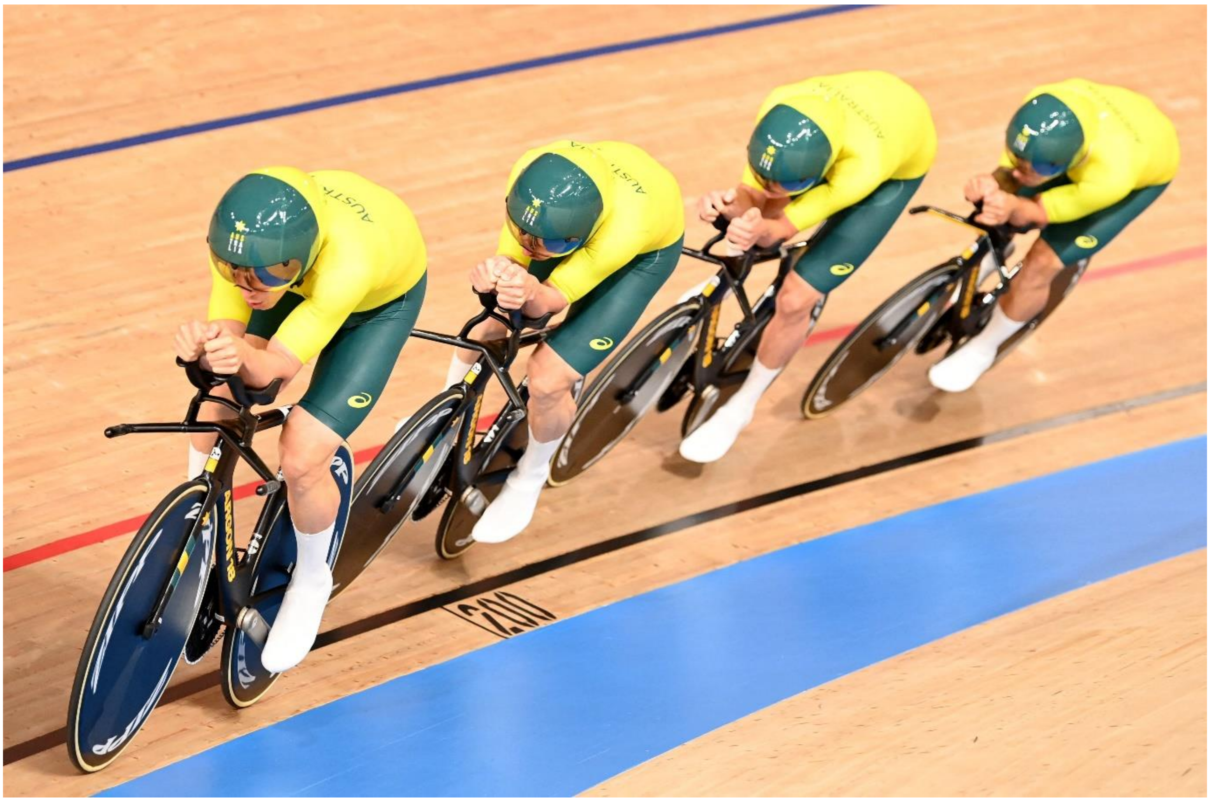


Report

An Investigation into the Handlebar Failure that Occurred in the Australian Men's Team Pursuit race at the Tokyo 2020 Olympics

Date of Incident: 2nd August 2021

Location: Izu Velodrome, Tokyo, Japan

This report has been prepared for AusCycling Limited under Contract which precludes selective quoting from this Report.

This report was prepared by John Baker, AM
For Its Not Your Fault Pty Ltd

Table of Contents

FIGURES AND TABLES 2
EXECUTIVE SUMMARY 3
INTRODUCTION 5
The Purpose 5
Administration 5
Terminology 6
INVESTIGATION PROCESS 6
Evidence Gathering 6
Investigation Method 7
Sequence of Events 8
SPECIFICATION, DESIGN AND MANUFACTURE 11
Specification 11
Design, Manufacture and Testing 13
Titanium Material 14
Pursuit Base Bar Forces: Specified versus Ride Data 15
Isometric Exercise and Base Bar to Fork Bolt Torques 17
BASTION BASE BAR CA-06 18
Base Bar CA-06 Overview 18
Bar CA-06 Additive Manufacture Configuration 20
Number One Base Bar Paint Removal. 23
USE AND MANAGEMENT OF THE BASE BAR BY THE AUSTRALIAN CYCLING TEAM 25
Usage Overview 25
The Australian Cycling Teams Base Bar Management 25
Equipment Steering Group 26
Documented Use of Base Bar CA-06 27
A glimpse into the Australian Cycling Team culture 27
CONCLUSIONS 29
FINDINGS 30
RECOMMENDATIONS 31
Annexes and Appendices 33

FIGURES AND TABLES

Figure 1: The Swiss Cheese Model. barriers are defeated by an accident trajectory............................8
Figure 2: Performance Systems Manager's proposal to The Australian Institute of Sport 9
Figure 3: Argon 18 Base Bar with 35mm Extension..10
Figure 4: Abridged Base Bar TimeLine 11
Figure 5: Computer Aided Design skin with 35mm extension as Specified..12
Figure 6: Base Bar CA-06 mounted in the Test Rig 14
Figure 7: Athlete rider on start release, Tokyo 2020...16
Table 1: Comparison of as-made-to-specification and actual factors of safety 17
Figure 8: Isometric Exercise Riding Position 17
Table 2: Base Bar to Steering Fork clamping Force Bolt Torques 18
Figure 9:Base Bar Manufactured in Parts 19
Figure 10: Base Bar Sleeve Joint 19
Figure 11: Base Bar Scan Data for all Four Bars overlaid on Computer Aided Design..........................21
Figure 12: Base Bar Longitudinal Centre Line Section 22
Figure 13: Enlarged Centre Line Section through the front Bolt Hole 22
Figure 14: Number One Base Bar with paint missing from the front bolt hole...................................24
Figure 15: Number One Base Bar under view..25

EXECUTIVE SUMMARY

On 2nd August 2021 at the 2020 Tokyo Olympic Games, the pursuit handlebars[1] of the fourth athlete rider in the Australian Teams Pursuit qualifying heat failed, spilling Alex Porter onto the track. AusCycling commissioned an investigation into the reasons for the failure. This Report is based on fact and gathered evidence and is the opinion of the Investigator.

Like most failures, there is no one cause for this event, there is however a prime cause which had more impact than any other.

The Australian Cycling Team changed the Pursuit Team starting technique and along with a smaller bike frame to improve aerodynamic performance, a bike geometry change was needed. The untraceable solution was an extended Base Bar and to meet the time frame, it was to be made locally. With familiarity with Bastion Cycles products, their Titanium additive manufacture Base Bar was commissioned.

The Australian Cycling Team Specified the required Base Bar with a Computer Aided Design electronic drawing of the outer skin along with testing to an International Standard; the timeframe to design and make was reduced from ten to four months. The Titanium material specified was lighter and stronger than steel but more sensitive to fatigue damage. Fatigue testing Specified was reduced by the Australian Cycling Team from 200,000 to 50,000 cycles.

In use, the additive manufactured Titanium Base Bar was exposed to riding and training forces some one-and-one half times the Australian Cycling Team Specified design and test forces.

Organisational change overlayed the extended Base Bar project where first Cycling Australia and then AusCycling were tasked with raising teams, training for and competing at World Championships, 2020 Olympics and National events.

The 3D printed Base Bar mates to a machined steering fork and immediately forward of the most forward attachment bolt was a .29mm elevated area which raised the local stress. Even without this mismatch, the high rider forces would have precipitated a failure elsewhere on the Base Bar.

The design, manufacture and laboratory test of the Base Bars were all properly controlled and completed as specified. Contemporary design methods for static and fatigue performance were used whilst the constrained fatigue tests were conducted in full and the results provided to the Australian Cycling Team.

Whilst an organisational structure was in place for the Australian Cycling Team, there were scant policies or processes in a technical sense and individuals made it up as they went along. An Equipment Steering Group was formed with a vison of “zero failure rate”; disappointingly there was

[1] Pursuit handlebars subsequently referred to in this paper as “bars”

scant documented structure behind the vision to implement it nor was this vision conveyed to Bastion Cycles. A comprehensive Bicycle Build Book was drafted but when issued, only partially covered the technical aspects.

What cannot be overlooked is the effect of the COVID-19 pandemic. When a requirement, which was out of the ordinary, arose, this requirement was first delayed, poorly specified, then hastily effected and in use, extant check and balance systems were ignored. At the time of Specification, the 2020 Olympics was seven months away, but COVID-19 delayed the Olympics until mid-2021 and with the original production and shortened testing time frame met, adequate time for in-use training became available. The 150,000 cycles of missed testing were never reinstated[2]. The Specification appears to have been raised in isolation and was not informed by material properties or fatigue geometry.

The Number One Base Bar was fitted and performed as required, was then swapped between bike frames to give all riders experience with the design change and when removed from service had completed some four lives when compared to the failed Number Four Base Bar. During testing as part of the investigation, the most used Number One Bar was found free from any cracks.

In service, on removal, on installation and during handling before and after transit, there were multiple opportunities to detect any Base Bar deterioration, but these opportunities were lost due to the lack of application of extant process and missing checks and balances until the Number Four Base Bar failed.

The prime cause of the Australian Cycling Team Base Bar failure was an inadequate Specification and then in use, exposing the Base Bar to athlete rider forces some one-and-one half times that Specified. The subsidiary causes can be classified as inadequate governance: inadequate functional configuration control and physical configuration control.

Recommendations are included.

[2] The ISO 4210- 5:2014 required 100,000 cycles loaded in-phase plus 100.000 cycles out-of-phase at table force values.

INTRODUCTION

The Purpose

1. On 2nd August 2021, whilst competing in an Olympic qualifying round for the Teams Pursuit at the Izu Velodrome, Tokyo, a Bastion Cycles CA-06 Base Bar failed on an Argo 18 bike of athlete rider Alex Porter spilling him onto the Velodrome. Thankfully Alex Porter was not seriously hurt however, AusCycling has sought an independent investigation into that failure and all reasonable associated aspects.

