LIVERPOOL JOHN MOORES UNIVERSITY

SCHOOL OF SPORT & EXERCISE SCIENCES
TOM REILLY BUILDING · BYROM STREET · LIVERPOOL L3 3AF

PERFORMANCE TESTING REPORT · 2024

Performance Testing *Report*

A laboratory-grade assessment of aerobic capacity, metabolic thresholds and individualised training prescription, prepared for the named athlete by the LJMU sport science testing team.

ATHLETE	SPORT / DISCIPLINE	TEST DATE	TEST PROTOCOL
Billy Bob	Road Cycling	12 June 2024	Incremental $\dot{V}O_2$ Max + Lactate

SUMMARY

Headline results

$\dot{V}O_2$ Max
MAXIMAL OXYGEN UPTAKE

RELATIVE
55.4
mL/kg/min

ABSOLUTE
4.02 L/min

CATEGORY
Excellent
Trained male, age 20–29

LACTATE THRESHOLD 1 (LT1)
186.5 W
150 bpm · 1.7 mmol/L · Piecewise breakpoint 1

LACTATE THRESHOLD 2 (LT2)
262.7 W
180 bpm · 3.7 mmol/L · Piecewise breakpoint 2

% $\dot{V}O_2$ MAX AT LT2
83 %
Fractional utilisation at LT2 is within typical trained-population values.

PEAK WORKLOAD
325 W
4.48 W/kg at the final completed stage.

MAX HEART RATE
192 bpm
Highest HR recorded during the test. Used to derive the heart-rate training zones.

01 **$\dot{V}O_2$ Max: 55.4 mL/kg/min (Excellent band).**
Reference comparison drawn from ACSM 11th ed / FRIEND registry male norms, 20–29 age band.

02 **LT2: 263 W (180 bpm).**
LT2 occurred at 83% of $\dot{V}O_2$ Max. Within typical trained-population values.

03 **Training zones — HR max 192 bpm, peak 325 W.**
Z1 115–144 bpm · 195–244 W
Z2 144–167 bpm · 244–283 W
Z3 167–182 bpm · 283–309 W
Z4 182–192 bpm · 309–325 W
Watts bands mirror HR-max fractions onto peak power; aerobic base in Z1.

04 **Recommended re-test interval: 10–12 weeks.**
A follow-up incremental test in this window allows the change in LT1/LT2 power and $\dot{V}O_2$ Max to be quantified.

SECTION 01

Introduction

Liverpool John Moores University's School of Sport and Exercise Sciences hosted your performance testing visit. This report summarises the data collected on the day and provides practical guidance on training intensities and session design.

The data should be used in consultation with your coach to plan your next training block. Section 1 of this report (overleaf) contains the headline take-homes; the remaining sections work through the underlying physiology, normative comparisons, threshold analysis, training-zone derivation, recommended session formats and the raw stage-by-stage data. If you have any questions about your test or this report, please contact the testing team on the back page.

LAB TRB 2.32 — Cycle Ergometry Suite	ERGOMETER Lode Excalibur Sport	GAS ANALYSIS Cortex MetaLyzer 3B
LACTATE EKF Biosen C-Line, capillary	PROTOCOL Step ramp · 3 min · stages to volitional exhaustion	LAB CONDITIONS Lab conditions logged at session.

SECTION 02

Aerobic Capacity ($\dot{V}O_2$ Max)

$\dot{V}O_2$ Max is the maximum rate at which your body can take in, transport and use oxygen during intense exercise. It is the gold-standard measure of aerobic fitness and a strong predictor of endurance performance. You completed an incremental exercise test to volitional exhaustion: the protocol began at a low intensity and progressed in stages until you could no longer continue. The values below are derived from the highest sustained intensity you reached.

2.1 Your Results

$\dot{V}O_2$ MAX (ML/KG/MIN)	$\dot{V}O_2$ MAX (L/MIN)	MAX HR (BPM)	PEAK WORKLOAD	RER AT PEAK	BODY MASS
55.4	**4.02**	**192**	**325 W**	**—**	**72.5 kg**

> Your relative $\dot{V}O_2$ Max of **55.4 mL/kg/min** places you in the **Excellent** category for the 20–29 age band. Between the 75th and 95th percentile on ACSM/FRIEND norms.

