Conduct of a Treadmill Fitness Test

Aerobic performance is one of the essential elements of physical fitness, along with muscle strength, flexibility, and body composition. Aerobic performance is defined by certain parameters that can be measured using carefully selected protocols. The best known of these parameters is maximum oxygen uptake (VO_{2max}) [1]. Other important parameters include the anaerobic threshold (AT), maximum and minimum heart rates, heart rate at AT, breathing rate at AT and heart rate recovery (HRR) assessments.

Establishing a Fitness Baseline is essential to designing a Fitness Program tailored to the needs of individual athletes or of a team. Field testing is a cost effective and time efficient method of establishing these fitness baseline parameters. Fitness testing is typically done for the following reasons:

- to determine intensity levels for training program development
- to observe training progress
- to document changes in aerobic performance due to exercise training in order to evaluate the effectiveness of the training program [1]

The concept of doing a Treadmill Fitness Test is a simple option for performing a fitness field test for a limited amount of people in a climate controlled environment with commonly available equipment. By utilizing the power of Zephyr's Physiological Status Monitoring (PSM) systems, it is possible to determine all of the aforementioned parameters in a single 10-20 minute test without obstructive masks or other equipment that may affect an individual's performance in the test.

To conduct a Treadmill Fitness Test utilizing the capabilities of the Zephyr PSM system, the following equipment will be required:

- Zephyr System that includes a BioHarness™ and OmniSense Software loaded onto a PC.
- A treadmill that can be set to a 5% grade and has speed settings that can be increased by 1 km/h or .1 mph increments.

To utilize the OmniSense software's auto-calculation features for determination of VO_{2max}, it is necessary to follow a specific protocol. While there are many protocols, Zephyr has chosen to utilize a protocol that holds a constant grade of 5% and increases speed every 3 minutes [2]. This allows for steady state requirements to be achieved in order to adhere with specifications for application of the American College of Sports Medicine's (ACSM) equation for determination of VO_{2max} [3]. Additionally, it meets the average user's needs of being compatible with the majority of treadmills on the market and covers a broad spectrum of fitness level ability groups. Details of the protocol are listed in table 1.

5% incline treadmill test					
Speed					
mph	km/h	time	% grade	ACSM VO_2	regression VO_2
3.7	6	1	5	28.00	25.72
3.7	6	2	5	28.00	28.40
3.7	6	3	5	28.00	31.09
5.0	8	4	5	36.17	33.77
5.0	8	5	5	36.17	36.46
5.0	8	6	5	36.17	39.14
6.2	10	7	5	44.34	41.83
6.2	10	8	5	44.34	44.51
6.2	10	9	5	44.34	47.20
7.5	12	10	5	52.51	49.88
7.5	12	11	5	52.51	52.57
7.5	12	12	5	52.51	55.25
8.7	14	13	5	60.68	57.94
8.7	14	14	5	60.68	60.62
8.7	14	15	5	60.68	63.31
9.9	16	16	5	68.85	65.99
9.9	16	17	5	68.85	68.68
9.9	16	18	5	68.85	71.36
11.2	18	19	5	77.01	74.05
11.2	18	20	5	77.01	76.73
11.2	18	21	5	77.01	79.42
12.4	20	22	5	85.18	82.10
12.4	20	23	5	85.18	84.79
12.4	20	24	5	85.18	87.47

Table 1. Speed and Grade by time with correlating VO_2 values from ACSM's Treadmill equation for running. Far right column provides by minute regression under steady state increments (approximately 5 bpm between successive minutes). Running level of activity is assumed from start to finish of the test though stage 1 and 2 could be done at a brisk walking gait.