Administration

2. AusCycling appointed an Investigation Manager, Ms Toni Cumpston, and secured the services of a professional Mechanical and Aeronautical Engineer, who is also licenced as an Aeronautical Technical tradesman across the five aviation disciplines, a Military Pilot, a Pilot Instructor an Airworthiness Regulator and an Aircraft Accident Investigator. Technical qualifications and experience with emphasis on technical governance along with total independence were crucial to this investigation.

3. The task was managed through a Consultancy Contract and this Report is a deliverable of that Contract. The Terms of Reference form Appendix A

4. The broken Base Bar parts were secured for examination and testing. Critical members of the Australian Cycling Team, Bastion Cycling and Bastion Advanced Engineering were identified and interviewed, some on multiple occasions.

5. Special thanks to Mr John Pitman, Head of Aerodynamic Solutions at the Australian Cycling Team, who provided a comprehensive report along with substantial follow-up information. ***Annex A*** is a list of the Australian Cycling Team and other authorities interviewed.

6. James Woolcock and Ben Schultz, along with other people interviewed at Bastion Cycles displayed a high level of professional and technical competence. Their assistance was instrumental in validating the scientific causes of this failure.

7. The Australian Cycling Team Performance Systems Manager who is no longer employed by AusCycling, had the carriage of the extended Base Bar acquisition, was uncontactable despite many and varied attempts. His pivotal role was pieced together from information retrieved from others.

8. All persons interviewed behaved in a professional manner and only corroborated evidence is included in this Report unless otherwise stated.

9. A special thanks to Ms Cumpston and Ms Fechner who provided timely and professional support throughout the investigation and to Ms Sue Henry for chasing down documents and publications.

Terminology

10. The Men's Track Cycling Team Pursuit handlebar comprises a Base Bar with extensions. The term Base Bar will be used to refer to the whole assembly except where specific reference to a part of the Base Bar is required.

11. This project was carried out under the management of the Australian Cycling Team.

12. The Australian Cycling Team was a part of the Cycling Australia Organisation that transitioned to AusCycling which came into being on the 1st November 2021.

13. Bastion Cycles of 412 Heidelberg Road, Fairfield, VIC has a design and test group named Bastion Advanced Engineering and a manufacturing arm known as Bastion Cycles. The name Bastion Cycles will be used for both groups in this Report.

14. Computer Aided Design is a method used for designing and drawing a component along with a method of analysing the internal stresses called Finite Element Analysis.

INVESTIGATION PROCESS

Evidence Gathering

15. Where a failure has occurred, securing the broken items and similar in-service items is the first step. Whilst individuals' memories can fade, once probed, those memories return however, a damaged fracture surface can hide valuable cues.

16. Conformance of the parts to the design and the design to manufacture were checked. Simple mensuration up to state-of-the-art laser scanning which could overlay the design to confirm accuracy, were used. As well, state-of-the-art thermal imaging techniques were applied to the intact Number One Base Bar to measure stress variations inside the component and the cooperation of The Defence Science Group was appreciated.

17. Statements were taken from management, engineers, designers, mechanics, one coach and athlete riders to inform the investigation.

18. Athlete performance data was used to find the critical loading force against which the design and manufacture could be compared.

19. Bastion Cycles facilitated the specialist testing and drafted engineering analysis and calculations, these were then validated by the Investigator: they expressed a passion to know what happened and why. The testing was completed under the purview of the Investigator whilst bike components were brought to the testing facility when required and removed when the tests were complete.

20. A timeline of critical events was constructed.

Investigation Method

21. The investigation method used to compile this Report was based on that used by the Australian Transport Safety Bureau (ATSB) for aircraft accidents (Appendix C)[3]: Occurrence Brief, Evidence collection, Examination, Analysis, Report.

Text Taken from the Australian Transport Safety Bureau Investigation Process[4]

Accident / incident

Notification

The ATSB is notified of the occurrence

Decision to investigate

An investigation team is deployed, if necessary

Collate site observations

Site observations are collated in situ, remotely or through third parties

Interview

Directly involved parties and witnesses are interviewed

Internal review

The draft report undergoes internal technical reviews and administrative reviews

Secure evidence

Operational records, technical documentation, wreckage and components are secured

External review

Directly involved parties are given the opportunity to fact check the draft report

Review

Data recorders, operational and technical documents are reviewed

Examine and test in the lab

Wreckage and other components are tested and examined

Follow-up interviews

Analysis

Hypotheses are tested against evidence

[3] The Investigation Process atsb.gov.au/about atsb/investigation-process/

[4] The complete ATSB investigation process including Legislative requirements forms Appendix C

22. Once this Investigation was commissioned, the broken and associated parts were identified and secured. The importance of evidence collection, especially to preserve fracture faces, cannot be over stressed.

23. In parallel, interview streams with Bastion and relevant Australian Cycling Team personnel were opened. The preference is to start with senior personnel and work down informing the investigation in the process; this proved impractical and people were interviewed as they became available. Some ground was repeated whilst at the same time, relevant documents were sourced.

24. As important as securing the failed components in the as-failed condition is the securing of unaltered documents at the time the failure occurred: traceability of actions completed and actions missed.

25. The Base Bar failure examined the need, the specification, the design, the manufacture and the use: from another perspective, the investigation looked at people and system approaches to this task. People aspects examined qualifications, experience and inattention whereas the systems examination included working conditions, organisational constraints, guidance and time limitations.

26. **The Swiss Cheese Model.** The process for the acquisition and use of a suitable extended Base Bar included defences, barriers and safeguards against error but these barriers are never absolute: each one will have some flaws. Like a block of Swiss cheese, the cumulative process will have holes and by rearranging slices from that block of Swiss cheese, accident paths can be blocked: no continuous holes. Conversely, when the holes align, unintended consequences occur.

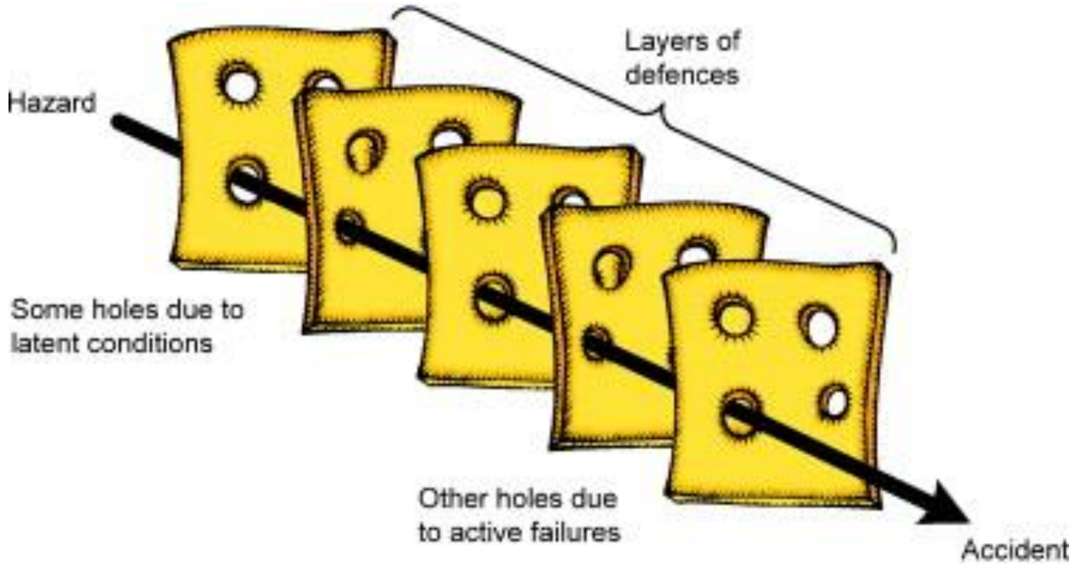


Figure 1: The Swiss Cheese Model. barriers are defeated by an accident trajectory

27. Application of the Swiss Cheese model for an extended Base Bar began with the Australian Cycling Team need. The need branched into timing, a Specification, the best material to be used, the manufacturing method, the conformance of the product to the design and subsequently the usage in particular mounting bolt torques, riding forces applied and the management of the Base Bar.

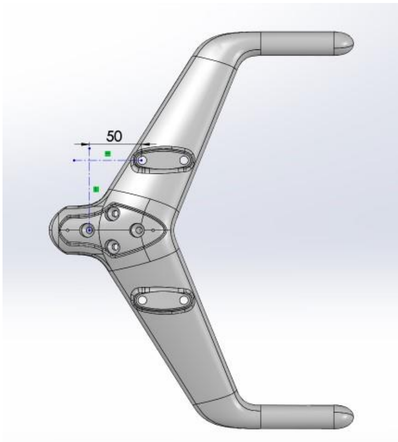
Sequence of Events

28. The sequence of events and their timing played a role in the Base Bar failure chain. The decisions to use smaller frames to reduce aerodynamic drag and a different starting technique both led to athlete rider Alex Porter having a physical distance conflict with the original Argon 18 bike: his knees hit the Base Bar. Undocumented and unrecorded discussion ensued between Performance

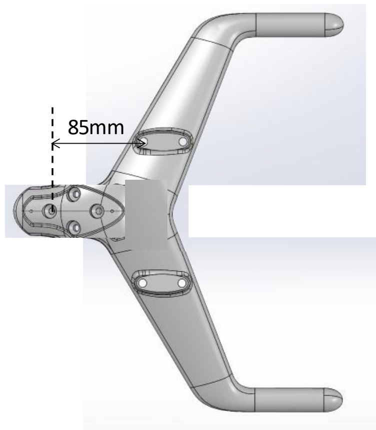
Staff and the Coach with the requirement confirmed to change the bike geometry, in particular the Base Bar position relative to the steering forks.