2.2 Comparison with Normative Data

The table below shows $\dot{V}O_2$ Max categories (mL/kg/min) by age band. Values shown are typical for trained male athletes; female norms run approximately 10–15% lower across the same categories. Your score is highlighted on the relevant row.

AGE	VERY POOR	POOR	FAIR	GOOD	EXCELLENT	SUPERIOR
13–19	<29.0	29.0-40.1	40.1-48.0	48.0-55.2	55.2-66.3	**>66.3**
20–29	<29.0	29.0-40.1	40.1-48.0	48.0-55.2	55.2-66.3	**>66.3** YOU · 55.4
30–39	<27.2	27.2-35.9	35.9-42.4	42.4-49.2	49.2-59.8	**>59.8**
40–49	<24.2	24.2-31.9	31.9-37.8	37.8-45.0	45.0-55.6	**>55.6**
50–59	<20.9	20.9-27.1	27.1-32.6	32.6-39.7	39.7-50.7	**>50.7**
60+	<17.4	17.4-23.7	23.7-28.2	28.2-34.5	34.5-43.0	**>43.0**

2.3 Performance Context

$\dot{V}O_2$ Max sets the upper limit of your aerobic capacity, but on its own it is a partial predictor of endurance performance. The fraction of $\dot{V}O_2$ Max that can be sustained — governed by the metabolic thresholds described in §3 — is the additional determinant. Raising the percentage of $\dot{V}O_2$ Max at which LT1 and LT2 occur is therefore a primary training target.

You can improve your $\dot{V}O_2$ Max through training, but the magnitude and rate of improvement are partly genetically determined. For most athletes, the biggest gains in race performance come from raising the threshold percentages and from improving exercise economy — not from chasing a higher $\dot{V}O_2$ Max in isolation.

SECTION 03

Metabolic Thresholds

Successful endurance performance depends on the percentage of your $\dot{V}O_2$ Max that you can sustain for the duration of an event. The deciding factor is how much aerobic work you can produce before relying on anaerobic energy pathways — the point of that transition is your metabolic threshold, and raising it is one of the most trainable, highest-impact targets in endurance training.

3.1 Lactate Threshold (LT1)

At low to moderate intensities your cardiovascular system meets oxygen demand comfortably. Lactate is produced and cleared at a stable, low level. **LT1** marks the first sustained rise in blood lactate above resting levels — typically the highest intensity you can hold for 60–90 minutes. Training around this point improves fat oxidation, mitochondrial density and the ability to clear lactate before it accumulates.

