

How to Perform the Moore Firefighter Treadmill VO₂max Test

Equipment needed:

Treadmill with incline up to 15% (in 1% increments)
Weighted vest that can hold at least 20% of each participant's body weight
Heart rate monitor or Electrocardiogram
Blood pressure cuff

This test is most safely performed when administered by a qualified person (see pages 3-4). Firefighters can, however, test themselves by simply increasing the speed/grade on the treadmill on their own.

Preparation:

1. Perform a safety screening on the participant and be sure you have proper supervision (see page 3).
2. Weigh the participant. Then prepare the vest to weigh 20% of the person's body weight, being sure to account for the weight of the vest itself. Have the participant warm up while the tester prepares the weighted vest.
3. Warm-up: It is very important to warm-up before this test. Failure to warm up could result in back and/or shin pain and would hinder participant's results, making their predicted VO₂max less accurate. At a minimum, the participant should walk on the treadmill for 5 minutes (without the weighted vest) and then stretch the hamstrings and back muscles for 5 minutes. The more warmed up the person is, the better.
4. After the warm-up, attach the heart rate monitor or electrocardiogram to the participant and take the person's blood pressure. Be sure there are no indications for not beginning an exercise test (see page 4).
5. Have the participant put on the vest and stand on the treadmill.

Performing the Test:

1. The treadmill test officially begins with the participant walking on the treadmill at 3.0 mph at 0% grade for the first 3 minutes. Use the clock on the treadmill as the official timer.

The person's heart rate/rhythm and blood pressure should be monitored throughout the test.

2. When the clock says 3:00, the treadmill speed should be increased to the participant's fastest possible walking speed. The person should be walking very briskly but not feel as if he/she needs to break into a run. This will be different for everybody based on their leg length but most people will be between 3.8 and 4.0 mph.

The participant walks at this speed at 0% grade for one minute. The speed will not change for the rest of the test.

3. When the clock says 4:00, increase the grade on the treadmill to 1%. Each minute after that, continue to increase the grade by 1%.
4. The participant should continue walking until he or she reaches exhaustion unless: a) the person completes 18 minutes – the maximum time, or b) they elicit any of the criteria for stopping a treadmill test (see page 4), or c) they request to stop.

Overview and Interpretation of the Test

1. Weigh the participant.
2. Prepare the vest to weigh 20% of the person's body weight
3. Have the participant warm-up for at least 5 minutes
4. Attach the heart rate monitor or electrocardiogram to the participant and take his/her blood pressure
5. Have the participant put on the vest and stand on the treadmill
6. Begin the test. The participant walks on the treadmill at 3.0 mph at 0% grade for the first 3 minutes.
7. At 3 minutes, increase the treadmill speed to the participant's fastest possible walking speed
8. At 4 minutes, increase the incline on the treadmill to 1%
9. At 5 minutes, increase the incline on the treadmill by 1%. The incline should now be 2%.
10. Increase the incline by 1% each minute until the person can no longer walk or completes 18 minutes (when the clock says 19:00). Record the number of minutes that the person was able to complete.
11. Look on the chart below to find the person's predicted VO₂max. This is their VO₂max ± 3.2.
12. Compare their predicted VO₂max to other people of the same age and gender using the charts on the right. (50th percentile is average; 80th percentile means your VO₂max is better than 80% of other people)

<u>Minute</u>	<u>Incline</u>	<u>Speed</u>	<u>VO₂max</u>
(0-2:59)	0%	3.0 mph / 4.8 kph	
3	0%	↑ to fast walk	17.9
4	1%	no change	20.1
5	2%		22.3
6	3%		24.5
7	4%		26.7
8	5%		28.8
9	6%		31.0
10	7%		33.2
11	8%		35.4
12	9%		37.6
13	10%		39.8
14	11%		41.9
15	12%		44.1
16	13%		46.3
17	14%		48.5
18	15%		50.7
19	Test stops when clock says 19:00		52.9

Firefighters should strive for a VO₂max of 42 or higher

<u>Percentile values for VO₂max (ml/Kg/min) in Men</u>				
<u>Percentile</u>	<u>20-29</u>	<u>30-39</u>	<u>40-49</u>	<u>50-59</u>
90	55.1	52.1	50.6	49.0
80	52.1	50.6	49.0	44.2
70	49.0	47.4	45.8	41.0
60	47.4	44.2	44.2	39.4
50	44.2	42.6	41.0	37.8
40	42.6	41.0	39.4	36.2
30	41.0	39.4	36.2	34.6
20	37.8	36.2	34.6	31.4
10	34.6	33.0	31.4	29.9

<u>Percentile values for VO₂max (ml/Kg/min) in Women</u>				
<u>Percentile</u>	<u>20-29</u>	<u>30-39</u>	<u>40-49</u>	<u>50-59</u>
90	49.0	45.8	42.6	37.8
80	44.2	41.0	39.4	34.6
70	41.0	39.4	36.2	33.0
60	39.4	36.2	34.6	31.4
50	37.8	34.6	33.0	29.9
40	36.2	33.0	31.4	28.3
30	33.0	31.4	29.9	26.7
20	31.4	29.9	28.3	25.1
10	28.3	26.7	25.1	21.9

Safety Precautions

The tester and participant should understand that there are risks associated with exercise and they are participating in this test at their own risk. However, said risk is no greater than if one was to participate in a high intensity workout or complete a firefighting task that required maximal exertion.