29. An attempt was made to change the Argon 18 requirement to include an extended Base Bar however, the Argon 18 manufacturing order had been cut with their supplier and the bikes were in production. To change the order would be costly with no guarantee that the modified Base Bar could be delivered in time. Again, seemingly undocumented, the final solution was to extend the Base Bar forward by the insertion of a 35mm plug and to design and make the item locally. The integration of a 35mm extension, in a structural sense, was undocumented except that the subsequent Request for Quotation (RFQ) to Bastion Advanced Engineering included a modified Argon 18 Base Bar Computer Aided Design skin drawing. On 31st October 2018, an approach was made to the Australian Institute of Sport (AIS) to print a titanium Base Bar to the extended design (*Annex B*). This titanium 3D print was not made instead, the Australian Cycling Team arranged for a Polylactic Acid (PLA) 3D printed material Base Bar, made on a Megaforge machine: the "plastic" bar.

Proposed Solution



Current Argon Basebar



Alex Porter Basebar. Move the two arms forward 35mm relative to the rear mounting holes

Figure 2: Performance Systems Manager's proposal to The Australian Institute of Sport

30. Prima facia, the extension was geometric to obviate a human to Base Bar conflict but from a structural perspective, the site of the extension and the flare into the wings of the Base Bar changed its stiffness and consequently its fatigue performance. This changed fatigue performance, constrained by the Specification Computer Aided Design drawing, was a factor in the failure.

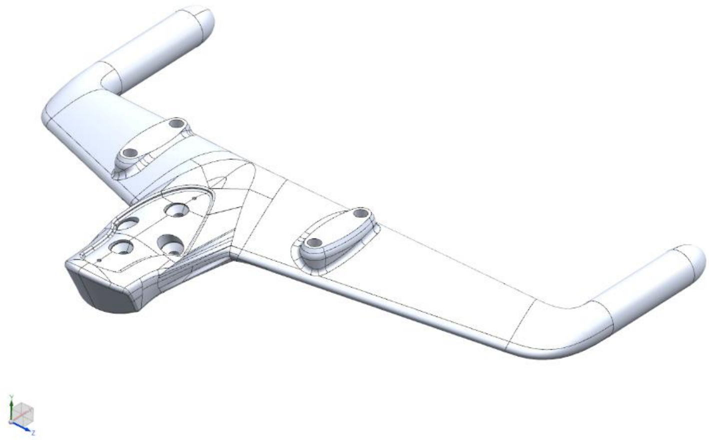


Figure 3: Argon 18 Base Bar with 35mm Extension

31. The plastic bar was tested for compatibility between the bike frame and athlete rider Alex Porter and with size compatibility confirmed, Bastion Cycles was commissioned to design two 3D additive manufacture Titanium Base Bars (*Annex D*). The specification, testing and time constraints were conveyed in an email dated 6th May 2019 sent by the Australian Cycling Team's Performance Systems Manager with the technical aspects of that email discussed in the Specification Section of this Report. Time wise, this was some six months after the trial printing request to The Australian Institute of Sport.

32. From notes made by the Lead Bicycle Mechanic at the 23rd May 2018 Equipment Steering Group meeting, oblique references were made to athlete rider Alex porter, bicycle frame size and questioning whether the Australian Institute of Sport had a 3D carbon additive manufacturing capability: no formal minutes were published of this meeting. These references suggest that a geometric conflict between Argon 18 bikes and athlete rider Alex Porter had been recognised. Some one year later, the Equipment Steering Group minutes/agenda dated 3rd May 2019 tasks the Performance Systems Manager with deciding the appropriate action however, the capability was not available for the March 2019 World Championship. The Australian Cycling Team had lost one year in acquiring a modified Base Bar.

33. Bastion completed the design and print, then tested and delivered the first two Base Bars on the 13th September 2019 and 22nd December 2020 respectively. During that period, the Australian Cycling Team doubled the order and Base Bars three and four were delivered on the 24th May 2021. Tax Invoices form Annex K.

34. A timeline of significant events forms Figure 4.

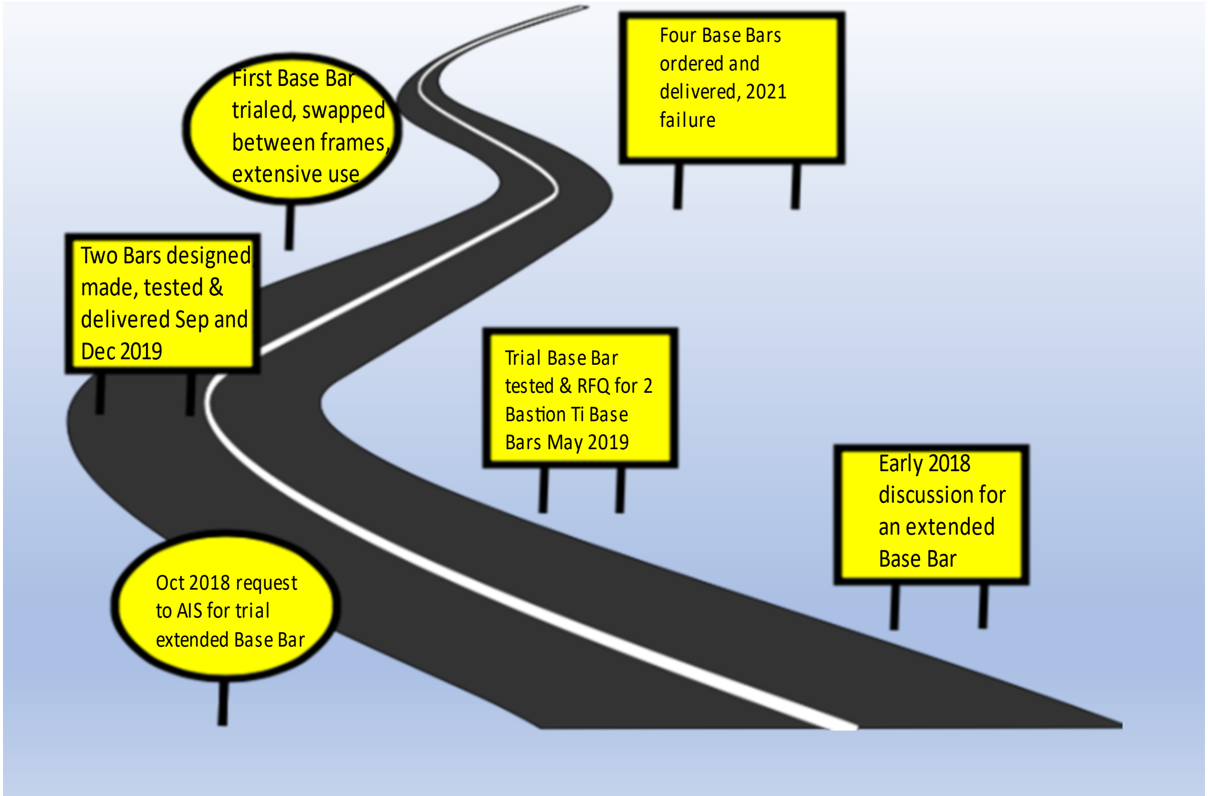


Figure 4: Abridged Base Bar TimeLine

SPECIFICATION, DESIGN AND MANUFACTURE

Specification

> "The specification **provides clear instructions on project intent, performance and construction**. It can reference the quality and standards which should be applied. Materials and manufacturers' products can be clearly defined. Installation, testing and handover requirements can be identified."[5]

35. In an email from the Australian Cycling Team to Bastion Advanced Engineering on 6th May 2019 (Annex C), the Specification provided a Computer Aided Design drawing confined to the outline skin of the extended Base Bar, along with the testing required:

> "Attached is the CAD model that we had the prototypes 3D printed. The bars would also need to be ISO tested, static and in and out of phase for racing bikes."[6]

[5] 15 Reasons why Specifications are still Important https://manufacturers.thenbs.com/resources/knowledge/15-reasons-why-specifications-are-still-important

[6] The full text of this email forms *Annex* C

The more illuminating outline of the requirement dated 31st October 2018, provided to Australian Institute of Sport (*Annex B*), was not provided to Bastion Advanced Engineering which denied them the development of the 35mm extension in particular its constraints.

36. The Computer Aided Design drawing was similar to the Argon 18 Base Bar but modified to include the 35mm extension moving the wings forward from the attachment boss to allow the wings to clear athlete rider Alex Porter's knees. Notwithstanding the designer and manufacturer selected had a credible track record for competent design, cutting edge manufacture and on-time delivery, the Australian Cycling Team was required to deliver a complete Specification to Bastion Advanced Engineering and it did not.

37. Writing a specification is demanding. The task is reduced by citing existing standards or parts thereof, but the client must then blend his specific needs with those defined in the standard and ensure the complete specification defines the item required and how to prove it.

38. As an example, an aircraft structural draft specification was written as:

"Generally, the requirements of MIL-S-XXXX [actual number cited in the original] will be met".

39. Structural integrity is crucial to aviation safety and the immediate question was: how "generally"; which requirements will be included, which will be excluded? Testing against "Generally" would be impossible.

40. Following investigation in Australia and overseas, the Australian Cycling Team settled on Argon of Canada to provide the bike which maximised the opportunity to achieve the best results at the 2020 Tokyo Olympics: Argon 18. Whilst Argon had the bikes made in China, a number were provided for trials and fitting.

41. It is not known how the Argon 18 Base Bar Computer Aided Design drawing was obtained or how it was modified to reflect the 35mm extension as the Performance Systems Manager responsible was not available for interview. This record of events has been assembled from interviews with current and past Australian Cycling Team staff associated with this project.

42. The Australian Cycling Teams Specification comprised a Computer Aided Design skin-only drawing and a test requirement: the skin drawing only specified a printed surface where the Base Bar mated with the machined aluminium surface on the top of the steering forks. Previously supplied Bastion Head Stems which mated to the steering fork were provided with a printed-only mating surface without any reported or documented mismatch.