3.2 Anaerobic Threshold (LT2)

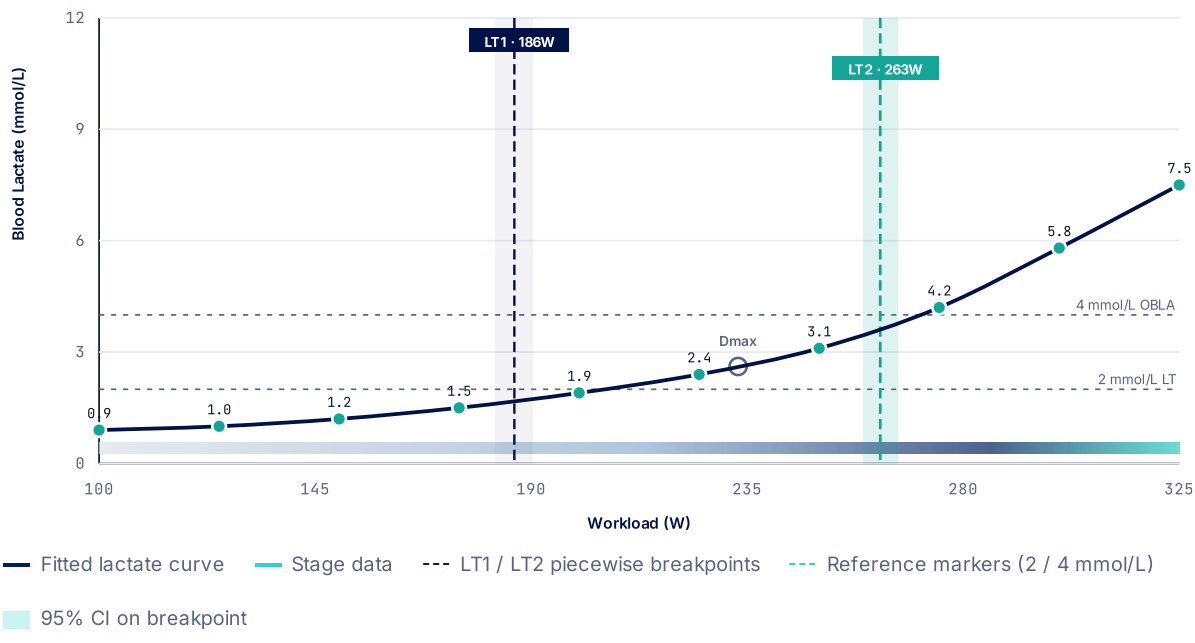
As intensity rises further, your cardiovascular system reaches its limit to deliver oxygen at the rate working muscles demand. Anaerobic energy production accelerates and lactate accumulates faster than the body can clear it. **LT2** marks the highest intensity at which lactate can still be balanced — usually sustainable for 30–60 minutes. Training at and above this point improves lactate tolerance, buffering capacity and the absolute power you can hold under race conditions.

3.3 Why the thresholds matter

Two athletes with comparable $\dot{V}O_2$ Max values can differ substantially in endurance performance. The fraction of $\dot{V}O_2$ Max sustainable at LT1 and LT2 — fractional utilisation — accounts for much of that difference. The chart below positions your individual thresholds against your stage data.

3.4 Your Lactate Profile

Blood lactate measured at each completed stage. Two complementary methods identify your training thresholds. The **primary** thresholds — LT1 and LT2 — come from a piecewise regression of your lactate data, which finds the natural inflection points in your curve rather than relying on fixed lactate values. Two reference markers (the conventional 2 mmol/L LT and 4 mmol/L OBLA) plus the Dmax point are shown for cross-comparison.



THRESHOLD	WORKLOAD	HEART RATE	LACTATE	METHOD
LT1	**186.5 W**	**150 bpm**	**1.7 mmol/L**	**Piecewise breakpoint 1**
LT2	**262.7 W**	**180 bpm**	**3.7 mmol/L**	**Piecewise breakpoint 2**
LT (2 mmol/L)	205.0 W	158 bpm	2.0 mmol/L	FIXED REFERENCE
OBLA (4 mmol/L)	270.5 W	183 bpm	4.0 mmol/L	FIXED REFERENCE
Dmax	233.1 W	170 bpm	2.61 mmol/L	POLYNOMIAL DMAX

