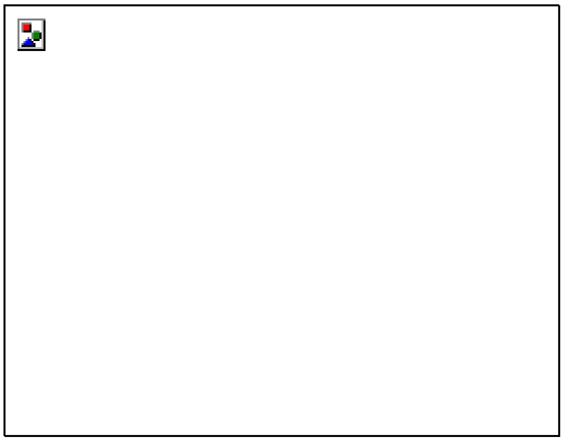
TRAINING METRICS FOR CYCLING



Power
Power is the rate at which energy is used (energy over time) and is measured in watts. In cycling, energy is expressed in terms of work (such as how hard you have to work to ascend a climb). It's a constant snapshot of your work rate at any given moment. It's the building block from which all power-based training flows. One cool fact: A watt is a watt, whether on a bike or powering your home. So when Lotto-Belisol's Andre Greipel unleashes 1,900 watts in a sprint, he could essentially power two houses at normal consumption level. Another comparison: 1 horsepower is 746 watts.

Average Power
This is exactly what it seems: your average power output for the interval or over the whole ride, just like your average speed readout. Here's the key: It includes coasting, so as we'll see in a moment it's only a part of how hard you rode (see Normalized Power).

Normalized Power
Normalized power (NP) is the adjusted (normalized) average power output for a ride or segment of a ride. Power output on a ride is variable (due to small changes in external power demands e.g. small changes in elevation, small surges in speed, wind, etc) so NP represents the physiological cost of the ride or segment of the ride if that power output had been constant.

Functional Threshold Power
FTP is a vital measurement of how much power you can sustainably produce over a one-hour period and is a fundamental metric of cycling fitness. Functional Threshold Power is the basis of Intensity Factor and Training Stress Score.

Watts/Kg
Raw watts aren't the most reliable metric of performance, because riders put out varying levels. A big rider like Argos-Shimano's Marcel Kittel can generally produce higher watts on flat or rolling terrain than a climber like Nairo Quintana of Movistar, but since Kittel is larger he must produce bigger numbers to keep the same speed. A better measure, especially on climbs, is watts produced per kilogram of body weight (that normalizes the size difference). This is commonly used when talking about threshold power, but it factors for the other tests as well.

Intensity Factor
Intensity Factor is the ratio of an athlete's Normalized Power/Pace to their Functional Threshold Power (FTP)/Pace. In effect, IF is the percentage of an athlete's FTP.

Typical IF Values

Some people use training zones, (ie,, zone 1-5), but there are a lot of variations on what each zone means, so I like to use IF values that correspond with the training stimulus provided to the various energy systems. Typical IF values for various training sessions and the type of training adaptation elicited are:

- Less than 0.55 is for recovery rides. Doing an easy ride is almost always more effective for recovery than doing nothing.
- 0.55-0.75 is for aerobic endurance. This is the foundation of all training and is the most important for endurance athletes (obviously). If you could only train one energy system, this would be the one to train.
- 0.75-0.88 is for tempo rides. Tempo rides are really high aerobic rides and are often called "no man's land" for training because unless you do *long* tempo training rides, you aren't getting much training benefit. But 'long' is relative and if you are fairly new to training, a long tempo ride could be 60-90 minutes of tempo intervals between 10 and 15 minutes in length. This is where a lot of (well-trained) Iron-distance triathlete will ride for their race, so doing longer sessions of Tempo training is beneficial for endurance racing.
- 0.88-0.94 is what we call sweet spot training. Sweet Spot Training. Sweet Spot training is effective because it increases your aerobic capacity and muscular endurance without being too exhausting. Continuous sweet spot workouts are generally less than an hour in length, but there are load of ways to work sweet spot intervals into longer rides.
- 0.94-1.05 is for Threshold training. Spending time close to your functional threshold power (FTP) offers extraordinary benefits to your aerobic capacity, muscular endurance, mental stamina, and sustained power capabilities. Not to mention, doing threshold intervals will help to increase your FTP!
- 1.05-1.20 is where you'll find VO_2 max intervals. There is a lot of debate about whether it's possible to improve one's VO_2 max, but regardless, that isn't the only reason to add these to your workouts. Veronique Billat, professor of Sport and Science at the University of Lille in France uses two reference points for VO_2 interval training: *velocity* at VO_2max (**vVO_2max**) and how *long you can ride at VO_2max velocity* (**tlimVO2max**). VO_2max, by itself, is a poor predictor of performance. Using vVO_2max and tlimVO_2max will provide a better indication of performance. This will also help you decide how hard and how long your intervals should be. VO_2 training is typically done in 3-8 minute intervals, and is very beneficial for masters athletes as our 'performance ceiling' declines with age.
- 1.20-1.50 is the intensity factor for Anaerobic Interval training. The anaerobic system bypasses the use of oxygen to create ATP (energy) quickly through glycolysis.

