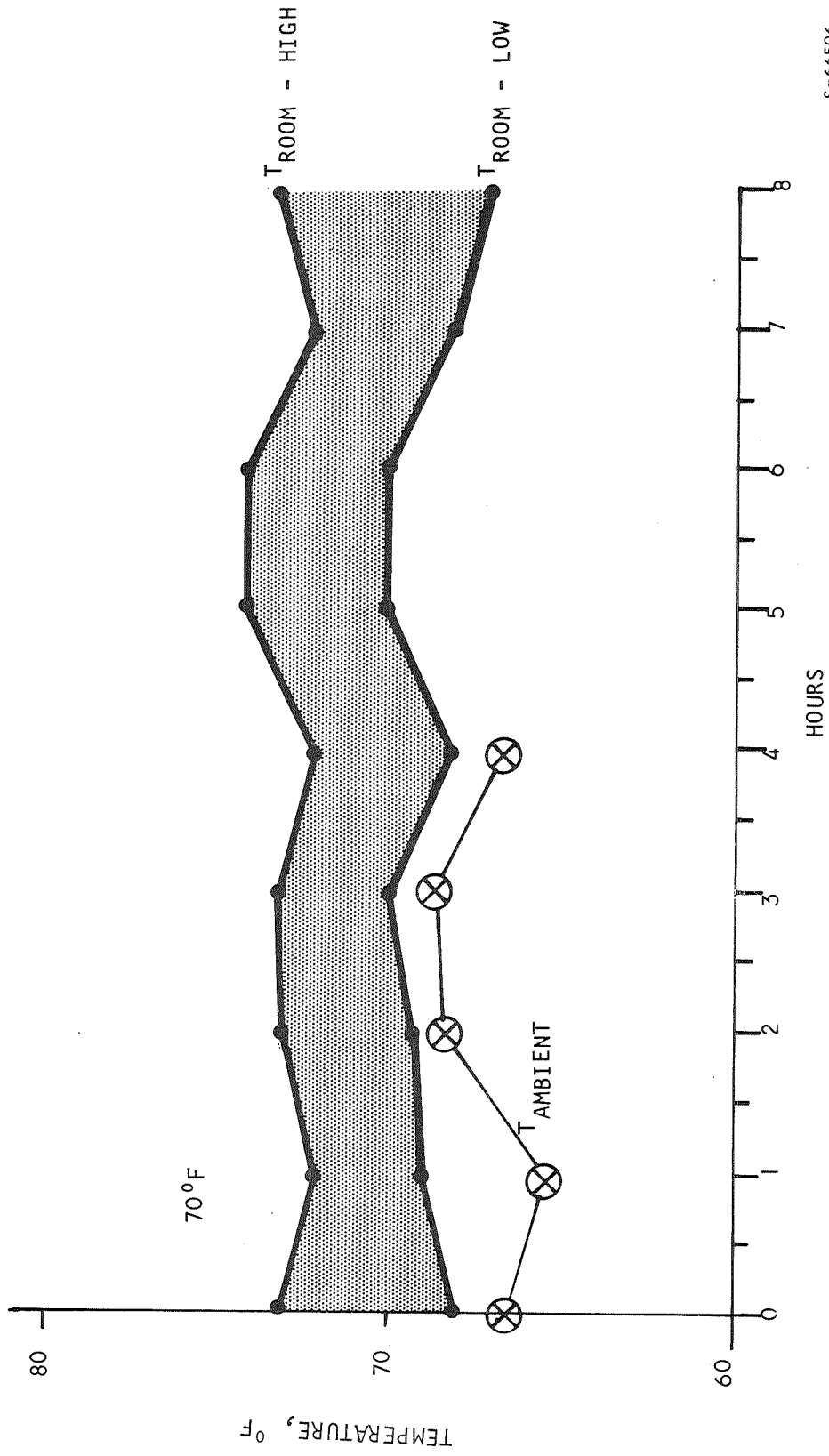


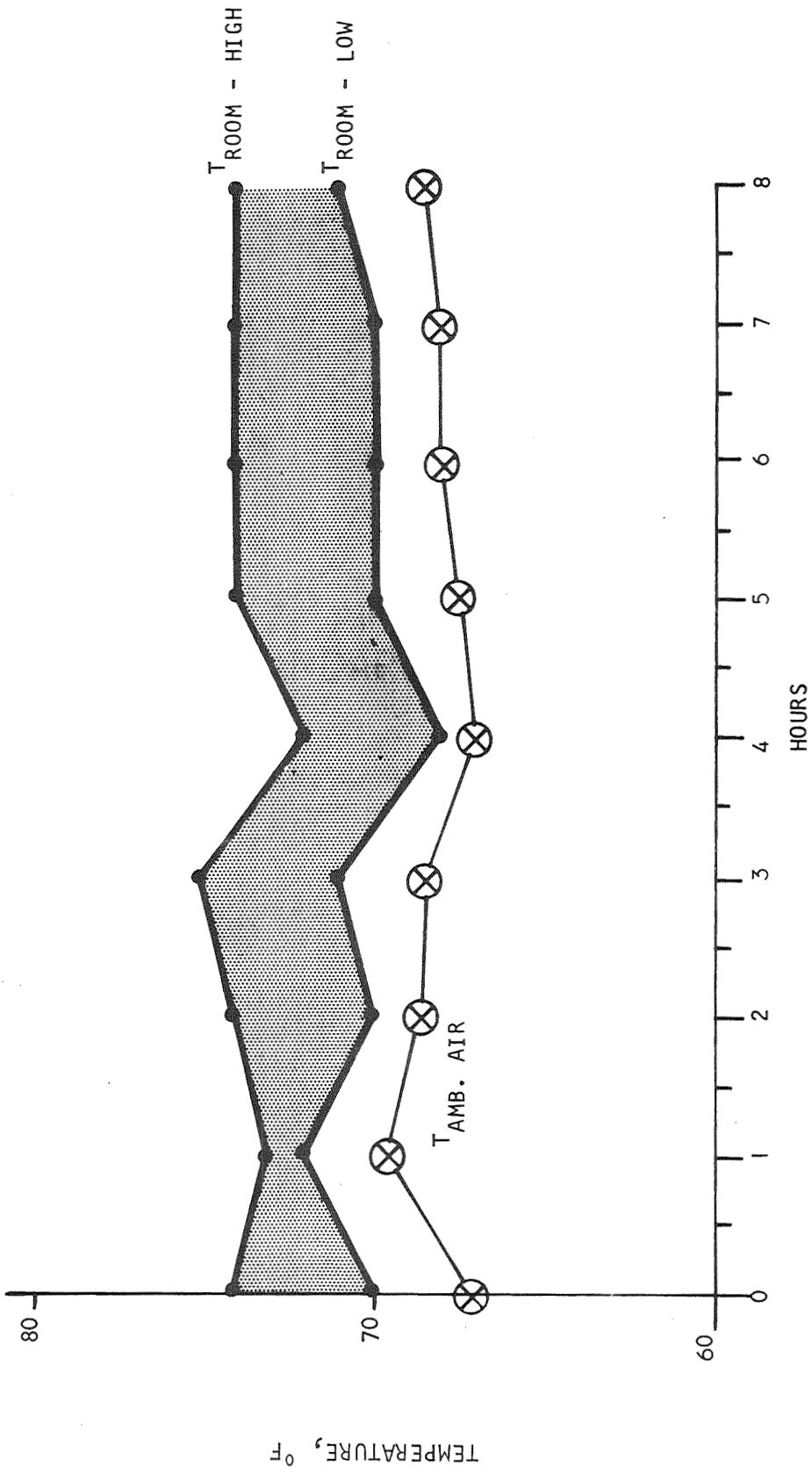
Figure A-3. Fatigue Test Temperature Data

S-66505



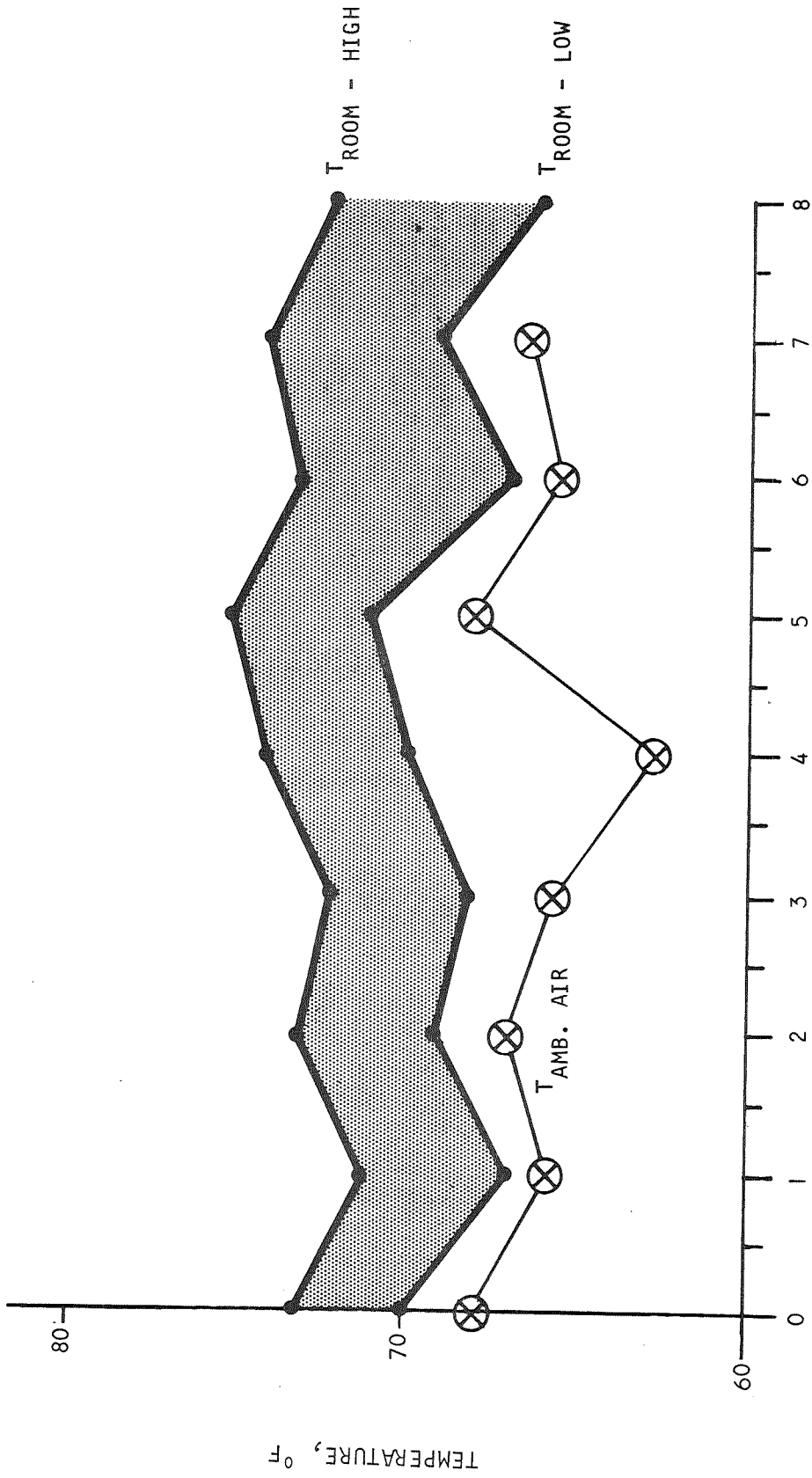
S-66506

Figure A-4. Fatigue Test Temperature Data



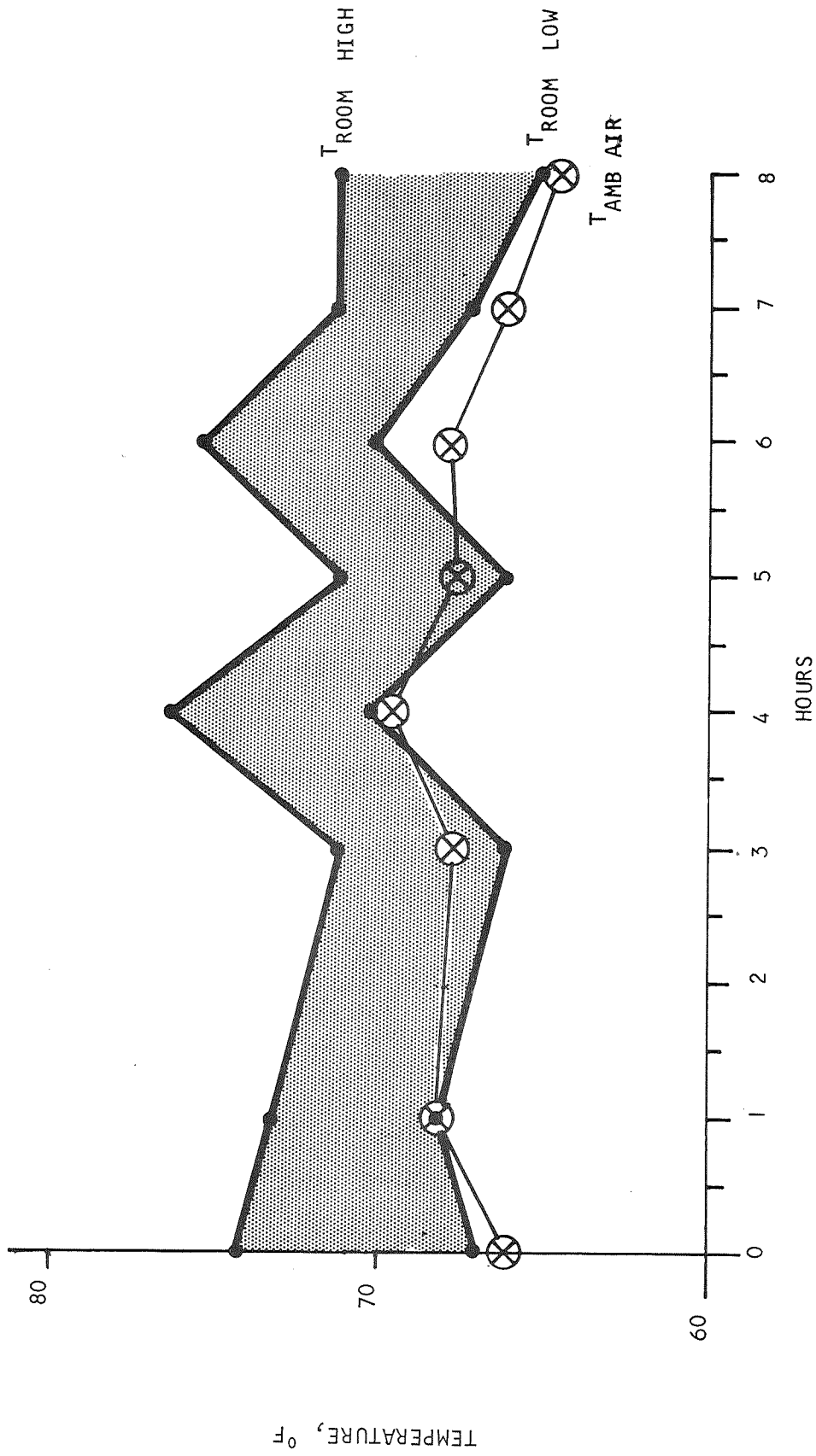
S-66507

Figure A-5. Fatigue Test Temperature Data



S-66508

Figure A-6. Fatigue Test Temperature Data



S-66509

Figure A-7. Fatigue Test Temperature Data

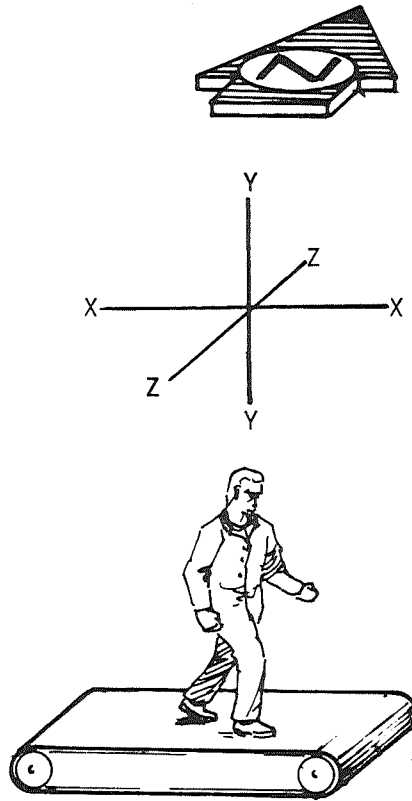
APPENDIX B

WIND VELOCITY IN THE TEST FACILITY

APPENDIX B

WIND VELOCITY IN THE TEST FACILITY

Wind velocity in the test facility was measured at approximately the height of the subject's shoulders directly over each treadmill using a Gellman-Wallac Thermo-Anemometer, Type GGA22/F. These wind velocities, shown in the accompanying figure and table, were judged to be negligible and to have no effect on the physiological data collected during this test program.



TREADMILL NO.	AXIS	WIND VELOCITY	MEAN VALUE
		fps RANGE	
1	XX	0 TO 2.0	0.5
	YY	0 TO 3.0	0.5
	ZZ	0 TO 2.0	0.5
2	XX	0 TO 0	0
	YY	0 TO 1.5	0.5
	ZZ	0 TO 0	0

FATIGUE TEST

THERMO-ANEMOMETER
 GELMAN-WALLAC TYPE
 GGA 22/F REGISTRY
 NO. 45E010 SCALE
 0 TO 15 fps

Figure B-1. Wind Velocity Data

S-66510

APPENDIX C
METABOLIC RATES BY TEST AND SUBJECT

TABLE C-1

TEST I. MEAN NORMALIZED METABOLIC RATES
AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	661	—	513	559	437	—	405	615	528	612	541 \pm 89
0:15	586	462	472	599	434	565	452	541	501	530	514 \pm 59
0:30	571	476	492	514	432	566	451	550	523	626	520 \pm 60
0:45	557	573	449	556	483	511	434	497	496	586	514 \pm 52
1:00	555	474	511	592	459	511	432	519	495	552	510 \pm 48
1:15	560	476	466	557	462	499	471	537	583	706	532 \pm 76
1:30	612	478	474	574	—	536	457	519	—	621	534 \pm 63
1:45	509	469	462	—	480	510	484	517	—	603	504 \pm 45
2:00	—	467	467	—	472	525	468	521	—	622	506 \pm 57
2:15	542	470	435	—	448	544	498	508	—	619	508 \pm 60
2:30	509	478	443	—	477	520	463	557	—	670	515 \pm 72
2:45	536	474	452	—	488	—	465	527	—	669	516 \pm 74
3:00	480	492	461	—	489	518	459	499	477	641	502 \pm 55
3:15	522	462	463	491	494	505	504	532	516	673	516 \pm 57
3:30	528	476	438	—	480	514	445	512	511	655	507 \pm 64
3:45	520	—	468	443	481	523	467	524	543	627	511 \pm 55
4:00	—	530	445	549	—	536	—	—	—	613	535 \pm 60
4:15	462	—	—	—	—	542	—	544	521	—	517 \pm 38
4:30	517	—	429	485	467	566	—	544	538	—	507 \pm 48
4:45	474	578	404	508	486	579	—	564	553	—	518 \pm 62
5:00	544	602	515	500	492	586	—	565	—	—	543 \pm 43
5:15	512	604	461	482	516	610	—	564	—	—	536 \pm 58
5:30	518	—	500	542	479	601	—	553	—	—	532 \pm 43
5:45	524	—	—	512	530	561	—	557	533	—	536 \pm 19
6:00	557	—	478	556	511	581	—	574	550	—	544 \pm 37
6:15	577	—	481	505	521	632	—	586	525	—	547 \pm 53
6:30	565	—	491	488	517	665	—	578	567	—	553 \pm 62
6:45	548	—	488	492	554	569	—	579	572	—	543 \pm 38
7:00	533	—	523	502	531	653	—	593	535	—	553 \pm 52
7:15	579	—	495	621	512	665	—	605	587	—	581 \pm 60
7:30	580	—	495	579	518	651	—	586	583	—	570 \pm 51
7:45	581	—	519	541	—	667	—	638	566	—	585 \pm 57