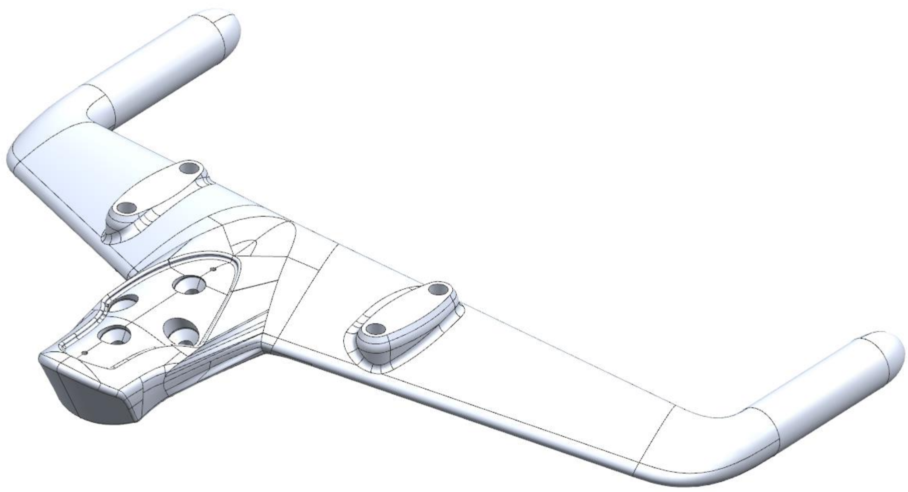


Figure 5: Computer Aided Design skin with 35mm extension as Specified

43. The test requirement for the extended Base Bar was loosely defined as:

> "ISO tested, static and in and out of phase for racing bikes."

44. The static force of 1000N cited in ISO 4210-5:2014 was applied to each Base Bar at production end and they all passed. ISO 4210-5:2014 is part of a suite of Cycles-Safety requirements for bicycles which includes ISO 4210-2:2015 Cycles Safety Requirements for bicycles (Steering) Testing referred to in TR-CA-06-001 (Annex F).

45. In discussions between the Australian Cycling Team and Bastion Advanced Engineering, the ISO 4210-5:2014 durability or fatigue requirement of 200,000 cycles was reduced by the Australian Cycling Teams Performance System Manager to 50,000 cycles reportedly on the basis that when installed, rider familiarisation and training would demonstrate acceptable durability: an acceptance that possible failure could occur in service. This philosophy is flawed as in-service pedal force values are not recorded in size or frequency to equate to the Standard requirements, it ignored the fatigue properties of Titanium and it contravened the "Zero Failure Rate" premise.

46. Specification ISO 1420-5:2014 was issued in 2014 and pictured drop-down type bars as the sample. Whether this specification applies to pursuit type bars is unknown and would be the subject of a separate study. Rider forces imposed on a Base Bar set with 35mm extension would not change significantly however the additional torque caused by the extension would affect the Base Bar fatigue durability.

47. The Specification for the design was inadequate and based only on a Computer Aided Design skin drawing modified to include a 35mm extension. Specifically, the Base Bar to steering fork mating surface was not required to be machined, nor was a tolerance stated.

Design, Manufacture and Testing

48. The Base Bar was designed by Bastion Cycles using contemporary Computer Aided Design and Finite Element Analysis techniques all of which are in current industry use: up-to-date methods and software were used. Testing was conducted to the Australian Cycling Team Specification (Annex C) and the products passed without failure. The Finite Element Analysis software was calibrated using printed 3D designs using the software and then testing those samples to destruction.

49. The manufacture was completed using some of the latest technology, was controlled and all stages were traceable through a manual quality control system. The quality control documents for all four Base Bars form Annex E. The post additive manufacturing process of heat treatment in an inert atmosphere was completed on all Base Bars with the tell-tale hint of a blue surface indicating the mildest of oxidation on all bars. This light colouring was expected.

50. Base Bars were tested using air rams, a controller and a data recorder in static force mode and in fatigue alternating force modes. Test forces applied, were resisted against a machined mounting fixture which replicated the top of the bike steering fork. Following the successful completion of all the testing to meet the Specification, as aurally amended by the Australian Cycling Team Performance Systems Manager, Bastion Cycles issued Test Report TR-CA-06-001 dated 17 July 2019. That Report forms *Annex F*. The test jig with a Base Bar mounted is depicted at Figure 6.

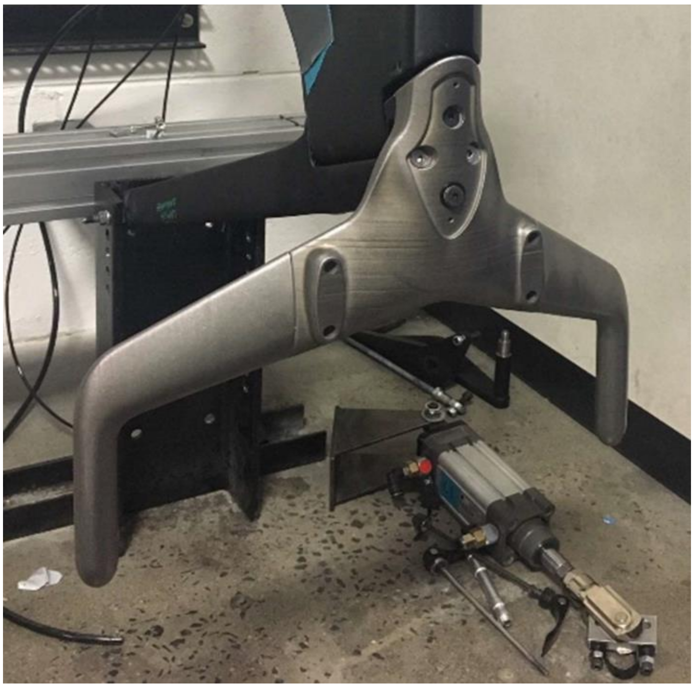


Figure 6: Base Bar CA-06 mounted in the Test Rig

51. Bastion Cycles had designed and manufactured cranks, head stems and other products using the Titanium 3D printing process. Whilst some items provided required modification, the items performed to the Australian Cycling Team's satisfaction.

52. The testing applied the forces specified in the ISO 4210-5:2014 Standard and all Base Bars passed with a static and fatigue margin well above the strength specified.[7]

Titanium Material

53. The Bastion CA-06 Base Bar was additive manufactured from Titanium powder type Ti-6Al-4V. A material certificate attesting to the quality of the powder forms Annex G. The base material is some four times stronger than steel with the Achilles Heel of having a poor fracture toughness which is also known as fatigue performance. Titanium's poor resilience to alternating force is a significant factor to be accounted for during design.

54. The strength versus weight advantage realises a lighter component whilst being able to carry the specified designed force. Fracture toughness relates to the durability of the structure under alternating forces. Following the design and manufacture, fracture toughness is best demonstrated by a comprehensive and controlled fatigue test.

55. As printed, a 3D additive manufacture surface is not as smooth as a machined surface. The process post printing is to smooth the surface by "rumbling" each product: the Base Bar is shaken with firstly ceramic modules and then sand blasted to smooth the surface. Whilst Bastion Sprint Stem to fork mating faces were not machined never-the-less, they were successful.

56. The Specification for Base Bar CA-06 called for fatigue (durability) testing to 200,000 cycles at a stated force. The Australian Cycling Team Performance Systems Manager aurally reduced that requirement to 50,000 cycles at the same force indicating that future durability would be proven by in-service riding. This decision ignores the limitation that in-service riding does not occur with

[7] Refer to Table One of this report for factors of safety above design requirements.

constant force or predictable frequency and the results are consequentially unreliable. Given the reduced fracture toughness of Titanium products and the decision to reduce the formal testing to one quarter of that required by the Standard, the scene was set for an in-service failure. There was no documented acceptance testing of the number one Base Bar as received by the Australian Cycling Team and no inspection record when the bar was moved from frame to frame. Significantly the number one bar has accrued some four times the use of the failed number four Base Bar without defect which attests to the adequacy of the design, the material and the manufacture even when exposed to one-and-one half times the specified force[8] .

57. Information gained during third party interview suggested that the Australian Cycling Teams Performance Systems Manager was cautioned about the use of titanium material, as opposed to carbon fibre, in respect of fatigue damage. There was no available corroboration or record of this caution.

Pursuit Base Bar Forces: Specified versus Ride Data

58. Design begins with a knowledge of the applied in-service forces on which is added a margin for abnormal excesses. Repetition of any force during use can lead to cumulative fatigue damage in manufactured items and design methods are used to allow for that damage. A safety factor of one indicates that applied forces are the maximum allowable for the product and consider the material, the force applied and the product geometry. In the case of the Base Bar, fatigue consideration forms part of the ISO Standard 4210. Strength at and above the minimum required strength are recorded as Safety Factors of one and above. Safety factors below one indicate the item is under designed whilst factors over one allow for overloading in use.

59. In use, the most severe forces applied to the Base Bar occurred immediately after the release at the start of a race. The starting position shows the athlete rider standing, rider weight forward over pedals, leveraging upwards on the Base Bar to achieve the maximum pedal force with pedal torque forces recorded on the infocrank system. As the Base Bar was used by many athlete riders, this starting torque was repeated and at varying values. Appendix B, Figure 33 of the Bastion Base Bar Failure Investigation Data Collection gives a clockwise torque of 410Nm from the left pedal and an additive clockwise torque of 95Nm from the right pedal at start: subtracting the upwards force on the one pedal from the downwards force on the other pedal results in a downward force which, less the rider’s weight, must be balanced by an upward force on the Base Bar.

[8] Applied load exceedance is discussed in the Pursuit Bar Loads Section

Figure 7: Athlete rider on start release, Tokyo 2020

60. A mathematical model, based on the forces and the moments in two planes so formed to achieve equilibrium in this worst case was created to extract the value of the critical design force imposed on the Base Bars. That model forms *Annex H* to this Report.

61. Whereas the ISO 4210-5:2014 static force was 1,000N, the upward start force on the Base Bar was calculated to be 1,411N, depending on the athlete rider: some one-and-one half times the Australian Cycling Teams Specification value and this was repeated at each training and at each race start.

