Indoor Cycling Association Audio Master Class
Lactate Threshold Field Tests

This is not the standard audio Master Class by Indoor Cycling Association. It is more like a Continuing Education Workshop. I am providing you with two alternative ways to estimate lactate threshold in your indoor cycling classes. A third method, using a talk-test, will be provided in a separate audio and video Master Class. The latter method will be appropriate for your less fit and/or newer students, or for when you (and your students) are just learning about using threshold or perhaps just beginning to incorporate using heart rate monitors in your training and in your instruction.

We know that monitoring heart rate is an effective way to gauge the intensity of our workout. When using a heart rate monitor (HRM) we are measuring the body's response to the demands of a workout. In order to make sense of the numbers our HRM is giving us, we need training zones to define how hard the workout is. But what do your base your training zones on? The most common way is by using a maximum HR formula of 220-age, but this method is only helpful for analyzing large groups as a macro-statistic. It can be dramatically incorrect for individuals. (Please see the *Myth of Max HR* on the Indoor Cycling Association website, in the Free Articles archives).

If not Max HR, then what should training zones be based on? Most exercise physiologists and coaches agree that the answer is lactate threshold (LT) or ventilatory threshold (VT). VT will be discussed in the talk-test edition of field testing. In this discussion, I will focus on LT. LT is a great predictor of performance and is the most accurate marker on which to base training zones. I am assuming you know what lactate threshold is; if not, please search in the Physiology category on the ICA website, and read up on exercise physiology for endurance athletes. I recommend Total Heart Rate Training by Joe Friel. The following is an excerpt from that book:

> Lactate threshold is the level of intensity at which you begin to *redline*. In other words, the effort above LT is so difficult that you find it difficult to continue. Your breathing is deep and forceful, you are about RPE 7, and you may experience a burning sensation in the working muscles. You can only maintain this level of effort for a few minutes up to an hour or so for a highly fit athlete. And the higher above LT the effort goes, the shorter the time it can be maintained.

Lactate threshold can vary widely as a percentage of MHR, anywhere from 70 to 90% of MHR, which is the primary reason why MHR is not accurate as a baseline on which to base training zones. Therefore, we need to find LT if we are to create training zones that are individualized according to the ability and fitness level of each and every participant.

Knowing your threshold is probably the single most important factor about your fitness that you should know. Finding it is the challenge. It can be measured easily in a lab using a metabolic cart or a pin-prick method to determine actual blood lactate content during a graded exercise test. These tests however, can be quite expensive and are not always readily available. The next best method is to estimate LT via a field test. Field tests aren't quite as precise as a metabolic test, but when conducted in a controlled environment, they can produce a threshold heart rate that closely equates to one's actual LT.

Laboratory tests have determined that a 60-minute field test (or time trial) most closely correlates with actual lactate threshold numbers, both in power and heart rate. 60-minutes at this level of exertion is out of reach for most indoor cycling students, in fact, it is out of reach for most cyclists! Further research has revealed that a 20-minute field-test very closely correlates to LTHR, and closely equates to FTP, or functional threshold power.

The good news is that field tests are easily conducted in your own cycling studio. They are, however, very challenging and are not for everyone. If you have less-fit or new students not used to cycling (even if they are fit), I recommend the graded talk test to determine VT. (Please see ICA for more information on the Talk-Test).

I am presenting you here with two different alternatives for field tests. I used to do just the 20-minute test and I have personally had a lot of success with it. But I have been reading up and talking to instructors who use Chris Carmichael's method of performing two 8-minute field tests instead of one 20-minute test. He describes this field test in his book The Time-Crunched Cyclist. I also had the chance to take this test a few months ago and it was very challenging, but not quite as daunting as the 20-minute one. Whichever option you select, I would stick with that one, at least during one entire season. The results may not be entirely comparable to each other.