TABLE C-2

TEST 2. MEAN NORMALIZED METABOLIC RATES
AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	514	-	-	680	-	568	592	547	-	627	588 \pm 59.3
0:15	504	-	500	560	484	525	573	576	456	591	530 \pm 47.1
0:30	524	-	387	608	473	587	543	-	411	600	517 \pm 85.2
0:45	503	-	443	630	486	580	568	549	434	569	529 \pm 66.4
1:00	505	-	430	576	550	529	558	526	476	609	529 \pm 53.7
1:15	605	-	460	566	482	552	508	546	448	594	529 \pm 57.2
1:30	545	-	417	545	-	558	500	555	452	577	519 \pm 57.0
1:45	500	-	430	536	469	554	539	569	451	578	514 \pm 53.7
2:00	486	-	372	546	522	559	516	566	494	547	512 \pm 59.4
2:15	472	-	391	542	480	548	573	538	449	567	507 \pm 61.8
2:30	493	-	379	568	462	569	562	598	451	-	510 \pm 76.1
2:45	509	-	474	567	472	563	607	560	447	-	525 \pm 57.2
3:00	418	-	440	553	464	559	538	569	486	560	510 \pm 58.2
3:15	490	-	447	555	457	588	524	549	474	523	512 \pm 48.0
3:30	485	-	494	586	463	517	563	554	445	533	516 \pm 47.6
3:45	493	-	395	546	532	596	556	562	492	626	533 \pm 67.5
4:00	-	-	-	526	492	-	576	-	484	543	524 \pm 37.7
4:15	505	-	406	-	-	-	-	594	-	-	502 \pm 94.0
4:30	517	-	459	576	473	572	-	-	-	-	519 \pm 54.3
4:45	524	-	456	564	490	593	600	573	485	565	539 \pm 51.9
5:00	513	-	463	551	464	607	564	552	480	571	529 \pm 51.6
5:15	538	-	368	571	518	587	578	576	473	595	534 \pm 73.4
5:30	523	-	389	562	466	584	582	541	498	576	524 \pm 64.9
5:45	519	-	469	560	475	526	581	568	556	585	538 \pm 43.3
6:00	511	-	504	555	491	565	539	-	491	581	530 \pm 35.1
6:15	518	-	511	556	454	593	562	583	492	565	537 \pm 46.1
6:30	533	-	410	579	466	596	590	567	474	596	534 \pm 68.5
6:45	531	-	515	527	470	636	604	553	517	590	549 \pm 51.9
7:00	522	-	542	462	466	623	589	581	555	576	546 \pm 54.8
7:15	539	-	462	487	473	561	588	550	518	552	526 \pm 43.3
7:30	521	-	368	471	470	602	590	606	550	545	525 \pm 77.7
7:45	-	-	484	547	479	639	545	-	533	620	550 \pm 61.3

TABLE C-3

TEST 3. MEAN NORMALIZED METABOLIC RATES
AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	549	522	551	—	443	523	544	527	601	532 \pm 44.2
0:15	554	486	526	503	470	591	534	536	—	551	528 \pm 37.1
0:30	574	453	510	499	468	562	526	562	524	546	522 \pm 40.6
0:45	578	—	495	513	468	609	499	583	534	610	543 \pm 53.0
1:00	575	489	494	501	485	600	483	526	467	598	522 \pm 50.5
1:15	565	—	474	481	—	598	520	548	516	578	535 \pm 44.9
1:30	543	440	466	535	480	603	516	518	515	534	515 \pm 45.4
1:45	561	—	501	502	463	582	537	512	522	579	529 \pm 39.7
2:00	522	427	465	560	466	601	529	532	478	534	511 \pm 51.8
2:15	556	453	489	478	477	598	553	573	—	571	528 \pm 52.9
2:30	546	430	496	488	471	605	526	540	488	553	514 \pm 49.7
2:45	537	494	455	496	489	586	520	533	533	573	522 \pm 39.7
3:00	534	444	470	488	484	617	483	509	530	568	513 \pm 51.2
3:15	516	440	486	501	482	564	546	537	546	581	520 \pm 43.0
3:30	526	426	452	544	502	546	556	536	521	510	512 \pm 42.2
3:45	524	456	514	506	467	603	540	565	518	527	522 \pm 42.8
4:00	—	—	—	—	462	577	491	521	—	555	521 \pm 46.6
4:15	535	465	480	518	—	584	520	—	559	564	528 \pm 41.2
4:30	529	464	449	510	507	—	—	554	524	550	511 \pm 37.7
4:45	545	465	522	553	473	601	523	513	550	—	527 \pm 41.8
5:00	527	430	444	518	470	626	552	510	508	—	509 \pm 59.1
5:15	543	—	468	516	470	602	501	515	544	572	526 \pm 44.5
5:30	544	465	477	510	476	592	552	511	554	552	523 \pm 42.0
5:45	555	—	490	511	456	619	566	518	559	595	541 \pm 51.7
6:00	556	436	505	529	464	596	478	509	530	567	517 \pm 49.1
6:15	553	—	424	519	465	638	572	525	526	556	531 \pm 61.5
6:30	539	468	490	508	451	618	549	509	535	558	522 \pm 48.3
6:45	554	473	446	541	472	630	569	526	536	568	531 \pm 55.1
7:00	562	495	479	529	441	602	502	511	542	579	524 \pm 48.7
7:15	560	475	462	540	470	642	532	517	539	567	530 \pm 54.2
7:30	558	471	502	543	465	591	566	519	534	560	531 \pm 41.5
7:45	551	523	480	528	447	602	—	517	556	594	533 \pm 49.9

TABLE C-4

TEST 4. MEAN NORMALIZED METABOLIC RATES
AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	543	—	512	536	524	574	554	536	510	567	540 \pm 22.5
0:15	547	—	456	552	487	545	528	526	521	511	526 \pm 35.3
0:30	540	—	523	503	473	618	—	571	493	563	535 \pm 47.5
0:45	524	442	454	504	485	578	517	603	527	542	518 \pm 50.2
1:00	411	—	474	529	465	584	500	508	523	574	508 \pm 53.9
1:15	515	—	456	535	478	575	562	486	523	603	526 \pm 48.3
1:30	514	481	499	494	440	551	548	485	499	589	510 \pm 42.5
1:45	523	499	436	503	500	604	559	500	545	535	520 \pm 44.7
2:00	526	506	462	503	445	588	538	564	513	558	520 \pm 44.6
2:15	485	494	476	504	462	568	485	520	512	590	510 \pm 40.6
2:30	517	—	452	491	450	574	541	515	493	497	503 \pm 39.5
2:45	533	474	470	521	489	605	494	538	487	481	509 \pm 41.4
3:00	537	478	487	491	474	613	558	499	528	486	515 \pm 44.2
3:15	504	502	491	523	480	563	—	515	501	527	512 \pm 24.2
3:30	532	—	439	490	—	570	502	—	—	484	503 \pm 44.6
3:45	521	508	—	—	—	589	462	535	488	492	514 \pm 40.8
4:00	—	—	381	—	452	571	569	502	492	—	494 \pm 72.3
4:15	546	535	454	500	461	—	480	517	543	511	505 \pm 34.3
4:30	534	—	—	504	448	569	526	504	524	505	514 \pm 34.4
4:45	527	541	484	542	453	576	540	534	525	505	523 \pm 34.4
5:00	522	—	450	530	433	572	573	507	517	483	510 \pm 48.3
5:15	511	548	471	514	436	555	501	506	534	496	507 \pm 35.4
5:30	529	—	520	494	467	569	548	531	556	505	524 \pm 32.1
5:45	518	598	527	493	439	550	537	513	525	539	524 \pm 40.7
6:00	544	—	491	501	441	596	574	514	534	504	522 \pm 46.3
6:15	535	—	524	516	516	581	512	562	507	504	528 \pm 26.4
6:30	548	—	511	580	447	590	561	556	537	418	528 \pm 59.0
6:45	541	—	501	559	439	584	593	467	549	557	532 \pm 52.4
7:00	536	—	472	534	436	588	619	537	540	491	528 \pm 56.1
7:15	539	—	493	545	459	491	590	526	537	519	522 \pm 37.8
7:30	524	—	524	530	449	526	664	540	531	517	534 \pm 55.6
7:45	529	—	543	571	425	597	634	535	538	555	547 \pm 57.2

TABLE C-5

TEST 5. MEAN NORMALIZED METABOLIC RATES
AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	562	568	455	513	480	580	508	562	546	550	532 \pm 41.5
0:15	571	462	481	541	477	574	483	568	546	469	517 \pm 46.6
0:30	556	473	478	510	495	568	528	554	552	489	520 \pm 35.7
0:45	570	511	487	549	493	570	468	551	562	497	526 \pm 38.5
1:00	561	526	502	491	502	544	504	536	608	502	528 \pm 36.2
1:15	570	530	458	530	-	518	503	539	575	494	524 \pm 36.6
1:30	550	505	458	486	522	-	511	537	566	488	514 \pm 34.0
1:45	572	460	450	490	496	-	514	587	560	500	514 \pm 48.6
2:00	553	484	480	518	539	487	499	528	-	472	507 \pm 28.8
2:15	542	471	469	542	494	-	509	556	561	468	512 \pm 38.6
2:30	548	448	462	492	534	570	550	524	556	471	515 \pm 43.7
2:45	561	466	440	538	520	547	518	520	557	489	516 \pm 39.7
3:00	-	-	437	-	-	-	515	512	548	462	495 \pm 44.6
3:15	545	457	-	-	-	519	-	-	560	-	520 \pm 45.4
3:30	534	457	-	485	473	472	530	553	543	485	504 \pm 36.1
3:45	534	475	524	507	526	523	484	538	548	498	516 \pm 23.9
4:00	517	569	420	509	481	615	497	533	567	495	520 \pm 54.4
4:15	568	460	414	499	453	488	513	520	565	499	498 \pm 48.0
4:30	535	456	458	529	450	548	494	526	553	471	502 \pm 40.7
4:45	537	447	507	503	470	594	516	528	544	482	513 \pm 41.7
5:00	540	419	426	493	496	579	513	516	544	483	501 \pm 50.1
5:15	554	439	435	505	479	592	561	546	549	405	506 \pm 63.8
5:30	548	456	513	483	458	528	514	540	560	482	508 \pm 37.0
5:45	547	455	458	539	490	534	502	534	574	506	514 \pm 38.7
6:00	-	-	-	-	-	-	-	-	-	-	
6:15	-	-	-	-	-	-	-	-	-	-	
6:30	-	-	-	-	-	-	-	-	-	-	
6:45	-	-	-	-	-	-	-	-	-	-	
7:00	-	-	-	-	-	-	-	-	-	-	
7:15	-	-	-	-	-	-	-	-	-	-	
7:30	-	-	-	-	-	-	-	-	-	-	
7:45	-	-	-	-	-	-	-	-	-	-	

TABLE C-6

TEST 6. MEAN NORMALIZED METABOLIC RATES
AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	581	565	—	—	464	720	520	—	506	472	547 \pm 88
0:15	579	565	478	558	476	605	542	534	531	487	538 \pm 46
0:30	564	583	478	505	487	608	515	530	531	490	530 \pm 44
0:45	562	481	466	578	496	634	507	571	470	507	528 \pm 55
1:00	—	481	485	527	490	635	529	575	523	544	534 \pm 52
1:15	—	497	494	607	510	660	520	566	431	497	531 \pm 69
1:30	—	506	470	493	480	536	529	—	505	493	503 \pm 21
1:45	—	497	457	497	500	542	485	—	—	490	495 \pm 25
2:00	—	481	441	508	484	557	512	—	527	468	497 \pm 36
2:15	—	505	434	510	477	631	502	—	518	488	509 \pm 56
2:30	—	508	468	496	483	601	512	—	498	472	505 \pm 42
2:45	—	471	448	574	507	532	540	607	499	490	519 \pm 50
3:00	—	550	462	523	506	526	493	604	490	483	515 \pm 42
3:15	—	460	436	508	483	619	514	539	525	485	508 \pm 53
3:30	—	457	470	—	469	589	407	—	537	458	484 \pm 60
3:45	—	461	453	495	444	600	569	—	507	494	503 \pm 56
4:00	—	—	—	530	—	—	—	—	572	—	551 \pm 30
4:15	548	525	—	530	523	645	521	—	526	474	536 \pm 49
4:30	539	556	445	488	501	589	527	—	521	462	514 \pm 45
4:45	548	517	483	536	475	578	517	—	485	486	514 \pm 35
5:00	570	451	444	514	473	622	517	525	495	467	508 \pm 55
5:15	—	469	469	—	491	582	515	535	524	542	516 \pm 39
5:30	539	482	459	515	473	622	529	533	515	528	520 \pm 45
5:45	541	555	444	552	460	627	521	546	536	505	529 \pm 52
6:00	546	480	471	514	450	630	516	—	543	528	520 \pm 53
6:15	565	496	472	528	470	589	537	562	566	484	527 \pm 44
6:30	548	475	448	512	472	611	509	533	494	483	508 \pm 47
6:45	534	582	455	529	498	612	564	547	532	492	534 \pm 46
7:00	570	—	459	526	473	594	488	539	571	485	523 \pm 49
7:15	546	—	466	543	452	629	539	520	569	527	532 \pm 53
7:30	555	—	437	517	483	636	528	555	555	533	533 \pm 55
7:45	537	—	462	530	476	603	506	524	563	590	532 \pm 48

TABLE C-7

TEST 7. MEAN NORMALIZED METABOLIC RATES
AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	534	460	508	477	610	517	553	605	—	533 \pm 54.6
0:15	551	483	464	521	463	535	551	538	544	552	520 \pm 36.2
0:30	512	550	488	526	478	570	521	558	587	551	534 \pm 35.3
0:45	565	448	512	529	478	551	513	557	581	587	532 \pm 45.0
1:00	545	436	504	498	468	555	540	555	562	540	520 \pm 42.3
1:15	590	445	493	556	484	601	516	551	581	537	535 \pm 50.6
1:30	555	452	463	474	475	532	503	557	558	581	515 \pm 47.1
1:45	552	471	490	509	483	529	511	540	593	562	524 \pm 38.5
2:00	551	486	462	506	525	594	508	549	578	510	527 \pm 41.0
2:15	559	484	426	544	497	550	491	524	588	587	525 \pm 51.0
2:30	529	409	470	473	471	540	503	587	556	512	505 \pm 51.4
2:45	534	421	511	—	481	567	497	515	544	599	519 \pm 51.4
3:00	561	388	477	566	492	550	531	559	554	565	524 \pm 57.1
3:15	534	460	462	533	478	526	538	540	559	468	510 \pm 38.1
3:30	546	418	448	515	474	534	615	527	566	578	522 \pm 60.6
3:45	555	406	446	569	480	563	521	536	564	522	516 \pm 55.4
4:00	—	—	—	510	—	—	—	—	—	550	530 \pm 28.3
4:15	542	441	—	—	480	541	505	535	—	—	507 \pm 40.6
4:30	567	411	507	—	500	546	498	525	544	545	516 \pm 45.9
4:45	500	412	472	526	391	536	511	558	556	611	507 \pm 67.3
5:00	498	430	509	—	443	—	504	545	558	562	506 \pm 49.5
5:15	561	416	544	496	459	557	484	529	624	564	523 \pm 60.3
5:30	437	427	—	516	463	517	509	523	598	540	503 \pm 53.5
5:45	530	438	536	526	473	541	517	537	588	576	526 \pm 44.0
6:00	549	395	502	520	483	563	515	535	571	551	518 \pm 51.4
6:15	518	—	—	542	466	555	525	523	561	580	534 \pm 34.7
6:30	486	434	485	507	470	560	533	539	537	508	506 \pm 38.0
6:45	492	416	518	517	458	559	504	540	575	576	515 \pm 51.2
7:00	512	408	507	526	466	584	503	550	576	570	520 \pm 54.4
7:15	494	416	562	510	458	567	515	532	560	605	522 \pm 56.1
7:30	535	409	503	528	468	605	476	549	550	537	516 \pm 54.4
7:45	564	428	459	548	461	584	483	546	559	540	517 \pm 54.1

TABLE C-8
 TEST 8. MEAN NORMALIZED METABOLIC RATES
 AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	553	455	—	555	536	606	433	577	559	499	530 \pm 51.0
0:15	543	432	444	545	548	606	511	591	536	497	525 \pm 56.2
0:30	557	414	450	544	511	590	504	595	564	493	522 \pm 59.2
0:45	562	428	429	535	548	582	—	559	558	—	525 \pm 61.1
1:00	561	420	409	553	519	621	504	550	531	471	514 \pm 65.7
1:15	591	422	444	535	497	599	482	545	541	421	508 \pm 65.2
1:30	561	475	420	540	437	572	516	537	560	—	519 \pm 49.7
1:45	564	411	480	537	514	600	524	548	512	474	516 \pm 52.7
2:00	554	418	515	506	519	591	479	542	517	—	516 \pm 48.5
2:15	571	409	524	547	479	609	579	510	—	—	536 \pm 64.6
2:30	546	410	455	547	472	596	492	524	—	486	503 \pm 56.1
2:45	568	431	479	557	458	589	534	519	535	506	518 \pm 49.9
3:00	544	421	532	554	455	574	502	549	526	465	512 \pm 49.9
3:15	560	416	499	540	448	598	498	556	544	485	514 \pm 55.6
3:30	604	384	476	557	453	555	518	521	531	605	520 \pm 68.2
3:45	551	384	455	—	436	626	476	528	543	—	500 \pm 76.8
4:00	—	—	—	—	—	—	—	—	519	—	519
4:15	556	410	—	—	468	—	—	—	517	567	504 \pm 65.1
4:30	572	391	450	—	493	566	528	519	426	492	493 \pm 61.4
4:45	545	416	455	—	464	524	520	564	489	575	506 \pm 53.5
5:00	570	402	472	—	470	569	534	542	544	540	516 \pm 56.0
5:15	543	412	483	—	487	585	490	490	—	563	507 \pm 54.9
5:30	544	449	482	—	489	566	402	544	547	548	508 \pm 55.7
5:45	543	419	494	—	471	622	483	543	506	561	516 \pm 59.0
6:00	552	491	498	—	489	611	488	554	563	—	531 \pm 45.8
6:15	556	428	494	—	476	633	502	591	523	570	530 \pm 63.3
6:30	541	442	480	—	478	554	487	579	513	571	516 \pm 47.6
6:45	564	421	495	—	477	595	505	531	536	556	520 \pm 52.1
7:00	541	404	500	—	460	601	497	534	528	565	514 \pm 58.1
7:15	570	468	—	—	461	606	512	501	539	561	527 \pm 50.9
7:30	551	450	—	—	472	593	492	594	522	566	530 \pm 54.9
7:45	—	451	—	—	467	517	562	542	536	590	532 \pm 53.5

APPENDIX D
HEART RATES BY TEST AND SUBJECT

TABLE D-1

TEST I. MEAN NORMALIZED HEART RATE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	108	—	87.5	105	90.6	81.7	109	82.2	81.2	72.0	90.8 \pm 13.4
0:15	105	97.8	81.0	99.7	89.3	84.5	109	93.9	79.0	81.4	92.7 \pm 10.1
0:30	102	100	88.1	90.2	90.6	99.0	112	94.2	75.3	90.0	94.1 \pm 9.9
0:45	103	101	88.2	106	90.2	96.5	111	99.9	73.4	94.4	96.4 \pm 10.7
1:00	98.1	100	86.7	106	92.8	103	104	105	75.6	98.4	97.0 \pm 9.5
1:15	94.4	101	87.9	96.7	93.2	106	106	102	76.2	101	96.6 \pm 9.4
1:30	92.1	97.8	89.0	93.4	—	103	107	101	—	104	99.2 \pm 7.1
1:45	89.1	97.8	87.7	—	88.4	101	110	105	—	108	99.7 \pm 8.9
2:00	—	95.7	82.6	—	88.3	106	109	109	—	111	100 \pm 11.4
2:15	89.3	95.7	81.4	—	86.9	108	103	104	—	111	97.4 \pm 10.7
2:30	88.8	95.4	82.2	—	95.9	—	105	110	—	117	99.2 \pm 12.2
2:45	89.0	93.3	82.1	—	93.0	106	111	106	—	118	99.8 \pm 12.3
3:00	88.7	94.6	88.0	—	94.0	107	110	103	75.8	121	98.0 \pm 13.6
3:15	89.2	97.0	86.5	91.9	92.2	106	104	102	82.3	122	97.3 \pm 11.6
3:30	90.6	99.1	85.5	—	89.0	108	115	105	82.7	122	99.7 \pm 13.7
3:45	87.6	—	105	92.6	102	107	116	102	81.0	122	102 \pm 13.1
4:00	—	101	88.7	95.2	—	110	—	—	—	105	100 \pm 8.3
4:15	90.1	—	—	—	—	—	—	106	76.9	—	91.0 \pm 14.6
4:30	97.5	91.8	92.5	95.4	97.4	104	—	108	80.3	—	95.9 \pm 8.4
4:45	93.1	115	92.0	96.1	100	106	—	107	82.0	—	98.9 \pm 10.4
5:00	92.9	102	95.8	95.2	107	105	—	103	82.2	—	97.9 \pm 8.1
5:15	95.8	100	95.9	100	106	104	—	104	85.0	—	98.8 \pm 6.7
5:30	97.4	—	99.5	116	110	104	—	102	79.4	—	101 \pm 11.5
5:45	99.7	—	99.2	103	115	104	—	106	84.4	—	102 \pm 9.2
6:00	101	—	98.8	112	121	103	—	107	79.6	—	103 \pm 12.8
6:15	103	—	102	103	124	110	—	106	80.6	—	104 \pm 12.9
6:30	103	—	99.2	102	132	119	—	103	81.3	—	106 \pm 16.0
6:45	102	—	101	100	137	—	—	103	85.0	—	105 \pm 17.2
7:00	103	—	103	98.8	140	108	—	101	85.2	—	106 \pm 16.8
7:15	103	—	102	107	134	109	—	107	84.5	—	107 \pm 14.6
7:30	106	—	102	114	138	138	—	102	86.6	—	112 \pm 19.3
7:45	108	—	102	104	111	107	—	98.5	87.1	—	103 \pm 7.9

