



## Testing protocol recommendation:

### 4X - Phase intermittent load Running Test

The protocol described below is useful for tests in the lab and in the field for a designated testing session with the aim to obtain the needed amount of data points in the shortest time period. The 4X-Phase intermittent load test provides robust data and therefore allows for accurate performance assessment. This test allows for more accurate and useful information, without requiring more time to test the athlete.

If you test on a treadmill, please set incline to 1% for all tests!

#### *Summary:*

- *Total estimated time demand: 40-50min*
- *Total lactate samples used: 14 - 18*
- *Treadmill or outdoor running*
- *Metabolic cart: NO*

#### Warm Up

Have your athletes warm up at a low intensity for 5-15'. Adjust the duration of the warm up as you like, but keep intensity low, except for: a short bout of exercise (1-2min) which should be at anticipated threshold or above. Ensure for sufficient time of low intensity warm up to clear lactate before the first phase.

### **Phase 1 – slightly above threshold \***

The aim of this first phase is to have your athletes run at a speed which is roughly at their anaerobic threshold (FTP, OBLA, maxLass). The aim of this phase is to obtain a lactate value of 3 mmol/l or higher.

*Do not be afraid of setting a high speed for phase 1 (in other words, having the athlete go too hard or too fast). If you obtain a lactate level well above the recommended range, you might have already completed phase 2. Therefore overestimating the intensity of phase 1 rarely results in increased time demand for the whole test.*

- Distance: depending on the speed/pace the distance should elicit a time of approximately 6min
- Duration: 4min – 6min, recommended = 5min
- Pacing: steady speed, no worries if the speed is slightly higher or lower than planned. This is not important, it is most important that the athlete is not increasing or decreasing speed, especially toward the end of the effort.
- Target lactate value: 3.0 – 5.0 mmol/l, ideal = 4 mmol/l
- Sampling: 1 baseline value (should be <2.5 mmol/l), post exercise at 0', 1', 3', 5' → stop sampling once lactate levels decline below the maximum!! In most cases 1' and 3' is sufficient
- Recovery: passive recovery (= sitting / standing still) during lactate sampling, then, 4'-6' active recovery before the next phase (to have lactate values decrease to <2.5 mmol/l). Start active recovery immediately after you stop lactate sampling! Only minimum recovery time might be needed to have lactate drop to < 2.5 mmol/l before phase 2.
- Data entry: Run 1-10 in excel sheet. Enter the duration in the format hh:mm:ss, distance ran, pre & post lactate values. Set maximum = "no"

*If lactate level in Phase 1 was < 3 mmol/l it is necessary to redo phase 1 with an increased exercise intensity. No active recovery needed before Phase 1 is redone!*

**\* if the approximate threshold intensity of your athlete is unknown please read appendix 1: "Threshold approximation methods"**

## **Phase 2 – significant above threshold**

The aim of the second phase is to have your athletes exercise at a load slightly above anaerobic threshold - FTP, OBLA, maxLass. Lactate should be significant higher compared to phase 1. The aim of this phase is to obtain a lactate value above 6 mmol/l.

- Distance: select the same distance chosen in phase 1
- Intensity: 106-109% of the speed of phase 1 if lactate level in phase one was >4 mmol/l; 108-111% of the speed of phase 1 if lactate in phase one was < 4 mmol/l
- Pacing: steady speed, no worries if the speed is slightly higher or lower than planned. This is not important, it is most important that the athlete is not increasing or decreasing speed, especially toward the end of the effort.
- Target lactate value: >5 mmol/l, ideal = 6 mmol/l (below 8 mmol/l to minimize recovery time).
- Sampling: 1 baseline value before the effort (<2.5 mmol/l), post exercise at 0', 1', 3', 5' → stop sampling once lactate levels start to decline!
- Recovery: passive recovery (standing still / sitting) during lactate sampling, Start 5-10' active recovery immediately after the end of lactate sampling, before the next phase.
- Data entry: Run 1-10 in excel sheet. Enter the duration in the format hh:mm:ss, distance ran, pre & post lactate values. Set maximum = "no"

## **Phase 3 – in between**

The aim of the third phase is to a) obtain another data set of lactate & speed above 3.5 mmol/l, and 2) provide a decent warm up before phase 4.

