measured at a specified set of anatomical sites. The sum of these skinfolds is used to calculate an estimate of the individual's percent body fat.

Because men and women deposit fat differently, it is typical that the specific measurement sites differ according to gender. The regression charts used to estimate body fat from the sum of skinfolds are also different for men and women. Many researchers have published such charts. Therefore, it is essential that the PFT use the exact skinfold sites along with the corresponding conversion chart specified by the author.

Body Composition Evaluations

Measure each of the three sites with the skinfold caliper. Male subjects are measured at the triceps, subscapular and pectoral sites while women are measured at the triceps, abdominal and suprailiac sites. To determine percent body fat, use the appropriate chart to cross-reference the sum with the subject's age and gender.

Aerobic Capacity

The leading occupation-related diseases causing premature departures from the fire service were heart disease and lung disease. Data since 1981 suggest that heart disease caused 45% of the deaths that occurred among U.S. fire fighters while they were on duty. Emergency fire fighting duties have been found to be associated with a risk of death from coronary heart disease that was markedly higher than the risk associated with non-emergency duties. Fire suppression tasks are associated with the highest risk, which is approximately 10 to 100 times as high as that for non-emergency duties. (Kales, S.N. et al., 2007)

Aerobic fitness is fundamental to the health, safety and performance of all uniformed personnel. Research suggests that a program of regular aerobic exercise will reduce an individual's risk of both heart and lung disease. Furthermore, such exercise will help improve cardiovascular fitness and maintain normal levels of body weight, blood pressure, cholesterol, and blood sugar. The risk of having a heart attack is significantly greater for physically inactive individuals.

Numerous studies have demonstrated the necessity of maintaining a high level of aerobic capacity for fire service duties (Kenney & Landy, 1998; Jackson, 1994; Shepard, 1991). Measurements of heart rate response taken during normal fire fighting tasks have been shown to be at, or near, maximal levels. In addition, the oxygen consumption rates associated with the performance of live fire, rescue, and suppression tasks fall within the range of 11 to 13 METs (or 38.5 to 45.5 ml/kg/min). The cardiovascular, respiratory, and thermoregulatory strain resulting from the performance of work at this high level of intensity is profound. Thus, optimal aerobic capacity is essential for the safety of the member and the performance of his or her job.

that we limit fat intake to no more than 30% of our total calories. People who are trying to lose weight may limit their fat intake to as little as 20% of total calories.

Cholesterol

For years, people were taught that they simply needed to eat less cholesterol to reduce serum cholesterol. It was then found that the amount and type of fat consumed influenced blood cholesterol levels more than the amount of dietary cholesterol consumed. Food companies and health professionals discuss fats in terms of "good" fats and "bad" fats because the two types affect cholesterol carriers in different ways. Good fats are the polyunsaturated and monounsaturated fats (fats from plant sources), and bad fats are the saturated fats (fats from animal sources). In reality, most dietary fats contain varying amounts of all three types (Figure 3.2).

Comparison of Dietary Fats

Type	Dietary Fat	Dietary Cholesterol (MG/TBSP)	% Saturated Fat	% Poly-unsaturated Fat	% Mono-unsaturated Fat	
M	Canola oil	0	6	32	62	Vegetable Fats
P	Safflower oil	0	10	77	13	
P	Sunflower oil	0	11	69	20	
P	Corn oil	0	13	62	25	
M	Olive oil	0	14	9	77	
P	Soybean oil	0	15	61	24	
M	Peanut oil	0	18	33	49	
S	Chicken fat	11	31	22	47	Animal Fats
S	Lard	12	41	12	47	
S	Beef fat	14	52	4	44	
S	Butter	33	66	4	30	

Legend: M=Monounsaturated fat P=Polyunsaturated fat S=Saturated fat

Figure 3.2. A Comparison of Dietary Fats

Saturated fats generally come from animal sources (meats, dairy products) and are solid at room temperature. Non-animal sources of saturated fat include tropical oils such as coconut, palm and palm kernel oil. Saturated fats interfere with the removal of cholesterol from the blood.

Polyunsaturated fats come from plant sources and are liquid at room temperature. Examples include corn, safflower, and sunflower oils. They tend to

Carbohydrates

Carbohydrates primarily function as a source of energy for red blood cells, the central nervous system, and muscles. Carbohydrate is the primary fuel during exercise and is the body's only fuel source during high-intensity exercise. Therefore, carbohydrates should be the foundation of an athlete's diet, contributing about 60% of total calorie intake. Most athletes fall short of the recommended intake for carbohydrates, consuming less than 50% of their total caloric intake from carbohydrate. This is also true of the U.S. population in general.