TABLE D-2

TEST 2. MEAN NORMALIZED HEART RATE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	—	—	105	—	102	97.1	102	51.0	87.7	90.8 \pm 20.4
0:15	111	—	73.6	109	86.1	105	104	98.8	75.1	90.8	94.8 \pm 14.1
0:30	112	—	90.1	107	88.2	102	104	—	78.0	91.1	96.6 \pm 11.5
0:45	110	—	102	107	84.6	107	97.2	98.2	84.8	91.3	98.0 \pm 9.5
1:00	106	—	103	104	88.2	102	102	95.3	73.0	88.5	95.8 \pm 10.8
1:15	105	—	102	103	84.4	98.0	99.1	97.1	77.0	83.2	94.3 \pm 10.1
1:30	102	—	106	102	—	110	98.9	95.7	77.9	85.2	97.2 \pm 10.8
1:45	104	—	108	95.3	82.7	124	95.0	96.6	76.8	87.3	96.6 \pm 14.2
2:00	94.9	—	106	99.8	79.8	103	87.7	91.9	73.4	83.0	91.1 \pm 11.0
2:15	96.4	—	111	96.5	85.5	107	95.5	92.1	74.8	87.4	94.0 \pm 11.0
2:30	99.5	—	111	98.5	85.2	104	98.7	90.3	75.6	83.2	94.0 \pm 11.2
2:45	102	—	112	102	83.4	106	102	95.7	86.3	—	98.7 \pm 9.7
3:00	100	—	110	98.6	83.7	106	96.8	92.6	80.1	86.0	94.9 \pm 10.1
3:15	95.2	—	112	98.2	88.2	120	97.7	96.0	90.8	83.7	98.0 \pm 11.4
3:30	97.3	—	112	98.5	84.0	67.2	102	91.3	76.7	88.3	90.8 \pm 13.6
3:45	96.7	—	114	95.4	86.7	107	103	102	78.4	86.7	96.7 \pm 11.2
4:00	92.6	—	—	97.6	83.7	—	101	—	79.6	85.4	90.0 \pm 8.4
4:15	—	—	112	—	—	—	—	97.0	—	—	104 \pm 10.6
4:30	95.1	—	116	103	88.0	90.6	—	—	—	—	98.5 \pm 11.3
4:45	100	—	113	94.4	90.6	127	102	101	80.0	87.1	99.5 \pm 14.1
5:00	106	—	87.5	99.6	85.2	88.5	105	102	77.7	85.9	93.0 \pm 10.2
5:15	105	—	95.9	104	91.1	123	108	101	76.3	88.0	99.1 \pm 13.4
5:30	105	—	107	102	91.6	117	112	101	76.1	85.0	99.6 \pm 13.1
5:45	106	—	97.8	103	94.3	110	110	106	84.2	85.6	99.7 \pm 9.8
6:00	104	—	100	104	90.8	114	105	—	82.3	88.5	98.6 \pm 10.5
6:15	105	—	107	99.0	93.8	135	112	106	85.1	89.4	104 \pm 14.7
6:30	111	—	111	98.8	94.1	112	113	108	86.4	81.8	102 \pm 12.0
6:45	112	—	105	97.6	103	110	118	112	87.3	85.1	103 \pm 11.4
7:00	109	—	109	95.0	101	113	116	110	84.8	81.2	103 \pm 11.4
7:15	112	—	105	98.9	101	110	122	113	87.2	88.0	104 \pm 11.6
7:30	107	—	110	103	108	113	122	—	89.6	86.3	105 \pm 11.8
7:45	110	—	106	104	108	113	126	—	89.5	85.1	105 \pm 13.0

TABLE D-3

TEST 3. MEAN NORMALIZED HEART RATE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	95.2	87.8	93.8	91.1	106	100	93.1	70.6	98.9	92.9 \pm 9.9
0:15	102	88.2	89.3	90.4	90.8	107	99.6	96.2	—	96.0	95.5 \pm 6.4
0:30	101	88.2	88.0	88.8	87.9	106	102	88.0	77.1	95.4	92.2 \pm 8.7
0:45	100	—	81.0	87.6	89.8	107	98.1	92.8	82.3	93.4	93.1 \pm 7.6
1:00	95.8	90.2	86.1	88.1	—	106	95.4	87.6	75.1	91.1	90.6 \pm 8.4
1:15	95.9	—	84.4	83.8	88.7	102	96.2	86.4	78.4	87.7	89.3 \pm 7.4
1:30	93.4	87.6	83.8	84.4	76.8	104	93.7	88.2	83.1	90.1	88.5 \pm 7.5
1:45	97.6	—	86.8	91.1	81.4	105	93.3	89.6	80.1	91.5	90.7 \pm 7.7
2:00	92.5	86.0	84.4	82.9	84.2	106	96.3	90.4	83.4	83.4	89.0 \pm 7.5
2:15	95.8	89.0	86.8	73.9	83.8	106	91.3	85.1	—	87.7	88.8 \pm 8.8
2:30	98.1	96.8	85.3	79.8	86.6	108	94.2	86.0	45.8	88.3	86.9 \pm 16.6
2:45	96.7	90.8	83.9	85.2	88.0	107	92.2	84.1	77.5	90.1	90.0 \pm 8.1
3:00	90.2	90.1	83.2	79.4	84.4	107	94.0	84.5	77.0	86.4	87.6 \pm 8.5
3:15	91.9	91.7	88.4	86.3	85.1	107	97.6	91.2	94.4	89.3	92.3 \pm 6.3
3:30	99.0	91.4	83.6	81.8	85.2	107	97.8	87.1	69.9	89.3	89.2 \pm 10.4
3:45	92.4	96.0	89.2	89.0	86.2	108	103	87.8	67.2	85.8	90.5 \pm 11.0
4:00	—	—	—	—	—	107	98.1	85.8	—	93.3	96.0 \pm 8.9
4:15	93.4	92.9	85.3	80.9	85.7	106	102	—	88.2	93.0	91.9 \pm 8.1
4:30	90.2	96.5	83.8	85.0	89.1	—	—	87.3	79.2	90.7	87.7 \pm 5.2
4:45	110	96.3	89.7	89.0	93.9	110	97.9	88.7	79.2	—	95.0 \pm 10.1
5:00	92.0	92.2	86.0	86.6	95.8	109	102	86.9	56.2	—	89.6 \pm 14.7
5:15	98.9	—	91.7	88.0	93.9	109	100	92.2	70.8	94.4	93.2 \pm 10.4
5:30	95.9	90.2	87.3	86.2	100	110	102	80.8	79.0	95.7	92.7 \pm 9.8
5:45	104	—	90.4	88.6	92.8	111	103	94.7	78.4	91.2	94.9 \pm 9.7
6:00	95.4	90.5	85.6	85.3	96.4	111	104	89.0	82.4	91.8	93.1 \pm 8.9
6:15	96.3	—	92.9	86.3	90.6	113	108	90.9	83.5	95.4	95.2 \pm 9.6
6:30	97.1	101	92.8	87.8	99.3	110	106	89.2	81.3	92.4	95.7 \pm 8.7
6:45	97.2	102	95.0	90.0	92.4	139	108	92.0	83.3	94.2	99.3 \pm 15.5
7:00	93.8	102	92.8	84.9	98.2	112	107	91.4	84.6	92.6	95.9 \pm 8.9
7:15	99.9	104	90.2	88.2	100	113	106	93.0	85.4	93.6	97.3 \pm 8.7
7:30	101	101	90.3	88.8	103	110	111	94.5	87.5	97.8	98.5 \pm 8.3
7:45	98.2	101	90.7	93.3	—	113	—	94.2	90.9	98.2	97.4 \pm 7.3

TABLE D-4

TEST 4. MEAN NORMALIZED HEART RATE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	—	95.2	95.3	79.7	106	113	97.7	83.6	83.3	94.2 \pm 11.6
0:15	102	—	95.0	95.5	79.0	105	109	91.4	83.0	89.5	94.4 \pm 9.9
0:30	94.0	—	94.5	88.1	74.8	104	—	90.6	75.3	95.7	89.6 \pm 10.1
0:45	97.8	100	95.4	91.0	86.0	102	102	87.6	76.7	100	93.8 \pm 8.4
1:00	97.9	94.6	90.6	84.3	83.2	99.3	100	85.6	75.1	103	91.4 \pm 9.1
1:15	93.8	95.4	91.9	91.8	81.6	98.6	107	86.8	75.9	105	92.8 \pm 9.7
1:30	93.9	96.2	83.5	87.4	81.6	98.7	107	87.6	75.1	109	92.0 \pm 11.0
1:45	91.1	99.3	91.6	90.6	75.4	101	95.3	89.6	73.8	100	90.8 \pm 9.5
2:00	93.9	95.8	86.0	90.8	79.3	102	95.9	86.9	73.5	109	91.3 \pm 10.5
2:15	91.2	94.6	93.2	77.8	80.9	105	99.2	87.8	74.3	104	90.8 \pm 10.6
2:30	92.2	93.0	89.4	84.6	78.3	108	93.9	83.2	71.1	106	90.0 \pm 11.4
2:45	96.5	96.8	85.8	90.2	80.8	104	97.4	91.0	72.7	106	92.1 \pm 10.3
3:00	91.5	94.6	86.6	86.1	77.3	104	96.0	87.0	76.6	103	90.3 \pm 9.4
3:15	93.3	95.8	92.4	89.9	83.8	104	—	89.8	76.1	98.4	91.5 \pm 8.1
3:30	91.2	94.6	91.4	86.0	—	104	89.6	—	—	102	94.1 \pm 6.6
3:45	93.8	98.6	—	—	—	107	95.8	89.3	76.1	101	94.5 \pm 9.9
4:00	—	—	86.0	—	83.9	106	101	85.0	79.6	—	90.2 \pm 10.6
4:15	94.1	100	92.4	78.6	85.4	—	94.3	87.1	75.1	102	89.9 \pm 9.1
4:30	96.5	—	—	88.2	82.4	106	93.2	85.0	73.6	107	91.5 \pm 11.6
4:45	97.6	100	96.6	82.6	84.7	104	95.4	89.7	76.8	101	92.8 \pm 9.0
5:00	90.2	—	93.6	88.5	83.1	105	95.7	88.8	77.2	101	91.5 \pm 8.6
5:15	94.9	102	93.9	84.3	87.4	106	100	90.6	78.5	93.5	93.1 \pm 8.3
5:30	97.4	—	94.1	87.9	82.8	107	96.0	91.8	76.0	103	92.9 \pm 9.7
5:45	96.8	110	91.0	91.5	84.8	105	100	93.3	79.3	98.0	95.0 \pm 9.1
6:00	94.5	—	92.7	92.2	81.8	105	101	88.6	79.5	102	93.0 \pm 8.8
6:15	96.2	—	97.0	93.9	88.9	107	104	91.5	79.1	105	95.8 \pm 8.9
6:30	95.4	—	95.3	89.5	85.6	106	105	90.8	76.8	105	94.4 \pm 9.9
6:45	96.7	—	99.3	92.7	88.1	107	104	97.4	79.8	103	96.4 \pm 8.5
7:00	93.7	—	92.8	88.7	85.4	108	104	93.4	78.9	108	94.8 \pm 10.1
7:15	97.0	—	97.3	94.5	86.2	103	110	93.0	78.1	104	95.9 \pm 9.6
7:30	92.3	—	95.6	96.1	85.4	102	111	93.0	78.3	102	95.1 \pm 9.6
7:45	99.3	—	96.0	99.8	89.3	108	110	94.1	82.2	111	98.9 \pm 9.7

TABLE D-5

TEST 5. MEAN NORMALIZED HEART RATE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	98.8	92.0	—	79.6	75.3	102	106	91.8	80.2	90.5	90.7 \pm 10.6
0:15	98.8	100	92.5	86.1	76.9	98.7	109	96.2	83.2	83.5	92.5 \pm 9.8
0:30	102	95.8	88.8	88.4	69.8	97.4	101	90.0	79.1	85.8	89.8 \pm 10.0
0:45	101	90.0	90.7	91.4	84.1	98.7	106	92.4	76.4	87.4	91.8 \pm 8.5
1:00	93.8	87.6	86.8	87.6	78.0	96.7	95.4	91.5	79.5	89.1	88.6 \pm 6.2
1:15	93.8	90.4	88.9	87.3	—	97.3	105	93.7	78.2	89.5	91.6 \pm 7.4
1:30	96.3	89.2	83.3	88.3	80.5	99.7	98.0	87.3	79.0	87.2	88.9 \pm 7.1
1:45	92.6	91.0	86.7	90.8	80.0	99.0	100	94.0	83.1	85.3	90.2 \pm 6.5
2:00	87.4	89.2	81.9	86.6	81.8	92.4	97.4	93.8	—	87.4	88.7 \pm 5.2
2:15	90.5	94.0	85.2	90.0	75.8	99.7	103	89.7	81.9	89.2	89.9 \pm 8.0
2:30	89.0	90.7	84.3	85.9	75.7	98.6	96.0	88.3	82.6	83.9	87.5 \pm 6.6
2:45	93.0	92.1	83.3	96.9	82.2	102	95.1	92.2	85.1	90.2	91.2 \pm 6.2
3:00	—	—	84.6	—	—	—	95.8	92.3	80.4	85.9	87.8 \pm 6.2
3:15	95.0	89.4	—	—	—	99.9	—	—	75.9	—	90.0 \pm 10.4
3:30	89.6	88.7	—	89.8	80.0	97.3	94.2	89.3	81.0	87.6	88.6 \pm 5.5
3:45	90.3	96.6	82.0	91.6	78.9	103	97.7	90.8	80.6	89.3	90.1 \pm 7.8
4:00	90.0	97.4	82.3	83.0	73.6	104	99.0	92.6	79.7	88.3	89.0 \pm 9.5
4:15	89.9	93.5	86.3	89.7	79.1	97.8	102	93.0	79.4	93.7	90.4 \pm 7.3
4:30	89.4	91.4	84.2	83.4	78.1	105	102	91.2	80.5	90.8	89.6 \pm 8.7
4:45	97.3	92.6	87.3	92.3	83.0	103	104	91.8	87.0	91.2	93.0 \pm 6.8
5:00	93.0	94.1	83.9	89.4	77.0	106	101	90.4	82.9	88.3	90.6 \pm 8.6
5:15	101	96.2	86.5	93.8	83.0	108	103	93.5	84.4	91.7	94.1 \pm 8.2
5:30	100	95.0	86.5	89.9	79.8	105	98.9	90.0	84.6	90.9	92.1 \pm 7.7
5:45	102	98.8	88.3	89.5	80.8	108	104	91.4	81.5	90.6	93.5 \pm 9.3
6:00	—	—	—	—	—	—	—	—	—	—	
6:15	—	—	—	—	—	—	—	—	—	—	
6:30	—	—	—	—	—	—	—	—	—	—	
6:45	—	—	—	—	—	—	—	—	—	—	
7:00	—	—	—	—	—	—	—	—	—	—	
7:15	—	—	—	—	—	—	—	—	—	—	
7:30	—	—	—	—	—	—	—	—	—	—	
7:45	—	—	—	—	—	—	—	—	—	—	

TABLE D-6

TEST 6. MEAN NORMALIZED HEART RATE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	94.9	98.2	—	—	79.5	—	105	96.7	95.3	110	97.1 \pm 9.6
0:15	117	101	82.2	93.0	81.6	—	104	102	81.3	93.1	95.0 \pm 12.2
0:30	105	95.4	84.6	94.7	78.0	—	102	95.9	79.3	93.7	92.1 \pm 9.5
0:45	106	94.2	87.8	95.1	77.7	—	105	95.8	75.2	92.5	92.1 \pm 10.6
1:00	—	93.7	87.4	88.1	80.2	—	109	94.8	77.4	87.2	89.7 \pm 9.8
1:15	—	95.6	86.4	89.6	79.6	—	104	97.7	77.3	93.5	90.5 \pm 9.1
1:30	—	92.8	83.4	87.2	81.7	—	105	92.6	79.0	84.4	88.3 \pm 8.4
1:45	—	93.8	83.6	86.4	76.9	—	100	—	82.2	81.9	86.4 \pm 7.9
2:00	—	95.5	79.7	84.6	76.7	—	109	91.6	79.4	83.8	87.5 \pm 10.7
2:15	—	98.6	81.5	87.4	87.0	—	104	—	79.1	84.6	88.9 \pm 9.1
2:30	—	96.8	79.8	81.6	80.8	—	103	—	79.5	83.0	87.2 \pm 9.3
2:45	—	98.4	84.4	86.8	87.0	—	106	90.2	77.2	81.8	89.0 \pm 9.3
3:00	—	91.7	78.8	87.5	78.0	—	96.5	88.2	74.2	87.6	85.3 \pm 7.6
3:15	—	92.1	84.1	83.8	78.2	—	103	93.8	77.8	85.4	87.3 \pm 8.5
3:30	—	92.6	77.5	80.3	83.6	—	95.8	84.3	78.7	86.4	84.9 \pm 6.5
3:45	—	91.8	80.8	85.2	80.1	—	105	—	80.0	85.8	87.0 \pm 9.0
4:00	—	—	—	82.4	—	—	—	—	76.9	—	79.6 \pm 3.9
4:15	95.0	96.3	—	85.1	91.2	—	103	—	82.6	81.5	90.7 \pm 8.0
4:30	94.2	99.4	99.0	84.0	83.2	—	103	—	81.0	80.7	90.6 \pm 9.3
4:45	93.3	98.3	93.1	88.7	99.1	—	104	—	78.5	86.4	92.7 \pm 8.1
5:00	93.8	97.4	87.1	81.2	87.7	—	104	91.3	74.1	83.6	88.9 \pm 9.0
5:15	97.4	99.6	88.5	87.0	85.7	—	100	89.5	75.2	90.7	90.4 \pm 7.9
5:30	92.0	95.8	92.4	87.3	87.3	—	103	91.8	77.1	91.6	90.9 \pm 7.0
5:45	90.9	106	93.5	91.2	89.7	—	105	92.6	79.7	88.6	93.0 \pm 8.1
6:00	97.0	97.2	—	87.6	89.0	—	106	93.2	78.6	89.3	92.2 \pm 8.1
6:15	98.5	103	99.7	90.1	91.4	—	107	97.3	80.7	89.4	95.2 \pm 8.1
6:30	96.6	101	92.2	94.8	89.0	—	102	96.2	76.5	92.6	93.4 \pm 7.6
6:45	94.8	110	97.6	96.5	79.5	—	110	95.5	82.0	87.2	94.8 \pm 10.8
7:00	92.4	—	95.2	88.7	84.6	—	107	96.0	76.1	89.2	91.2 \pm 9.0
7:15	95.0	—	95.0	94.8	92.8	—	112	98.5	77.8	85.7	94.0 \pm 9.8
7:30	95.7	—	92.0	89.1	89.3	—	108	98.2	76.4	88.0	92.1 \pm 9.1
7:45	97.2	—	95.9	90.5	96.6	—	114	102	82.5	93.1	96.5 \pm 9.1