- Distance: same as in phase 4.
- Intensity: same speed as phase 2.
- Pacing: steady speed, no worries if the speed is slightly higher or lower than planned. This isn't important, it is most important that the athlete is not increasing or decreasing speed, especially toward the end of the effort.
- Target lactate value: 3.5 – 5.0 mmol/l
- Sampling: 1 baseline value before the effort (<2.5 mmol/l), post exercise at 0', 1', 3', 5' → stop sampling once lactate levels decline! Note- this is different sampling rate than Phase 2.
- Recovery: passive recovery during lactate sampling, 2' active recovery before the next phase. Start active recovery as soon as lactate levels start to decline! Only minimum recovery time might be needed to have lactate drop to < 2.5 mmol/l before phase 4.

- Data entry: Run 1-10 in excel sheet. Enter the duration in the format hh:mm:ss, distance ran, pre & post lactate values. Set maximum = “no”

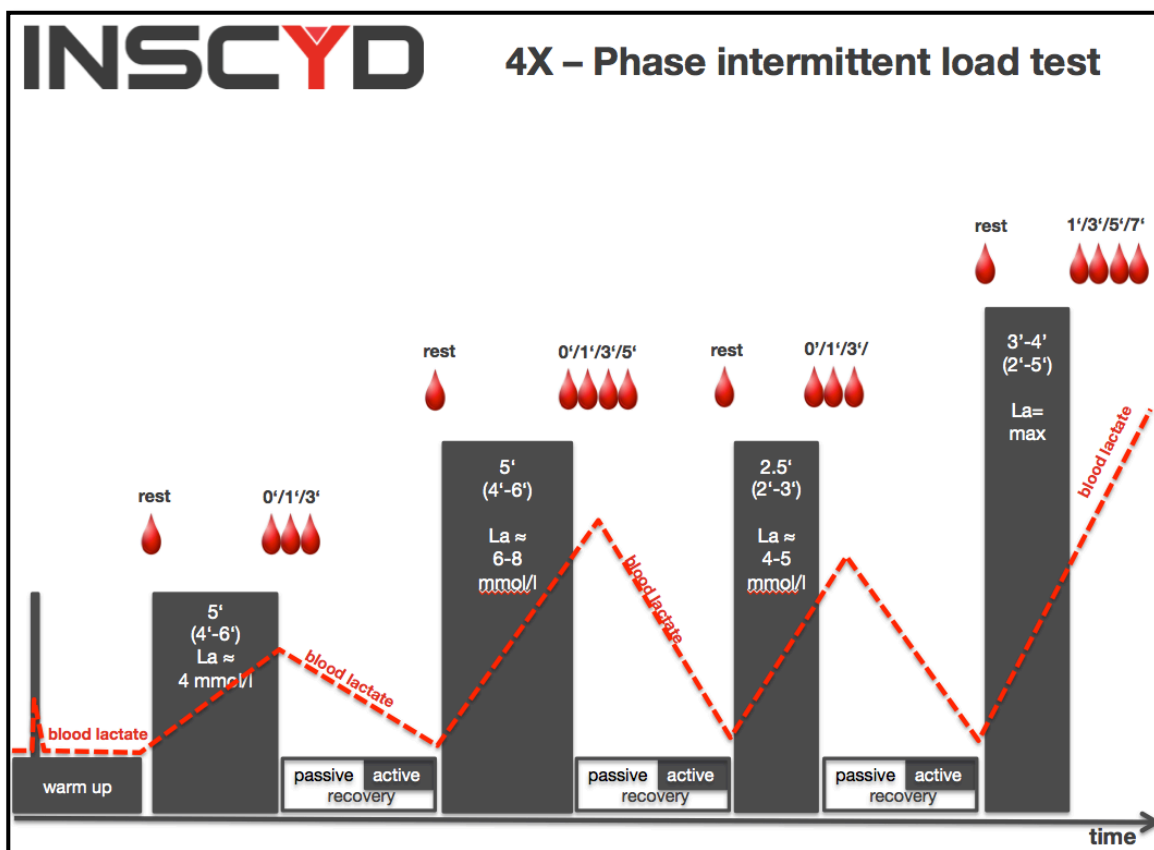
#### **Phase 4 – till exhaustion**

The aim of the fourth phase is to a) obtain the maximum lactate value your athlete can reach 2) obtain the power-time relation for an all out effort of 2-4min.