What is the difference between the 20-minute test and the 8-minute tests?
The 20-minute method is the suggested method in *Training and Racing with a Power Meter* by two of the most highly regarding endurance coaches in the world, Hunter Allen and Andrew Coggan, PhD. It is probably the most widely accepted field test in the endurance coaching world and is generally thought to most closely correlate with a 60-minute time trial or a lab-tested lactate threshold. There are some variations, for example Joe Friel recommends a 30-minute effort, while still only recording the average HR over the final 20 minutes.

However, 20-minutes is still a very long time for many students to give it their all. It is not only physically taxing, but mentally taxing. The Carmichael option of two sets of 8-minute efforts provides a slightly more palatable means of testing, and may be more attainable by a wider number of students. The following is directly from The Time-Crunched Cyclist:

> Some athletes and coaches ask me about the rationale behind the two 8-minute efforts that make up the CTS field test (Carmichael Training System). My field test is unique in its brevity; it's not a 60-minute or even a 20-minute time trial because I've found that I don't need to put athletes through such an effort to gather necessary data. It's not that a 60- or 20-minute time trial effort won't work; in fact, these tests work quite well. However my coaches and I work with a very broad

> spectrum of athletes, and a field test of two 8–minute efforts can be performed well by novices as well as experienced masters competitors and even pros.

Carmichael also believes there is valuable information to be learned from observing the ability of the athlete to recover from and repeat a hard effort.

The difference however, is that you can obviously work harder for 8 minutes than you can for 20 minutes, so you will have to use a conversion factor to determine threshold heart rate and FTP for the 8-minute test. Carmichael describes how they've determined that the CTS 8-minute tests are about 10% higher than an athlete's lab tested threshold (The Time-Crunched Cyclist, page 77). However, keep in mind that the shorter the duration of the field test, the more questionable the correlation becomes with LT. Converting HR becomes a bit of a conundrum, as you will see. But we aren't (usually) working with skilled athletes, so the numbers your students achieve are going to be fine for your (and their) purposes, and even if slightly off, will still be a huge improvement over using maximum heart rate to determine zones.

You will see that the 20-minute field test may also require a conversion for your *very* fit students who are strong cyclists if you are testing FTP. Please read each section carefully on what to do with the numbers you achieve.

Whichever method you decide to implement, conducting a field test should be a special class, one that you should promote for a few weeks prior or have on your schedule every four to six weeks. It also requires educating your students on what LT is, why it's important, why it is more accurate than using the age-predicted charts, and also what they will do with the HR numbers following the test.

Heart rate or power

Both of these field tests can be used to determine average heart rate (LT estimation) or functional threshold power (FTP) if you have bikes with power meters. Depending on which test you use, and depending on the level of fitness of your riders, you may need to use a conversion factor (90-95%) of your field-tested heart rate or power, to arrive at a threshold estimate. Please read each test carefully on what to do with the numbers following the test.

If you are using power, before each effort, you will have to set the power meter to zero, and start the test from a standing start. This also means that for the 20-minute test, you do not need the 1-minute ramp-up time to let HR settle into a steady state – start the test immediately. You will still record HR, but since you have power, your primary zones will be based on the FTP and not average heart rate. (Make sure you know how your power meters work to reset at zero at the start of the test).

General considerations for all field tests

All threshold field tests are performed at the *highest sustainable intensity* that the rider can maintain for that duration (whether 20-minutes or 8-minutes). *Sustainable* is the operative word here. Threshold is sub-maximal, but it is a *maximal effort for that duration*. You are not going to sprint into the effort – because you couldn't hold a sprint for long at all. The goal during the field test is to continually push the envelope without spiking the heart rate. You don't want to see high

peaks in heart rate followed by a reduction in effort. It is far better to see a fairly constant heart rate with only minor fluctuations.

Any field test must be repeatable and comparable. What this means is that the next time you do the test, you should do it in very similar situation, environment and mode. The temperature of the room should be the same. If the second time you do one, the A/C goes out, you won't have comparable results. It should be the same time of day. Riders should be well hydrated and fueled for all tests.

If at all possible, your riders should try to consume the same kind of food prior to the test. This doesn't mean they must eat the *exact* same thing, but if on test #1 they have a small carbohydrate snack such as an energy bar 30 minutes before the ride, they don't want to come either hungry or following a 3-course meal for the second one. Consistency in fuel is important.