TABLE D-7

TEST 7. MEAN NORMALIZED HEART RATE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	99.2	95.8	95.7	94.4	107	101	88.7	90.2	—	96.5 \pm 5.9
0:15	114	91.8	94.4	108	93.6	101	107	89.8	86.8	97.2	98.4 \pm 8.9
0:30	110	96.6	90.7	105	90.2	104	108	86.2	88.5	99.9	97.9 \pm 8.7
0:45	110	91.0	93.1	99.7	91.9	98.6	103	94.2	91.7	99.2	97.2 \pm 6.1
1:00	108	87.9	92.2	97.0	90.3	101	101	87.1	90.4	95.0	95.0 \pm 6.7
1:15	103	89.6	92.6	100	93.0	101	99.5	89.0	93.8	94.2	95.6 \pm 4.9
1:30	103	90.7	89.2	99.2	88.0	96.6	101	86.1	92.3	98.0	94.4 \pm 5.9
1:45	102	87.5	93.2	106	86.1	96.9	103	88.9	86.2	94.9	94.5 \pm 7.4
2:00	96.5	87.8	88.8	94.2	85.6	97.5	95.7	87.2	90.1	95.4	91.9 \pm 4.4
2:15	100	92.9	90.4	101	88.4	96.6	104	82.5	91.9	96.2	94.4 \pm 6.5
2:30	95.3	89.4	91.5	91.6	82.3	97.2	99.8	86.7	89.5	88.2	91.2 \pm 5.2
2:45	97.2	90.7	88.2	—	83.5	96.0	104	87.3	90.5	92.8	92.2 \pm 6.1
3:00	93.8	89.6	87.4	98.1	85.0	99.0	101	85.3	90.9	95.4	92.6 \pm 5.8
3:15	97.0	88.4	89.8	97.4	84.7	99.0	105	85.8	90.9	89.7	92.8 \pm 6.5
3:30	94.2	87.3	84.6	95.6	84.5	96.5	105	86.2	90.6	92.6	91.7 \pm 6.5
3:45	100	85.9	90.0	97.3	84.5	97.8	105	88.0	90.6	92.0	93.1 \pm 6.6
4:00	—	—	—	93.7	—	—	—	—	—	92.3	93.0 \pm 1.0
4:15	95.3	89.0	—	—	87.1	99.8	102	85.3	—	—	93.1 \pm 7.0
4:30	99.8	86.3	79.0	—	84.6	93.9	98.1	86.8	88.4	84.9	89.1 \pm 6.8
4:45	97.0	84.2	80.7	99.2	83.4	97.8	102	89.3	87.8	84.0	90.5 \pm 7.8
5:00	98.8	88.2	81.4	94.8	81.6	104	102	85.2	93.4	83.4	91.3 \pm 8.5
5:15	103	89.2	84.2	94.3	82.5	98.8	103	86.8	91.7	87.6	92.1 \pm 7.4
5:30	97.9	90.0	80.3	91.8	87.3	98.3	97.9	84.6	90.0	81.3	89.9 \pm 6.7
5:45	101	92.7	84.6	96.8	91.5	98.5	106	87.6	94.0	87.3	94.0 \pm 6.7
6:00	98.0	96.1	82.1	96.1	85.3	100	103	87.9	103	84.6	93.6 \pm 7.9
6:15	103	100	87.6	99.4	87.9	102	104	90.4	94.8	85.4	95.4 \pm 7.1
6:30	101	88.4	84.2	91.0	87.2	105	100	86.6	93.1	78.7	91.5 \pm 8.3
6:45	102	93.8	87.9	102	84.5	107	105	90.2	93.3	82.6	94.8 \pm 8.7
7:00	101	94.8	85.5	104	86.7	105	108	88.4	94.7	82.8	95.1 \pm 9.1
7:15	106	94.4	86.7	104	89.6	106	103	88.6	95.2	83.4	95.7 \pm 8.5
7:30	108	99.0	84.0	101	88.9	105	103	92.6	92.5	79.6	95.4 \pm 9.4
7:45	112	101	84.4	102	93.8	105	112	96.3	98.2	87.7	99.2 \pm 9.2

TABLE D-8

TEST 8. MEAN NORMALIZED HEART RATE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	101	94.5	—	—	76.6	103	101	92.2	76.8	79.9	90.6 \pm 11.3
0:15	101	97.6	89.1	116	89.2	103	106	92.4	75.2	95.8	96.5 \pm 11.1
0:30	102	91.2	83.8	115	80.9	105	104	95.4	75.8	95.2	94.8 \pm 12.2
0:45	96.0	96.4	89.5	115	89.4	103	99.6	95.7	75.5	—	95.6 \pm 10.8
1:00	93.7	90.5	85.9	110	79.1	102	98.3	90.8	75.9	88.0	91.4 \pm 10.3
1:15	93.3	90.3	85.6	117	80.2	102	97.6	90.5	76.9	89.9	92.3 \pm 11.4
1:30	92.9	88.7	86.0	112	79.0	99.9	94.9	89.2	77.8	89.4	91.0 \pm 10.0
1:45	94.2	91.2	83.2	114	83.3	101	91.9	91.4	80.5	86.6	91.7 \pm 9.9
2:00	95.8	86.7	85.9	109	78.0	103	89.5	87.6	76.1	87.8	89.9 \pm 10.2
2:15	93.8	88.8	85.5	111	77.6	103	97.0	89.8	—	92.6	93.2 \pm 9.8
2:30	90.3	88.1	84.6	112	75.2	99.4	86.9	92.0	—	90.3	91.0 \pm 10.2
2:45	88.0	97.2	85.3	108	74.9	102	90.0	92.4	79.6	87.3	90.5 \pm 10.0
3:00	89.5	96.2	83.2	108	74.5	98.9	87.6	88.8	75.8	86.8	88.9 \pm 10.2
3:15	95.2	90.4	84.2	110	79.5	103	92.4	92.6	71.9	91.5	91.1 \pm 10.9
3:30	88.6	90.4	84.6	110	77.2	100	91.3	87.2	77.5	84.5	89.1 \pm 9.9
3:45	90.9	87.1	91.4	108	78.2	103	91.3	89.9	75.0	—	90.5 \pm 10.4
4:00	—	—	—	—	—	—	—	—	74.8	—	74.8 \pm
4:15	92.0	96.3	—	105	80.8	—	—	89.1	75.3	94.7	90.5 \pm 9.9
4:30	92.7	91.9	82.6	107	76.0	106	84.5	86.9	68.7	90.2	88.6 \pm 11.9
4:45	99.6	90.2	91.0	106	76.7	103	91.0	89.4	74.4	101	92.2 \pm 10.6
5:00	92.5	90.6	85.1	108	75.2	105	79.7	92.2	74.6	92.0	89.5 \pm 11.3
5:15	100	93.2	85.4	102	77.6	105	87.5	89.2	—	95.8	92.9 \pm 8.8
5:30	95.0	98.9	86.0	106	78.5	106	85.0	87.9	70.0	92.8	90.6 \pm 11.5
5:45	94.8	100	85.5	102	81.4	109	85.6	93.8	75.0	98.4	92.6 \pm 10.5
6:00	95.5	94.8	84.1	101	78.8	109	85.3	90.5	74.0	96.9	91.0 \pm 10.6
6:15	96.2	99.6	88.8	102	81.0	105	89.3	90.2	74.4	100	92.6 \pm 9.8
6:30	94.9	101	87.2	105	81.1	108	89.9	92.0	70.8	96.2	92.6 \pm 11.2
6:45	100	103	85.4	103	82.2	108	92.7	91.6	74.7	96.3	93.7 \pm 10.5
7:00	101	97.5	89.2	99.8	80.6	108	88.4	93.3	72.5	95.2	92.6 \pm 10.4
7:15	94.2	105	—	98.0	85.8	106	97.6	88.5	71.0	94.2	93.4 \pm 10.7
7:30	101	106	—	102	83.5	110	92.0	95.0	70.1	99.8	95.5 \pm 12.3
7:45	97.2	101	—	99.1	86.0	107	100	91.0	75.8	104	95.7 \pm 9.8

APPENDIX E

RECTAL TEMPERATURE BY TEST AND SUBJECT

TABLE E-1

TEST 1. MEAN NORMALIZED RECTAL TEMPERATURE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	37.3	—	37.0	37.1	37.1	37.3	37.0	37.3	37.1	37.2	37.2 \pm 0.1
0:15	37.3	37.3	37.1	37.3	37.1	37.5	37.1	37.4	37.2	37.2	37.2 \pm 0.1
0:30	37.4	37.4	37.3	37.4	37.1	37.6	37.1	37.5	37.3	37.3	37.3 \pm 0.2
0:45	37.4	37.5	37.4	37.5	37.1	37.6	37.2	37.6	37.3	37.4	37.4 \pm 0.2
1:00	37.4	37.5	37.4	—	37.1	37.6	37.2	37.6	37.2	37.4	37.4 \pm 0.2
1:15	37.4	37.5	37.5	—	37.2	37.7	37.3	37.7	37.2	37.4	37.4 \pm 0.2
1:30	37.4	37.6	37.5	—	—	37.7	37.3	37.7	—	37.4	37.5 \pm 0.2
1:45	37.4	37.6	37.4	—	37.2	37.7	37.4	37.7	—	37.4	37.5 \pm 0.2
2:00	—	37.5	37.4	—	37.2	37.6	37.4	37.7	—	37.4	37.5 \pm 0.2
2:15	37.3	37.5	37.4	—	37.2	37.7	37.4	37.5	—	37.3	37.4 \pm 0.2
2:30	37.3	37.6	37.3	—	37.2	—	37.4	37.4	—	37.3	37.4 \pm 0.1
2:45	37.3	37.5	37.3	—	37.2	37.8	37.4	37.4	—	37.4	37.4 \pm 0.2
3:00	37.3	37.6	37.3	—	37.2	37.7	37.4	37.4	37.3	37.4	37.4 \pm 0.2
3:15	37.3	37.6	37.3	—	37.2	37.8	37.4	37.5	37.2	37.4	37.4 \pm 0.2
3:30	37.3	37.6	37.3	—	37.3	37.8	37.4	37.5	37.2	37.4	37.4 \pm 0.2
3:45	37.3	—	37.3	—	37.4	37.8	37.3	37.4	37.1	37.4	37.4 \pm 0.2
4:00	—	37.6	37.0	—	—	37.7	—	—	—	37.4	37.4 \pm 0.3
4:15	37.3	—	—	—	—	—	—	37.3	37.2	—	37.3 \pm 0.1
4:30	37.3	37.6	37.2	—	37.4	38.3	—	37.3	37.1	—	37.5 \pm 0.4
4:45	37.4	37.5	37.1	—	37.5	38.3	—	37.4	37.1	—	37.5 \pm 0.4
5:00	37.4	37.5	37.2	—	37.5	38.3	—	37.4	37.1	—	37.5 \pm 0.4
5:15	37.4	37.5	37.2	—	37.6	38.4	—	37.4	37.2	—	37.5 \pm 0.4
5:30	37.4	—	37.3	—	37.7	38.3	—	37.4	37.2	—	37.6 \pm 0.4
5:45	37.4	—	37.2	—	37.5	38.4	—	37.4	37.2	—	37.5 \pm 0.4
6:00	37.4	—	37.2	—	37.9	38.5	—	37.4	37.2	—	37.6 \pm 0.5
6:15	—	—	37.2	—	38.1	38.5	—	37.4	37.2	—	37.7 \pm 0.6
6:30	37.5	—	37.2	—	38.4	38.6	—	37.5	37.2	—	37.7 \pm 0.6
6:45	37.5	—	37.3	—	38.6	38.5	—	37.6	37.2	—	37.8 \pm 0.6
7:00	37.5	—	37.3	—	38.7	38.0	—	37.6	37.3	—	37.7 \pm 0.5
7:15	37.6	—	37.4	—	38.9	—	—	37.7	37.4	—	37.8 \pm 0.6
7:30	37.6	—	37.4	—	39.0	—	—	37.7	37.4	—	37.8 \pm 0.7
7:45	37.7	—	37.4	—	38.8	—	—	37.8	37.5	—	37.8 \pm 0.6

TABLE E-2

TEST 2. MEAN NORMALIZED RECTAL TEMPERATURE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	—	—	37.2	—	37.5	37.2	37.4	36.9	37.2	37.2 \pm 0.2
0:15	37.2	—	37.2	37.5	37.4	37.7	37.3	37.5	37.1	37.4	37.4 \pm 0.2
0:30	37.3	—	37.3	37.7	37.4	37.8	37.4	—	37.2	37.6	37.5 \pm 0.2
0:45	37.3	—	37.2	37.8	37.5	37.9	37.5	37.5	37.3	37.6	37.5 \pm 0.2
1:00	37.3	—	36.2	37.8	37.5	37.8	37.5	37.5	37.1	37.6	37.4 \pm 0.5
1:15	37.2	—	36.5	37.8	37.6	37.9	37.6	37.5	37.2	37.6	37.4 \pm 0.4
1:30	37.3	—	36.5	37.7	—	38.0	37.6	37.5	37.2	37.6	37.4 \pm 0.4
1:45	37.3	—	36.4	37.7	37.6	38.0	37.6	37.5	37.1	37.5	37.4 \pm 0.5
2:00	37.2	—	37.3	37.6	37.5	37.9	37.5	37.4	36.9	37.5	37.4 \pm 0.3
2:15	37.4	—	37.2	37.6	37.5	38.0	37.6	37.4	37.0	37.5	37.5 \pm 0.3
2:30	37.4	—	37.2	37.6	37.5	38.1	37.6	37.3	37.0	37.5	37.5 \pm 0.3
2:45	37.4	—	37.3	37.6	37.5	38.1	37.6	37.4	37.0	—	37.5 \pm 0.3
3:00	37.3	—	37.2	37.5	37.4	37.9	37.4	37.4	36.9	37.4	37.4 \pm 0.3
3:15	37.3	—	37.2	37.6	37.4	38.0	37.5	37.4	36.9	37.4	37.4 \pm 0.3
3:30	37.3	—	37.3	37.5	37.4	38.1	37.5	37.4	37.0	37.3	37.4 \pm 0.3
3:45	37.3	—	37.3	37.7	37.4	38.2	37.5	37.4	37.0	37.4	37.5 \pm 0.3
4:00	37.2	—	—	37.6	37.3	—	37.4	—	36.9	37.4	37.3 \pm 0.2
4:15	—	—	37.3	—	—	—	—	37.3	—	—	37.3 \pm 0.0
4:30	37.2	—	37.2	37.6	37.3	38.1	—	—	—	—	37.5 \pm 0.4
4:45	37.3	—	37.4	37.6	37.3	38.3	37.5	37.3	37.0	37.4	37.5 \pm 0.4
5:00	37.2	—	37.2	37.6	37.2	38.3	37.4	37.4	36.9	37.3	37.4 \pm 0.4
5:15	37.3	—	37.3	37.6	37.3	38.3	37.5	37.4	37.0	37.4	37.5 \pm 0.4
5:30	37.3	—	37.2	37.6	37.3	38.2	37.5	37.4	37.0	37.4	37.4 \pm 0.3
5:45	37.4	—	37.3	37.6	37.3	38.3	37.5	37.4	37.1	37.4	37.5 \pm 0.3
6:00	37.3	—	37.2	37.6	37.3	38.3	37.4	—	37.0	37.3	37.4 \pm 0.4
6:15	37.4	—	37.3	37.6	37.4	38.3	37.5	37.5	37.0	37.4	37.5 \pm 0.3
6:30	37.4	—	37.3	37.6	37.4	38.4	37.6	37.5	37.1	37.4	37.5 \pm 0.4
6:45	37.4	—	37.3	37.6	37.5	38.5	37.6	37.7	37.1	37.4	37.6 \pm 0.4
7:00	37.3	—	37.2	37.5	37.4	38.5	37.5	37.7	37.0	37.3	37.5 \pm 0.4
7:15	37.4	—	37.3	37.6	37.5	38.5	37.7	37.7	37.2	37.3	37.6 \pm 0.4
7:30	37.4	—	37.4	37.5	37.5	38.5	37.8	—	37.2	37.3	37.6 \pm 0.4
7:45	37.5	—	37.5	37.6	37.5	38.6	37.8	—	37.3	37.3	37.6 \pm 0.4

TABLE E-3

TEST 3. MEAN NORMALIZED RECTAL TEMPERATURE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	37.3	37.2	37.0	37.3	37.4	37.2	37.2	36.8	37.1	37.2 \pm 0.2
0:15	37.2	37.4	37.3	37.2	37.3	37.4	37.4	37.3	—	37.3	37.3 \pm 0.1
0:30	37.2	37.4	37.3	37.2	37.3	37.6	36.7	37.3	37.1	37.3	37.2 \pm 0.2
0:45	37.3	—	37.4	37.4	37.5	37.7	37.0	37.4	37.2	37.3	37.4 \pm 0.2
1:00	37.3	37.5	37.4	37.4	—	37.8	36.3	37.3	37.1	37.3	37.3 \pm 0.4
1:15	37.4	—	37.5	37.4	37.5	37.7	36.8	37.3	37.2	37.4	37.4 \pm 0.3
1:30	37.3	37.6	37.4	37.4	37.5	37.7	36.4	37.3	37.1	37.3	37.3 \pm 0.4
1:45	37.4	—	37.4	37.4	37.4	37.7	36.8	37.3	37.1	37.4	37.3 \pm 0.3
2:00	37.4	37.6	37.4	37.3	37.7	37.7	—	37.3	37.0	37.3	37.4 \pm 0.2
2:15	37.4	37.5	37.4	37.3	37.7	37.9	—	37.3	—	37.4	37.5 \pm 0.2
2:30	37.3	37.4	37.3	37.3	37.6	37.8	—	37.2	37.0	37.3	37.4 \pm 0.2
2:45	37.3	37.5	37.3	37.3	37.7	37.8	—	37.4	37.1	37.4	37.4 \pm 0.2
3:00	37.3	37.5	37.3	37.2	37.6	37.7	—	37.3	37.0	37.4	37.4 \pm 0.2
3:15	37.3	37.5	37.3	37.2	37.6	37.8	—	37.5	37.0	37.4	37.4 \pm 0.2
3:30	37.3	37.6	37.2	37.2	37.5	37.7	—	37.4	36.9	37.3	37.3 \pm 0.2
3:45	37.4	37.6	37.2	37.2	37.6	37.8	—	37.5	37.0	37.4	37.4 \pm 0.2
4:00	—	—	—	—	—	37.8	—	37.5	—	37.4	37.6 \pm 0.2
4:15	37.3	37.4	36.8	37.2	37.5	37.8	—	—	37.0	37.4	37.3 \pm 0.3
4:30	37.2	37.5	36.8	37.2	37.5	—	—	37.5	37.0	37.3	37.2 \pm 0.3
4:45	37.3	37.5	37.0	37.3	37.5	37.9	—	37.5	37.0	—	37.4 \pm 0.3
5:00	37.3	37.6	36.6	37.2	37.5	37.9	—	37.5	37.0	—	37.3 \pm 0.4
5:15	37.4	—	37.0	37.3	37.5	37.9	—	37.5	37.1	37.4	37.4 \pm 0.3
5:30	37.3	37.6	36.8	37.2	37.6	37.9	—	37.5	37.1	37.4	37.4 \pm 0.3
5:45	37.4	—	37.0	37.2	37.5	37.9	—	37.5	37.1	37.4	37.4 \pm 0.3
6:00	37.5	37.4	36.7	37.2	37.5	38.0	—	37.4	37.1	37.4	37.4 \pm 0.4
6:15	37.5	—	36.9	37.2	37.4	38.0	—	37.5	37.1	37.4	37.4 \pm 0.3
6:30	37.3	37.5	36.8	37.2	37.5	37.9	—	37.4	37.1	37.4	37.3 \pm 0.3
6:45	37.4	37.6	37.0	37.2	37.5	38.0	—	37.5	37.1	37.5	37.4 \pm 0.3
7:00	37.3	37.6	36.6	37.2	37.5	38.0	—	37.5	37.0	37.6	37.4 \pm 0.4
7:15	37.3	37.6	36.9	37.2	37.5	38.1	—	37.5	37.1	37.4	37.4 \pm 0.3
7:30	37.3	37.6	36.8	37.2	37.5	38.1	—	37.4	37.1	37.6	37.4 \pm 0.4
7:45	37.3	37.6	36.9	37.2	—	38.2	—	37.5	37.2	37.4	37.4 \pm 0.4