Carbohydrates in the body are stored as glycogen in the muscle and the liver. The amount of glycogen available influences the total amount of energy available to do work. Two factors determine the amount of stored carbohydrate available for exercise: diet and fitness level. As an adaptation to exercise, athletes are able to store more glycogen in their muscle. Diet determines the availability of carbohydrates to be stored as glycogen in the muscle and the rate at which the body replenishes depleted glycogen stores after exercise. There is an overwhelming amount of science which shows that athletes on high carbohydrate diets can exercise longer and at greater intensities compared to athletes on low carbohydrate diets.

Recommendations for carbohydrate intake are often expressed as a percent of total calorie intake, determined by body weight and physical activity (Figure 3.6). A 220-pound weight lifter requires more energy and, therefore, two to three times more carbohydrates than a 150-pound person who only occasionally works out. Consistent with the recommendations for good health, the majority of those carbohydrates should be complex carbohydrates, such as whole grains, pasta, cereals and vegetables (Table 3.8).

EXAMPLE:
CARBOHYDRATE REQUIREMENT

220 lb body builder	150 lb recreational athlete
calorie needs = 3,600 kcal/day	calorie needs = 2,127 kcal/day
carbohydrate = 2,160 kcal or 60% of diet	carbohydrate = 1,170 kcal or 55% of diet
grams of carbohydrate per day = 540 grams	grams of carbohydrate per day = 292 g

Figure 3.6. Carbohydrate Requirement Example

Carbohydrates should provide 55% to 65% of total energy intake. Sixty percent of calorie intake translates to about 450 to 600 grams of carbohydrate per day.

Not only do complex carbohydrates provide energy, they are also packed with nutrients and are good sources of fiber. Simple carbohydrates (sugars) do provide energy, but they provide little additional nutrition.

Equipment

All evaluation equipment must be as specified in these protocols. Equipment must not be substituted unless otherwise indicated. All equipment must be maintained and properly calibrated in accordance with the manufacturer's instructions. Failure to do so may result in inaccurate or invalid data.

The Wellness Fitness Initiative fitness assessment protocols, and the equipment needed to perform them, are described below.

Body Composition

- Lange Skinfold Calipers or equivalent
- Flexible tape measure
- Water-soluble marker

Aerobic Capacity

- Treadmill—The treadmill shall be a commercial treadmill capable of obtaining a minimum of 15% grade and 10 mph.
- Heart Rate Monitor
- Stopwatch
- Stepmill—The Stepmill should be a StairMaster 7000PT. Many generations of the Stairmaster Stepmill have been manufactured over the years. Consequently, the steps/min rate varies from model to model. The new WFI test was validated on a unit that has 20 intensity levels. It is imperative that the administrator be insure that the unit is calibrated to the same steps-per-minute rate for each level indicated in the testing protocol. Refer to Table 5.1.

Level	Steps/min	Level	Steps/min
1	24	11	97
2	31	12	104
3	39	13	111
4	46	14	118
5	53	15	126
6	60	16	133
7	68	17	140
8	75	18	147
9	82	19	155
10	89	20	162

Table 5.1. Intensity (steps/min) for Each Level on the Stepmill

Note:
If your Stepmill is **not** calibrated to the same steps/min rate as the 20-level table, the test may be **invalid** for your Stepmill. Please refer to the manufacturer for options.

the previous formula (Table 5.4). Be aware that the heart rate can be affected by variables such as body temperature, hydration state, anxiety, stress and medications. In addition to heart rate, body mass (height-to-weight ratio), is also a significant variable in both prediction equations. The relationship between height and weight is recorded as Body Mass Index (BMI). It is important to note that BMI is not being used in these aerobic protocols to estimate body composition; but rather, is used to represent the mass of each participant. Whereas all predictive tests are subject to varying degrees of error, it is believed that these new changes will provide vast improvements from previous protocols in reliability, validity and accuracy in estimating $\dot{V}O_{2max}$.