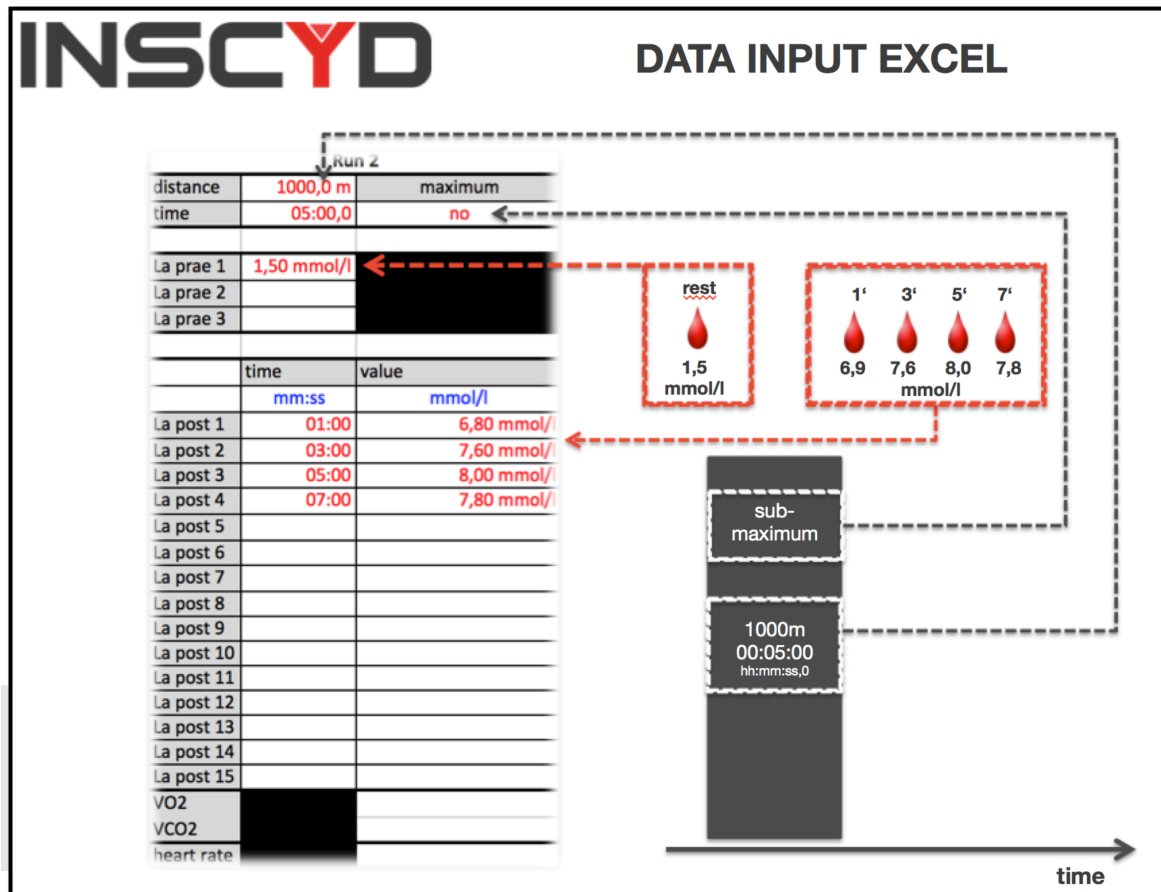
- Distance: based on the speed/pace the distance should elicit a duration for the effort of approximately 2 – 4min. Ideal duration is 2.5 – 3min, so also here it is advisable to set intensity to the upper possible range.
- Intensity: 113-116% the speed of phase 2 for professional endurance athletes, 118-124% of the speed of phase 2 for all other athletes.
- Pacing: steady speed, do not worry if the speed is slightly higher or lower than planned. This is not important, it is most important that the athlete does not increase or decrease speed, especially toward the end of the effort.
- Target lactate value: obtaining maximal lactate value
- Sampling: 1 baseline value before the effort (<2.5 mmol/l), post exercise at 1', 3', 5', 7', 10', 13', 17' → stop sampling once lactate levels decline!
- Recovery: passive recovery during lactate sampling. No further recovery needed if phase 4 marks the end of the whole testing session.
- Data entry: Run 1-10 in excel sheet. Enter the duration in the format hh:mm:ss, distance ran, pre & post lactate values. Set maximum = “yes”

*Please see appendix 2 for troubleshooting*

## Schematic visualization of the 4 – Phase intermittent load test



## Schematic visualization of how data of each phase is entered in Excel



## Phase X – optional sprint test

If you test outside on the road / track – where the athlete can choose his/her speed or if you are a brake free treadmill with an incline (Woodway curve, Woodway Demo Pro XL) which allow for freely chosen speed, at any time, you may want to add an additional 15s all out sprint test.