TABLE E-4

TEST 4. MEAN NORMALIZED RECTAL TEMPERATURE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	37.0	—	37.3	37.2	37.0	37.5	37.1	37.1	37.0	37.1	37.1 \pm 0.2
0:15	37.2	—	37.4	37.4	37.1	37.8	37.2	37.2	37.2	37.3	37.3 \pm 0.2
0:30	37.3	—	37.5	37.4	37.2	38.0	—	37.2	37.2	37.3	37.4 \pm 0.3
0:45	37.4	37.6	37.7	37.5	37.3	38.1	37.3	37.3	37.3	37.4	37.5 \pm 0.3
1:00	37.4	37.6	37.7	37.1	37.2	38.2	37.3	37.3	37.2	37.5	37.4 \pm 0.3
1:15	37.4	37.7	37.7	37.3	37.3	38.2	37.4	37.3	37.3	37.6	37.5 \pm 0.3
1:30	37.3	37.7	37.6	37.3	37.3	38.2	37.4	37.3	37.1	37.5	37.5 \pm 0.3
1:45	37.4	37.7	37.6	37.4	37.3	38.3	37.4	37.4	37.1	37.4	37.5 \pm 0.3
2:00	37.3	37.8	37.7	37.2	37.3	38.3	37.3	37.4	37.0	37.4	37.5 \pm 0.4
2:15	37.4	37.8	37.6	37.2	37.3	38.3	37.3	37.4	37.1	37.4	37.5 \pm 0.3
2:30	37.3	37.8	37.5	37.2	37.3	38.3	37.2	37.4	37.1	37.4	37.4 \pm 0.4
2:45	37.4	37.7	37.5	37.2	37.3	38.4	37.3	37.3	37.1	37.5	37.5 \pm 0.4
3:00	37.3	37.7	37.5	37.1	37.2	38.4	37.3	37.3	37.0	37.4	37.4 \pm 0.4
3:15	37.3	37.7	37.5	37.1	37.2	38.5	—	37.3	37.1	37.3	37.4 \pm 0.4
3:30	37.2	37.6	36.7	37.1	—	38.4	37.3	—	—	37.3	37.4 \pm 0.5
3:45	37.3	37.6	—	—	—	38.4	37.4	37.2	37.1	37.3	37.5 \pm 0.4
4:00	—	—	36.9	—	37.2	38.4	37.4	37.2	37.0	—	37.4 \pm 0.5
4:15	37.3	37.7	37.0	37.5	37.2	—	37.4	37.2	37.1	37.3	37.3 \pm 0.2
4:30	37.3	—	—	37.0	37.1	38.4	37.3	37.2	37.0	37.2	37.3 \pm 0.5
4:45	37.4	37.8	37.0	37.1	37.1	38.4	37.4	37.2	37.1	37.3	37.4 \pm 0.4
5:00	37.4	—	36.5	37.1	37.0	38.4	37.5	37.2	37.1	37.2	37.3 \pm 0.5
5:15	37.4	37.8	37.0	37.0	37.2	38.4	37.5	37.3	37.2	37.3	37.4 \pm 0.4
5:30	37.4	—	36.9	37.0	37.1	38.3	37.4	37.3	37.1	37.2	37.3 \pm 0.4
5:45	37.4	37.8	37.0	37.1	37.2	38.3	37.5	37.3	37.1	37.3	37.4 \pm 0.4
6:00	37.3	—	—	37.1	37.2	38.3	37.5	37.2	37.0	37.3	37.4 \pm 0.4
6:15	37.3	—	—	37.2	37.3	38.3	37.6	37.2	37.1	37.3	37.4 \pm 0.4
6:30	37.2	—	—	37.1	37.2	38.1	37.5	37.3	37.0	37.3	37.3 \pm 0.3
6:45	37.3	—	—	37.2	37.2	38.2	37.6	37.3	37.1	37.4	37.4 \pm 0.4
7:00	37.3	—	—	37.2	37.2	38.2	37.6	37.3	37.0	37.3	37.4 \pm 0.4
7:15	37.3	—	—	37.3	37.2	38.4	37.6	37.4	37.1	37.4	37.5 \pm 0.4
7:30	37.3	—	—	37.4	36.9	38.3	37.6	37.3	37.1	37.4	37.4 \pm 0.4
7:45	37.4	—	—	37.5	37.2	38.4	37.7	37.4	37.2	37.7	37.6 \pm 0.4

TABLE E-5

TEST 5. MEAN NORMALIZED RECTAL TEMPERATURE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	37.0	37.5	37.4	36.7	37.0	37.6	37.1	37.0	—	36.9	37.1 \pm 0.3
0:15	37.1	37.5	37.4	36.9	37.1	37.8	37.3	37.1	—	37.1	37.3 \pm 0.3
0:30	37.1	37.5	37.5	37.0	37.1	37.8	37.4	37.1	—	37.3	37.3 \pm 0.3
0:45	37.2	37.6	37.5	37.2	37.3	37.9	37.6	37.2	—	37.3	37.4 \pm 0.2
1:00	37.2	37.7	37.6	37.2	37.4	37.9	37.6	37.2	—	37.5	37.5 \pm 0.3
1:15	37.2	37.7	37.0	37.2	—	37.9	36.9	37.1	—	37.5	37.3 \pm 0.4
1:30	37.2	37.6	36.2	37.1	37.4	37.9	36.5	37.1	—	37.5	37.2 \pm 0.5
1:45	37.2	37.7	36.3	37.2	37.5	37.9	36.7	37.2	—	37.6	37.3 \pm 0.5
2:00	37.2	37.6	36.3	37.2	37.4	38.0	36.3	37.2	—	37.6	37.2 \pm 0.6
2:15	37.2	37.7	36.5	37.2	37.4	37.9	36.6	37.1	—	37.5	37.2 \pm 0.5
2:30	37.2	37.6	36.4	37.2	37.3	38.0	36.2	37.0	—	37.5	37.2 \pm 0.6
2:45	37.3	37.7	36.5	37.2	37.4	38.0	36.6	37.2	—	37.5	37.3 \pm 0.5
3:00	—	—	36.7	—	—	—	36.3	37.2	—	37.5	36.9 \pm 0.5
3:15	37.2	37.7	—	—	—	38.1	—	—	—	—	37.7 \pm 0.5
3:30	37.2	37.6	—	37.1	37.3	38.0	36.5	37.0	—	37.4	37.3 \pm 0.4
3:45	37.2	37.7	36.4	37.1	37.3	38.0	36.3	37.0	—	37.4	37.2 \pm 0.6
4:00	37.1	37.7	36.7	37.2	37.3	38.1	36.6	37.0	—	37.3	37.2 \pm 0.5
4:15	37.2	37.8	36.3	37.1	37.3	38.1	36.2	37.0	—	37.4	37.2 \pm 0.6
4:30	37.2	37.6	36.2	37.1	37.3	38.1	37.3	37.0	—	37.4	37.2 \pm 0.5
4:45	37.2	37.6	36.4	37.1	37.3	38.2	37.0	37.0	—	37.5	37.3 \pm 0.5
5:00	37.2	37.6	37.3	37.1	37.2	38.2	—	36.9	—	37.5	37.4 \pm 0.4
5:15	37.2	37.7	36.2	37.1	37.2	38.3	—	37.0	—	37.5	37.3 \pm 0.6
5:30	37.2	37.6	36.6	37.0	37.1	38.3	—	37.0	—	37.4	37.3 \pm 0.5
5:45	37.3	37.7	36.2	37.1	37.1	38.3	—	37.1	—	37.4	37.3 \pm 0.6
6:00	—	—	—	—	—	—	—	—	—	—	
6:15	—	—	—	—	—	—	—	—	—	—	
6:30	—	—	—	—	—	—	—	—	—	—	
6:45	—	—	—	—	—	—	—	—	—	—	
7:00	—	—	—	—	—	—	—	—	—	—	
7:15	—	—	—	—	—	—	—	—	—	—	
7:30	—	—	—	—	—	—	—	—	—	—	
7:45	—	—	—	—	—	—	—	—	—	—	

TABLE E-6

TEST 6. MEAN NORMALIZED RECTAL TEMPERATURE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	37.2	37.3	—	36.9	37.2	37.7	37.3	37.0	—	37.0	37.2 \pm 0.3
0:15	37.3	37.4	36.7	37.1	37.2	38.0	37.5	37.3	—	37.2	37.3 \pm 0.3
0:30	37.3	37.4	36.9	37.2	37.2	38.0	37.3	37.4	—	37.3	37.3 \pm 0.3
0:45	37.4	37.5	37.0	37.4	37.3	38.2	37.4	36.9	—	37.5	37.4 \pm 0.4
1:00	—	37.4	36.9	37.4	37.4	38.2	37.4	37.1	—	37.6	37.4 \pm 0.4
1:15	—	37.5	37.1	37.4	37.4	38.4	37.6	37.6	—	37.5	37.6 \pm 0.4
1:30	—	37.4	37.0	37.3	37.5	38.3	37.6	36.7	—	37.4	37.4 \pm 0.5
1:45	—	37.6	37.2	37.3	37.5	38.4	37.6	—	—	37.4	37.6 \pm 0.4
2:00	—	37.5	37.0	37.3	37.5	38.3	37.6	—	—	37.5	37.5 \pm 0.4
2:15	—	37.7	37.1	37.3	37.5	38.5	37.6	—	—	37.5	37.6 \pm 0.4
2:30	—	37.6	37.0	37.3	37.5	38.5	37.5	—	—	37.6	37.6 \pm 0.5
2:45	—	37.7	—	37.3	37.5	38.6	37.6	—	—	37.5	37.7 \pm 0.5
3:00	—	37.7	—	37.3	37.4	38.5	37.6	—	—	37.5	37.7 \pm 0.4
3:15	—	37.6	—	37.3	37.4	38.6	37.7	—	—	37.5	37.7 \pm 0.5
3:30	—	37.6	—	37.3	37.4	38.6	37.7	—	—	37.5	37.7 \pm 0.5
3:45	—	37.6	—	37.3	37.4	38.7	37.8	—	—	37.5	37.7 \pm 0.5
4:00	—	—	—	37.3	—	—	—	—	—	—	37.3 \pm 0.0
4:15	37.3	37.6	—	37.3	37.4	38.7	37.6	—	—	37.5	37.6 \pm 0.5
4:30	37.3	37.6	—	37.2	37.2	38.7	37.6	—	—	37.4	37.6 \pm 0.5
4:45	37.3	37.6	—	37.2	37.2	38.8	37.8	—	—	37.5	37.6 \pm 0.6
5:00	37.3	37.7	—	37.1	37.1	38.7	37.6	37.6	—	37.4	37.6 \pm 0.5
5:15	37.3	37.7	—	37.1	37.1	38.7	37.8	—	—	37.4	37.6 \pm 0.6
5:30	37.3	37.7	—	37.1	37.2	38.7	37.6	37.1	—	37.5	37.5 \pm 0.5
5:45	37.4	37.6	—	37.2	37.1	38.6	37.8	37.6	—	37.5	37.6 \pm 0.5
6:00	37.3	37.6	—	37.1	37.1	38.6	37.6	37.1	—	37.4	37.5 \pm 0.5
6:15	37.4	37.6	—	37.2	37.1	38.6	37.6	37.1	—	37.6	37.6 \pm 0.5
6:30	37.4	37.5	—	37.2	37.2	38.5	37.6	37.1	—	37.6	37.5 \pm 0.4
6:45	37.4	37.6	—	37.2	37.2	38.5	37.4	37.1	—	37.6	37.5 \pm 0.4
7:00	37.4	—	—	37.0	37.1	38.5	36.8	37.0	—	37.6	37.3 \pm 0.6
7:15	37.4	—	—	37.0	37.2	38.6	36.8	37.1	—	37.6	37.4 \pm 0.6
7:30	37.4	—	—	37.0	37.2	38.6	36.2	37.1	—	37.5	37.3 \pm 0.7
7:45	37.4	—	—	37.2	37.3	38.6	36.5	37.2	—	37.5	37.4 \pm 0.6

TABLE E-7

TEST 7. MEAN NORMALIZED RECTAL TEMPERATURE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	37.3	37.0	37.2	36.8	37.2	36.9	37.0	36.8	37.4	37.1 \pm 0.2
0:15	37.2	37.4	37.1	37.3	36.8	37.4	37.2	37.1	37.0	37.5	37.2 \pm 0.2
0:30	37.3	37.4	37.1	37.3	36.8	37.5	37.2	37.1	37.0	37.5	37.2 \pm 0.2
0:45	37.2	37.5	37.3	37.4	36.9	37.6	37.3	37.2	37.1	37.6	37.3 \pm 0.2
1:00	37.2	37.5	37.3	37.4	37.0	37.6	36.8	37.2	37.1	37.4	37.2 \pm 0.2
1:15	37.2	37.5	37.4	37.5	37.0	37.7	36.5	37.1	37.2	37.6	37.3 \pm 0.4
1:30	37.2	37.5	37.4	37.5	37.0	37.8	—	37.1	37.2	37.5	37.4 \pm 0.3
1:45	37.2	37.5	37.4	37.4	37.1	37.8	—	37.2	37.2	37.6	37.4 \pm 0.2
2:00	37.1	37.5	37.4	37.4	37.2	37.8	—	37.2	37.1	37.5	37.4 \pm 0.2
2:15	37.2	37.4	37.4	37.4	37.2	37.8	—	37.4	37.1	37.5	37.4 \pm 0.2
2:30	37.2	37.4	37.7	37.3	37.1	37.8	—	37.3	37.0	37.5	37.4 \pm 0.3
2:45	37.2	37.4	37.4	—	37.2	37.8	—	37.3	37.1	37.5	37.4 \pm 0.2
3:00	37.1	37.3	—	37.3	37.2	37.8	37.2	37.2	37.1	37.5	37.3 \pm 0.2
3:15	37.1	37.3	—	37.4	37.2	37.7	37.4	37.2	37.2	37.5	37.3 \pm 0.2
3:30	37.0	37.3	—	37.3	37.1	37.7	37.4	37.2	37.1	37.4	37.3 \pm 0.2
3:45	37.1	37.5	—	37.4	37.1	37.8	37.6	37.2	37.2	37.5	37.4 \pm 0.2
4:00	—	—	—	37.3	—	—	—	—	—	37.5	37.4 \pm 0.1
4:15	37.1	37.5	—	—	37.1	37.7	37.6	37.2	—	—	37.4 \pm 0.3
4:30	37.0	37.2	—	—	37.0	37.7	37.5	37.1	37.0	37.4	37.2 \pm 0.3
4:45	37.1	36.8	37.1	37.3	37.0	37.8	37.0	37.2	37.1	37.5	37.2 \pm 0.3
5:00	37.0	36.2	37.3	37.2	37.1	37.7	—	37.2	37.1	37.4	37.1 \pm 0.4
5:15	37.1	36.5	37.5	37.3	37.2	37.7	—	37.2	37.1	37.5	37.2 \pm 0.3
5:30	37.1	36.4	37.3	37.2	37.2	37.6	—	37.2	37.0	37.5	37.2 \pm 0.3
5:45	37.1	36.6	—	37.2	37.1	37.7	—	37.3	37.1	37.5	37.2 \pm 0.3
6:00	37.1	36.5	37.4	37.2	37.1	37.7	—	37.3	37.0	37.4	37.2 \pm 0.3
6:15	37.1	36.3	—	37.2	37.1	37.7	—	37.3	37.1	37.4	37.2 \pm 0.4
6:30	37.2	—	—	37.2	37.1	37.7	—	37.3	37.1	37.4	37.3 \pm 0.2
6:45	37.2	—	—	37.3	37.1	37.9	—	37.3	37.1	37.4	37.3 \pm 0.3
7:00	37.3	—	—	37.3	37.1	37.8	—	37.2	37.0	37.4	37.3 \pm 0.3
7:15	37.4	—	—	37.3	37.1	37.9	—	37.3	37.1	37.4	37.4 \pm 0.3
7:30	37.4	—	—	37.3	37.0	37.9	—	37.3	37.1	37.4	37.3 \pm 0.3
7:45	37.5	—	—	37.2	37.1	37.9	—	37.4	37.2	37.5	37.4 \pm 0.3

TABLE E-8

TEST 8. MEAN NORMALIZED RECTAL TEMPERATURE AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	37.1	37.4	—	—	36.8	37.3	37.1	36.8	37.0	37.2	37.1 \pm 0.2
0:15	37.2	37.4	37.1	37.6	36.9	37.4	37.3	37.0	37.0	37.4	37.2 \pm 0.2
0:30	37.2	37.4	37.2	37.6	36.9	37.6	37.3	37.0	37.2	37.5	37.3 \pm 0.2
0:45	37.2	37.5	37.2	37.7	37.0	37.6	37.4	37.1	37.0	—	37.3 \pm 0.3
1:00	37.2	37.4	37.3	37.7	37.0	37.7	37.4	37.1	36.9	37.6	37.3 \pm 0.3
1:15	37.2	37.5	37.4	37.7	37.0	37.6	37.5	37.2	36.8	37.6	37.4 \pm 0.3
1:30	37.2	37.4	37.5	37.6	37.1	37.6	37.4	37.1	37.0	37.4	37.3 \pm 0.2
1:45	37.3	37.4	37.5	37.7	37.2	37.8	37.4	37.1	—	37.4	37.4 \pm 0.2
2:00	37.2	37.4	37.4	37.5	37.2	37.8	37.3	37.1	37.1	37.4	37.3 \pm 0.2
2:15	37.3	37.4	37.5	37.6	37.2	37.7	37.3	37.1	—	37.4	37.4 \pm 0.2
2:30	37.2	37.4	37.3	37.5	37.1	37.7	37.2	37.1	—	37.6	37.3 \pm 0.2
2:45	37.3	37.5	37.3	37.6	37.2	37.7	37.2	37.1	37.2	37.5	37.4 \pm 0.2
3:00	37.2	37.6	37.2	37.6	37.1	37.7	37.2	37.0	37.0	37.5	37.3 \pm 0.3
3:15	37.2	37.7	37.3	37.6	37.1	37.7	37.3	37.1	37.1	37.6	37.4 \pm 0.3
3:30	37.2	37.6	37.2	37.5	37.1	37.7	37.2	37.0	37.2	37.5	37.3 \pm 0.2
3:45	37.2	37.6	37.1	37.6	37.1	37.7	37.3	37.0	—	—	37.3 \pm 0.3
4:00	—	—	—	—	—	—	—	—	—	—	
4:15	37.1	37.6	—	37.5	37.1	—	—	37.0	37.0	37.5	37.3 \pm 0.3
4:30	37.1	37.6	—	37.3	37.1	37.8	37.2	36.9	—	37.5	37.3 \pm 0.3
4:45	37.1	37.6	—	37.5	37.1	37.8	37.2	37.0	—	37.5	37.4 \pm 0.3
5:00	37.0	37.5	—	37.4	37.1	37.6	37.2	36.9	—	37.5	37.3 \pm 0.3
5:15	37.1	37.5	—	37.4	37.1	37.6	37.3	36.9	—	37.6	37.3 \pm 0.3
5:30	37.1	37.4	—	37.2	37.1	37.6	37.2	36.9	—	37.5	37.2 \pm 0.2
5:45	37.2	37.5	—	37.3	37.1	37.7	37.3	37.0	—	37.6	37.3 \pm 0.2
6:00	37.1	37.5	—	37.2	37.1	37.8	37.3	36.9	—	37.5	37.3 \pm 0.3
6:15	37.2	37.5	—	37.2	37.2	37.7	37.4	37.0	—	37.6	37.4 \pm 0.2
6:30	37.2	37.5	—	37.2	37.2	37.7	37.3	36.9	—	37.6	37.3 \pm 0.3
6:45	37.2	37.6	—	37.2	37.2	37.7	37.4	37.0	—	37.6	37.4 \pm 0.3
7:00	37.2	37.5	—	37.1	37.1	37.8	37.4	37.0	—	37.6	37.3 \pm 0.3
7:15	37.2	37.6	—	37.2	37.2	37.8	37.4	37.0	—	37.6	37.4 \pm 0.3
7:30	37.2	37.5	—	37.2	37.2	37.8	37.3	37.0	—	37.6	37.4 \pm 0.3
7:45	37.3	37.6	—	37.2	37.2	37.8	37.5	37.1	—	37.8	37.4 \pm 0.3