Although a steady-state endurance rider uses their Anaerobic energy system for only a fraction of their riding, some anaerobic training will improve how your body clears lactate (a byproduct of glycolysis). FUN FACT: Every time you start exercising, the anaerobic system kicks in to provide a quick burst of energy before the aerobic system takes over. This is why you have to catch your breath from walking up a flight of stairs even though you are fit. The anaerobic system creates energy quickly from glycogen until the aerobic system takes over clearing lactate and producing energy from stored fat.

- 1.50 and up is for Neuromusclar/Sprint intervals done in short bursts of up to 20 seconds. (ie,Tabatas). Sprint training forces the physiological adaptations that increase neuromuscular power by recruiting more type II muscle fibers.

KiloJoules

Kilojoules are a measure of the mechanical work you performed by pedaling. Due to a metabolic and mathematical coincidence, you can generally view kilojoules of work done on the bike to be roughly equal to the calories burned to produce that work. The conversion from kJ to kcal is 4.184 kJ=1 kcal=1 Calorie. So, why doesn't 1000 kJ of work mean 250+ Calories burned? Because the mechanical efficiency of a human on a bicycle is about 25%, meaning it takes 4 Calories to produce 1 kJ of mechanical work. So, the Calories required to do 1000 kJ of work would be 250/.25, or 1000 Calories. Although it's not actually a 1:1 equivalent, it's close enough for most purposes.

Training Stress Score

Training Stress Score (TSS) is a composite number that takes into account the duration and intensity of a workout to arrive at a single estimate of the overall training load and physiological stress created by that training session. It is conceptually modeled after the heart rate-based training impulse (TRIMP). By definition, one hour spent at Functional Threshold Power (FTP) is equal to 100 points.

- Normalized Power (NP): An estimate of the power that you could have maintained for the same physiological "cost" if your power had been perfectly constant, such as on an ergometer, instead of variable power output. NP is used to calculate TSS.
- Intensity Factor (IF) for TSS: For any workout or part of a workout, the ratio of the Normalized Power to the rider's functional threshold power, which gives the user a relative intensity in relation to their threshold power. IF is used to calculate TSS.

Heart Rate

Power is a measurement of training output. Heart rate (HR) is your body's response to the work. And it's an important barometer of how you feel. Let's say you go ride and on a climb you feel awful; your heart rate spikes but your power just isn't there. You might be overtrained or getting sick. An unusually high heart rate signals that something's not right. You might be pushing too hard for hot and humid conditions, despite having ridden at your current watts during indoor training with a fan. Ignore heart rate and your own peril – especially during longer events.

Cadence

Cadence in cycling is defined as the number of revolutions per minute (RPM) you complete at a given speed. The power you are able to produce on the bike is the product of torque (force on the pedal) x angular velocity (or your pedal speed). Based on this formula it is easy to see why an increase or decrease in your cycling cadence will directly impact the power you produce on the bike. While many cyclists will work towards their sought-after goal of increasing their threshold power, potentially a new benchmark could be to increase their cycling efficiency by focusing on cadence work.

By increasing your cycling cadence at a given power, you produce less force on your pedal, creating less muscular strain. Reduce your muscular strain and you increase your time to fatigue. Even athletes with minimal training have higher aerobic efficiency than muscular endurance. Ideal cycling cadence is between 85-95 rpms, and if you are going to run off the bike, 90-95 rpms.