SECTION 04

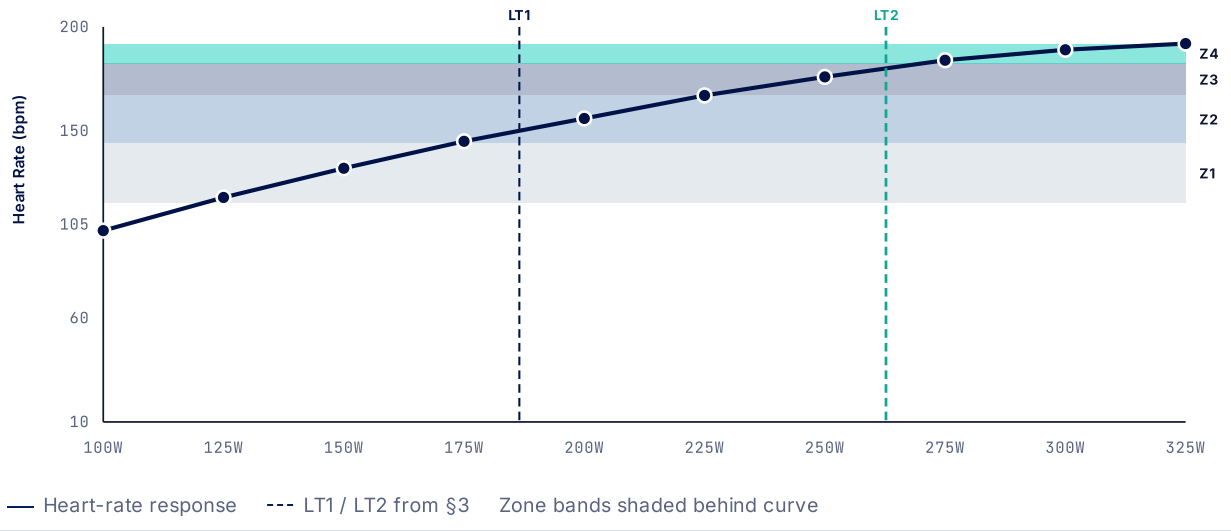
Training Zones

Training zones are derived from your maximum heart rate of **192 bpm**. The majority of your training should sit in Zones 1 and 2; add 1–2 sessions per week of higher-intensity work (Zones 3 and 4) according to your training phase and goals.

4.1 Heart Rate Zones

Z1 — Aerobic (Low)	60–75% HRmax	**115–144 bpm**	*30 min – 3 hours*
Z2 — Aerobic (High)	75–87% HRmax	**144–167 bpm**	*8 – 60 minutes*
Z3 — Aerobic Maximum	87–95% HRmax	**167–182 bpm**	*30 sec – 3 minutes*
Z4 — Anaerobic	95–100% HRmax	**182–192 bpm**	*10 – 60 seconds*

Your test data plotted below, with HR zones shaded behind the curve so you can see when each zone was crossed during the stages.



— Heart-rate response --- LT1 / LT2 from §3 Zone bands shaded behind curve

4.2 Recommended Sessions

The blocks below describe five session types you can rotate through your training week. Each one targets a specific zone and adaptation. Build the lower-intensity sessions first; add the high-intensity work once those are sustainable.

01 Long & Steady — Aerobic Base

ZONES 1–2 · 1–3 × PER WEEK — Z1 / Z2

OUTLINE
Steady effort lasting 30 min to 2 hr at an easy to moderate pace, sitting at or just below LT1. Build into the target pace; aim to avoid cardiac drift over the session.

PROS
Low to moderate training stress. Stimulates aerobic adaptations (mitochondrial density, capillarisation, fat oxidation). Sustainable and easy to recover from.

CONS
Time-intensive. Used in isolation, a single steady intensity can plateau adaptations after a training block.

ZONE	TARGET HR	TARGET WORKLOAD
Aerobic → LT1	115–144 bpm	≈ 60–80 % peak

02 Threshold — 2 × 20 min

ZONE 3 · 1 × PER WEEK — Z3

OUTLINE
Two intervals of 20 minutes at 85–90 % of max HR (between LT1 and LT2), with 5–10 min easy recovery between them.

PROS
High training stimulus per minute. Improves lactate clearance and sustainable power at threshold.

CONS
High recovery demand. Pace control across both intervals is important to maintain the target intensity.

ZONE	TARGET HR	TARGET WORKLOAD
LT1 → LT2	144–167 bpm	≈ 85–90 % of 325 W = 276–292 W

SECTION 04 CONT.

Recommended Sessions

Continued from §4.2. The three sessions below sit higher up the intensity spectrum. They produce the largest performance gains per minute of training, but they cost the most in recovery. Schedule them carefully and build from the lower-intensity work first.

03 Over / Under Threshold

ZONE 3 · 0–1 × PER WEEK — Z3

OUTLINE

Trains the body's ability to clear lactate while still producing it. Typically **4 × [3 min just above threshold + 2 min just below]**. Total 20 minutes of continuous work after a thorough warm-up.

PROS

Specific to the demands of variable-intensity endurance events. Improves lactate buffering and tolerance to repeated supra-threshold exposures.

CONS

Pacing accuracy is critical: drifting too far above LT2 compromises the under-threshold sections. Best executed with HR or power data.