62. The forces applied are converted to stress in the Base Bar material which is force divided by material area and the Computer Aided Design/ Finite Element Model calculates these stresses in the Titanium material. When the material stresses resulting from the applied forces equal the material type yield stress, the Base Bar is considered to be carrying the maximum force. This is expressed as a safety factor of one. Safety factors are an immediately gauge of an items ability to carry a specified force: safety factors greater than one are acceptable, less than one are unsafe. Fatigue design demands a much lower allowable yield stress than the static yield stress and this lower allowable is obtained from material data sheets but, especially for Titanium, by a standard testing method. CA-06 Base Bar Standing Start Force Analysis (Annex H) calculates the safety factors for static and for fatigue analyses of the Base Bar when using the supplied Specification and when using actual rider forces. Table 1 contains the extracted factors of safety.

Bastion Base Bar CA-06	As Designed using the Australian Cycling Team Specification forces	Using Actual forces from isocrank data
Factor of Safety: **STATIC**	8.87	2.82
Factor of Safety: **FATIGUE**	2.97	0.65

Table 1: Comparison of as-made-to-specification and actual factors of safety

63. Under the Australian Cycling Teams actual usage, the Base Bar was designed and made only 65% as strong as was needed. The actual applied forces could have been reflected in the Australian Cycling Team Specification but were not: the excess actual applied forces invalidated the design and the manufacture.

Isometric Exercise and Base Bar to Fork Bolt Torques

64. The forces imposed on the Base Bar during athlete rider isometric exercise and the effect on the Base Bar to Fork bolted joint were examined.

65. **Isometric Exercises.** Athlete riders complete isometric exercise to prepare their muscles for maximum effort, all at a particular joint angle; when on training camps and at the 2020 Tokyo Olympics, these exercises were completed on the racing frames and the Coach estimated some 324 repetitions for all four Base Bars. The force at the Base Bar to be reacted by the mass of the athlete rider, the seat and the muscle-to-pedal force was extracted by the Australian Cycling Team (Annex I). On examination, the value extracted was found to be in error, in that not all of the contributions to a rigid body equilibrium had been included. The error was traced to inadequate process and checking.

66. Isometric exercise forces did not constitute the critical design case but should be considered when a fatigue spectrum for AusCycling is being generated.

Figure 8: Isometric Exercise Riding Position

67. **Base Bar to Steering Fork connecting Bolt Torque**. The Argon18 Cockpit build instructions Section 11, page 30, requires a 12Nm torque value for the Argon 18 carbon fibre bar to fork mounting bolts. The Australian Cycling Teams (Annex G) Bicycle Build Book for the same assembly Section 4.1.1. page 38 requires only 8Nm torque. In discussions, bicycle mechanics believed the manufacturer's 12Nm was too high and that 6Nm torque was sufficient. Australian Cycling Team contractors and employees attached Base Bars to steering forks but without worksheets documenting the process, bolt torque values and tightening sequence as specified in the Bicycle Build Book, went unrecorded. In providing the CA-06 Base Bar, Bastion Cycles provided no advice on bar to fork connecting bolt torque, that being a responsibility of the Australian Cycling Team; Bastion was not aware of an Australian Cycling Team Bicycle Build Book. Using this range of bolt torque values, an assessment was made of the consequences of the bolted joint suitability when the critical design case force was applied: ***Annex J*** is that assessment.

68. Bolt torques are specified to create required clamping forces between mating parts. Torquing the fastener creates a tensile force within the fastener which in turn generates the clamping force. The actual clamping force is sensitive to thread and fastener head lubrication, both of which are called for in the Australian Cycling Team Bicycle Build Book. From *Annex J* using Engineering Texts and a first approximation moment diagram the clamping force for a range of bolt torques forms Table 2. The minimum clamping force required at race start between the Base Bar and the steering fork is 6072N.

Bolt Torque Values [Nm]	Bolt induced clamping force [N]	Factor of Safety between clamping force required and clamping force generated
12	16,667	2.7
8	11,111	1.83
6	8,333	1.37

Table 2: Base Bar to Steering Fork clamping Force Bolt Torques

BASTION BASE BAR CA-06

Base Bar CA-06 Overview

69. Bastion Advanced Engineering opened project CA-06 to meet the Australian Cycling Team Specification: two units were requested. A quote for the design and fabrication was requested and that Quotation forms ***Annex D***.

70. The design was stressed skin and manufactured in three parts: left horn, right horn, and centre mount. After part production, the left and right horns were sleeved into the centre mount and glued. This concept and the strength of the glue joints have not been in question.

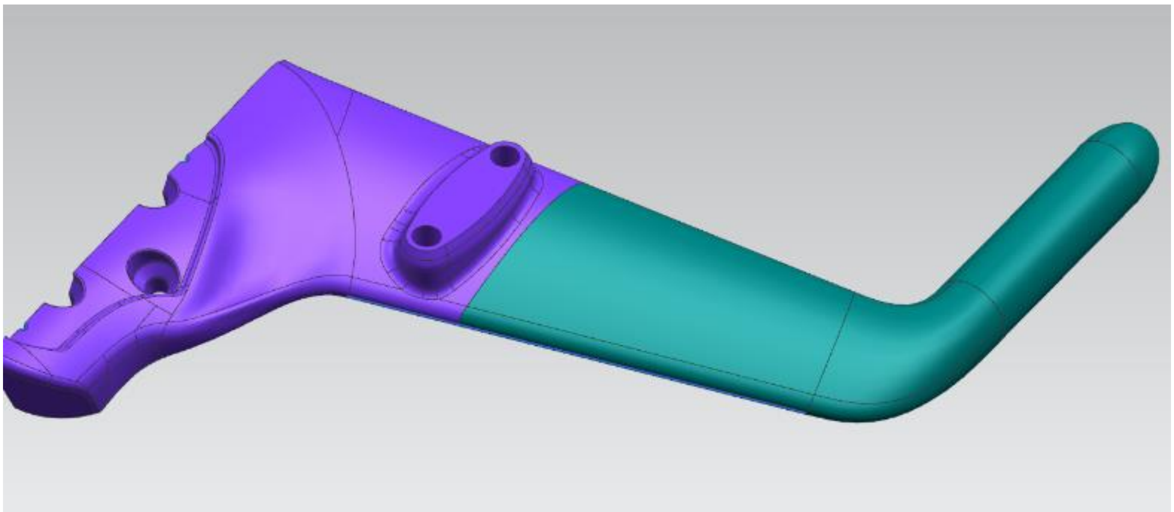


Figure 9:Base Bar Manufactured in Parts

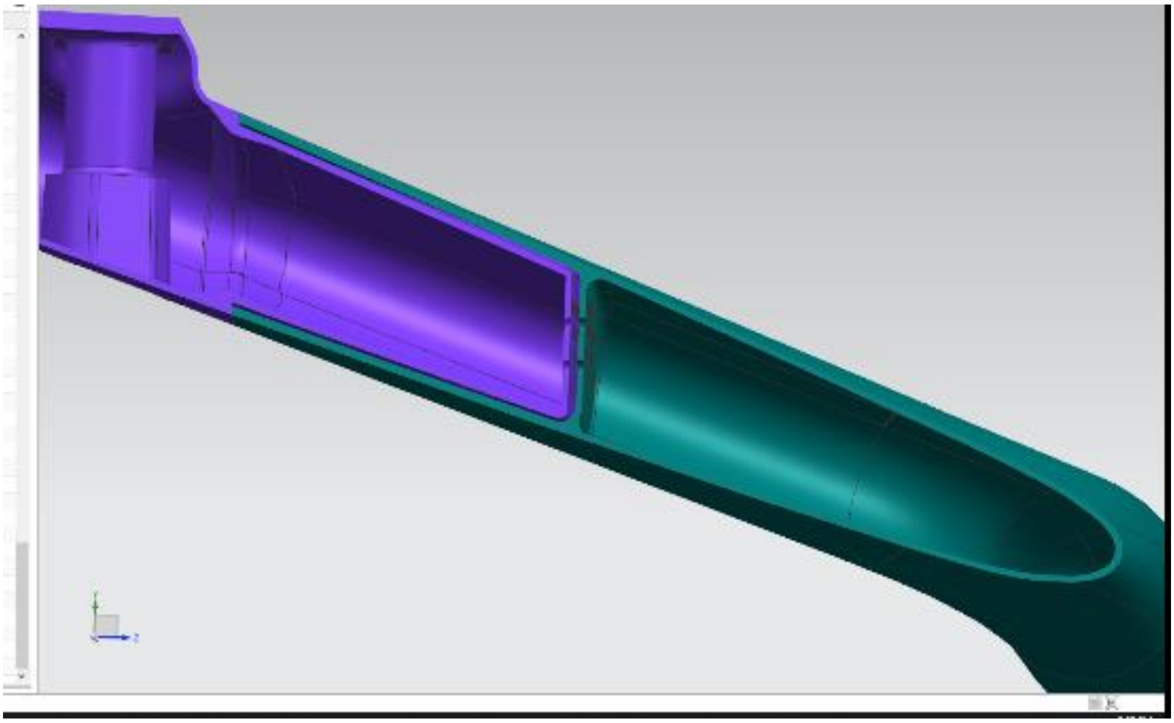


Figure 10: Base Bar Sleeve Joint

71. Additive manufacture or 3D printing, begins with quality assured, powder sized particles of the correct material type. The powder must be of uniform size and composition to assure a quality product: the start of the process is recorded in Bastion Cycles Quality Assurance documentation. The Computer Aided Design file is sent to the printer and layer-by-layer, the part is built by welding powder to the last exposed surface using a high-powered laser, all under computer control. The process is under strict temperate control and in an inert atmosphere to prevent oxidation. These conditions and the progression of the build are again Bastion Cycles quality assured by monitoring cameras and parameter checking: ***Annex E*** comprises paper records for each of the four Base Bars.

72. When the printed part is complete and cooled, the part is transferred to a furnace where it is heated again in an inert atmosphere to anneal the structure of the component. If this last process is ignored, the part will not be homogenous and if not completed in an inert atmosphere, can precipitate oxidation: if present, this oxidation is characterised by a thick deep blue colouring of the Titanium surface.