APPENDIX F
MINUTE VOLUME BY TEST AND SUBJECT

TABLE F-1
 TEST I. MEAN NORMALIZED MINUTE VOLUME AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	26.7	21.4	20.9	22.9	16.5	20.5	19.5	19.4	22.8	26.2	21.7 \pm 3.1
0:15	26.6	19.0	19.7	22.9	15.2	21.0	20.8	17.2	22.1	27.6	21.2 \pm 3.8
0:30	25.2	19.2	19.6	20.5	16.0	23.1	20.4	16.7	22.4	28.1	21.1 \pm 3.7
0:45	26.7	23.2	19.4	21.7	16.6	22.6	22.3	19.9	23.9	26.8	22.3 \pm 3.2
1:00	24.3	18.3	20.4	23.2	15.6	23.0	20.4	17.7	23.2	27.5	21.4 \pm 3.6
1:15	27.8	18.2	19.5	22.2	15.7	22.5	20.2	18.2	25.7	32.2	22.2 \pm 5.0
1:30	25.2	18.7	20.0	23.8	—	21.8	20.9	18.6	—	29.3	22.3 \pm 3.7
1:45	23.0	18.3	19.0	—	16.1	22.0	21.9	17.9	—	28.7	20.9 \pm 4.0
2:00	—	17.5	17.5	—	15.4	24.2	22.0	18.5	—	27.5	20.4 \pm 4.3
2:15	27.3	18.2	16.9	—	15.3	22.3	23.5	17.6	—	27.4	21.1 \pm 4.7
2:30	23.8	20.0	16.8	—	16.1	—	21.1	18.6	—	27.9	20.6 \pm 4.1
2:45	27.7	18.4	17.3	—	16.2	21.8	21.5	17.1	—	29.5	21.2 \pm 5.0
3:00	24.0	18.5	16.7	—	15.8	20.6	21.5	17.6	21.7	27.4	20.4 \pm 3.7
3:15	25.1	17.3	18.0	20.3	16.4	22.5	23.9	20.2	23.2	29.2	21.6 \pm 4.0
3:30	24.7	17.9	16.8	—	17.0	23.1	25.6	19.8	22.9	29.6	21.9 \pm 4.4
3:45	24.8	—	17.2	18.3	16.2	21.4	21.1	20.1	23.4	26.6	21.0 \pm 3.5
4:00	—	19.8	18.2	22.9	—	22.5	—	—	—	27.2	22.1 \pm 3.4
4:15	22.4	—	—	—	—	—	—	18.3	21.7	—	20.8 \pm 2.2
4:30	26.5	19.5	17.6	20.1	15.6	28.3	—	18.1	24.8	—	21.3 \pm 4.6
4:45	23.4	21.5	15.6	20.3	16.2	28.6	—	18.3	24.9	—	21.1 \pm 4.4
5:00	23.9	24.0	18.0	21.0	16.0	31.4	—	19.9	—	—	22.0 \pm 5.1
5:15	23.5	23.0	17.8	19.6	17.2	27.6	—	19.6	—	—	21.2 \pm 3.7
5:30	24.8	—	18.5	25.4	15.7	24.0	—	19.5	—	—	21.3 \pm 4.0
5:45	22.2	—	—	20.3	16.6	27.6	—	19.5	21.5	—	21.3 \pm 3.7
6:00	27.8	—	—	21.5	17.8	25.0	—	19.4	23.1	—	22.4 \pm 3.7
6:15	25.4	—	19.0	21.5	17.0	31.5	—	19.5	24.6	—	22.6 \pm 4.9
6:30	24.6	—	19.7	21.1	17.0	27.7	—	19.7	24.8	—	22.0 \pm 3.8
6:45	24.9	—	17.8	20.7	17.4	32.7	—	19.8	25.4	—	22.7 \pm 5.4
7:00	24.8	—	18.6	21.4	17.6	30.1	—	20.2	24.5	—	22.5 \pm 4.3
7:15	25.0	—	18.5	24.8	17.7	33.3	—	19.2	24.5	—	23.3 \pm 5.4
7:30	26.2	—	18.3	24.8	17.9	30.4	—	20.9	25.2	—	23.4 \pm 4.6
7:45	28.0	—	19.6	24.1	—	33.6	—	22.2	25.0	—	25.4 \pm 4.9

TABLE F-2

TEST 2. MEAN NORMALIZED MINUTE VOLUME AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	—	—	27.5	—	22.2	25.1	17.6	22.2	27.0	23.6 \pm 3.7
0:15	23.6	—	22.2	21.7	16.0	23.5	26.4	18.0	22.2	25.1	22.1 \pm 3.3
0:30	24.5	—	16.4	24.5	16.8	24.4	27.7	—	18.5	25.2	22.2 \pm 4.3
0:45	22.4	—	18.2	24.0	16.7	23.3	24.5	18.6	20.9	23.5	21.3 \pm 2.9
1:00	22.1	—	16.8	23.8	17.2	22.0	26.4	18.9	20.1	25.2	21.4 \pm 3.4
1:15	21.2	—	18.5	23.6	17.8	23.9	23.7	19.1	19.9	24.2	21.3 \pm 2.6
1:30	23.1	—	17.4	23.3	—	24.0	26.8	18.6	20.4	24.1	22.2 \pm 3.1
1:45	21.4	—	17.0	22.8	16.3	24.1	28.8	20.6	20.3	24.2	21.7 \pm 3.8
2:00	21.7	—	14.8	22.1	18.6	23.5	24.1	19.9	22.7	23.3	21.2 \pm 3.0
2:15	22.1	—	15.8	22.1	17.2	24.1	23.9	20.2	20.4	23.5	21.0 \pm 2.9
2:30	22.1	—	15.8	23.1	16.4	23.5	27.3	22.3	19.7	—	21.3 \pm 3.8
2:45	21.7	—	18.8	22.4	16.1	23.4	29.6	19.7	19.7	—	21.4 \pm 4.0
3:00	21.7	—	17.4	21.8	15.7	21.4	25.6	20.1	20.2	23.6	20.8 \pm 3.0
3:15	20.4	—	17.2	22.6	15.4	22.5	22.1	18.8	21.0	21.9	20.2 \pm 2.6
3:30	19.5	—	19.5	23.2	15.6	22.6	26.4	21.6	18.4	22.6	21.0 \pm 3.2
3:45	18.5	—	16.9	22.0	18.7	25.6	25.9	20.4	18.6	25.6	21.4 \pm 3.5
4:00	21.5	—	—	21.4	17.8	—	27.8	—	18.8	23.3	21.8 \pm 3.6
4:15	—	—	15.8	—	—	—	—	19.5	—	—	17.6 \pm 2.6
4:30	20.9	—	18.4	22.6	16.3	24.4	—	—	—	—	20.5 \pm 3.2
4:45	22.5	—	18.2	22.0	17.4	25.1	27.2	20.6	20.9	22.9	21.9 \pm 3.1
5:00	22.9	—	18.9	21.2	15.6	24.1	24.4	19.7	19.6	22.4	21.0 \pm 2.8
5:15	22.4	—	15.5	21.2	17.6	22.8	31.1	19.4	20.5	24.1	21.6 \pm 4.4
5:30	23.5	—	15.5	21.6	16.2	22.5	27.9	18.8	20.7	24.2	21.2 \pm 3.9
5:45	21.6	—	18.2	21.0	16.0	24.0	26.9	18.4	20.5	23.4	21.1 \pm 3.3
6:00	22.0	—	19.1	20.5	17.3	22.7	22.0	—	20.5	24.4	21.1 \pm 2.2
6:15	22.9	—	19.8	22.4	15.8	23.4	24.2	20.5	21.5	24.1	21.6 \pm 2.7
6:30	22.4	—	17.6	21.0	16.7	25.5	24.4	19.2	21.4	24.3	21.4 \pm 3.1
6:45	22.9	—	19.3	19.9	15.5	26.1	24.1	20.1	21.6	24.8	21.6 \pm 3.3
7:00	23.1	—	20.0	18.9	16.1	27.2	25.2	20.3	22.4	23.4	21.8 \pm 3.4
7:15	24.9	—	18.3	18.7	15.3	28.9	24.6	19.6	23.1	23.6	21.9 \pm 4.2
7:30	23.3	—	16.6	18.8	14.4	31.1	25.5	—	23.3	21.6	21.8 \pm 5.3
7:45	23.2	—	18.9	20.8	15.6	33.6	23.0	—	22.1	24.9	22.8 \pm 5.2

TABLE F-3

TEST 3. MEAN NORMALIZED MINUTE VOLUME AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	22.0	22.4	22.1	16.8	15.2	25.0	16.6	23.3	26.4	21.1 \pm 4.0
0:15	24.8	19.9	22.0	20.6	16.6	21.9	25.0	16.7	—	26.4	21.5 \pm 3.5
0:30	25.8	18.0	21.8	20.8	16.2	25.5	25.0	18.1	23.7	25.9	22.1 \pm 3.7
0:45	26.3	—	21.1	22.4	16.3	29.2	24.2	18.0	22.7	27.7	23.1 \pm 4.3
1:00	25.8	19.6	21.4	22.4	—	28.2	22.6	16.1	21.8	27.0	22.8 \pm 3.8
1:15	25.5	—	21.3	20.6	17.7	29.2	23.5	18.0	21.6	25.7	22.6 \pm 3.8
1:30	24.3	18.2	19.9	22.9	17.6	31.3	24.5	16.8	20.8	27.1	22.3 \pm 4.6
1:45	27.3	—	21.7	21.4	17.8	27.5	26.9	16.2	21.1	26.4	22.9 \pm 4.3
2:00	25.1	18.2	20.2	20.3	17.7	29.7	26.4	16.5	21.2	25.8	22.1 \pm 4.4
2:15	26.6	18.6	20.3	19.6	18.0	32.0	28.1	20.3	—	25.8	23.3 \pm 5.0
2:30	25.0	17.5	21.3	18.8	17.2	31.8	25.0	19.5	22.4	26.2	22.5 \pm 4.6
2:45	24.6	20.3	18.8	20.5	17.1	22.3	24.8	21.2	23.2	27.0	22.0 \pm 3.0
3:00	26.1	18.0	19.4	19.6	17.5	22.6	23.6	18.7	23.3	26.2	21.5 \pm 3.3
3:15	23.2	18.0	19.3	20.4	17.7	22.4	27.2	18.2	23.3	26.3	21.6 \pm 3.4
3:30	23.9	17.4	17.8	21.6	16.8	23.2	28.4	17.2	22.0	23.1	21.1 \pm 3.8
3:45	24.4	18.8	21.0	20.8	17.3	22.4	29.7	20.3	22.6	24.3	22.2 \pm 3.5
4:00	—	—	—	—	—	25.5	23.2	21.1	—	25.2	23.8 \pm 2.0
4:15	24.6	17.8	19.9	20.1	17.9	25.8	27.2	—	23.4	25.8	22.5 \pm 3.6
4:30	24.6	18.0	19.2	20.0	16.8	—	—	17.9	22.1	26.1	20.6 \pm 3.4
4:45	25.6	18.5	20.4	22.4	16.4	25.3	24.7	18.2	23.3	—	21.6 \pm 3.4
5:00	24.8	17.3	17.7	20.0	18.0	27.9	23.8	16.5	22.3	—	20.9 \pm 4.0
5:15	25.4	—	19.7	20.6	16.3	24.6	25.9	18.0	23.3	25.8	22.2 \pm 3.6
5:30	26.0	18.6	19.0	20.5	16.8	22.5	26.3	17.9	23.5	24.8	21.6 \pm 3.5
5:45	27.2	—	19.5	21.4	16.5	24.5	25.5	17.2	24.3	26.3	22.5 \pm 4.0
6:00	25.6	18.4	20.2	21.1	16.5	25.1	26.7	17.1	23.2	25.3	21.9 \pm 3.8
6:15	25.8	—	16.8	21.4	16.2	26.2	26.4	18.4	23.8	25.8	22.3 \pm 4.2
6:30	25.1	19.0	18.1	20.1	16.7	23.3	25.8	17.0	22.9	25.4	21.3 \pm 3.6
6:45	25.3	19.4	19.2	21.0	16.8	23.9	25.0	18.4	26.3	26.3	22.1 \pm 3.7
7:00	24.8	21.7	19.8	20.3	16.9	32.0	30.0	17.0	24.2	26.5	23.3 \pm 5.1
7:15	27.0	19.7	18.7	21.1	16.9	26.1	25.8	18.2	24.0	26.3	22.4 \pm 3.9
7:30	26.4	19.9	20.9	20.2	16.6	29.6	31.0	16.8	23.8	26.0	23.7 \pm 6.3
7:45	24.2	20.8	20.3	22.2	—	31.0	—	17.5	24.7	26.8	23.4 \pm 4.2

TABLE F-4

TEST 4. MEAN NORMALIZED MINUTE VOLUME AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	25.0	—	21.4	21.9	16.9	30.2	25.9	17.1	24.0	27.1	23.3 \pm 4.4
0:15	26.0	—	19.4	21.4	17.5	24.4	32.2	17.3	23.7	26.4	23.1 \pm 4.8
0:30	24.8	—	21.4	20.9	17.2	26.7	—	17.1	23.5	25.8	22.2 \pm 3.7
0:45	24.7	18.0	19.8	20.3	18.1	34.6	23.5	17.6	24.1	26.7	22.7 \pm 5.2
1:00	25.9	—	20.0	21.2	17.0	27.5	25.9	18.4	24.1	27.6	23.1 \pm 4.0
1:15	24.1	—	20.0	21.5	16.7	27.8	31.6	19.7	23.5	28.2	24.3 \pm 6.2
1:30	24.8	20.7	22.3	20.0	17.0	27.2	34.1	18.0	22.6	26.7	23.3 \pm 5.1
1:45	23.9	22.7	19.6	20.8	17.8	28.8	23.3	19.4	24.7	26.8	22.8 \pm 3.5
2:00	24.1	23.0	19.9	20.4	15.7	29.7	34.5	18.6	22.3	26.7	23.5 \pm 5.6
2:15	24.0	19.2	18.7	20.4	16.5	28.2	32.3	19.6	22.4	26.2	22.8 \pm 4.9
2:30	23.6	—	17.9	19.2	16.1	27.3	34.4	19.9	22.6	24.4	22.8 \pm 5.6
2:45	25.2	20.7	20.1	21.4	17.6	27.4	30.2	19.8	22.7	24.1	22.9 \pm 3.8
3:00	23.5	21.5	20.8	19.6	16.1	26.1	33.8	19.4	22.3	23.6	22.7 \pm 4.8
3:15	23.9	19.8	19.8	20.2	17.1	26.5	—	18.8	23.1	23.6	21.4 \pm 3.0
3:30	23.9	—	17.8	19.5	—	26.6	25.1	—	—	23.1	22.7 \pm 3.4
3:45	24.2	22.5	—	—	—	28.1	23.2	18.2	22.3	23.1	23.1 \pm 2.9
4:00	—	—	18.6	—	15.7	28.0	30.1	18.2	22.3	—	22.2 \pm 5.8
4:15	24.5	21.9	18.9	19.1	15.9	—	27.3	18.3	23.3	23.8	21.4 \pm 3.6
4:30	23.6	—	—	20.1	15.5	26.3	27.3	18.2	22.4	22.8	22.0 \pm 4.0
4:45	24.1	21.4	19.6	21.3	15.5	33.2	31.2	18.6	23.1	23.4	23.1 \pm 5.4
5:00	23.7	—	18.3	21.2	14.8	33.6	26.2	16.6	22.4	22.8	22.2 \pm 5.6
5:15	23.7	22.2	18.7	20.3	15.3	27.7	33.4	18.9	22.6	23.2	22.6 \pm 5.1
5:30	23.4	—	20.0	20.0	16.5	25.9	29.3	17.4	20.7	22.7	21.8 \pm 4.1
5:45	23.5	25.2	20.8	20.6	16.4	29.2	30.0	19.5	22.6	23.6	23.1 \pm 4.2
6:00	23.9	—	19.5	20.2	15.5	30.6	31.5	18.7	22.4	23.7	22.9 \pm 5.3
6:15	23.7	—	20.0	20.2	18.8	32.1	25.3	18.9	22.6	23.9	22.8 \pm 4.2
6:30	24.0	—	19.5	23.9	15.2	32.5	31.8	17.7	23.0	22.7	23.4 \pm 5.8
6:45	24.3	—	19.5	22.3	15.2	33.4	30.5	16.3	22.7	25.1	23.3 \pm 6.0
7:00	24.2	—	18.4	20.3	15.6	36.5	30.9	18.2	22.6	23.8	23.4 \pm 6.6
7:15	24.2	—	19.5	21.9	16.2	27.1	33.6	20.0	23.1	24.3	23.3 \pm 5.0
7:30	24.4	—	20.8	21.4	16.0	34.0	37.0	19.8	22.6	24.3	24.5 \pm 6.8
7:45	24.6	—	21.6	23.0	15.5	32.5	38.7	18.8	23.0	23.5	24.6 \pm 7.0

TABLE F-5

TEST 5. MEAN NORMALIZED MINUTE VOLUME AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	25.5	23.7	20.3	22.6	16.1	21.0	29.6	17.9	24.6	25.8	22.7 \pm 4.0
0:15	26.2	19.5	20.6	23.3	16.8	31.4	30.9	19.3	26.3	23.5	23.8 \pm 4.9
0:30	25.3	18.2	20.5	21.6	16.4	28.8	26.0	19.5	25.2	24.0	22.6 \pm 3.9
0:45	27.0	21.7	21.3	22.6	17.1	32.2	27.3	18.0	27.2	24.1	23.8 \pm 4.7
1:00	25.9	22.0	21.9	21.6	18.1	26.0	27.3	18.7	27.9	24.1	23.4 \pm 3.4
1:15	26.4	22.6	21.3	21.5	—	28.4	25.0	18.0	26.2	24.1	23.7 \pm 3.2
1:30	24.6	19.8	19.8	19.5	17.1	24.2	27.5	19.5	25.0	23.5	22.0 \pm 3.3
1:45	25.1	19.4	21.4	19.5	16.8	28.5	29.0	20.4	25.9	23.5	23.0 \pm 4.1
2:00	25.8	19.1	21.1	19.4	18.3	26.9	26.0	18.1	—	22.1	21.9 \pm 3.5
2:15	25.3	18.1	20.8	20.6	17.5	27.6	27.3	19.9	24.9	22.8	22.5 \pm 3.7
2:30	24.4	17.6	19.9	19.1	17.9	28.0	24.6	19.2	24.7	21.9	21.7 \pm 3.5
2:45	25.4	17.9	20.3	19.8	17.7	28.1	27.1	20.2	25.0	23.4	22.5 \pm 3.8
3:00	—	—	17.4	—	—	—	22.6	20.7	24.3	22.6	21.5 \pm 2.6
3:15	24.9	19.1	—	—	—	25.2	—	—	24.6	—	23.4 \pm 2.9
3:30	24.8	18.7	—	19.9	15.4	23.5	26.9	19.2	23.7	22.0	21.6 \pm 3.6
3:45	24.4	19.6	19.4	19.9	16.9	27.2	25.5	18.4	25.0	22.8	21.9 \pm 3.5
4:00	23.5	22.7	18.4	18.9	16.2	30.0	26.1	17.8	24.5	22.9	22.1 \pm 4.3
4:15	26.0	18.8	18.7	20.1	16.0	26.2	25.3	18.4	24.9	22.8	21.7 \pm 3.7
4:30	24.5	18.1	18.2	20.7	15.9	25.5	23.7	18.1	24.2	21.7	21.1 \pm 3.4
4:45	25.8	18.3	19.8	20.0	17.0	27.8	25.0	17.6	21.0	22.0	21.4 \pm 3.7
5:00	25.2	19.1	18.5	19.4	16.5	26.6	24.2	17.8	23.6	22.7	21.4 \pm 3.5
5:15	24.5	17.8	18.7	20.1	16.4	31.0	25.5	18.9	24.3	22.9	22.0 \pm 4.5
5:30	24.8	18.0	19.6	18.7	15.3	35.9	24.7	18.0	23.1	22.7	22.1 \pm 5.8
5:45	23.9	18.2	19.9	21.6	16.9	32.0	23.4	18.0	24.3	23.2	22.1 \pm 4.4
6:00	—	—	—	—	—	—	—	—	—	—	
6:15	—	—	—	—	—	—	—	—	—	—	
6:30	—	—	—	—	—	—	—	—	—	—	
6:45	—	—	—	—	—	—	—	—	—	—	
7:00	—	—	—	—	—	—	—	—	—	—	
7:15	—	—	—	—	—	—	—	—	—	—	
7:30	—	—	—	—	—	—	—	—	—	—	
7:45	—	—	—	—	—	—	—	—	—	—	

