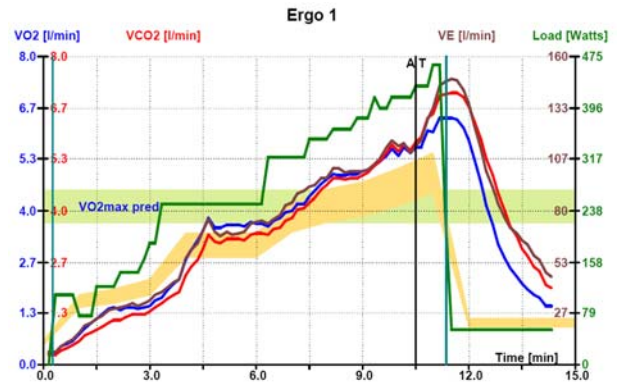




## VO<sub>2</sub> Max Fitness Test

### Test Summary

VO<sub>2</sub> Max testing measures how effectively the body consumes oxygen during exercise. It is a measure of an athlete's maximum ability to pull oxygen from the air, transport it into the blood, and deliver it to active muscles. VO<sub>2</sub> Max is dependant on several factors, including lung capacity and function, cardiac output, oxygen delivery, and the oxidative capacity of muscle cells. Theoretically, since the greater the volume of oxygen consumed by the body the greater the body's ability to do aerobic work, VO<sub>2</sub> Max values can be used as a benchmark for individual's level of fitness.



During exercise, in order to produce energy most efficiently, muscle cells require oxygen. When workloads increase and muscles' demands for oxygen exceed the body's ability to deliver, energy must be produced through different means, via anaerobic metabolism. Anaerobic metabolism is a highly inefficient process that also produces byproducts associated with fatigue and muscle soreness. During a VO<sub>2</sub> Max test subjects exercise to their maximum capacity, and measurements are taken to determine the maximum amount of oxygen one's body is able to deliver and to identify what demand forces the body to convert to anaerobic energy production. One of the best ways to increase performance in endurance athletes is to extend the time, and workload, that the body can remain in aerobic metabolism. VO<sub>2</sub> Max testing gives athletes the information necessary to understand their body's boundaries and to push those boundaries through future training.

### Test Protocol

Testing can be administered using either a treadmill or a bike according to the subject's preference. To begin the exam, subjects will be fitted with a respiratory mask, covering their mouth and nose, and will be connected to a cardiac monitoring device, either a Heart Rate Monitor or a 12 Lead EKG. Prior to testing, vital statistics will be measured as a baseline, including Heart Rate, Resting Respiration, and Blood Pressure. During the test subjects are encouraged to exercise to their maximum heart rate, calculated by subtracting their age from 220. The workload will increase approximately every minute until maximum heart rate is achieved and the test will conclude with a three minute recovery period at a light workload. All data is recorded continuously throughout the test period, and the test can be stopped by the subject at any time for whatever reason.

### Key Data Points

- **VO<sub>2</sub> Max** – This is a relative measure of the rate at which your body delivers oxygen to active muscles during exercise, measured in milliliters per minute per kilogram body weight (ml/min/kg). VO<sub>2</sub> Max is dependant on age, level of fitness, genetics, type of athlete (endurance vs. strength), etc and it is a measure of endurance performance.
- **Anaerobic Threshold (AT)** – This is defined as a point during exercise where muscles' oxygen demands exceed the body's ability to deliver and Anaerobic, rather than Aerobic, metabolism becomes the body's primary means of energy production. Several data points are collected here, including time, workload, VO<sub>2</sub>, etc.
- **Respiratory Exchange Ratio (RER)** – This value is the ratio of expired carbon dioxide over consumed oxygen (VCO<sub>2</sub>/VO<sub>2</sub>). This value can be useful for determining the type of fuel the body is burning at different stages of exercise. At lesser workloads, the body converts fat into energy (RER ~ .75) while at more intense workloads carbohydrates are used as fuel (RER > 1.0). Also, an RER > 1.10 is used as an indicator of a valid VO<sub>2</sub> Max.



# Human Performance Laboratory



## Frequently Asked Questions (FAQ)

***How long will the test take?*** A complete  $VO_2$  Max test takes approximately 1 hour including set-up and cool-down; however the exercise phase will never exceed 10-12 minutes.

***What do I need to bring?*** It is important that subjects wear athletic apparel, including shoes, appropriate for the type of test they will be performing (bike or treadmill). Subjects will be given time prior to their test to stretch and warm-up.

***What are the risks?*** There are risks associated with any maximum exercise test, including sudden death; however these risks can be lowered substantially with proper precautions. Subjects' vital signs will be closely monitored throughout the test and it is important that test subjects communicate any symptoms to staff, including chest pain, difficulty breathing, dizziness, etc.

***What will the results show?***  $VO_2$  Max data can be used as a measure of individual fitness and it can be useful as a benchmark for setting future goals and formulating training.



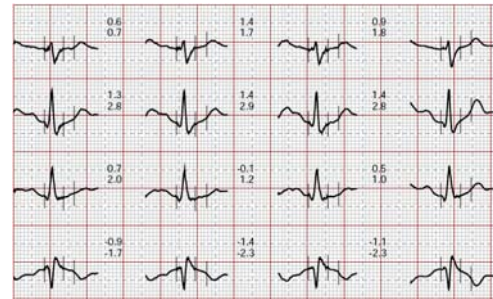
## Exercise EKG

### Test Summary

During exercise the heart is placed under tremendous stress to circulate blood and deliver oxygen to active muscles. Exercise EKG testing offers insight into the heart's response to exercise, allowing visibility into the stresses placed on the heart during exercise and the efficiency with which the heart operates under such stresses. Exercise EKG data can be used to analyze an individual's level of fitness and to define future exercise and training prescriptions.