73. Between October 2021 and January 2022, Bastion Cycles completed stress testing to failure of printed titanium samples. Post manufacture, the samples were exposed to different levels of furnace heat treatment in the presence of different mixtures of oxygen and argon. The samples showed differing depths of blue colouring but the test results demonstrated no significant strength difference across the range of samples. The blue colouring gives no indication to strength reduction. Bastion Cycles report TR-RBF-002_220218 refers.

74. Any required machining is done, the external surface is prepared and if required surface finished to meet the customers specification. For the CA-06 Base Bar, parts were mated, glued and surface finished before testing.

75. Each bar produced was tested to the ISO 4210-5:2014 static force requirement of 1,000N and successful completion of this force test is recorded in the Bastion Cycles Quality Assurance sign-off.

Bar CA-06 Additive Manufacture Configuration

76. As specified by the Australian Cycling Team, the Base Bar to steering fork mating surface was "as printed". The aluminium steering fork mating surface was machined; the accuracy of the Base Bar mating surface was an area for attention.

77. The structure of the Base Bar is stressed skin which is similar to an aircraft fuselage where the skin carries all of the bending, flexing and pressurisation forces and is kept in geometric space by annulus frames and stringers: lattice equivalent. In the case of the Base Bar, the skin was kept in its geometric shape by an internal geodetic lattice. On inspection after failure, the skin thickness was measured and found to conform to the design in multiple locations.

78. A surface laser scanner was used to map the surface of all four Base Bars: the Number One Base Bar was scanned first with the paint on as-received from use, then with the paint removed with a minimum guaranteed accuracy of 0.04mm. The results are pictured in Figure 10.

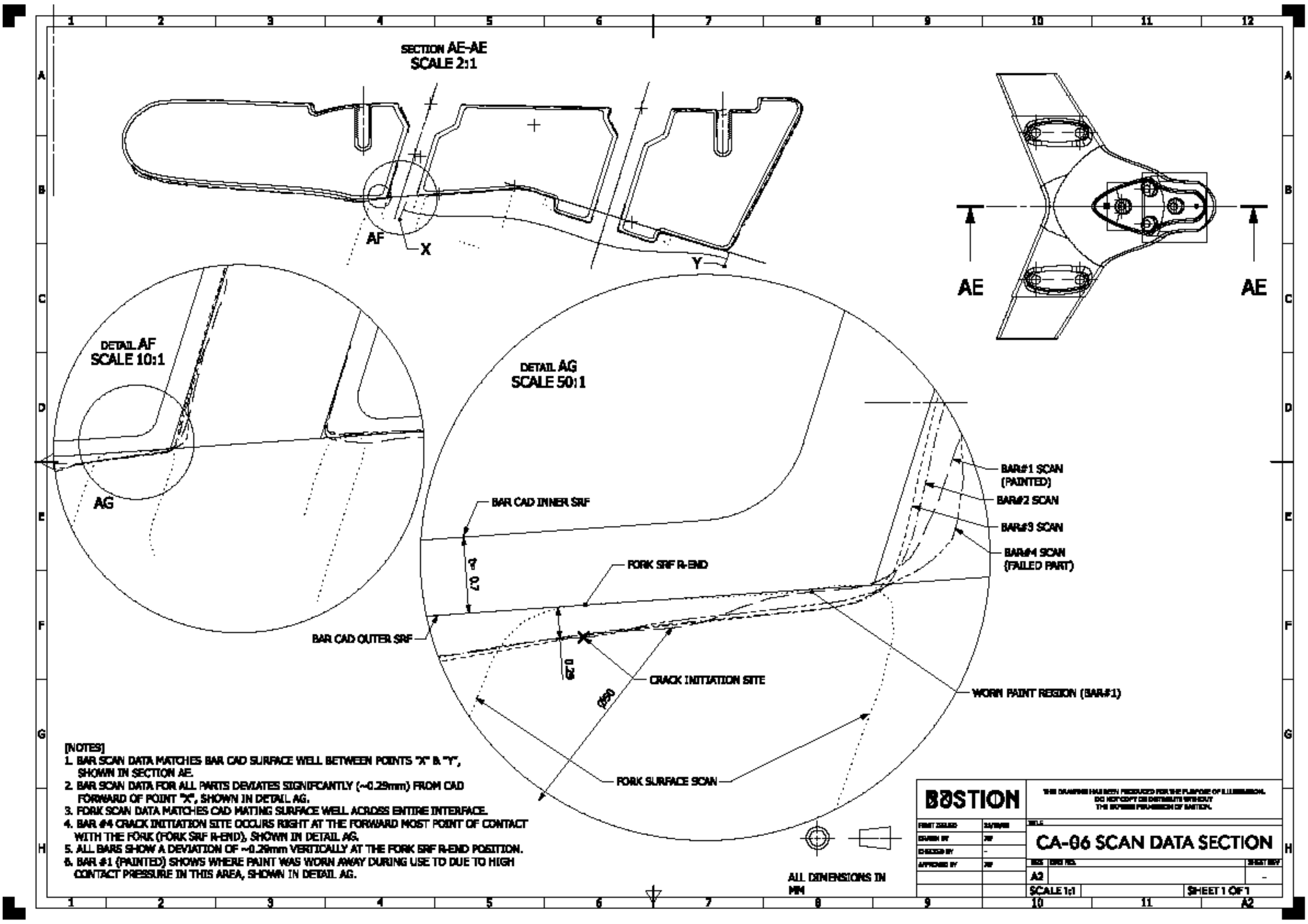


Figure 11: Base Bar Scan Data for all Four Bars overlaid on Computer Aided Design

79. Section AE-AE on Figure 11 is a fore and aft slice through the Base Bar at the steering fork to Base Bar mating section. The bull nose of that section is shown facing forward. The steering fork contact is depicted by the dotted lines going downwards and annotated on enlargement Detail AG.

80. The coloured enlargements at Figures 12 and 13 depict a centre line slice through the contact area and the forward bolt hole between the bar and the steering fork directly forward of the most forward securing bolt tube.

81. The .29mm elevated area with respect to the remainder of the Base Bar to steering fork mating surface would place the Base Bar material at that point in compression. From science, cracks do not grow in compression however, the Base Bar is a thin skin component and whilst the external skin would be compressed the corresponding inside surface would be in tension and exposed to a change of geometry, a change of stiffness and elevated stress from the excess force applied to the Base Bar.

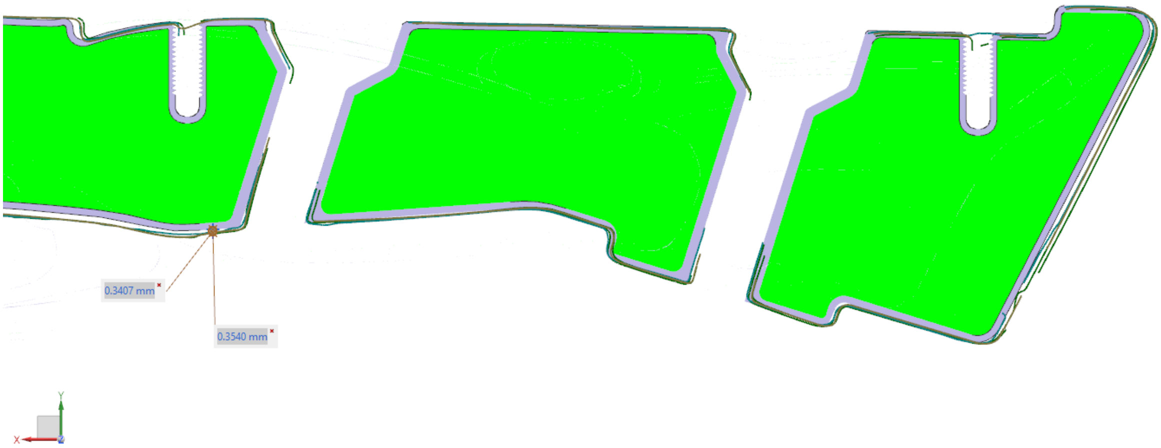


Figure 12: Base Bar Longitudinal Centre Line Section

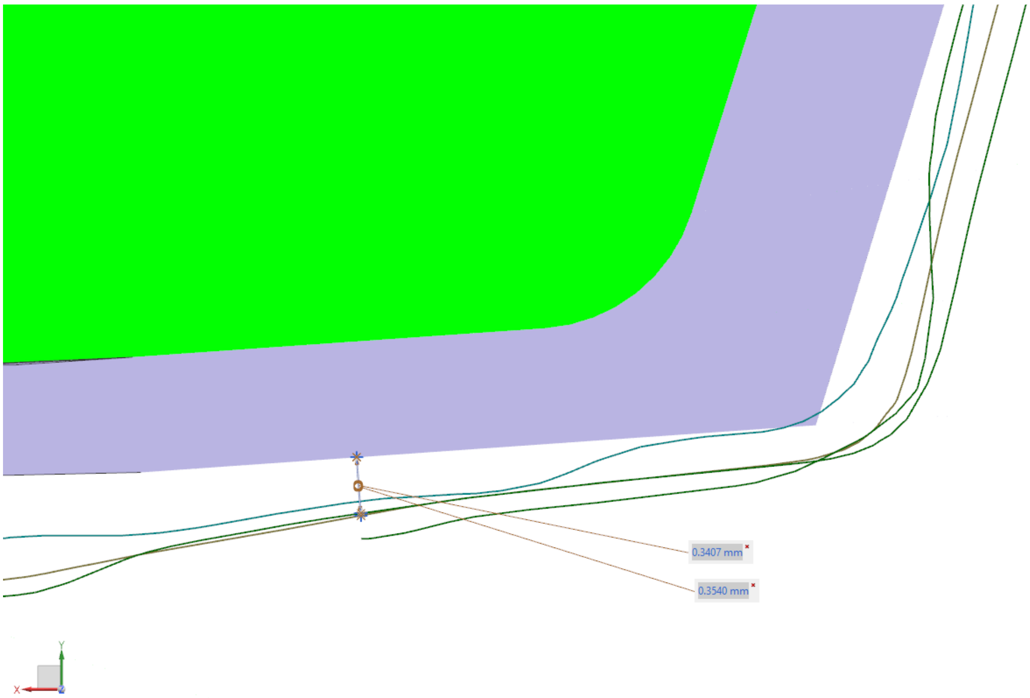


Figure 13: Enlarged Centre Line Section through the front Bolt Hole

82. The crack emanated immediately ahead of the steering fork to Base Bar contact. This crack propagated in a spanwise direction as the stiffness of the now cracked Base Bar was reduced. A transverse line through the crack initiation site aligns with the spread of the left and the right wings towards each horn. Were the specification to have left this external design geometry detail to the designer with the critical geometric distance to achieve athlete rider requirements fixed, the fatigue sensitivity of this area may well have been reduced and the crack prevented.