The tester must have the cognitive skills needed to conduct exercise testing including being knowledgeable about initial screening and appropriate supervision, indications for not beginning an exercise test, and the criteria for stopping an exercise test. These are explained below.

Initial screening and appropriate supervision

Initial screening should be done to ensure that the participant has the proper clearance and supervision for participating in a maximal exercise test/high intensity exercise. This will reduce the risk of the participant experiencing cardiac complications during the test and will ensure that the tester cannot be held liable for any adverse events occurring on the basis of negligence.

Initial screening is completed by determining the person's risk category for heart disease (low, moderate or high) according to the American College of Sports Medicine (ACSM) Guidelines.

Listed below are the heart disease risk factors. People who have less than two of these risk factors are considered **low risk** and do not need physician approval to exercise or special supervision to participate in a maximal exercise test. People with two or more of the heart disease risk factors are considered **moderate risk**. According to ACSM, people in the moderate risk category should be encouraged to consult with their physicians prior to participating in high intensity exercise but do not need special supervision to participate in a maximal exercise test.

- Age: males > 45 years of age, or females > 55 years of age
- Family history: myocardial infarction (heart attack), coronary revascularization, or sudden death in an immediate relative (male <55 years or female <65 years)
- Smoking: current smoker or those who quit within the past 6 months
- Hypertension: resting systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg, or on antihypertensive medication (counts as no more than 1 risk factor if any apply)
- Poor cholesterol: Total cholesterol >200 mg/dL or HDL cholesterol <40 mg/dL or LDL cholesterol >130 mg/dL, or on lipid-lowering medication (no more than 1 risk factor if any apply)
- High blood glucose: Fasting blood glucose ≥ 100 mg/dL confirmed on two separate occasions,
- Obesity: BMI >30, or waist girth >102 cm (40 in) for men and > 88 cm (35 in) for women, or waist-to-hip ratio ≥ 0.95 for men and ≥ 0.86 for women
- Inactivity: not participating in a regular exercise program or accumulating 30 minutes or more of moderate physical activity on most days of the week
- Subtract one risk factor if the person possesses an HDL cholesterol >60 mg/dL

A person is only considered **high risk** if they have one of the following conditions or symptoms listed below. People who have or are at high risk for heart disease should be supervised by a physician or a paramedic while participating in a maximal exercise test. According to ACSM, "supervision" means that they are "in the immediate vicinity and available for emergencies."

- Cardiac heart, peripheral vascular, or cerebrovascular disease
- chronic obstructive pulmonary disorder, asthma, interstitial lung disease, or cystic fibrosis
- Diabetes mellitus type 1 or 2, thyroid disorders, renal, or liver disease
- angina (chest pain)

- ankle edema
- shortness of breath at rest or with mild exertion, or unusual fatigue or shortness of breath with usual activities, or dizziness or syncope (fainting), or orthopnea or paroxysmal nocturnal dyspnea
- palpitations or tachycardia
- intermittent claudication
- known heart murmur

If appropriate supervision is unavailable, or if the participant and/or the tester do not feel comfortable having the participant perform the test to maximal exertion, the participant could stop at a submaximal level and estimate the number of minutes that he/she thinks he/she could have achieved. This will reduce risk but will also make the predicted aerobic capacity less accurate.

While this test can be completed just using a heart rate monitor, if the participant is connected to an electrocardiogram (EKG), that will provide an additional level of safety.

Indications for not beginning an exercise test

The tester should also be mindful that the participant may not be in a condition to even start an exercise test. The following are indications that the person is not safe to participate in the exercise test:

- Any cardiac event having occurred recently
- Suspected ischemia or myocardial infarction, aortic stenosis, heart failure, pulmonary embolus/infarction, myocarditis/pericarditis, dissecting/ventricular aneurism, left main coronary stenosis, stenotic valvular heart disease, hypertrophic cardiomyopathy, electrolyte abnormalities
- Chest pain
- uncontrolled cardiac arrhythmias: ie. second / third degree AV block, atrial fibrillation, left bundle branch block, frequent premature ventricular contractions or ventricular tachycardia
- systolic blood pressure greater than 160 mmHg or diastolic blood pressure greater than 110 mmHg (note that the systolic cutoff of 160 mmHg is more stringent than the ACSM guidelines which states 200 mmHg)
- ST-segment elevation or depression
- Current acute illness, chronic infectious disease, or uncontrolled metabolic disease

Criteria for stopping an exercise test

The tester should also be mindful that the participant may not respond appropriately to exercise. The following are indications that the person is not safe to continue the exercise test:

- chest pain
- drop in systolic blood pressure of >10 mmHg
- rise in systolic blood pressure > 250 mmHg or diastolic blood pressure > 115 mmHg
- ST-segment elevation (+ 1.0 mm) or depression (> 2 mm horizontal, or downsloping depression)
- Signs of poor perfusion (circulation or blood flow), including pallor (pale appearance to the skin), cyanosis (bluish discoloration), or cold and clammy skin
- Severe or unusual shortness of breath, wheezing, leg cramps or claudications
- Central nervous system symptoms: ie. ataxia (failure of muscular coordination), vertigo, visual or gait problems, confusion
- Serious arrhythmias: ie. second / third degree AV block, atrial fibrillation, bundle branch block, increasing premature ventricular contractions or sustained ventricular tachycardia
- Patient's request (to stop)