Being repeatable and comparable also means you don't want the HR to fluctuate due to variations in terrain. Therefore, the test should be done seated in the saddle for as much of the test as possible, at a constant cadence between 85-95 rpm. If the rider needs a short saddle break, it's ok to stand for very brief periods of 5-15 seconds, but ask them to limit those as much as possible. Standing for very long tends to spike the heart rate artificially. They can use a standing position to bring their effort back up if they feel it waning, but again, keep it short. (Note that this is not as vital when measuring FTP. Power is power, regardless of position).

RPE during a field test should be a 7-8 on the 1-10 RPE Scale. Effort level is "hard", breathing is deep and forceful, but not ragged and breathless. There may be some burning in the legs, but not enough to force you to slow down or back off.

Heart rate monitors are required for the field tests even if you are testing their functional threshold power. But make sure they know how to use them. I have found that sometimes students will bring the HR monitor, just out of the box, not knowing how to use it. This is not the time to learn, and every monitor is different, so you are not likely to know how each model works in order to give them advice. Make it very clear in your promotional material for the test that they must know how to use their heart rate monitors before class, especially how to use the lap function or reset to determine average HR for a given period of time.

The Twenty-Minute Field Test

I first created this field test in 2007 to present at the World Spinning and Sports Conference in Miami and have been presenting it at numerous conferences since then. This test closely follows the protocol created by Hunter Allen and Andrew Coggan in the book *Training and Racing with a Power Meter* (pages 50-51) although I've made a few modifications so that it can be performed in a 60-minute time slot. It would not be a very effective test if you tried to fit it into less time. If your classes are generally shorter than 60-minutes, you may want to make an exception just for field tests.

Test protocol:

- 10-15 minute warm-up. RPE = 2 (easy) building to 4 (moderate). Include some fast leg surges, up to 100rpm, for 1 min at a time.
- 5 minute HARD effort. Usually done in a standing climb, or whatever your riders want to do. The goal of this hard effort is to "prime the pump", activate the body's energy systems, and open the pre-capillary sphincters (which act like gate-keepers) to maximize circulation. The 20-minute effort is not as successful without this early hard effort.
- 10-minutes easy
- Start the test, a 21-minute HARD effort. Use the first minute to ramp up to the highest sustainable and controllable intensity that you can manage, without sprinting into the effort. Stand up that first minute if needed. It may take this long for the HR to stabilize. At 1-minute, start the stopwatch of the HR monitor, and sit down. WHEN TESTING FTP: you do not need the 1-min ramp up. Start your power meters from the very beginning and continue for 20 minutes.
- Settle into a flat-road rhythm for 20-minutes. Instructor should motivate riders every now and then, to see if they can add a few more beats.
- At 20-minutes, everyone STOPS monitor and notes the average HR (and/or power) for the 20 minutes.
- Cool down at least 10 minutes.
- Stretch

What to do with the numbers

Heart Rate: In the 20-minute test, your actual average heart rate can be assumed to be your threshold value for almost all of your students; there is no need to take a percentage of this number. This is because after 8-10 minutes, your heart rate will likely settle into the highest sustainable effort that can be maintained. That is, *unless* you are an elite level cyclist. In that case that elite cyclist may want to take 95% of his tested average HR as his threshold. (On the other hand, an elite cyclist will most likely have a lab or field-tested value already and is not as likely to be in your class).

Power: Most relatively fit cyclists can hold a power level for 20-minutes that is a little bit higher (usually around 5% higher) than their 60-minute FTP. Therefore, most riders should take their field-tested average power and multiply it by 95% to arrive at an FTP (as per Training and Racing with a Power Meter, page 51). However, some of your students may not be strong enough riders to push a power level above their threshold power for very long. You know who they are – they do not come to class on a consistent basis, they do not ride outside at all and are

unfamiliar with the sensations of a consistent hard effort, and/or they just don't tend to push themselves very high as everyone else, perhaps out of fear or their age. For these students, I would take 100% of their average tested threshold power as their FTP. On the other hand, if you have a lot of these kinds of students in your class, perhaps you should be doing the 8-minute field-tests or even the talk-test instead of the 20-minute effort to estimate threshold.