TABLE F-6

TEST 6. MEAN NORMALIZED MINUTE VOLUME AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	25.3	24.7	—	—	17.4	28.7	26.2	18.3	22.4	22.8	23.2 \pm 3.9
0:15	26.9	23.8	19.0	23.7	17.7	37.7	33.5	19.0	23.4	23.7	24.8 \pm 6.4
0:30	24.9	24.0	21.5	21.5	17.7	33.3	23.3	18.5	22.9	23.5	23.1 \pm 4.3
0:45	24.3	20.6	19.8	23.8	18.9	30.0	23.2	19.3	23.3	24.4	22.8 \pm 3.3
1:00	—	19.4	18.5	22.3	17.4	32.2	24.8	20.1	22.1	25.1	22.4 \pm 4.5
1:15	—	19.7	21.4	23.8	19.2	32.5	26.1	19.5	22.1	23.7	23.1 \pm 4.2
1:30	—	20.2	19.8	21.4	18.0	24.6	28.6	—	22.0	23.3	22.2 \pm 3.3
1:45	—	20.0	19.6	21.1	18.8	26.8	23.6	—	22.2	23.3	21.9 \pm 2.6
2:00	—	20.0	19.7	20.6	18.5	24.9	25.0	—	21.5	22.8	21.6 \pm 2.4
2:15	—	20.4	19.0	20.9	17.9	30.9	23.2	—	22.1	23.2	22.2 \pm 4.0
2:30	—	19.9	19.6	21.6	17.5	29.9	27.8	—	21.6	22.6	22.6 \pm 4.2
2:45	—	19.2	20.0	23.8	19.4	28.9	27.7	20.8	21.4	22.8	22.7 \pm 3.5
3:00	—	20.7	20.0	20.6	18.9	29.8	22.8	19.8	21.0	23.0	21.8 \pm 3.3
3:15	—	19.4	17.8	20.4	18.2	33.1	27.1	18.1	22.7	22.1	22.1 \pm 5.1
3:30	—	19.4	18.5	—	17.2	28.4	24.6	—	21.8	20.3	21.5 \pm 3.9
3:45	—	19.7	18.6	19.9	17.1	33.3	25.3	—	22.3	22.5	22.3 \pm 5.1
4:00	—	—	—	20.2	—	—	—	—	22.1	—	21.2 \pm 1.3
4:15	23.9	20.9	—	20.0	17.2	34.9	25.4	—	21.6	21.8	23.3 \pm 5.4
4:30	23.6	20.3	16.8	20.6	17.6	29.2	24.6	—	20.7	21.4	21.6 \pm 3.8
4:45	26.3	22.0	17.6	21.8	16.8	32.5	25.5	—	20.0	22.2	22.7 \pm 4.8
5:00	25.4	19.7	17.8	20.2	16.7	31.0	23.0	19.1	20.1	21.9	21.5 \pm 4.2
5:15	22.6	20.4	18.5	—	17.9	31.3	27.7	17.8	21.4	22.9	22.3 \pm 4.6
5:30	23.8	19.6	18.3	19.8	16.8	34.5	28.2	19.3	21.7	23.2	22.5 \pm 5.3
5:45	23.2	21.0	17.6	21.4	16.5	40.1	25.9	19.8	22.4	21.8	23.0 \pm 6.6
6:00	23.8	19.6	17.7	19.3	16.3	31.2	24.1	—	22.2	23.1	21.9 \pm 4.4
6:15	24.3	21.4	18.2	20.9	17.4	30.7	24.5	20.2	23.2	22.0	22.3 \pm 3.8
6:30	22.3	19.8	18.0	19.0	16.5	29.0	25.0	17.2	22.0	21.9	21.1 \pm 3.8
6:45	23.1	23.1	18.0	21.3	17.6	36.1	31.3	19.2	23.2	22.0	23.6 \pm 5.9
7:00	25.3	—	18.3	19.5	17.5	31.1	24.5	19.1	22.7	21.3	22.1 \pm 4.3
7:15	24.8	—	18.7	20.7	16.4	35.5	27.4	20.0	23.3	22.9	23.3 \pm 5.6
7:30	27.5	—	17.8	20.0	17.4	35.3	30.3	19.5	23.4	23.8	23.9 \pm 6.1
7:45	24.0	—	18.7	21.3	17.5	31.6	26.7	18.8	23.4	25.3	23.0 \pm 4.5

TABLE F-7

TEST 7. MEAN NORMALIZED MINUTE VOLUME AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	21.0	19.1	21.2	17.6	23.0	32.4	20.2	22.1	—	22.1 \pm 4.5
0:15	26.0	20.4	19.7	23.0	16.7	27.9	33.9	17.5	21.7	26.2	23.3 \pm 5.3
0:30	24.2	19.4	20.3	22.5	18.0	24.1	32.4	19.9	21.4	24.6	22.7 \pm 4.1
0:45	25.1	18.7	21.5	21.8	18.4	29.1	29.2	17.4	23.9	27.0	23.2 \pm 4.4
1:00	26.5	18.5	21.5	20.6	17.9	24.9	31.8	17.1	22.2	25.5	22.6 \pm 4.6
1:15	26.4	18.5	21.9	22.6	17.9	33.6	27.5	18.3	21.6	24.6	23.3 \pm 4.9
1:30	24.4	19.1	20.3	20.6	17.7	27.7	30.8	19.6	20.8	26.6	22.8 \pm 4.3
1:45	23.3	20.4	21.8	21.5	19.7	27.9	29.4	19.9	22.2	26.1	23.2 \pm 3.4
2:00	23.9	20.5	19.7	19.7	18.9	27.5	27.9	19.2	21.3	25.0	22.4 \pm 3.5
2:15	24.8	19.9	19.2	22.3	18.7	26.5	28.1	21.3	22.7	26.0	23.0 \pm 3.3
2:30	23.7	17.8	19.9	19.3	17.9	25.8	28.0	21.5	20.0	22.8	21.7 \pm 3.4
2:45	23.3	18.7	22.8	—	18.1	27.4	30.9	18.9	20.6	25.9	23.0 \pm 4.4
3:00	22.3	16.9	20.7	22.8	18.5	25.7	26.9	19.4	20.9	24.6	21.9 \pm 3.2
3:15	23.1	19.6	19.7	21.7	18.4	24.8	30.0	19.4	20.5	21.9	21.9 \pm 3.4
3:30	23.4	17.1	19.6	20.1	17.3	32.5	31.4	18.1	20.7	24.7	22.5 \pm 5.6
3:45	22.5	18.0	19.0	24.2	18.1	29.4	27.2	19.8	20.6	23.2	22.2 \pm 3.9
4:00	—	—	—	20.5	—	—	—	—	—	24.5	22.5 \pm 2.9
4:15	20.9	18.3	—	—	17.5	32.9	24.7	18.8	—	—	22.2 \pm 5.9
4:30	21.7	17.1	21.6	—	17.3	30.7	23.3	18.7	19.1	25.1	21.6 \pm 4.3
4:45	21.5	17.6	19.8	20.6	16.8	28.6	28.5	20.0	22.6	25.7	22.2 \pm 4.2
5:00	21.1	19.6	21.4	—	16.1	—	29.0	19.5	18.5	25.3	21.3 \pm 4.1
5:15	22.5	17.6	24.1	21.2	17.3	30.7	25.8	19.6	23.6	26.3	22.9 \pm 4.2
5:30	21.3	17.6	—	19.8	16.0	28.2	23.8	18.9	21.3	27.4	21.6 \pm 4.2
5:45	22.0	18.5	22.0	22.3	17.0	32.1	24.2	19.8	19.2	25.3	22.2 \pm 4.3
6:00	22.4	17.3	21.1	19.6	16.3	33.2	21.8	18.4	19.8	25.1	21.5 \pm 4.8
6:15	21.2	17.1	—	21.4	15.8	28.1	24.7	19.0	20.1	25.0	21.4 \pm 4.0
6:30	19.8	17.8	19.1	20.2	16.2	30.1	26.5	18.4	18.8	23.8	21.1 \pm 4.4
6:45	20.7	17.8	21.2	21.0	16.7	28.1	24.8	18.4	20.8	25.1	21.5 \pm 3.6
7:00	21.3	17.1	21.3	20.9	16.1	32.8	26.8	18.9	19.7	24.6	22.0 \pm 5.0
7:15	20.8	17.9	22.6	19.7	15.7	31.1	28.3	18.6	21.2	25.1	22.1 \pm 4.8
7:30	21.9	17.3	20.6	20.4	16.2	36.2	24.3	19.1	20.7	23.0	22.0 \pm 5.6
7:45	23.9	18.4	19.7	20.7	16.8	34.7	20.1	19.1	21.7	26.4	22.2 \pm 5.2

TABLE F-8

TEST 8. MEAN NORMALIZED MINUTE VOLUME AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	24.7	19.8	—	—	19.3	27.4	26.1	19.8	25.2	24.6	23.4 \pm 3.2
0:15	24.2	17.0	20.5	23.1	19.7	30.0	25.3	22.0	22.0	24.3	22.8 \pm 3.5
0:30	26.2	18.1	19.9	23.0	18.3	26.4	25.1	19.9	25.1	25.2	22.7 \pm 3.3
0:45	24.8	18.3	19.9	22.9	19.6	28.9	23.2	20.9	25.2	—	22.6 \pm 3.3
1:00	24.8	17.5	18.8	22.1	18.7	28.9	26.4	20.5	24.0	23.6	22.5 \pm 3.7
1:15	26.4	17.8	19.8	22.5	19.0	27.9	24.8	22.6	23.9	20.5	22.5 \pm 3.3
1:30	24.5	21.2	18.4	21.2	17.7	29.1	33.0	19.0	24.6	—	23.2 \pm 5.2
1:45	24.3	18.0	20.9	20.6	18.8	30.6	24.7	20.8	21.4	22.6	22.3 \pm 3.6
2:00	24.6	18.8	20.3	21.9	22.9	29.2	22.7	18.9	22.8	—	22.5 \pm 3.2
2:15	26.0	17.5	21.5	21.0	17.5	29.8	24.3	20.1	—	—	22.2 \pm 4.3
2:30	23.7	18.0	18.5	21.3	17.0	31.7	23.8	19.2	—	19.1	21.4 \pm 4.6
2:45	24.8	18.6	19.5	20.9	17.5	34.1	34.0	21.4	22.3	24.0	23.7 \pm 5.9
3:00	24.1	17.2	19.7	21.3	16.6	28.0	30.7	20.7	22.3	23.1	22.4 \pm 4.4
3:15	24.8	17.1	20.5	22.2	18.1	31.1	27.2	22.0	23.0	23.0	22.9 \pm 4.1
3:30	25.5	16.6	18.9	21.0	16.8	30.7	22.0	19.8	22.8	28.5	22.3 \pm 4.7
3:45	24.6	16.0	18.7	22.1	16.4	34.9	29.5	19.7	22.9	—	22.8 \pm 6.2
4:00	—	—	—	—	—	—	—	—	22.1	—	22.1 \pm 0.0
4:15	24.5	16.9	—	20.6	16.7	—	—	18.6	22.8	25.5	20.8 \pm 3.6
4:30	25.9	15.8	18.9	19.9	17.0	31.3	25.0	17.4	18.3	23.4	21.3 \pm 4.9
4:45	24.4	16.9	18.6	21.1	16.4	27.4	29.8	20.0	21.4	26.8	22.3 \pm 4.6
5:00	25.0	15.9	18.4	18.8	16.6	31.9	22.6	19.2	22.7	24.5	21.6 \pm 4.8
5:15	25.5	16.1	19.3	21.2	16.8	33.8	29.5	19.2	—	27.2	22.7 \pm 5.7
5:30	23.6	17.4	18.3	20.5	17.0	31.5	20.4	19.0	21.6	25.6	21.5 \pm 4.4
5:45	24.6	16.1	19.8	20.2	17.3	32.7	23.1	19.8	21.6	26.4	22.2 \pm 4.8
6:00	23.6	18.9	19.7	19.9	17.4	32.9	21.5	20.8	23.0	—	22.0 \pm 4.5
6:15	24.1	17.3	19.5	19.8	16.4	33.8	23.4	21.3	24.1	27.0	22.7 \pm 5.1
6:30	23.6	16.8	18.7	20.4	16.5	33.9	22.0	20.2	21.4	26.2	22.0 \pm 5.1
6:45	23.9	17.1	19.9	20.6	14.9	35.1	23.3	20.5	23.4	26.3	22.5 \pm 5.6
7:00	22.4	15.6	19.7	20.8	16.1	34.6	25.6	19.8	22.7	26.4	22.4 \pm 5.6
7:15	22.7	16.6	—	20.9	16.8	34.0	23.9	20.1	23.5	27.2	22.9 \pm 5.4
7:30	23.6	16.1	—	20.3	16.1	35.9	26.8	20.9	22.1	27.0	23.2 \pm 6.2
7:45	—	17.7	—	22.7	15.6	36.2	27.6	20.5	23.1	28.0	23.9 \pm 6.6

APPENDIX G

RESPIRATORY QUOTIENT
BY TEST AND SUBJECT

TABLE G-1

TEST I. MEAN NORMALIZED RESPIRATORY QUOTIENT AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	.836	—	.974	.937	.924	.911	.925	.905	.928	.963	0.923 \pm 0.039
0:15	.918	1.04	1.03	.878	.901	.894	1.03	.871	.956	.962	0.948 \pm 0.066
0:30	.862	1.01	.928	.911	1.01	.949	.935	.858	.922	1.02	0.940 \pm 0.058
0:45	.934	.972	.968	.887	.913	.926	.932	.994	.965	1.03	0.952 \pm 0.042
1:00	.877	.974	.861	.850	.870	.950	1.02	.887	.940	1.04	0.927 \pm 0.068
1:15	.939	.960	.952	.873	.884	.883	1.06	.848	.891	.980	0.927 \pm 0.064
1:30	.794	.972	.958	.889	—	.880	.989	.862	—	.986	0.916 \pm 0.071
1:45	.896	.957	.916	—	.878	.898	1.03	.863	—	.993	0.929 \pm 0.059
2:00	—	.908	.829	—	.828	.892	1.03	.880	—	.942	0.901 \pm 0.070
2:15	.963	.946	.843	—	.860	.893	.957	.847	—	.964	0.909 \pm 0.054
2:30	.880	.967	.854	—	.852	—	1.02	.799	—	.880	0.893 \pm 0.075
2:45	.885	.950	.861	—	.847	.888	1.02	.796	—	.873	0.890 \pm 0.068
3:00	.949	.918	.835	—	.818	.898	.945	.851	.822	.842	0.875 \pm 0.052
3:15	.889	.911	.790	.809	.833	.888	1.00	.816	.862	.809	0.861 \pm 0.064
3:30	.887	.907	.818	—	.846	.936	.984	.838	.863	.871	0.883 \pm 0.052
3:45	.881	—	.788	.836	.806	.872	.961	.807	.800	.876	0.847 \pm 0.056
4:00	—	.876	.847	.800	—	.853	—	—	—	.942	0.864 \pm 0.052
4:15	.924	—	—	—	—	—	—	.816	.844	—	0.861 \pm 0.056
4:30	.926	—	.866	.819	.820	.957	—	.819	.874	—	0.869 \pm 0.055
4:45	.922	.825	.801	.825	.750	.941	—	.779	.855	—	0.837 \pm 0.066
5:00	.840	.864	.858	.847	.784	1.01	—	.791	—	—	0.856 \pm 0.075
5:15	.846	.843	.799	.873	.766	.933	—	.790	—	—	0.836 \pm 0.057
5:30	.893	—	.773	.880	.773	.914	—	.808	—	—	0.840 \pm 0.063
5:45	.788	—	—	.824	.706	1.02	—	.825	.861	—	0.837 \pm 0.104
6:00	.858	—	—	.784	.808	.928	—	.780	.898	—	0.843 \pm 0.062
6:15	.784	—	.840	.904	.786	.928	—	.795	.917	—	0.851 \pm 0.065
6:30	.795	—	.863	.870	.782	.900	—	.810	.853	—	0.839 \pm 0.044
6:45	.822	—	.776	.844	.724	.913	—	.826	.872	—	0.825 \pm 0.062
7:00	.851	—	.774	.872	.769	.801	—	.808	.902	—	0.825 \pm 0.051
7:15	.813	—	.876	.817	.803	.883	—	.792	.827	—	0.830 \pm 0.035
7:30	.812	—	.805	.850	.776	.925	—	.807	.830	—	0.829 \pm 0.048
7:45	.871	—	.808	.848	—	.944	—	.782	.837	—	0.848 \pm 0.056

TABLE G-2

TEST 2. MEAN NORMALIZED RESPIRATORY QUOTIENT AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	—	—	1.03	—	.968	.872	.906	—	.844	0.924 \pm 0.075
0:15	1.03	—	.953	.977	.904	.950	.966	.923	.984	.845	0.948 \pm 0.053
0:30	.970	—	.924	.918	.951	.951	1.09	—	.906	.794	0.938 \pm 0.082
0:45	.958	—	.911	.864	.884	.915	.925	.890	.958	.812	0.902 \pm 0.046
1:00	.985	—	.822	.926	.804	.954	.976	.948	.888	.810	0.901 \pm 0.073
1:15	.901	—	.827	.962	.915	.988	1.00	.909	.898	.767	0.907 \pm 0.074
1:30	.783	—	.853	.955	—	.968	1.00	.955	.887	.790	0.899 \pm 0.083
1:45	.844	—	.841	.996	.926	.983	.944	.922	.863	.781	0.900 \pm 0.072
2:00	.861	—	.898	.896	.913	.900	.913	.886	.846	.806	0.880 \pm 0.035
2:15	.901	—	.880	.902	.932	.940	.850	.926	.846	.782	0.884 \pm 0.051
2:30	.978	—	.932	.912	.880	.883	.888	.913	.832	—	0.902 \pm 0.043
2:45	.928	—	.820	.802	.895	.884	.828	.878	.820	—	0.857 \pm 0.045
3:00	.893	—	.838	.831	.809	.866	.870	.848	.783	.766	0.834 \pm 0.041
3:15	1.00	—	.809	.818	.840	.865	.882	.820	.852	.796	0.854 \pm 0.061
3:30	.941	—	.808	.812	.797	.949	.880	.898	.790	.778	0.850 \pm 0.067
3:45	.867	—	.859	.827	.803	.951	.898	.853	.794	.743	0.844 \pm 0.061
4:00	.855	—	—	.791	.803	—	.846	—	.805	.800	0.817 \pm 0.027
4:15	—	—	.782	—	—	—	—	.934	—	—	0.858 \pm 0.107
4:30	.821	—	.812	.836	.863	.898	—	—	—	—	0.846 \pm 0.035
4:45	.844	—	.824	.786	.847	.884	.918	.907	.821	.790	0.847 \pm 0.048
5:00	.871	—	.857	.789	.800	.832	.846	.824	.810	.726	0.817 \pm 0.043
5:15	.870	—	.911	.777	.790	.897	.872	.794	.792	.737	0.827 \pm 0.061
5:30	.834	—	.809	.798	.819	.892	.790	.849	.790	.756	0.815 \pm 0.039
5:45	.836	—	.830	.812	.831	.920	.850	.809	.815	.733	0.826 \pm 0.048
6:00	.818	—	.763	.776	.858	.852	.822	—	.774	.754	0.802 \pm 0.041
6:15	.878	—	.783	.860	.831	.906	.865	.812	.814	.751	0.833 \pm 0.049
6:30	.857	—	.817	.788	.832	.921	.820	.788	.858	.710	0.821 \pm 0.058
6:45	.838	—	.768	.826	.794	.842	.800	.866	.828	.743	0.812 \pm 0.039
7:00	.844	—	.798	.896	.828	.924	.838	.842	.713	.740	0.825 \pm 0.067
7:15	.908	—	.819	.822	.795	1.00	.836	.835	.781	.779	0.842 \pm 0.071
7:30	.835	—	.992	.885	.784	1.03	.848	—	.802	.760	0.867 \pm 0.097
7:45	.874	—	.810	.842	.819	1.05	.837	—	.755	.734	0.840 \pm 0.096