ZONE	TARGET HR	TARGET WORKLOAD
LT1 ↔ LT2	144 → 182 bpm	≈ 90 % ↔ 95 % peak

04 $\dot{V}O_2$ Max Intervals — 5 × 3 min

ZONES 3–4 · 1–2 × PER WEEK MAX — Z3 / Z4

OUTLINE

Perform 3–8 rounds of 3 minutes at your $\dot{V}O_2$ Max intensity. Best done indoors on a turbo or outdoors on a steady hill. Warm up for 10–15 min, then 5 min at threshold pace before the first interval. Recover for 3 min between intervals at very easy pace.

PROS

Improves $\dot{V}O_2$ Max and high-intensity power output. Adaptations are typically measurable within 4–6 weeks.

CONS

High physiological stress. Limit to 1–2 sessions per week with full recovery days adjacent. Not appropriate when fatigued or in-season for shorter events.

ZONE	TARGET HR	TARGET WORKLOAD
$\dot{V}O_2$ Max	167 → 192 bpm	At or near peak

05 Anaerobic Intervals — 30 s All-Out

ZONE 4 · ≤ 1 × PER WEEK — Z4

OUTLINE

Warm up for 10–15 min, gradually building to threshold pace and holding for 3 min. Perform **6–10 rounds of 30 s all-out with 90 s very easy recovery**. Cool down 10 min.

PROS

Rapid adaptations to anaerobic capacity, lactate buffering and peak power. Short total session time.

CONS

High physiological cost. Should not be scheduled on consecutive days or on top of accumulated fatigue.

ZONE	TARGET HR	TARGET WORKLOAD
Anaerobic	182–192 bpm	Maximal each rep

Weekly scheduling. A typical 5-day microcycle: three Long & Steady sessions (§01) with one threshold session (§02 or §03) mid-week. $\dot{V}O_2$ Max work (§04) is best confined to dedicated build blocks. Anaerobic intervals (§05) are appropriate in the final 4–6 weeks before a target event, not during base training. Hard / easy day spacing should be preserved.

SECTION 05

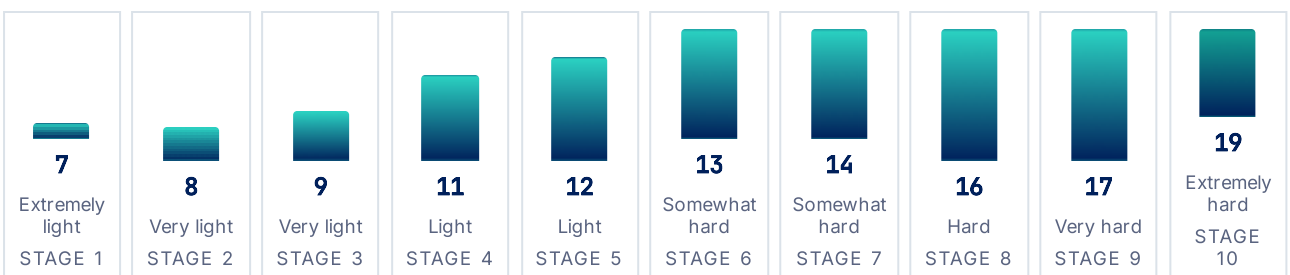
Stage-by-Stage Test Data

The data recorded during your incremental test. This is the source data used for all calculations above. Values reported are the final-30-second mean for HR and gas exchange and the immediate post-stage capillary lactate.

STAGE	TIME (MIN)	WORKLOAD (W)	W·KG⁻¹	HR (BPM)	V̇O₂ (ML/KG/MIN)	RER	LACTATE (MMOL/L)	RPE (6–20)
1	0:00–3:00	100	1.38	102	21.9	–	0.9	7
2	3:00–6:00	125	1.72	118	25.6	–	1.0	8
3	6:00–9:00	150	2.07	132	29.3	–	1.2	9
4	9:00–12:00	175	2.41	145	33.1	–	1.5	11
5	12:00–15:00	200	2.76	156	36.8	–	1.9	12
6	15:00–18:00	225	3.1	167	40.5	–	2.4	13
7 LT2	**18:00–21:00**	**250**	**3.45**	**176**	**44.2**	**–**	**3.1**	**14**
8 LT2	**21:00–24:00**	**275**	**3.79**	**184**	**48.0**	**–**	**4.2**	**16**
9	24:00–27:00	300	4.14	189	51.7	–	5.8	17
10 PEAK	27:00–30:00	325	4.48	192	55.4	–	7.5	19

5.1 Perceived Exertion

Your perceived effort at each stage of the test, on the Borg 6–20 scale. RPE adds a subjective dimension to the objective HR and lactate data and is particularly useful for prescribing training when no HR strap or power meter is available.