83. In the immediate aftermath of the accident, Bastion Cycles identified a minor internal surface notch in the Computer Aided Design data defining the Base Bar skin thickness. This anomaly was passed to the ACT in Japan with advice to remove all Bastion Cycles Base Bars as a precautionary measure. Further examination identified the notch as being smaller than the pool of titanium melted by the high power laser on each pass as part of the 3D printing. The consequence is that any such small notch would be consumed by the metal melt pool and would not appear in the final product.

Number One Base Bar Paint Removal.

84. When the Number one Base Bar was painted, the under-surface cover was complete including the Base Bar to steering fork mating surface. Annex L was the paint plan used. Base Bars Two, Three and Four were painted differently with no traceability of the relevant paint plans. Significantly, the steering fork mating surface for Base Bars Two, Three and Four were not painted and left as printed. On examination during the investigation, paint forward of the forward bolt hole on the Base Bar One was missing. Complimentary, but less significant is the missing paint around the two lateral holes.

Figure 14: Number One Base Bar with paint missing from the front bolt hole

85. Before painting, the whole surface was cleaned and primed. The paint immediately forward of the forward bolt hole on Number One Base Bar had been subject to compressive force and the bond to the titanium had failed; at a Base Bar exchange to another frame, the paint chips so separated from the printed surface had fallen off. This is the area identified in the laser scan where the printed Base Bar was .29mm "higher" than its surrounds. With the paint on the remainder of the mating surfaces, but missing on the elevated section, the whole surfaced has been effectively levelled and a stress raiser removed.

86. Decreasing the Base Bar to steering fork clamping force by reducing the clamping bolt torque would allow movement and consequential paint separation by rubbing.

87. The missing paint has identified an elevated area, formed during printing, which under one-and-one half times the designed force can be cited as a stress raiser for Base Bars Two, Three and Four and a consequential Low Cycle Fatigue failure initiation site.

USE AND MANAGEMENT OF THE BASE BAR BY THE AUSTRALIAN CYCLING TEAM

Usage Overview

88. Use of Base Bar type CA-06 includes receipt, fitment, removal and inspection along with associated transportation. Management of the Base Bars in the Australian Cycling Teams control includes the policy, process and procedure during use.

The Australian Cycling Teams Base Bar Management

89. On receipt of the first Base Bar from Bastion Cycles, an acceptance testing programme was required by the Process for the Introduction of New Componentry [Appendix E}, but this acceptance testing was never completed. Base Bar Number one was distinctive in that it was painted mat black on the top and yellow and green underneath.

Figure 15: Number One Base Bar under view

90. Whilst athlete performance along with team performance relies heavily on individuals, the provision of equipment which is fit for purpose on time and all of the time, caveated with a NO FAIL policy, demands qualified and experienced individuals, suitably trained, working within an authorised structure and to approved procedures. Those interviewed were professional and at the various levels, competent, but the absence of process and compliance was striking.

91. Having requested copies of the Australian Cycling Teams technical policy, a Risk Management spreadsheet, and a Bicycle Build Book were the only technically related policy documents found; only the Build Book related to equipment acquisition or support.

92. The Australian Cycling Teams Project Numbers spreadsheet listed 41 of the 50 projects having “Requirements” all being conveyed “verbally”.

93. Bikes were transported three to a crate. Frames were secured in the crate, wheels were packed in “pillow slips” and sandwiched in the free space whilst handlebars were wrapped in bubble-wrap and again squeezed into the vacant spaces. Without being secured in the box, the handlebars were free to move depending on how the box was oriented and moved, perhaps dropped. Given the sensitivity of both carbon fibre and titanium to surface marking which creates stress concentrations, the securing of all bike parts within the protective box during transit is paramount.

Equipment Steering Group

94. An Equipment Steering Group (ESG) which began in May 2018, met monthly and from record was more a task history with estimated completion dates and citing individuals responsible for actions. Minutes of Group meetings did not record argument, reasons for and against and decisions. The Agenda and the Minutes were combined, sometimes being called Agenda, at other times Minutes. There were Minutes dated the same day and time but contained different information. The debate about what is required, why and when along with how it was to be supported when acquired were not recorded. The ESG agenda mentions the acquisition of the CA-06 Base Bar.

95. Leading up to the need for an extended Base Bar, Bastion Cycles first received mention in the ESG Agenda on 28 Jun 18 for printed stem manufacture and again on the 17 Jul 18 and 15 Aug 18 recording the completion of that task. To show precedence, no reference was made to the stem specification, the stem testing or the in-service experience for that item: the Australian Cycling Team was satisfied with Bastion products. The need for an extended Base Bar was recorded in the ESG Agenda on 19 Dec 18, some two months after the Performance Systems Manager had approached the AIS with the request for a trial print. The catch phrase “ZERO FAILURE RATE” was introduced at the 9 Jan 19 meeting but was never complimented with what it meant, how it was to be implemented or how its success versus cost would be tested; Bastion was not aware of the “Zero Failure Rate” philosophy. The picture of a “hanging participle” comes to mind[9]. Oblique mention of the extended Base Bar was recorded in the ESG Agenda on 9 Jan 19, 6 Feb 19 and 20 Feb 19 where the Performance Director questioned the need for the extended Base Bar modification. The extended Base Bar received ESG mention on 3 May 19, the 15 Oct 19 and the 13 Nov 19. On 27 Nov 19, the ESG Agenda recorded ten training sessions had been completed with the extended Base Bar and that it was “Good to Go”. The ESG ceased on 27 May 20 but was reactivated on 17 Sep 21 where all Bastion produced parts were to be removed from service.

96. With multiple repetition of the phrase “this will be discussed next meeting”, the ESG appears to be a general discussion forum to keep people informed and to hold others to account rather than a “steering” forum using the cumulative wisdom of all parties affected and then recording that wisdom. Without suitable records, the suggestion was the ESG engaged in significant repetition.

97. During interview, there was reference to the discussion between performance staff and coach about whether the proposed change in starting technique and therefore an extended Base Bar, was necessary. Except for the oblique ESG comment, there is no other evidence of these discussions in particular the costs[10] versus the expected gains. The proposal for the AIS to produce a

[9] “ …use of the participle is clearly wrong when it has no subject of reference…it makes the meaning ambiguous or nonsensical.” Ironman R. M.I.Inf.Sc., Writing the Executive Report, pp55.
[10] Costs may be gauged in race time saved verses race time to win.

test Base Bar for trial purposes was dated 31 Oct 18 but the reminder for the Performance Systems Manager to procure the modified Base Bar by local manufacture was raised at the 3rd May 2019 ESG Meeting.

98. More than manufacture, this extended Base Bar had to be designed, made and tested. From interview, there were multiple telephone conversations between the Australian Cycling Team and Bastion Cycles but the formal request for quotation was sent by email[11] on 6th May 2019 with an optimistic time frame to complete the tasks. The time frame was met but required a reallocation of design and manufacturing resources: manufacturers want to please their customers.

Documented Use of Base Bar CA-06

99. On receipt, the first CA-06 Base Bar was to be exercised to prove its suitability in accordance with the Australian Cycling Team Process for the Introduction of New Componentry (Appendix E). A record was called for, but no record could be located. When non-destructive testing was completed as part of this investigation Number One Base Bar was found to be fully compliant with the 6th May 2019 Specification and free from mechanical defect, notwithstanding, that Base Bar had passed the specified testing, then was subjected to forces some one-and-one half times that specified and experienced some four times the use of the failed item.

100. The Base Bars were exchanged between frames so that other athlete riders could experiment to achieve the best performance. At each removal and installation, each Base Bar was to be checked and inspected as per the Australia Cycling teams Handlebar Service Schedule Appendix D. Given that Base Bars two and three exhibit crack initiation sites visible to the naked eye, this inspection process for every Base Bar exchange seems not to have been carried out diligently or recorded[12].

101. The workplace culture did not support a disciplined conformance to process.

102. One Base Bar was delivered with a broken machining element: a partial thread forming tap was buried in the Base Bar. The finished hole would be used to secure a cover plate and was not structural. Bastion approached the Australian Cycling Team outlining the delay to remanufacture and the Australian Cycling Team accepted the non-conforming Base Bar as the fitting was purely aesthetic. At interview, this non-conformance was raised as a Bastion deficiency when the situation had been explained to and accepted by the Australian Cycling Team. There was no record of the Australian Cycling Teams acceptance of the non-conformance.

103. On delivery, Base Bar Number Two was found to have an incorrectly machined extension on which the arm rests were to be mounted. This Base Bar was returned to Bastion Cycles and re-machined. They acknowledge the error and the lapse in quality checking against the Computer Aided Design skin drawing. The manufacturing quality system was amended to address this issue and it did not reoccur.

A glimpse into the Australian Cycling Team culture

104. The Australian Cycling Team hired a graduate engineer: a mechanical engineer having just received his degree and seeking mentoring and experience. Institution of Engineers Australia provides a structured experiential learning programme that employers can use: the Australian Cycling Team did not use this facility. This graduate was also a keen cyclist and had mechanical hand skills from his exposure to cycling so he was employed as a bicycle mechanic when needed and as an engineer at other times. At interview he was aware of the extended Base Bar requirement but was offered no opportunity to participate at the time.

