The EKBLOM-BAK test
- a submaximal cycle ergometry test for estimation of VO2max

The test is based on change in heart rate between a low standard workrate (same workrate for all subjects performing the test), followed by an individually chosen higher workrate (4 min each). The pedalling rate is 60 rpm, and average heart rate is measured during the last minute on each workrate, respectively.

1. Calibrate the ergometry cycle according to standard procedures.

2. Ensure that the individual being tested has followed conventional pre-test conditions (comment on this in the end of this manual).

3. Adjust seat and handlebar, and introduce Borg’s RPE-scale.

4. Before the test, estimate a suitable higher work rate to allow the individual to reach a heart rate in the range 120-150 bpm (for individuals < 50 years) and 110-140 bpm (for individuals ≥ 50 years), respectively, aiming at a rated perceived exertion of ≈14 according to the Borg RPE-scale. The table below gives a rough guide to reach these pre-requisites with regard to sex and activity level.

<table>
<thead>
<tr>
<th></th>
<th>Woman</th>
<th>Man</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inactive</td>
<td>59 or 64 W</td>
<td>88 or 95 W</td>
</tr>
<tr>
<td>Low</td>
<td>88 or 95 W</td>
<td>118 or 127 W</td>
</tr>
<tr>
<td>Moderate</td>
<td>118 or 127 W</td>
<td>147 or 159 W</td>
</tr>
<tr>
<td>High</td>
<td>147 or 159 W</td>
<td>177 or 191 W</td>
</tr>
</tbody>
</table>

The watts depends on whether the work rate is measured by the flywheel or the pedals

5. Start standard work rate pedalling for 4 min at 60 rpm and the standard resistance. Check each minute that both pedalling speed and resistance are kept constant.

6. Measure average heart rate during the 4th min by taking notes of the heart rate at four occasions (3.15, 3.30, 3.45, and 4.00) and average these.

7. Increase resistance to the higher individual work rate (point 4 above). Check each minute that both pedalling speed and resistance are kept constant.

8. Ask for RPE during the 2nd min at the higher rate.

9. If RPE is < 10, increase resistance with 1 kp and redo point 8.
   If 10-11, increase with 0.5 kp and redo point 8.
   If 12 – 16, maintain rate and go to point 10.
   If 17 or higher, stop the test and let the subject rest for 20 min before performing a new test at a lower rate. However, it is preferable to cease testing and perform the test on another occasion.

10. Measure average heart rate during the 4th min at the higher rate by taking notes of the heart rate at four occasions (3.15, 3.30, 3.45, and 4.00) and average these.

11. After completed test, ask for RPE for the 4 min at the higher rate.
Procedure for estimating VO\textsubscript{2max}

**Electronically**
An application for estimating VO\textsubscript{2max} with the EKBLOM-BAK test is available at www.gih.se/ekblombaktest.

**Manually**
Input the relevant variables* into the following equation:

**Men**
\[
\text{VO}_{2\text{max}} = \exp((2.04900 - 0.00858\times\text{Age}) - (0.90742\times\frac{\Delta \text{HR}}{\Delta \text{PO}} + (0.00178\times\Delta \text{PO}) - (0.00290\times\text{HR at standard work rate}))
\]

**Women**
\[
\text{VO}_{2\text{max}} = \exp((1.84390 - 0.00673\times\text{Age}) - (0.62578\times\frac{\Delta \text{HR}}{\Delta \text{PO}} + (0.00175\times\Delta \text{PO}) - (0.00471\times\text{HR at standard work rate}))
\]

*\(\Delta \text{HF}/\Delta \text{PO}\) with 2 decimals; Sex 0=Woman, 1=Man; Age in years.

<table>
<thead>
<tr>
<th>Higher work rate (watts)*</th>
<th>Factor for higher work rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>59 or 64</td>
<td>32</td>
</tr>
<tr>
<td>88 or 95</td>
<td>64</td>
</tr>
<tr>
<td>118 or 127</td>
<td>95</td>
</tr>
<tr>
<td>147 or 159</td>
<td>127</td>
</tr>
<tr>
<td>177 or 191</td>
<td>159</td>
</tr>
<tr>
<td>206 or 222</td>
<td>191</td>
</tr>
<tr>
<td>235 or 254</td>
<td>222</td>
</tr>
</tbody>
</table>

**Notate Bene**
The test has not been validated for electronically braked ergometers.

The test is only valid within the VO\textsubscript{2max} range 19-62 ml·min\(^{-1}\)·kg\(^{-1}\) for women and 24-76 ml·min\(^{-1}\)·kg\(^{-1}\) for men, and age range 21-86 years for women and 20-84 years for men.

Conventional pre-test conditions include restrictions such as
- A heavy meal no later than 3 hours before the test.
- Smoking no later than 2 hours before the test.
- No vigorous activity on the day before and on the same day as the test.
- Avoiding running, cycling or stressing to the test.

If these pre-test conditions are not complied to, or if the individual being tested is taking medications that could influence the heart rate response, it is likely that the heart rate response and the estimation of VO\textsubscript{2max} could be influenced.

The test was developed using a mechanically braked Monark cycle ergometer (Model 828E). It is important to consider that other types of cycle ergometers may give different work rate responses when adding the same resistance at higher work rates, and consequently a variation in the pulse response.

Available on www.gih.se/ekblombaktest is a list over equipment needed for the test and the Borg RPE scale.