Target Heart Rate (THR) for Respective Age
*THR is used as endpoint in submaximal aerobic capacity protocols

Age (yrs)	THR (BPM)	Age (yrs)	THR (BPM)	Age (yrs)	THR (BPM)	Age (yrs)	THR (BPM)
18	166	29	160	40	153	51	146
19	165	30	159	41	152	52	146
20	165	31	158	42	152	53	145
21	164	32	158	43	151	54	145
22	164	33	157	44	151	55	144
23	163	34	157	45	150	56	143
24	163	35	156	46	149	57	143
25	162	36	155	47	149	58	142
26	161	37	155	48	148	59	142
27	161	38	154	49	148	60	141
28	160	39	154	50	147	61	140

THR Formula: [208-(0.7 x age)]x 0.85

Table 5.4. Target Heart Rate (THR) for Respective Age

Pre-Evaluation Procedures

1. Choose the aerobic capacity protocol and worksheet.
2. Measure the participant's:
   - Resting heart rate
   - Resting blood pressure
   - Age
   - Height
   - Weight
   - Gender
3. Determine the participant's Body Mass Index (BMI) Refer to Table 5.5 & Table 5.6.

4. Determine the Target Heart Rate (THR). Refer to Table 5.4 to determine the appropriate exercise heart rate for the participant's age.
5. Record the target exercise heart rate on the protocol worksheet.
6. Inform the participant of all evaluation components. Ensure that the participant is in proper clothing and footwear.
7. Review all indicators for stopping the evaluation with the participant.
8. Secure heart rate transmitter (chest strap) on the participant's chest in accordance with the manufacturer's instructions. Evaluator shall hold or wear the heart rate receiver.

Body Mass Index Example

$$BMI = \frac{\text{Weight (kg)}}{\text{Height}^2 \text{ (m)}} \quad \text{or} \quad \frac{703 \times \text{weight (lb)}}{\text{Height}^2 \text{ (in)}}$$

Convert weight from pounds (lb) to kilograms (kg) by dividing weight in lb by 2.2

$$\text{Weight} = 140 \text{ lb} \quad \frac{140}{2.2} = 63.6 \text{ kg}$$

Convert height from inches to centimeters (cm), and then to meters (m), by multiplying height in inches by 2.54 and then dividing by 100:

$$\text{Height} = 58 \text{ inches}$$
$$58 \times 2.54 = 147.3 \text{ cm} \qquad \frac{147.3}{100} = 1.47 \text{ m}$$

$$BMI = \frac{63.6}{1.47^2} = 29.4$$

Table 5.5. Body Mass Index (BMI) Formulas

Example of the computations required to calculate VO_2 max:
Age: 48 yrs
Weight: 221 lbs
Height: 6'
BMI = 30
THR = 148 bpm

Example Scenario:
At 7 minutes and 32 seconds the participant exceeds their THR. They continue with the assessment for the additional 15 second monitoring period. The HR remained above their THR. Test terminated and time recorded at 7min 32 sec.

Using Table 5.7 convert 32 seconds to decimal = 0.53
7 min + 0.53 = test time 7.53

Calculate VO_2 using treadmill formula:

$VO_2 = 56.981 + (1.242 \times TT) - (0.805 \times BMI)$
$VO_2 = 56.981 + (1.242 \times 7.53) - (0.805 \times 30)$
$VO_2 = 56.981 + 9.35 - 24.15$
$VO_2 = 42.18$ ml/kg/min

Seconds Converted to Decimal

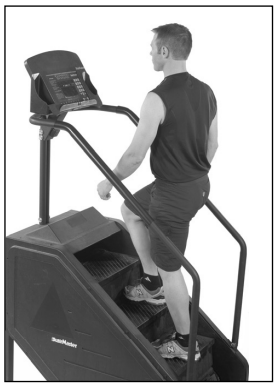
Time seconds	Decimal Equivalent	Time seconds	Decimal Equivalent	Time seconds	Decimal Equivalent
1	0.02	21	0.35	41	0.68
2	0.03	22	0.37	42	0.70
3	0.05	23	0.38	43	0.72
4	0.07	24	0.40	44	0.73
5	0.08	25	0.42	45	0.75
6	0.10	26	0.43	46	0.77
7	0.12	27	0.45	47	0.78
8	0.13	28	0.47	48	0.80
9	0.15	29	0.48	49	0.82
10	0.17	30	0.50	50	0.83
11	0.18	31	0.52	51	0.85
12	0.20	32	0.53	52	0.87
13	0.22	33	0.55	53	0.88
14	0.23	34	0.57	54	0.90
15	0.25	35	0.58	55	0.92
16	0.27	36	0.60	56	0.93
17	0.28	37	0.62	57	0.95
18	0.30	38	0.63	58	0.97
19	0.32	39	0.65	59	0.98
20	0.33	40	0.67	60	1.00