TABLE G-3

TEST 3. MEAN NORMALIZED RESPIRATORY QUOTIENT AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	.918	1.04	.974	.845	.940	.997	.907	.895	.916	0.937 \pm 0.059
0:15	.995	.909	.978	.967	.856	.950	.975	.920	—	1.01	0.951 \pm 0.048
0:30	.918	.859	.989	.956	.850	.998	1.03	.914	.912	.993	0.942 \pm 0.061
0:45	.900	—	.993	.995	.830	.998	.942	.906	.874	.926	0.929 \pm 0.059
1:00	.868	.860	.970	.968	—	.993	.974	.890	.895	.958	0.931 \pm 0.051
1:15	.905	—	.977	.979	.882	.928	.936	.880	.853	.906	0.916 \pm 0.043
1:30	.876	.866	.961	.924	.892	.952	.947	.916	.817	.922	0.908 \pm 0.045
1:45	.893	—	.905	.934	.902	.988	.927	.896	.807	.859	0.901 \pm 0.050
2:00	.902	.828	.912	.850	.846	.914	.908	.887	.830	.856	0.873 \pm 0.035
2:15	.927	.827	.907	.891	.893	.980	.950	.867	—	.839	0.898 \pm 0.050
2:30	.852	.853	.893	.835	.800	.962	.896	.876	.832	.878	0.868 \pm 0.044
2:45	.888	.850	.894	.864	.819	.927	.840	.877	.785	.913	0.866 \pm 0.043
3:00	.893	.864	.908	.795	.820	.830	.866	.848	.812	.831	0.847 \pm 0.036
3:15	.875	.870	.847	.853	.780	.904	.902	.816	.821	.837	0.850 \pm 0.039
3:30	.852	.853	.887	.779	.806	.896	.802	.798	.784	.828	0.828 \pm 0.042
3:45	.886	.884	.868	.837	.828	.866	.881	.835	.812	.855	0.855 \pm 0.026
4:00	—	—	—	—	—	.875	.779	.886	—	.853	0.848 \pm 0.048
4:15	.863	.797	.840	.807	.779	.893	.900	—	.786	.843	0.834 \pm 0.045
4:30	.873	.803	.857	.807	.788	—	—	.773	.818	.852	0.821 \pm 0.035
4:45	.871	.823	.850	.802	.785	.880	.840	.821	.795	—	0.830 \pm 0.033
5:00	.878	.821	.871	.792	.810	.929	.780	.780	.813	—	0.830 \pm 0.051
5:15	.876	—	.869	.813	.772	.888	.963	.790	.805	.836	0.846 \pm 0.059
5:30	.856	.784	.794	.806	.779	.842	.854	.783	.789	.803	0.809 \pm 0.030
5:45	.916	—	.856	.872	.766	.876	.856	.798	.819	.829	0.843 \pm 0.045
6:00	.829	.825	.885	.826	.791	.911	.899	.794	.788	.784	0.833 \pm 0.048
6:15	.881	—	.869	.860	.802	.894	.830	.807	.832	.852	0.847 \pm 0.032
6:30	.855	.814	.819	.804	.798	.835	.822	.785	.789	.802	0.812 \pm 0.021
6:45	.854	.794	.892	.823	.784	.872	.809	.802	.801	.841	0.827 \pm 0.036
7:00	.822	.823	.868	.801	.808	.992	.900	.775	.824	.842	0.846 \pm 0.062
7:15	.910	.799	.874	.866	.799	.833	.851	.782	.792	.862	0.837 \pm 0.042
7:30	.890	.820	.867	.798	.838	.959	.921	.783	.810	.836	0.852 \pm 0.056
7:45	.828	.805	.880	.914	—	.944	—	—	.805	.836	0.859 \pm 0.055

TABLE G-4

TEST 4. MEAN NORMALIZED RESPIRATORY QUOTIENT AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	.925	—	.998	.940	.880	1.03	.948	.898	.897	.912	0.931 \pm 0.044
0:15	.928	—	.951	.937	.928	1.01	.953	.915	.915	.937	0.942 \pm 0.027
0:30	.864	—	.834	.918	.896	1.04	—	.792	.935	.892	0.896 \pm 0.074
0:45	.899	.957	.938	.899	.933	1.02	.869	.799	.919	.974	0.921 \pm 0.060
1:00	.914	.939	.872	.877	.863	.973	.914	.885	.894	.894	0.902 \pm 0.033
1:15	.898	1.11	.878	.881	.857	.990	1.07	.993	.896	.848	0.942 \pm 0.093
1:30	.921	.917	.867	.917	.904	.968	.952	.964	.876	.881	0.917 \pm 0.036
1:45	.900	.975	.906	.899	.880	.954	.790	.974	.856	.982	0.912 \pm 0.061
2:00	.877	.976	.874	.882	.880	.974	.863	.871	.821	.897	0.892 \pm 0.048
2:15	.966	.880	.882	.847	.879	.987	.966	.931	.818	.866	0.902 \pm 0.057
2:30	.882	.926	.828	.860	.853	.941	.887	.894	.854	.872	0.880 \pm 0.034
2:45	.913	.895	.812	.925	.890	.864	.882	.853	.856	.921	0.881 \pm 0.035
3:00	.786	.898	.843	.819	.813	.789	.820	.866	.791	.898	0.832 \pm 0.042
3:15	.902	.871	.756	.794	.842	.876	—	.835	.869	.790	0.837 \pm 0.048
3:30	.836	.874	.833	.796	—	.906	.799	—	—	.848	0.842 \pm 0.039
3:45	.865	.866	—	—	—	.908	.900	.828	.834	.846	0.864 \pm 0.031
4:00	—	—	1.02	—	.782	.924	.809	.823	.818	—	0.863 \pm 0.091
4:15	.827	.786	.822	.833	.758	—	.720	.819	.771	.814	0.794 \pm 0.038
4:30	.819	—	—	.818	.756	.911	.798	.822	.779	.789	0.812 \pm 0.046
4:45	.840	.747	.817	.863	.775	1.04	.802	.796	.776	.822	0.828 \pm 0.082
5:00	.816	—	.814	.856	.750	.956	.748	.808	.773	.829	0.817 \pm 0.063
5:15	.869	.819	.817	.850	.819	.926	.952	.831	.740	.834	0.846 \pm 0.060
5:30	.812	—	.782	.858	.808	.890	.804	.760	.732	.790	0.804 \pm 0.048
5:45	.874	.860	.798	.869	.859	.982	.821	.828	.812	.759	0.846 \pm 0.060
6:00	.812	—	.855	.854	.792	.915	.778	.821	.780	.842	0.828 \pm 0.044
6:15	.848	—	.794	.839	.835	.962	.819	.793	.837	.848	0.842 \pm 0.050
6:30	.813	—	.808	.856	.794	.956	.858	.766	.804	.801	0.828 \pm 0.056
6:45	.831	—	.814	.818	.808	1.00	.796	.825	.806	.854	0.839 \pm 0.063
7:00	.817	—	.784	.805	.806	1.03	.769	.806	.748	.860	0.825 \pm 0.083
7:15	.845	—	.834	.816	.790	.942	.859	.822	.784	.813	0.834 \pm 0.047
7:30	.873	—	.826	.831	.803	1.06	.838	.798	.760	.857	0.850 \pm 0.086
7:45	.874	—	.804	.857	.840	.939	.920	.834	.834	.844	0.861 \pm 0.043

TABLE G-5

TEST 5. MEAN NORMALIZED RESPIRATORY QUOTIENT AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	.917	1.02	1.01	.924	.882	.938	.916	.681	.888	.902	0.928 \pm 0.049
0:15	.944	1.02	.921	.892	.917	1.04	1.01	.956	.898	.926	0.952 \pm 0.053
0:30	.922	.964	.994	.885	.852	.956	.857	.913	.885	.903	0.913 \pm 0.047
0:45	.976	1.01	.940	.824	.851	1.02	.878	.902	.892	.874	0.917 \pm 0.067
1:00	.922	1.02	.921	.904	.842	.964	.948	.912	.863	.868	0.916 \pm 0.053
1:15	.942	.973	1.00	.822	—	1.07	.919	.920	.851	.858	0.928 \pm 0.079
1:30	.919	.967	.882	.832	.814	—	.929	.919	.798	.859	0.880 \pm 0.058
1:45	.888	.965	.940	.870	.814	—	.942	.904	.822	.841	0.887 \pm 0.055
2:00	.923	.946	.859	.796	.841	1.01	.836	.938	—	.838	0.887 \pm 0.069
2:15	.948	.907	.866	.810	.852	—	.878	.930	.810	.868	0.875 \pm 0.048
2:30	.878	.938	.832	.824	.816	1.00	.816	.898	.802	.819	0.862 \pm 0.065
2:45	.858	.906	.887	.789	.807	.964	.894	.926	.833	.860	0.872 \pm 0.054
3:00	—	—	.888	—	—	—	.782	.911	.808	.851	0.848 \pm 0.054
3:15	.898	.890	—	—	—	.913	—	—	.813	—	0.878 \pm 0.045
3:30	.894	.886	—	.864	.790	.908	.813	.860	.826	.792	0.848 \pm 0.044
3:45	.887	.886	.716	.806	.735	.924	.838	.847	.845	.812	0.830 \pm 0.065
4:00	.873	.867	.938	.776	.778	.850	.831	.807	.786	.818	0.832 \pm 0.051
4:15	.871	.857	.864	.849	.832	.945	.822	.872	.813	.826	0.855 \pm 0.038
4:30	.863	.836	.840	.798	.796	.862	.850	.827	.855	.804	0.833 \pm 0.026
4:45	.894	.844	.765	.796	.824	.850	.835	.813	.828	.820	0.827 \pm 0.034
5:00	.852	.983	.884	.814	.738	.837	.833	.820	.790	.838	0.839 \pm 0.064
5:15	.850	.843	.886	.846	.803	.916	.778	.827	.817	.815	0.838 \pm 0.040
5:30	.849	.818	.795	.806	.762	1.06	.835	.808	.779	.831	0.834 \pm 0.083
5:45	.827	.872	.966	.838	.797	.993	.893	.840	.812	.834	0.867 \pm 0.065
6:00	—	—	—	—	—	—	—	—	—	—	
6:15	—	—	—	—	—	—	—	—	—	—	
6:30	—	—	—	—	—	—	—	—	—	—	
6:45	—	—	—	—	—	—	—	—	—	—	
7:00	—	—	—	—	—	—	—	—	—	—	
7:15	—	—	—	—	—	—	—	—	—	—	
7:30	—	—	—	—	—	—	—	—	—	—	
7:45	—	—	—	—	—	—	—	—	—	—	

TABLE G-6

TEST 6. MEAN NORMALIZED RESPIRATORY QUOTIENT AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	.887	.993	—	—	.903	.954	.861	—	1.01	.933	0.934 \pm 0.055
0:15	.965	.926	.980	.932	.884	1.05	.896	.958	.965	.935	0.949 \pm 0.047
0:30	.916	1.01	1.06	.904	.864	.996	.838	.982	.928	.915	0.941 \pm 0.069
0:45	.886	.995	.966	.888	.915	.966	.859	.949	1.03	.909	0.936 \pm 0.054
1:00	—	.999	.923	.908	.838	.946	.845	.962	.851	.902	0.908 \pm 0.056
1:15	—	1.01	.969	.902	.881	.964	.883	.898	1.08	.923	0.946 \pm 0.067
1:30	—	.984	.865	.898	.848	.922	.856	—	.835	.856	0.883 \pm 0.049
1:45	—	1.00	.920	.904	.888	.950	.893	—	—	.855	0.916 \pm 0.047
2:00	—	1.01	.954	.814	.881	.889	.840	—	.798	.874	0.882 \pm 0.071
2:15	—	1.01	.931	.869	.851	.943	.840	—	.832	.853	0.891 \pm 0.063
2:30	—	.955	.864	.855	.797	.957	.844	—	.825	.822	0.865 \pm 0.060
2:45	—	1.01	.928	.874	.844	1.01	.833	.946	.818	.826	0.899 \pm 0.077
3:00	—	.858	.905	.820	.817	1.04	.804	.842	.772	.827	0.854 \pm 0.079
3:15	—	.944	.859	.816	.819	.995	.835	.887	.776	.797	0.859 \pm 0.072
3:30	—	.942	.804	—	.792	.921	.963	—	.764	.808	0.856 \pm 0.082
3:45	—	.958	.848	.832	.848	1.02	.734	—	.785	.799	0.853 \pm 0.093
4:00	—	—	—	.780	—	—	—	—	.775	—	0.778 \pm 0.003
4:15	.862	.915	—	.763	.754	.915	.744	—	.773	.832	0.820 \pm 0.071
4:30	.818	.878	.789	.866	.750	.872	.766	—	.740	.800	0.809 \pm 0.053
4:45	.887	.982	.760	.830	.792	.980	.843	—	.786	.826	0.854 \pm 0.081
5:00	.839	.962	.830	.768	.795	.838	.771	.846	.748	.813	0.821 \pm 0.060
5:15	—	.912	.809	—	.788	.924	.757	.822	.774	.747	0.817 \pm 0.067
5:30	.830	.892	.806	.786	.778	.940	.770	.836	.768	.756	0.816 \pm 0.060
5:45	.846	.872	.815	.782	.812	.990	.803	.806	.788	.786	0.830 \pm 0.063
6:00	.839	.833	.789	.766	.786	.839	.772	—	.760	.804	0.799 \pm 0.031
6:15	.845	.855	.806	.806	.809	.957	.763	.847	.780	.823	0.829 \pm 0.054
6:30	.799	.843	.831	.786	.777	.828	.773	.782	.856	.820	0.810 \pm 0.030
6:45	.819	.855	.859	.819	.778	.973	.805	.823	.800	.808	0.834 \pm 0.054
7:00	.833	—	.815	.812	.789	.899	.792	.829	.712	.824	0.812 \pm 0.049
7:15	.862	—	.811	.821	.827	.981	.771	.870	.723	.810	0.831 \pm 0.072
7:30	.860	—	.839	.820	.776	.921	.796	.805	.732	.813	0.818 \pm 0.053
7:45	.874	—	.838	.840	.822	.894	.805	.874	.740	.822	0.834 \pm 0.046

TABLE G-7

TEST 7. MEAN NORMALIZED RESPIRATORY QUOTIENT AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	—	.919	.995	.981	.959	.960	1.03	.930	.938	—	0.964 \pm 0.037
0:15	.941	.946	1.02	.967	.930	.972	1.02	.897	.995	.924	0.961 \pm 0.041
0:30	1.01	.839	.995	.956	.943	.989	1.03	.882	.909	.875	0.943 \pm 0.064
0:45	.955	.964	1.01	.903	.943	.959	1.05	.861	.936	.873	0.945 \pm 0.058
1:00	1.01	.942	.971	.894	.926	.949	1.04	.841	.961	.918	0.945 \pm 0.056
1:15	.937	.936	1.00	.850	.909	1.01	1.04	.848	.918	.919	0.937 \pm 0.064
1:30	.924	.913	.945	.951	.927	.985	1.06	.837	.898	.867	0.931 \pm 0.063
1:45	.886	.908	.973	.949	.987	.966	.970	.894	.901	.878	0.931 \pm 0.042
2:00	.893	.913	.911	.814	.869	.918	.966	.878	.866	.949	0.898 \pm 0.044
2:15	.926	.879	.983	.895	.918	.904	.935	.877	.924	.834	0.908 \pm 0.040
2:30	.884	.839	.900	.864	.891	.896	.935	.870	.875	.754	0.871 \pm 0.048
2:45	.858	.862	.935	—	.900	.891	1.05	.886	.881	.750	0.890 \pm 0.078
3:00	.818	.851	.886	.834	.902	.890	.878	.832	.881	.787	0.856 \pm 0.037
3:15	.877	.846	.905	.849	.911	.889	.922	.825	.839	.811	0.867 \pm 0.038
3:30	.828	.800	.893	.810	.882	.991	.838	.812	.861	.740	0.846 \pm 0.067
3:45	.799	.828	.898	.772	.912	.884	.720	.850	.847	.780	0.829 \pm 0.061
4:00	—	—	—	.805	—	—	—	—	—	.771	0.788 \pm 0.024
4:15	.780	.800	—	—	.869	.953	.912	.827	—	—	0.857 \pm 0.067
4:30	.797	.832	.876	—	.795	.944	.893	.808	.824	.823	0.844 \pm 0.050
4:45	.841	.849	.894	.826	1.03	.889	.999	.849	.836	.757	0.877 \pm 0.082
5:00	.848	.795	.855	—	.850	—	.891	.820	.841	.798	0.837 \pm 0.032
5:15	.803	.846	.920	.906	.842	.900	.991	.834	.862	.843	0.875 \pm 0.055
5:30	1.09	.813	—	.785	.777	.932	.907	.825	.813	.760	0.856 \pm 0.105
5:45	.821	.808	.834	.897	.801	.941	.933	.830	.805	.816	0.849 \pm 0.054
6:00	.798	.845	.850	.786	.754	.910	.853	.796	.792	.819	0.820 \pm 0.045
6:15	.816	—	—	.810	.796	.862	.882	.859	.805	.791	0.828 \pm 0.034
6:30	.787	.765	.810	.814	.781	.864	.891	.787	.784	.815	0.810 \pm 0.039
6:45	.834	.831	.889	.886	.819	.860	.957	.796	.832	.795	0.850 \pm 0.050
7:00	.809	.828	.886	.841	.774	.893	.937	.776	.781	.759	0.828 \pm 0.060
7:15	.853	.836	.908	.838	.780	.923	.958	.804	.829	.731	0.846 \pm 0.068
7:30	.814	.834	.880	.878	.768	.989	.976	.809	.830	.757	0.854 \pm 0.079
7:45	.862	.878	.908	.861	.831	.982	.871	.802	.852	.948	0.880 \pm 0.053

TABLE G-8

TEST 8. MEAN NORMALIZED RESPIRATORY QUOTIENT AND STANDARD DEVIATIONS

TIME	SUBJECT										MEAN \pm S.D.
	1	2	3	4	5	6	7	8	9	10	
0:00	.942	1.09	—	—	.920	.914	.955	.911	.874	.884	0.936 \pm 0.068
0:15	.924	1.02	1.04	.951	.909	.876	.996	.958	.911	.875	0.946 \pm 0.058
0:30	.912	1.05	.932	.933	.889	.892	.958	.882	.867	.874	0.919 \pm 0.054
0:45	.883	1.02	.964	.955	.879	.831	—	.968	.852	—	0.919 \pm 0.067
1:00	.886	.993	.970	.879	.891	.914	1.03	.938	.834	.817	0.915 \pm 0.068
1:15	.918	1.04	.926	.850	.906	.857	1.00	.925	.839	.852	0.911 \pm 0.067
1:30	.874	1.04	.914	.844	.877	.974	.948	.909	.804	—	0.909 \pm 0.071
1:45	.871	1.04	.923	.806	.891	.923	.903	.950	.858	.792	0.896 \pm 0.072
2:00	.895	1.02	.895	.860	.869	.939	.916	.900	.824	—	0.902 \pm 0.055
2:15	.886	1.01	.867	.826	.848	.904	.892	.916	—	—	0.894 \pm 0.055
2:30	.822	.969	.826	.831	.805	.948	.824	.930	—	.808	0.863 \pm 0.066
2:45	.831	1.00	.832	.787	.861	1.01	.865	.959	.786	.789	0.872 \pm 0.087
3:00	.848	.947	.815	.782	.836	.912	.858	.888	.782	.798	0.847 \pm 0.056
3:15	.821	.966	.829	.822	.843	.937	.862	.880	.777	.762	0.850 \pm 0.064
3:30	.813	.936	.820	.774	.845	.978	.783	.853	.774	.748	0.832 \pm 0.074
3:45	.862	.912	.811	.833	.895	.957	.852	.856	.787	—	0.863 \pm 0.052
4:00	—	—	—	—	—	—	—	—	.766	—	0.766 \pm 0.000
4:15	.818	.900	—	.818	.805	—	—	.860	.799	.799	0.828 \pm 0.038
4:30	.833	.878	.803	.782	.769	.954	.819	.822	.772	.787	0.822 \pm 0.057
4:45	.854	.905	.842	.811	.791	.952	.847	.822	.802	.810	0.844 \pm 0.050
5:00	.790	.857	.787	.783	.764	.955	.770	.819	.735	.784	0.804 \pm 0.062
5:15	.845	.865	.828	.790	.789	.967	.883	.857	—	.809	0.848 \pm 0.055
5:30	.798	.854	.778	.764	.774	.952	.847	.805	.708	.781	0.806 \pm 0.066
5:45	.833	.855	.821	.814	.820	.951	.857	.837	.786	.785	0.836 \pm 0.047
6:00	.779	.840	.802	.792	.774	.951	.805	.817	.794	—	0.817 \pm 0.054
6:15	.815	.893	.810	.820	.787	.954	.846	.828	.839	.789	0.838 \pm 0.051
6:30	.838	.854	.799	.800	.765	1.00	.810	.796	.744	.803	0.821 \pm 0.070
6:45	.817	.891	.821	.860	.763	1.01	.856	.902	.804	.806	0.853 \pm 0.069
7:00	.817	.861	.805	.805	.770	.975	.829	.839	.793	.790	0.828 \pm 0.058
7:15	.827	.848	—	.844	.773	.976	.822	.888	.802	.815	0.844 \pm 0.059
7:30	.857	.861	—	.779	.755	.980	.799	.822	.796	.820	0.830 \pm 0.066
7:45	—	.858	—	.849	.765	1.01	.767	.895	.828	.800	0.846 \pm 0.080