

WHITE PAPER

Trek Bicycles Wind Tunnel Investigation

August 7 2007

Purpose

To compare drag forces on (1) Trek and other brand framesets, and (2) various hydration systems, forks, wheels, helmets, and tires on the same frameset, all with rider on board. Details described in this white paper cover (1) only.

Wind Tunnel

Tunnel: San Diego Air & Space Museum Low Speed Wind Tunnel

Location: San Diego, California, USA

Date: August 7, 2007, approximately 9 a.m. to 7 p.m.

Tunnel Configuration

Air Speed approximately 25 mph, data normalized to 25 mph.

Wheel speed: 25 mph (both front and rear wheel spinning)

Rider: Doug Cusack

Cadence: 90 RPM +/-5 RPM

Yaw angles 0, 10, 20 degrees (for non-proprietary runs).

Drag force taken in body axis (not wind axis), including “cosine beta squared” correction.

Temperature, humidity and pressure corrected.

General Bike Configuration for comparing Trek and other brand framesets

Identical Shimano components, including crank (172.5 mm on all bikes), brake calipers (with 5mm housing), bb, front and rear derailleurs, chain, and bar end shifters (with 4mm housing). Bontrager Race X Lite Pro saddle, Bontrager Race X Lite carbon base bar with TT brake levers, Bontrager Race X Lite carbon clip on aero bar (ends taped closed). Time pedals. Bontrager flat (Zipp) disc, Bontrager Aeolus 16 spoke ACC front wheel. Cables routed as designed (internally on bikes designed with internal cables, externally on bikes designed with external cables). Headsets as supplied with each frameset.

Rider Position

All bikes were set up with the same rider position. Dimensions listed below:

- saddle height = 74.7 cm
- saddle set back = 4.0 cm
- drop = 11.0 cm (from top of saddle to top surface of the elbow supports).
- reach = 80.0 cm (from front of saddle to farthest tip of aero bar extensions)

Note: Where frame reach differed, rider reach was held constant by extending or retracting the aero bar extensions.

Specific Bike Configurations

Run 7: Bontrager Race Lite OS -17 degree stem. 15 mm of spacers under stem.

Run 20: Repeatability check: same as Run 7.

Run 23: Look adjustable stem, with negative rise to get the same drop as other bikes.

Run 24: Bontrager Race Lite OS -17 degree stem. 10 mm of spacers under stem.

Run 25: Bontrager Race Lite OS -17 degree stem. No spacers under stem.

Note: Spacers were added or removed to achieve the same actual measured drop, rather than adding spacers according to published frame stack dimensions. Any differences may be due to manufacturing tolerances, different headset top caps, etc.

Run Schedule

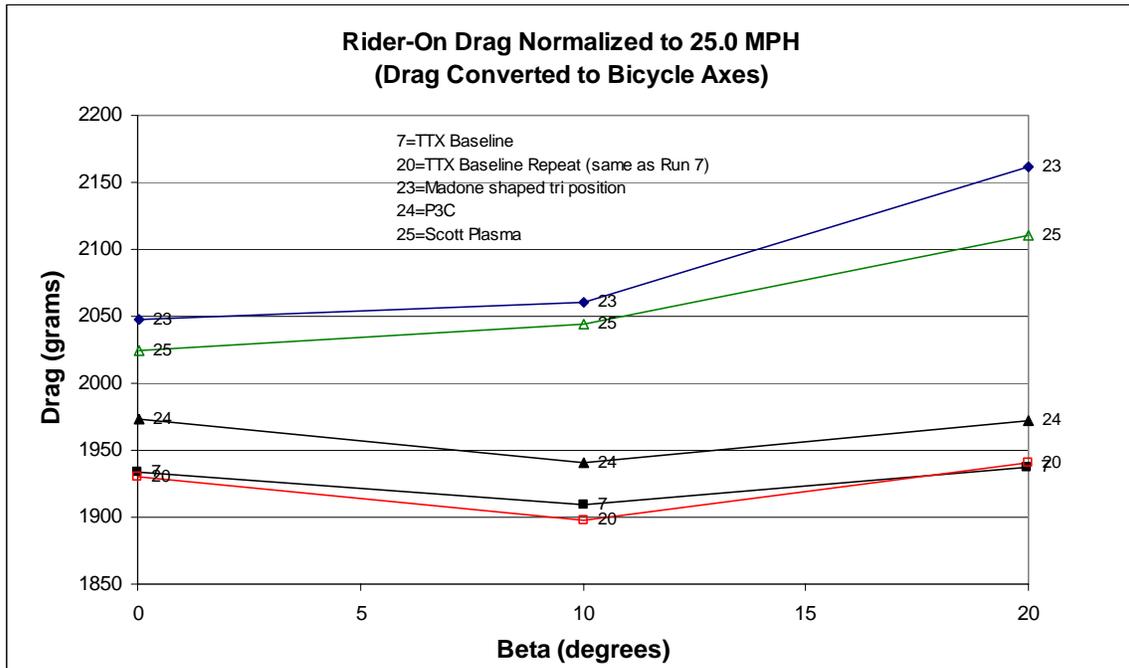
Data for runs in **bold font** have been made public. Proprietary runs are for internal research & development and are not public.

1. Proprietary – Trek experimental frame 1
2. Proprietary – Trek experimental frame 2
3. Proprietary – Trek experimental frame 3
4. Proprietary – Trek experimental frame 4
5. Proprietary – Trek experimental hydration system 1
6. Proprietary – Trek experimental hydration system 2
- 7. 2007 Trek Equinox TTX, size M/56 (baseline)**
8. Proprietary – Trek experimental hydration system 3
9. Proprietary – Trek experimental hydration system 4
10. Proprietary – Trek experimental frame 5
11. Proprietary – Trek experimental frame 6
12. Proprietary – Trek experimental fork 1
13. Proprietary – Trek experimental fork 2
14. Proprietary – Trek experimental fork 3
15. Proprietary – Trek experimental fork 4
16. Proprietary – Trek experimental fork 5
17. Proprietary – Trek experimental fork 6
18. Proprietary – Trek experimental hydration system 5
19. Proprietary – Trek experimental hydration system 6
- 20. 2007 Trek Equinox TTX, size M/56 (repeat run 7)**
21. Proprietary – position 1a
22. Proprietary – position 1b
- 23. 2006 Trek Madone, size M/56**
- 24. 2005 Cervelo P3C, size M/56**
- 25. 2007 Scott Plasma, size M/54**
26. Proprietary – helmet 1
27. Proprietary – helmet 2
28. Proprietary – helmet 3
29. Proprietary – Trek experimental frame 7

Results comparing Trek and other brand framesets

Body-axis drag force in grams:

RUN	0 deg yaw	10 deg yaw	20 deg yaw
7	1934	1909	1937
20	1930	1898	1940
23	2047	2061	2162
24	1973	1941	1973
25	2024	2044	2110



Beta is yaw angle.

Photos



Run 7



Run 20

Note: Rider is stationary for photo, not yet in riding position.



Run 23

Note: Rider is stationary for photo, not yet in riding position.



Run 24

Note: Rider is stationary for photo, not yet in riding position.



Run 25

Note: Rider is stationary for photo, not yet in riding position.

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End