***These are the Power Training Levels that will be referred to in your training plan. Please print this article out, and take a few minutes to become familiar with the chart below. To read more about training with power please refer to http://www.cyclingpeakssoftware.com/power411.html**

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Power Training Levels

By Andy Coggan, PhD

With more and more cyclists using power meters, the need has clearly developed for power-based training programs akin to those used with heart rate monitors. To help meet this demand, built directly into the CyclingPeaks Software program are a series of power-based training levels, or zones. These training levels, which are described below, were developed by drawing upon fundamental principles of exercise physiology as well as approximately two decades of experience with power-based training in both laboratory and field settings. Some of the logic behind the development of this classification scheme is described below.

Basis for system/number of levels: Power at lactate threshold (LT) is the most important physiological determinant of endurance cycling performance, since it integrates VO2max, the percentage of VO2max that can be sustained for a given duration, and cycling efficiency. As such, it is more logical to define training levels relative to an athlete's threshold power, vs., for example, power at VO2max (just as it is more logical to define HR-based training levels relative to threshold HR vs. maximal HR). On the other hand, determining the appropriate number of levels is somewhat arbitrary, since the physiological responses to exercise really fall on a continuum, with one intensity domain simply blending into the next. A compromise must therefore be made between defining more levels, thus better reflecting this fact, and defining fewer levels, for the sake of simplicity. In the present system, seven levels were felt to be the minimum needed to represent the full range of physiological responses and to adequately describe the different types of training required/used to meet the demands of competitive cycling. **This table lists the primary physiological adaptations expected to result from training at each level**, although these will obviously be influenced by factors such as the initial fitness of the individual, the duration of each workout, the time taken between each interval effort, etc.

Determination of LT power: At least in theory, the most precise way of determining an athlete's power at LT would be to rely on laboratory-based testing with invasive blood sampling. Very few individuals, however, have access to such measurements on a routine basis. Furthermore, while LT is often defined by sports scientists as the initial non-linear increase in lactate with increasing exercise intensity, this intensity tends to be significantly below that which coaches and athletes tend to associate, on the basis of practical experience, with the concept of a "threshold" exercise intensity. Thus, probably the easiest and most direct way of estimating a rider's functional threshold power is to simply rely on data collected in the field using a power meter.

HR guidelines: Relating or translating the specified power levels to corresponding HR ranges or zones is somewhat difficult, due to the inherent variability of HR as well as individual differences in the power-HR relationship (even when referenced to threshold power). Nonetheless, approximate HR guidelines have been provided in Table 1, such that they can be used along with power to help guide training if desired.

Perceived exertion (PE) guidelines: The values given are from **Borg's 10 point category-ratio scale,** not the original 20 point scale that is more commonly used. The category-ratio scale is used because it explicitly recognizes the non-linear response of many physiological variables (e.g., blood and muscle lactate), and thus provides a better indicator of overall effort. Since perceived exertion increases over time even at a constant exercise intensity (power), the suggested values or ranges refer to perceived effort as determined relatively early in a training session/series of intervals.

Other issues: While the system is based on the average power during a workout or interval effort, consideration must also be given to the distribution of power. For example, average power during mass start races typically falls within level 3, but races are often more stressful than training at level 3, due to the greater variability (and therefore higher peaks) in power. Similarly, due to soft-pedaling/coasting, the same average power achieved during a hilly ride or group training session will not reflect the same stress as the same average power achieved during a completely flat ride or solo workout. In part, the variability in power is taken into account in defining the various levels, especially levels 2 and 3 (training at the higher levels will tend to be much more structured, thus limiting variations in power). Furthermore, there is obviously an inverse relationship between power output and the duration that power can be sustained. Thus, it is axiomatic that power during shorter training sessions or efforts will fall towards the higher end of a given range, whereas power during longer sessions or efforts will fall towards the lower end of a given range. Nonetheless, a workout consisting of, for example, 30 min of cycling at level 1 (as warm-up), 60 min of cycling at level 3, and another 30 min of cycling at level 1 (as warm down) would best be described as a tempo training session, even though the overall average power might fall within level 2.