RPE increased monotonically across stages and tracked the heart-rate response.

SECTION 06

Recommendations

Based on your test data, the following areas are worth focusing on in the coming training block. The testing team has tailored these comments to your specific test observations; please use them as a starting point for discussion with your coach.

6.1 — STRENGTHS

- **$\dot{V}O_2$ Max.** 55.4 mL/kg/min — **Excellent** band on ACSM/FRIEND male norms for the 20–29 age range.
- **Heart-rate response.** HR rose from 102 bpm at stage 1 to 192 bpm at peak; the response across stages was monotonic and consistent with a well-paced incremental test.
- **Perceived exertion.** RPE rose monotonically across stages and tracked HR through the test.
- **Test integrity.** Test was carried to volitional exhaustion within laboratory QA bounds.

6.2 — AREAS FOR DEVELOPMENT

- **LT2 fractional utilisation.** Currently 83% of $\dot{V}O_2$ Max. A 6–8 week block of LT2-targeted work (Sessions 02 / 03, 1× per week) is indicated.
- **Sub-LT1 training volume.** Add one extra Z1–Z2 session per week. Aerobic adaptations at this intensity are driven by time-in-zone rather than peak intensity.
- **Peak power output.** Peak workload of 325 W. Three $\dot{V}O_2$ Max sessions (§04) over a 4-week build are indicated to address this.
- **Re-test interval.** A follow-up incremental test in **10–12 weeks** will quantify the change in LT2 power and $\dot{V}O_2$ Max.

6.3 Suggested 6-week training emphasis

WEEK	FOCUS	Z1–Z2 (VOLUME)	Z3 (THRESHOLD)	Z4 ($\dot{V}O_2$ / ANAEROBIC)	NOTES
1	Base build	5 hr	1 × Threshold (§02)	—	Re-establish routine after testing.
2	Base build	6 hr	1 × Over/Under (§03)	—	Add one steady ride.
3	Threshold	5 hr	2 × Threshold (§02)	—	Two threshold sessions, 72 hr apart.
4	Recovery	4 hr	1 × short (§02 reduced)	—	40 % volume drop. Watch HR drift.
5	$\dot{V}O_2$ build	5 hr	1 × Over/Under (§03)	1 × $\dot{V}O_2$ (§04)	Introduce $\dot{V}O_2$ on a fresh day.
6	$\dot{V}O_2$ build	5 hr	1 × Threshold (§02)	1 × $\dot{V}O_2$ (§04)	Re-test in week 7 or 8.

Caveat. These recommendations are based on a single laboratory assessment. Day-to-day training load should be adjusted for sleep, accumulated fatigue, illness, ambient conditions and competing demands. The plan should be reviewed with your coach.

CLOSING

Thank you for visiting our laboratory.

Please get in touch if you have any questions about your data, would like a more detailed walk-through of any section, or would like to book a follow-up test later in the year. We're glad to chat.

J. A. Donaldson

Dr J. A. Donaldson
Lead Sport Scientist · Performance Testing

Test confirmed clean and within QA bounds.

ADDRESS
School of Sport & Exercise Sciences
Tom Reilly Building, Byrom Street
Liverpool L3 3AF

EMAIL
j.a.donaldson@ljmu.ac.uk

LAB PHONE
+44 (0)151 904 6238

WEB
ljmu.ac.uk/sport-and-exercise-sciences

DOCUMENT
Performance Testing Report — generated 29 May 2026. Internal reference: PTR-24-06-BILLY-.

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RE-TEST
Recommended re-test window: **21 August – 4 September 2024**. Book at testing@ljmu.ac.uk.