Once you've got your numbers, plug them into the ICA training zone spreadsheet to determine their 5-zone training zones. Or, use whatever training zones you prefer. Remember, *the actual zone methodology you use is not that important;* what matters is that threshold becomes your 100%, and everything is based around that point.

Carmichael 8-minute Field Tests

Chris Carmichael is famous for being Lance Armstrong's coach for many years, but also for creating a successful coaching business that includes hundreds of coaches and thousands of athletes from new cyclists to recreational to elite to pro. If you are going to do this test, I recommend that you purchase and read The Time-Crunched Cyclist by Chris Carmichael and Jim Rutberg He describes the test in chapter three.

I've modified it slightly for an indoor class environment. It will require a 60-minute time period.

Test Protocol

- 10-15 minute warm-up. Easy to moderate riding.
- Pre-field-test drills (10 min) – include the following:
  2-minute high cadence effort (RPE 5-6)
  1-min easy (RPE 2-3)
  1-min high cadence harder effort (RPE 7)
  1-min easy
  1-min high cadence harder effort (RPE 7)
  4 minutes easy
- Field Test Effort #1 – RPE 8-9
  Stand up to bring your HR and power to the highest sustainable effort you can maintain for 8 minutes. (HR will lag behind power). Push literally as hard as you can, without blowing up or slowing down for eight minutes. If you want, you can stand up and push even harder the final minute. At 8 minutes, record your average HR (and power if you have it)
- Ride easy for 10 minutes. You should feel drained at first. Make sure to drink plenty of water and breathe deeply to relax. By the time 10 minutes have passed, you should feel ready to perform the test again at full tilt.
- Field Test Effort #2 – RPE 8-9
  Repeat the test as you did before, trying to maintain the same perceived effort level as the first one. Give it everything you have, pushing even harder the final minute. At 8 minutes, record your average HR (and power if you have it)
- Cool down at least 10 minutes.
- Stretch

What to do with the numbers

You have done two separate tests. Do not average them; rather take the highest value of the two tests. I'll discuss what Carmichael interprets from any differences in the two tests in a moment, but first let's talk about the number you achieve.

All riders should be able to put out an effort for eight minutes that is greater than their 20-minute effort – Carmichael's data suggests about 10% higher. Therefore, you should take your field tested heart rate and/or power number and multiply by 90% to arrive at an estimate for LTHR and FTP, respectively. Once you have that number, plug them into the ICA 5-zone training zone spreadsheet, or use any other threshold-based zone methodology you prefer.

In this field test, you will notice that there is not a 1-minute period to reach the sustained heart rate. This is a conundrum I had with this method (using HR as opposed to power). Power is immediate; HR takes a while to respond. But Carmichael may not feel this is as important, since his focus is power. Also, one of the benefits of doing the CTS field test is to keep it shorter – it's an 8-minute effort, not a 9-minute effort! I considered suggesting that you take only 92-95% of the HR that you achieve in the 8 minutes, taking into consideration that the first minute won't be as high as the rest of the effort. But that would really complicate things. Also, in reality, we are only *estimating* threshold, and you will be validating your values in the weeks to come, so we are probably only talking about a few beats. I do not have any statistical data to back up this method anyway, so I don't want to take a stand on that. Better to just use 90% of both heart rate and power, and fine-tune it over the following few weeks.

If you have Carmichael's book, you will notice that he does not actually multiply his values by 90%. Instead, this 10% difference is *already factored* into his very specific training zones. That means his training zones are not directly threshold based (they are indirectly) but based on the CTS field test result and *only* the CTS field test result. In other words, you cannot plug a lab-tested LT into his zones and have training zones that make sense.