The protocol requires that an individual do a moderate warm-up prior to commencement for approximately 10 minutes. The test will commence on the treadmill after the subject has completed the warm-up and heart rate has

returned to a normal level (about 2-3 minutes after the warm-up). The initial treadmill setting should be at 3.7 mph (6 km/h) at a grade of 5%. The grade will stay at 5% through the entire test, but the speed needs to be manually increased by 1.2-1.3 mph (2 km/h) every 3 minutes (as shown in table 1) preferably by someone other than the individual running. For best results the subject should try to breathe naturally and avoid any cadence based breathing patterns that will skew the results. The subject is to follow the protocol increasing speed until a physical or cardiorespiratory limit in ability is reached, at which point the subject should hit the stop button on the treadmill and stand still to gain HRR values for up to three minutes, but no less than 30 seconds. VO_{2max} is determined based on the completion time as depicted in Table 2 applying a by minute regression to the ACSM Treadmill Equation.

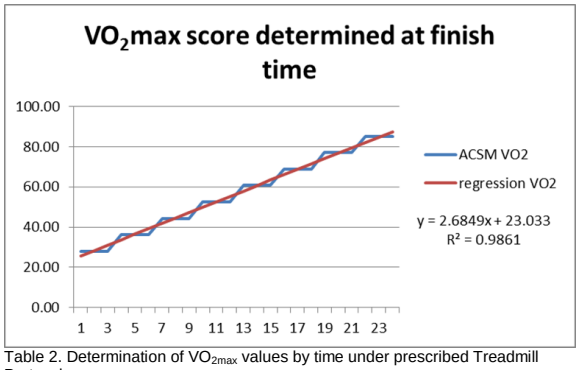

Table 2. Determination of VO_{2max} values by time under prescribed Treadmill Protocol.

For a true measure of Cardiorespiratory Fitness, maximal exertion is required and the following standardization should be adhered to in order to achieve reliable and consistent results:

- Abstain from prior eating (>4 hours)
- Abstain from prior strenuous exercise (>24 hours)
- Abstain from prior caffeine ingestion (>12-24 hours)
- Abstain from prior nicotine use (>3 hours)
- Abstain from prior alcohol use (>24 hours)
- Medication considerations (if the individual's medications affect resting or exercise HR, it will invalidate the test)

Prior to commencement, each individual that will be tested should fill out a Physical Activity Readiness Questionnaire (PAR-Q) in accordance with American Heart Association and ACSM guidelines [1]. PAR-Q forms can be found online, but the basic questionnaire is summarized below in Table 3.

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE

- I have a heart condition and my healthcare professional recommends only medically supervised physical activity.
- During or right after I exercise, I often have pains or pressure in my neck, left shoulder, or arm.
- I have developed chest pain within the last month.
- I tend to lose consciousness or fall over due to dizziness.
- I feel extremely breathless after mild exertion.
- My healthcare provider recommended that I take medicine for high blood pressure or a heart condition.
- I have bone or joint problems that limit my ability to do moderate-intensity physical activity.
- I have a medical condition or other physical reason not mentioned here that might need special attention in an exercise program.
- I am pregnant and my healthcare professional hasn't given me the OK to be physically active.
- I am over 50, haven't been physically active and am planning a vigorous exercise program.

If you selected one or more items, it's important that you see your healthcare professional before you conduct the exercise test.

Table 3. This questionnaire is an example of a PAR-Q taken from AHA website address below: http://www.americanheart.org/downloadable/heart/1176844249407Phys%20Activity%20Questionnaire.pdf

A standard treadmill fitness test will provide the monitor with a means to determine a VO_{2max} for each subject. However, as a basis for establishing a training program, VO_{2max} alone is not very useful. While VO_{2max} can provide a picture of an athlete's potential, which does not change much in conditioned athletes, coupling this data with a measure of the anaerobic threshold of the athlete provides a benchmark for conditioning levels in relation to that potential. This measure of fitness can be measured and tracked by determining heart rate at anaerobic threshold (HR@AT), the percentage of maximum oxygen uptake the individual can sustain at AT (%VO_{2max}), or even the breathing rate at AT (BR@AT) as applied for specific activities.

Another essential component of an athlete's conditioning level is the ability to recovery from high exertion exercise. By measuring HRR at various time intervals, the Zephyr System can

provide this highly important component of an athlete's conditioning profile. In a traditional treadmill fitness test, these highly important parameters would be left unmeasured.

Table 3 depicts the relationships of these essential baseline parameters and how they relate to an incremental maximal effort fitness test (such as this treadmill test).