### Test Protocol

Exercise EKG testing can be administered using either a treadmill or a bike according to the subject's preference. To begin the exam, subjects will be led to a private area where adhesive electrodes will be applied to their skin. Some skin preparation may be necessary prior to application, including alcohol swabbing, abrading, and shaving. Prior to testing, vital statistics will be measured as a baseline, including Heart Rate, Resting Respiration, and Blood Pressure. During the test subjects are encouraged to exercise to their maximum heart rate, calculated by subtracting their age from 220. The workload will increase approximately every minute until maximum heart rate is achieved and the test will conclude with a three minute recovery period at a light workload. All data is recorded continuously throughout the test period, and the test can be stopped by the subject at any time for whatever reason. Exercise EKG tests are often delivered in conjunction with VO<sub>2</sub> Max testing.



### Key Data Points

- **Max Heart Rate** – Maximum Heart Rate (beats/min) is dependant on several factors including anatomical constraints, fitness, and age. Maximum Heart Rate can be useful in determining exercise prescriptions.
- **% Max Heart Rate** – Maximum Heart Rate is determined by subtracting one's age from 220. % Max Heart Rate therefore identifies what percent of your predicted heart rate you achieved during maximum exercise. This value can be used as a fitness benchmark.
- **Heart Rate Recovery** – Heart Rate Recovery measures how quickly your heart rate returns to within a resting range after an exercise period. It is a measurement of fitness and is useful in defining the amount of stress placed upon the heart during exercise.
- **EKG Averages** – EKG Averages show the heart's actual electrical activity and give full insight into the heart's response to exercise.

### Frequently Asked Questions (FAQ)

**How long will the test take?** A complete Exercise EKG test takes approximately 45 minutes including set-up and cool-down; however the exercise phase will never exceed 10-12 minutes.

**What do I need to bring?** It is important that subjects wear athletic apparel, including shoes, appropriate for the type of test they will be performing (bike or treadmill). Subjects will be given time prior to their test to stretch and warm-up. Females should be sure to wear athletic/sport's bras so as to allow electrode hook-up.

**What are the risks?** There are risks associated with any maximum exercise test, including sudden death; however these risks can be lowered substantially with proper precautions. Subjects' vital signs will be closely monitored throughout the test and it is important that test subjects communicate any symptoms to staff, including chest pain, difficulty breathing, dizziness, etc.

**What will the results show?** Exercise EKG data acts as a measurement for cardiovascular fitness and describes the heart's response to exercise. Data can be used to understand exercise capacity and to set future training goals.



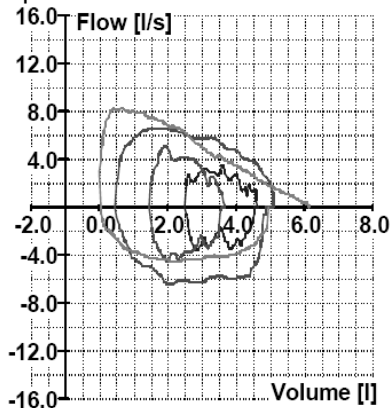
## ***Spirometry – Pulmonary Function Fitness Evaluation***

### **Test Summary**

Spirometry defines a battery of tests that are used to assess pulmonary functionality. Test results reveal the lung's capacity to move air through the pulmonary system. Three different types of tests are available, including Forced Vital Capacity (FVC), Slow Vital Capacity (SVC), and Maximum Voluntary Ventilation (MVV).

### **Test Protocols**

For all Spirometry tests, subjects will be asked to breathe into a measurement device and each test will be repeated at least three times to insure consistency. A complete Spirometry exam, including explanation and set-up, should take no more than 15 minutes. The three different types of tests are described below:



**Forced Vital Capacity (FVC)** – Subjects are instructed to inhale as deeply as possible and then immediately exhale as quickly and as fully as possible, holding the exhalation for 6 seconds at which time subjects will be prompted to take a maximum inhalation.

**Slow Vital Capacity (SVC)** – Subjects should take three normal breaths, inhale to maximum lung capacity and then exhale as fully as possible.

**Maximum Voluntary Ventilation (MVV)** – Subjects should breathe as deeply and as rapidly as possible for 10 to 12 seconds. Due to the hyperventilation that is forced during this test, it is not uncommon for tests subjects to feel slightly light headed upon completion. This test is always conducted in a seated position.

### **Key Data Points**

- **FVC** – Forced Vital Capacity – This is the maximum amount of air that can be expired after a forced maximum inspiration. Forced Vital Capacity is measured in liters (l) and is a measurement of lung volume.
- **FEV1** – Forced Expiratory Volume in 1 Second – This is the amount of air that can be forcibly exhaled in the first second of expiration. Again this measurement is taken in liters (l) and is useful in identifying airway functionality.
- **FEV1/FVC** – This ratio gives you the percentage of your total lung volume that you are able to exhale within the first second of expiration. In normal lung function this ration should be greater than 75%.
- **PEF** – Peak Expiratory Flow – This value is the maximum rate, measured in liters/second (l/s), of expiration that was reached during exhalation. Again this value helps describe airway functionality.

### **Frequently Asked Questions (FAQ)**

**How long will the test take?** The test should take no more than 15 minutes, including set-up and explanation.

**What do I need to bring?** The Stanford Human Performance Lab will provide all the necessary equipment for completing a Spirometry test, however, loose fitting clothing should be worn so as to allow deep breathing.

**What are the risks?** There are no significant risks associated with Spirometry tests.

**What will the results show?** Spirometry results show the capacity of the lungs to move air. These results can be viewed from a fitness perspective and can be tracked to see if improvements are made with training. In addition, for subjects with known asthma, Spirometry results can measure the effectiveness of asthma medications.