By the same token, it is for this reason that you cannot consider the data from an 8-min field test as your "threshold heart rate" or your "FTP". Nor can you use those numbers in any other training zone methodology than the CTS zones. In order to use the data achieved in the 8-minute field test in other threshold training zones, you must first use the 90% conversion.

The value of doing two field tests

As stated earlier, Carmichael states that there is much to learn about an athlete's fitness when two tests are performed. A strong and fit cyclist should be able to perform the second test within 5% of the first test. If your second test is 10% or more less than the first test, then your aerobic endurance is probably not where it should be. It also provides you with valuable information to evaluate your progress. If your average numbers become more equal the second time you do this field test, following a period of focused training, then you can ascertain that your ability to process lactate and buffer acid has been improved. The first effort was less taxing and you were able to recover more quickly in order to put out a similar effort the second time. This tells you that your aerobic endurance has benefitted from your training! I find this to be very useful information in an indoor cycling situation, especially when you only have heart rate and not the quantifiable benefit of power measurement.

On the other hand, if a rider has an average power output or HR that is higher on the second effort, then that means you either held back on the first one (out of fear perhaps), or your warm-up was insufficient and essentially, your first test became your warm-up. This has value from the point of view of the learning curve of taking field tests.

How to validate your field-tested threshold

Regardless of the method you use to estimate your lactate threshold, you should spend a few weeks confirming your results. It is possible that your results were affected or skewed by an uncontrollable variable (such as temperature, humidity, fatigue, stress, etc) or that you did this for the first time and the learning curve curved away from you. Either you didn't push yourself hard enough or pushed too hard at the beginning and were forced to slow down. Even a lab-tested LT should be validated, because there may be the chance of tester error in interpretation or poor calibration of equipment.

Your confirmation is going to be subjective of course; there is no surefire way to do this. But your goal is to determine that your LTHR or FTP is just about right, not too high or too low. Validating your test results in this way allows you to fine-tune your numbers (and therefore training zones) so that they truly make sense.

How do you do this? You pay close attention to your perceived exertion over the few weeks following your field test. As your intensity increases and you approach your "alleged" threshold, your breathing should be deeper and more labored. You should start to sense the beginning of a burning sensation in the legs. There is a very apparent difference in your breathing right at your LT/FTP. It should correlate with your ventilatory threshold, the point at which your breathing changes markedly due to the metabolic changes that take place at your LT. This is due in part to the increase in CO2 as the contribution in energy production from anaerobic metabolism increases, which in turn causes a sharp increase in ventilation in order to rid the body of the CO2.

If you notice that this sharp increase in breathing occurs prior to your tested LTHR or FTP, you may want to revise your numbers downward a few points. Conversely, if you notice that you can reach your "alleged" LTHR or FTP values *before* sensing that sharp increase in your breathing, or before you reach an RPE of 7-8, then you can revise your values a few points higher. This fine-tuning of your tested results is an excellent way to not only fine-tune your training numbers, but also an excellent way for you – and your students – to learn more intimately the sensations that take place at his threshold level of effort.

References

Books

Allen, H and Coggan, A, 2006. Training and Racing with a Power Meter. Velo Press.

Carmichael, C and Rutberg, J, 2009. The Time-Crunched Cyclist. Velo Press.

Friel, J. 2006. Total Heart Rate Training. Ulysses Press.

Studies

Boulay, M.R. Simoneau J.A., and Bouchard C. 1997. Monitoring high-intensity endurance exercise with heart rate and thresholds. *Medicine and Science in Sports and Exercise* 29 (1): 125-32

Cheng, B, Kuipers H. Snyder A.C. et al. 1992. A new approach for the determination of ventilatory and lactate thresholds. *International Journal of Sports Medicine* 13 (7): 518-22

McGehee J., Tanner C., and Houmard J. 2005. A comparison of methods for estimating the lactate threshold. *The Journal of Strength and Conditioning Research* 19 (3): 553-58

Robergas R.A. and Landwehr R. 2002. The surprising history of the "HRmax=220-age" equation. *Journal of Exercise Physiology* 5 (2): 1-10.