Table 1 - Power Based Training Levels

Level	Name	Average Power	Average HR	Perceived Exertion	Description
1	Active Recovery	≤55%	≤68	<2	"Easy spinning" or "light pedal pressure", i.e., very low level exercise, too low in and of itself to induce significant physiological adaptations. Minimal sensation of leg effort/fatigue. Requires no concentration to maintain pace, and continuous conversation possible. Typically used for active recovery after strenuous training days (or races), between interval efforts, or for socializing.
2	Endurance	56-75%	69-83%	2-3	"All day" pace, or classic long slow distance (LSD) training. Sensation of leg effort/fatigue generally low, but may rise periodically to higher levels (e.g., when climbing). Concentration generally required to maintain effort only at highest end of range and/or during longer training sessions. Breathing is more regular than at level 1, but continuous conversation still possible. Frequent (daily) training sessions of moderate duration (e.g., 2 h) at level 2 possible (provided dietary carbohydrate intake is adequate), but complete recovery from very long workouts may take more than 24 hs.
3	Tempo	76-90%	84-94%	3-4	Typical intensity of fartlek workout, 'spirited' group ride, or briskly moving paceline. More frequent/greater sensation of leg effort/fatigue than at level 2. Requires concentration to maintain alone, especially at upper end of range, to prevent effort from falling back to level 2. Breathing deeper and more rhythmic than level 2, such that any conversation must be somewhat halting, but not as difficult as at level 4. Recovery from level 3 training sessions more difficult than after level 2 workouts, but consecutive days of level 3 training still possible if duration is not excessive and dietary carbohydrate intake is adequate.
4	Lactate Threshold	91-105%	95-105%(may not be achieved during initial phases of effort(s))	4-5	Just below to just above TT effort, taking into account duration, current fitness, environmental conditions, etc. Essentially continuous sensation of moderate or even greater leg effort/fatigue. Continuous conversation difficult at best, due to depth/frequency of breathing. Effort sufficiently high that sustained exercise at this level is mentally very taxing - therefore typically performed in training as multiple 'repeats', 'modules', or 'blocks' of 10-30 min duration. Consecutive days of training at level 4 possible, but such workouts generally only performed when sufficiently rested/recovered from prior training so as to be able to maintain intensity.
5	VO_2 Max	106-120%	>106%	6-7	Typical intensity of longer (3-8 min) intervals intended to increase VO2max. Strong to severe sensations of leg effort/fatigue, such that completion of more than 30-40 min total training time is difficult at best. Conversation not possible due to often 'ragged' breathing. Should generally be attempted only when adequately recovered from prior training - consecutive days of level 5 work not necessarily desirable even if possible. **Note:** At this level, the average heart rate may not be due to slowness of heart rate response and/or ceiling imposed by maximum heart rate)
6	Anaerobic Capacity	≥121%	N/A	>7	Short (30 s to 3 min), high intensity intervals designed to increase anaerobic capacity. Heart rate generally not useful as guide to intensity due to non-steady-state nature of effort. Severe sensation of leg effort/fatigue, and conversation impossible. Consecutive days

					of extended level 6 training usually not attempted.
7	Neuromuscular Power	N/A	N/A	* (Maximal)	Very short, very high intensity efforts (e.g., jumps, standing starts, short sprints) that generally place greater stress on musculoskeletal rather than metabolic systems. Power useful as guide, but only in reference to prior similar efforts, not TT pace.

Table 2 - Expected physiological/performance adaptations resulting from training at levels 1-7:

	1	2	3	4	5	6	7
Increased plasma volume		✔	✔✔	✔✔✔	✔✔✔✔	✔	
Increased muscle mitochondrial enzymes		✔✔	✔✔✔	✔✔✔✔	✔✔	✔	
Increased lactate threshold		✔✔	✔✔✔	✔✔✔✔	✔✔	✔	
Increased muscle glycogen storage		✔✔	✔✔✔✔	✔✔✔	✔✔	✔	
Hypertrophy of slow twitch muscle fibers		✔	✔✔	✔✔	✔✔✔	✔	
Increased muscle capillarization		✔	✔✔	✔✔	✔✔✔	✔	
Interconversion of fast twitch muscle fibers (type IIb -> type IIa)		✔✔	✔✔✔	✔✔✔	✔✔	✔	
Increased stroke volume/maximal cardiac output		✔	✔✔	✔✔✔	✔✔✔✔	✔	
Increased VO2 Max		✔	✔✔	✔✔✔	✔✔✔✔	✔	
Increased muscle high energy phosphate (ATP/PCr) Stores						✔	✔✔
Increased anaerobic capacity ("lactate tolerance")					✔	✔✔✔	✔
Hypertrophy of fast twitch fibers						✔	✔✔
Increased neuromuscular power						✔	✔✔✔

Table 3 - Borg's 10 point category-ratio scale of perceived exertion:

Perceived Exertion	Description
0	Nothing at all
0.5	Extremely weak
1	Very weak
2	Weak (light)
3	Moderate
4	Somewhat Strong
5	Strong (Heavy)
6	
7	Very Strong
8	
9	
10	Extremely Strong
*	Maximal