Table 5.7. Seconds Converted to Decimal

Stepmill Evaluation

Equipment

StairMaster 7000 PT Stepmill
Heart Rate Monitor
Stopwatch
Height/Weight Scale
Calculator



Time	Level	Step/min
0:00 – 1:00	4	46
1:01 – 2:00	4	46
2:01 – 3:00	5	53
3:01 – 4:00	7	68
4:01 – 5:00	8	75
5:01 – 6:00	9	82
6:01 – 7:00	10	89
7:01 – 8:00	11	97
8:01 – 9:00	12	104
9:01 – 10:00	13	111
10:01 – 11:00	14	118
11:01 – 12:00	15	126
12:01 – 13:00	16	133
13:01 – 14:00	17	140
14:01 – 15:00	18	147
15:01 – 16:00	19	155
Recovery Phase		
0:00 – 1:00	3	39
1:01 – 2:00	3	39

Assessment

The purpose of this assessment is to estimate the $\dot{V}O_{2max}$ of each participant.

1. Conduct Pre-Evaluation Procedures.
2. Monitor the participant's heart rate continuously throughout the assessment.
3. Instruct the participant to temporarily grasp the handrails to reduce the possibility of losing balance when the stairs begin to move.
4. The starting position is approximately two-thirds of the way up the stairs.
5. The assessment starts at level 4 for 2 minutes, then level 5 for 1 minute (warm-up period). Start the stopwatch at this time. Inform the participant that the evaluation is a series of 1-minute intervals with increasing work loads on each subsequent minute.
6. Once the assessment commences, do not allow the participant to hold or lean on the handrails; this will result in overestimation of aerobic capacity.
7. At the completion of the 3 minute-warm-up, proceed to level 7 for 1 minute. *Note: This is marked by increasing the workload from level 5 to level 7.
8. Once the heart rate exceeds the target exercise heart rate, note the time and continue the assessment for an additional 15 seconds. Do not make any changes to the assessment intensity level during this time. If the participant's heart rate remains above the target heart rate for the full 15 seconds, then the participant has completed the assessment. Stop the assessment and record the time at which the participant exceeded the target heart rate (THR). The total time (TT) extends from the warm-up is up, to the point at which the participant exceeds their target HR. It does not include the final 15 second monitoring period that the HR was above the THR.
9. The assessment is complete once the participant's heart rate exceeds the target for 15 seconds. If the participant's heart rate exceeds the target, but then drops down to the target heart rate or below within 15 seconds, then the assessment should continue.
10. Once the assessment is completed, the participant will cool down for a minimum of 2 minutes at level 3. Continue to monitor the heart rate during the cool-down. Record the heart rate at one minute of cool-down. The participant may grasp the handrails during the cool-down phase.
11. Upon completion of the cool-down, instruct the participant to grasp the handrails. Stop the Stepmill and assist the participant off the apparatus.
12. Terminate the assessment if any of the following occurs:
    a. The participant's heart rate exceeds THR for 15 seconds.
    b. The target exercise heart rate has not been met after 16 minutes.
    c. The participant asks to terminate the exercise.
    d. The equipment malfunctions.
    e. Medical conditions arise that prohibit completing the assessment.
13. Record the reason for terminating the assessment and the initial time the target heart had been exceeded (if applicable). Record time in minutes and convert second(s) into decimal. See Table 5.7.

14. Insert the test time (TT) at which the participant completed the assessment, along with the Stepmill conversion formula to estimate $\dot{V}O_{2max}$.
15. Record the $\dot{V}O_{2max}$.

WFI Stepmill Sub-maximal VO_2 Prediction Formula

$\dot{V}O_{2max} = 57.774 + (1.757 \times TT) - (0.904 \times BMI)$
*Note: TT is the time in minutes that the participant's HR was exceeded the THR, and the test terminated

The following example illustrates the computations required to calculate $\dot{V}O_{2max}$ for the Stepmill.

Age: 48 yrs Weight: 221 lbs Height: 6' BMI = 30 THR = 148 bpm

Example Scenario:
At 5 minutes and 8 seconds the participant exceeds THR. Continue with the assessment for the additional 15 second monitoring period. If the participant exceeds the THR after 5 minutes and 52 seconds, continue with the assessment for the additional 15-second monitoring period. Should the participant's HR stay above the THR during the 15-second monitoring period, the test would be terminated and the time recorded at 5 min 52 sec.