The aim of this test is to retrieve an approximation of the maximum lactate production rate – or maximum glycolytic power –  $VLa_{max}$ . In combination with the 4 Phase intermittent testing protocol, it provides additional security and therefore may add accuracy to the metabolic profile of your athlete.

- Duration: 15s
- Intensity: maximum effort, all out sprint.
- Pacing: hyperbolic – all out start
- Target lactate value: obtaining maximal lactate value
- Sampling: 1-3 baseline values before the effort ( $<2.5$  mmol/l), post exercise at 1', 3', 5', 7', 10' → stop sampling one lactate levels decline!
- Pre test: 5' before the test keep activity as low as possible, full rest if possible. The aim is to reduce the activity of the aerobic metabolism to the minimum.
- Recovery: passive recovery during lactate sampling,
- Data entry: Run 1-10 in excel sheet. Enter the duration in the format hh:mm:ss, distance ran, pre & post lactate values. Set maximum = “yes”.  
Note: the start & range value in the optimizer section of the excel template (cell B4 & B5) will turn blank. INSCYD will automatically detect a valid  $VLa_{max}$  approximation sprint test was entered, and therefore the optimizer start & range values will be set automatically.

*If you are unwilling or unable to carry out the sprint test, but want to add another data set to your testing battery, it is recommended to perform a 1min all out test.*

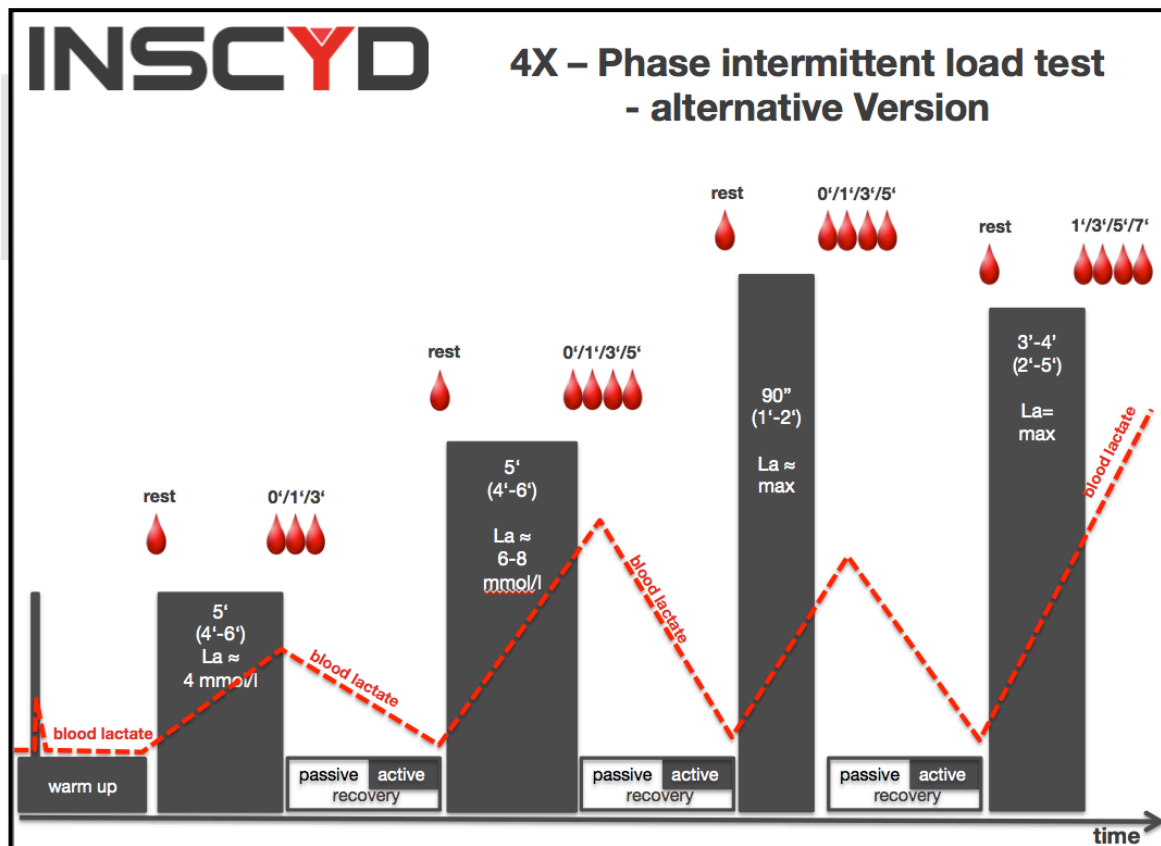
*The settings for this test are identical to the settings for the 15s sprint test, except for the pacing: this should be as steady as possible. Furthermore, there is no need for resting before the test, instead easy activity / active recovery is highly recommended.*