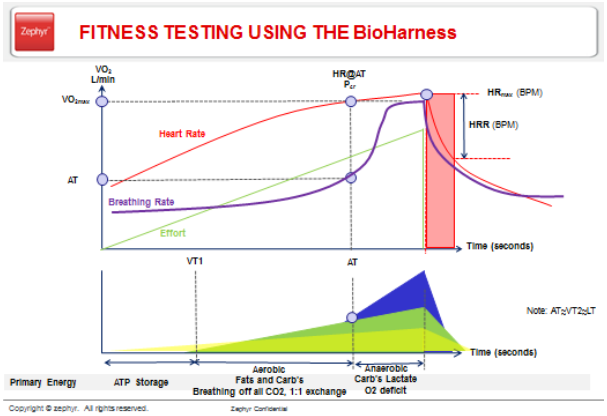

Table 3. This table depicts the relationship of the body's energy systems to the physiological effects of an increasing effort fitness test (heart rate and breathing rate) and demonstrates at what points key baseline parameters can be determined during that testing session or through OmniSense Analysis.

The Zephyr PSM system utilizes a combination of heart rate, breathing rate, activity, posture, and skin temperature measurements to provide the researcher, coach, or team leader with a more complete picture of an individual's status under virtually any type of activity. The aerobic performance of an individual is dependent on how much oxygen their body can utilize to metabolize energy and how efficiently disposal of by-products occurs. Beyond aerobic capacity is the body's anaerobic capacity, which utilizes lactate to metabolize glycogen, and produces lactic acid and carbon dioxide as a by-product. At the second ventilatory threshold the body compensates for being unable to dispose of excess carbon dioxide that results from the jump in anaerobic metabolism by an involuntary influx in respiration. This breathing rate inflection point correlates to the anaerobic threshold [4].

The monitoring of training intensity requires the setting of exercise intensity zones that are relevant to a particular athlete. The use of the Anaerobic Threshold as a marker for training intensity is well accepted in training circles [1]. Identification of this marker is essential in prescription of exercise intensity zone based fitness programs [1].

The following table depicts how the specified Treadmill Protocol is analysed in OmniSense.

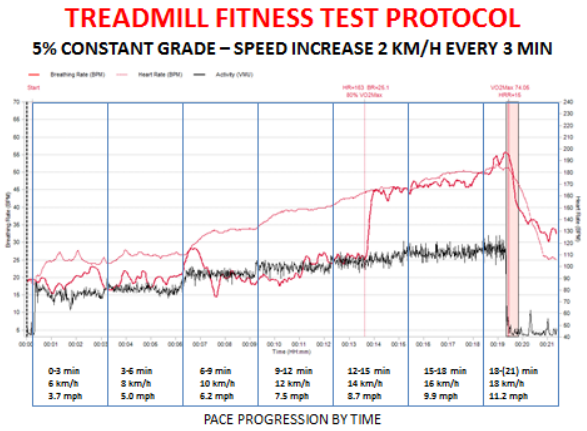

Table 4 shows data collected during a treadmill fitness test depicts how these benchmark data points are pulled out of the provided OmniSense software Treadmill Test utility. AT is plotted where there is a significant inflection in BR toward the end of the test [4].

For a discussion of how to apply these baseline parameters and markers to training program development, find additional Application Notes at www.zephyr-technology.com.

References:

[1] Cooper, C. and Storer, T. (2001). Exercise Testing and Interpretation: A Practical Approach. Cambridge, UK: Cambridge University Press.

[2] Pokan, R. et al. Effects of Treadmill Exercise Protocol with Constant and Ascending Grade on Levelling-Off 0_2, Uptake and $V0_2max$. International Journal of Sports Medicine (1995) 16, 238-242.

[3] Glass, S. and Dwyer, G. (2007). ACSM's Metabolic Calculations Handbook. Baltimore, MD: Lippincott Williams & Wilkins.

[4] Carey, D. et al. Respiratory rate is a valid and reliable marker for the anaerobic threshold: implications for measuring change in fitness. *Journal of Sports Science and Medicine* (2005) 4, 482-488.

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