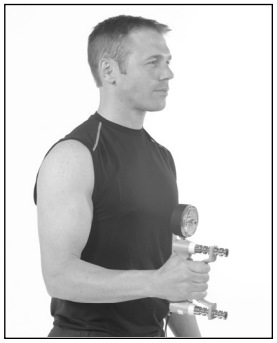
If the participant's heart rate drops below the THR after 10 seconds of monitoring, the appropriate course of action would be to continue with the assessment.

Using Table 5.7 convert 52 seconds to decimal = 0.87
5 min + 0.87 = test time 5.87
Calculate the $\dot{V}O_2$ using Stepmill formula:
$\dot{V}O_2 = 57.774 + (1.757 \times (TT) - (0.904 \times BMI)$
$\dot{V}O_2 = 57.774 + (1.757 \times 5.87) - (0.904 \times 30)$
$\dot{V}O_2 = 57.774 + 10.31 - 27.12$
$\dot{V}O_2 = 40.96$ ml/kg/min

WFI Grip Strength

Equipment

JAMAR Hydraulic Hand dynamometer
Towel



Assessment

The purpose of this assessment is to evaluate the maximum isometric muscular strength of the flexor muscles of the hands. There is a strong correlation between hand grip strength and upper body strength.

CPAT Testing Procedures

The CPAT is a sequence of eight events that requires candidates to progress along a predetermined path from event to event in a continuous manner. The CPAT is a pass/fail test based on a validated maximum total time of 10 minutes and 20 seconds.

During CPAT events, the candidate wears a 50-pound vest to simulate the weight of self-contained breathing apparatus (SCBA) and fire fighter protective clothing. An additional 25 pounds, using two 12.5-pound weights that simulate a high-rise pack (hose bundle), is added for the stair climb event.

Throughout all events, the candidate must wear long pants, a hard hat with chinstrap, work gloves and footwear with no open heel or toe. Watches and loose or restrictive jewelry are not permitted.

All props were chosen to provide the highest level of consistency, safety, and validity in measuring the candidate's physical abilities. Schematic drawings and specifications for each prop are included in Appendix 5 of the CPAT Manual. All props for the CPAT must be purchased through the vendors specified by the CPAT Manual. Modification of props or substitution of tools/equipment may alter the validity of the test and, therefore, are not permitted. The entire test is designed to be portable and allow for either indoor or outdoor setup. The floor of the venue must be consistent for all events and for all candidates.

The events are placed in a sequence that best simulates their use in a fire scene, while allowing for an 85-foot walk between events. To ensure the highest level of safety and to prevent candidates from becoming exhausted, no running is allowed between events. This walk allows the candidate approximately 20 seconds to recover before each event.

To ensure scoring accuracy by eliminating timer failure, two stopwatches are used to time the CPAT. One stopwatch is designated as the official test time stopwatch; the second is the backup stopwatch. If mechanical failure occurs, the time on the backup stopwatch is used. The stopwatches are set to the past/fail time and countdown from 10 minutes and 20 seconds. If time elapses prior to the completion of the test, the test is concluded, and the candidate fails the test.

The CPAT includes eight sequential events as follows:

1. Stair climbing
2. Hose drag
3. Equipment carry
4. Ladder raise and extension
5. Forcible entry

13. Forearm Stretch

Forearms

- Stand upright and grab right fingers with left hand.
- Slowly fold right wrist backwards until mild tension is felt.
- Hold for ten seconds, then push slightly farther until you feel slightly more tension.
- Repeat sequence, this time folding wrist forwards.
- Return to starting position and repeat sequence with left arm.
- Repeat entire sequence 2 or 3 times.

General Principles of Exercise

To maximize the results from your training program, several exercise principles should be understood.

Adaptation

Adaptation means that the body can adjust to any overload as long as it is done in small increments. The amount of progress the body can make depends on adequate rest, consistency of workouts, adequate nutrition, and genetic makeup.

Overload

Overload, in exercise training programs, means that a training program causes the body to adapt only when the demands are greater than what the body is accustomed to doing. This does not mean that the overload is greater than your maximum; rather overload is generally greater than 60% of your maximal effort.

Progression

The principle of progression states that as the body adapts to the exercise program you must gradually increase the overload to continue to adapt. It is critical that all progressions are gradual and small in nature to prevent over loading the body's ability to recover.

Specificity

Specificity of training is the principle that your body will adapt to whatever exercises you perform. This means that if you only perform bench presses, your body will not adapt to sit-ups. It may, therefore, be beneficial for you to alter your training to prepare for the Candidate Physical Ability Test.

Overtraining

Over-training addresses the body's need for adequate rest and nutrition following exercise to recuperate before the next exercise session. If