## Alternative Version

The aim of the protocol is to retrieve a good variety of different lactate levels at different intensities (power/speed) and different durations. With most athletes this is easy to achieve. However for athletes who have a low ability to reach high lactate values, the spread and variety of lactate levels can be rather poor. On the other hand, those athletes usually clear lactate very quick from the bloodstream. Therefore a slight variation of the protocol is advisable:

For athletes with low ability to reach high lactate concentration ( $> 8$  mmol/L) it is recommended to complete Phase 1, 2 and 4 as described above. However Phase 3 should be substituted by a rather short (1-2min) high intensity, almost maximum bout of exercise. Such an effort will enable the athlete to reach a comparable high lactate concentration. Furthermore it adds on to a greater variety of a) load and b) duration.

The intensity for the alternative phase 3 should be approx. 140 – 150% of the intensity of Phase 2!





## Appendix 1: Threshold approximation methods

In order to start phase 1, a rough approximation of the speed which elicits a lactate level  $> 3$  mmol/l is needed. The following methods may help to make an assumption on the intensity for phase 1.

1) Incremental / Step test:

A safe way to come to the speed for phase 1, is to work your way towards the target speed by carrying out a shortened incremental test. You may reduce the time duration to 3' instead of the recommended 5' for phase 1. Take lactate samples after approx. 2.5min of each step. This should allow you to obtain the result of the lactate sample before the 3min are completed! Once you see a lactate level above 3 in a step, keep going until 5min are completed. Thereby phase 1 is completed. You may start the incremental protocol without the warm up phase to keep time demand minimal.

2) Pre-Test check with

You may ask you athlete to do a 10-20min all out effort a few days prior the testing with you. 90% - 95% of the speed (pace) of such as test will often be the correct guideline for setting the speed of phase 1.

3) Race data

You may use historical race data, the newer the data the better, to approximate actual PB for 5k and 10k runs. The target speed for phase 1 will be around the speed for the 5k run, and therefore slightly slower than the 10k speed.

4) Heart rate extrapolation

If you don't want to do the incremental test, and do not have any power data, heart rate data can be a valid predictor of a suitable power for phase 1. Assuming that you have an approximation which is the heart rate at threshold power you may split up the warm up to 2x3' at two significant different intensities (for example 110 Watt and 140 Watt). The raise in heart rate is good enough to predict the power at a given heart rate. INSCYD has created a little heart rate tool for you to retrieve the needed information within seconds (download in the user area ([link](#))).

## Appendix 2: Troubleshooting - most common issues

- 1) Lactate in phase 1 was  $< 3$  mmol/l  
If the first lactate sample (0' after end of effort of phase 1) measured immediately after the exercise is  $< 3$  mmol/l, stop sampling lactate. You may immediately continue with another bout of exercise with a higher speed in order to have a valid phase 1 lactate sample. There is no need to enter the data of this "failed" effort with lactate levels  $< 3$  mmol/l in to the excel template.
- 2) Lactate in phase 1 was  $> 5$  mmol/l  
If the first value you obtain immediately after the end of phase 1 is above 5 mmol/l – keep sampling lactate to measure the peak lactate value. If you obtain a value above 6 mmol/l you may now use this data set as valid data for phase 2. Allow for sufficient recovery (lactate back to baseline  $< 2.5$  mmol/l). Reduce speed and run another phase 1 trial. As phase 2 is therefore completed already, continue to phase 3.

INSCYD