[11] Annex C
[12] No Handlebar Service Schedule Reports for any CA-06 Base Bars were found

105. Being self-motivated, the graduate raised a Bicycle Build Book as a structured guide to build and fit out a racing frame. The draft version (V0.2) contained 11 Sections, which covered race bicycle technical activity from receipt to disposal; some sections were left vacant to be completed in subsequent editions. When the authorised version of the Bicycle Build Book was issued (V1.0), these "to be completed" sections had been deleted, including the index reference, giving no lead to subsequent expansion of the document. In particular, Disassembly for Travel and Reassembly after Travel were removed and did not appear in the approved Version 1.0. The absence of critical bicycle support instructions is a concern. The Bicycle Build Book does not included instructions to fit or remove the CA-06 Base Bar.

106. Also at interview, this graduate engineer highlighted the "closed shop" environment to implement improved procedures as a major frustration. As an example, the Argon 18 Bicycle instructions called for Base Bar to steering fork bolt tightening torque to be 12Nm[13]; an Australian Cycling Team bicycle mechanic opined that this torque was excessive and was reportedly reducing it to 6Nm. A compromise was reached with the Bicycle Build Book requiring 8Nm. The matter of bolt tightening torque and its role in transferring athlete rider force from the Base Bar to the frame are addressed in the Isometric Exercise and Base Bar to Fork Bolt Torques Section of this Report.

107. Without a career path, mentoring or encouragement the graduate engineer left the Australian Cycling Team employ. Given the original hour interview, he documented his thoughts and subsequently reconnected to expand on his feelings and his experience. Most telling was his statement "I have tried to forget [my experience]".

108. Management action following a formal investigation can disadvantage individuals: investigators must be alert to minor issues which can illuminate broader unsatisfactory cultures. Tool control by the Australian Cycling Team was one issue. Reportedly, at least one mechanic uses his own tools complicating quality control. As well, bolt torque values are critical to the proper operation of bolted joints and the Australian Cycling Team had no record of any tool calibration, especially torque wrenches. Providing the best quality tools, checking their condition regularly including any calibration, and mandating their use to the exclusion of all other tools are critical elements for the foundation of technical excellence and an example of a supporting process to achieve "Zero Failure Rate"[14].

109. Only a small number of Australian Cycling Team people were originally involved in the Specification, acceptance, fitting and removal of the Bastion Base Bar. Given Covid-19 and the reluctance of some to travel, along with vacancies in the group, a larger range of engineers and mechanics, some being contractors, were involved. Without policies, processes or documented work done across a range of tasks, how the Base Bars were specified, used and transferred between bikes is a mystery.

110. As with any organisation, during interview, grievances between individuals were aired, all of which challenged the effectiveness and efficiency of the Australian Cycling Team. The significant absence of decision traceability along with associated arguments made a full investigation of the depth of these interactions difficult.

[13] Nm is abbreviation for Newton metres: a force in Newtons multiplied by the arm in metres.

[14] Pedantically, rate is the number of occurrences in a given time. With the aim of zero occurrences, I suggest Zero Failures may be a more appropriate catch phrase.

CONCLUSIONS

111. At the 2020 Tokyo Olympics, Athlete rider Alex Porter's Pursuit Team Base Bar broke: thankfully he was not badly hurt. AusCycling instigated an independent investigation into the causes of the failure.

112. The Pursuit Team starting technique was changed along with a smaller bike frame to improve aerodynamic performance; a bike geometry change was needed. The untraceable solution was an extended Base Bar and to meet the time frame, it was to be made locally. With familiarity with Bastion Cycles products, their Titanium additive manufacture Base Bar was chosen.

113. A Specification comprising an external skin electronic drawing and a test Standard were raised to design and make two Base Bars. The timeframe had reduced from two years to one year and this was met. Both Base Bars were tested as required and fully passed. The order was doubled to four Base Bars.

114. The Specification was wrong and the additive manufactured Titanium Base Bar was exposed to riding forces some one-and-one half times that Specified. As well, fatigue testing was reduced to one quarter of the specified amount by the Australian Cycling Team.

115. The failure mechanism was Low Cycle Fatigue caused by the higher than Specified rider forces from an initiation site just forward of the Base Bar to steering fork front mounting bolt hole. A .29mm non-conformity between the Computer Aided Design Model used to make the Base Bar and the finished item realised higher localised clamping forces at this point and may have attracted cumulative fatigue damage.

116. The Australian Cycling Team had previously specified and used Bastion Cycling cranks, head-stems and other titanium additive manufactured components without major issue.

117. Within the Australian Cycling Team, policy and procedures were scant, were not up to date nor were they followed. No traceability of how the Specification was arrived at or checked was available. Technical activity control for the acquisition and the use of the extended Base Bar was by individuals acting alone, but essentially in good faith. This laissez-faire attitude appeared to have spread across a range of equipment acquisition, maintenance and support activities. Many chances to identify the consequences of inadequate Specification were missed until the catastrophic failure. During transit, only the bike frames were secured in the transit case to prevent damage; the unsecured wheels and Base Bars were free to move and incur damage.

118. With a bike manufacturer's defined Base Bar to steering fork clamping bolt torque listed as 12Nm[15], there was no justification for the Australian Cycling Team Bicycle Build Book to reduce this torque to 8Nm with anecdotal evidence that some mechanics used 6Nm. On analysis, 6Nm realised a safety factor of 1.37 which is marginal at preventing Base Bar to steering fork movement.

119. The main cause of the Base Bar failure at the 2020 Olympics was the incorrect Specification in particular, riding forces which were some one-and-one half times that Specified for the design. The reduction in controlled fatigue testing was an opportunity lost to probe the Specification for accuracy.

120. The crack initiation site was adjacent to a .29mm elevated additive manufacture feature but the crack would have initiated somewhere else because of overload had this feature not existed. The lack of proper Australian Cycling Team process and the absence of discipline to follow extant process provided many missed opportunities to identify the impending failure before it became catastrophic.

[15] A Newton metre abbreviated Nm is a unit of torque

FINDINGS

121. Findings are:

a. The Australian Cycling Team provided an inaccurate Specification for the design and manufacture of a replacement pursuit Base Bar, in particular actual riding forces were some one-and-one half times those Specified.

b. The testing Standard included in the Specification included fatigue strength testing. This requirement was reduced from 200,000 test cycles to 50,000 test cycles by the Australian Cycling Team without justification.

c. The Australian Cycling Teams consultation with Bastion was sparce especially in respect of the final shape of the Base Bar when considering fatigue sensitivities and the Titanium material used.

d. Australian Cycling Teams policies and procedures were scant, those in existence were not followed whilst verbal interaction was used without documented follow up.

e. Bastion Cycles was asked to design and make the Base Bars in a very short time frame when the issue had been identified one year earlier.

f. With the applied forces as Specified, the contemporary design methods did not show any unusual stress concentrations ahead of the Base Bar front mounting bolt. Under some one-and one-half times the Specified forces, that area became especially sensitive to fatigue failure.

g. The CA-06 Base Bar showed a 0.29mm bulge on the front of the clamped Base Bar to steering forks mating surface which would raise the stress in that area and attract adjacent fatigue damage. The contribution of this to the failure cannot be gauged.

h. The Australian Cycling Team had experience with Bastion Cycles Head Stems and cranks along with components made for paralympic riders and used these products with success.

i. In use, there were Base Bar inspections to detect in-service degradation of components but these were missed.

j. Reduction in the Base Bar mounting bolt torques is believed to have led to movement in the Base Bar to steering fork junction.

k. Bastion Cycles provided no advice on Base Bar mounting bolt torques and was not required to: it would have been prudent to do so. As well. They were unaware of the Australian Cycling Teams Bicycle Build Book where relevant torque values were stated.

l. Investigations of any technical failure must include an initial requirement to coral the failed items, associated serviceable items and all related documents.

m. During interview, muscle contractions in a static position - called isometric exercise - were found to use the racing bike frames as props. The estimate of force applied to the bike frame was eclipsed by the race start applied force however, the isometric exercise forces must be considered in any future fatigue study.

RECOMMENDATIONS

122. Recommendations for AusCycling emanating from this investigation are:

a. To employ qualified and experienced people who are appropriately authorised for the tasks and are working with approved processes in a controlled environment.
b. People in the organisation to be hired against a description of the tasks they will be completing.
c. Invest in a technical quality culture with a focus on a single vision, a mission and supporting goals along with a means of assessing the effectiveness of that culture.
d. When a requirement arises, debate and document the justifiable and cost-effective need for that requirement.
e. When raising an equipment requirement, test that requirement in every detail with qualified and experienced advice, which can include a trusted supplier, before that requirement is released.
f. Crucial steps in every technical process are subject to independent review and a record of that review retained.
g. That every significant activity be documented, when it is completed, so that traceability is readily available.
h. A process exists to accept all technical equipment acquired including confirmation that the acquisition meets the originating requirement. This requirement be tied to the invoiced payment for the capability.
i. Specifications be raised in outcome format as opposed to product definition.
j. Quality control be exercised across all of the hardware, tools and software used to produce the sport outcomes.
k. Those Bastion Cycles components for which full justification and satisfactory in-service experience is held, be reinstated to full use.
l. Future investigations, when required, be independent, and that an informed mentor be available to navigate the cycling landscape.
m. Any investigation follows a structured process to capture all reasonable physical and documentary evidence and then run to a substantiated conclusion.
n. When staff are released, an exit interview be conducted and as a condition of post employment, they agree to contribute to work they were involved in.

123. Recommendations for Bastion Cycles are:

a. Identify whether the .29mm protrusion in the Base Bar print was within tolerance for the production process and if not correct it.
b. Work with the customer iteratively to understand the exact need and suggest alternatives to the initiating idea bringing specialist engineering toward a better product.
c. Review design and production quality assurance procedures to illuminate non-conforming products. Use customer feedback to inform the review.
d. Pursue technological test methods as used in this investigation to improve the effectiveness and efficiency of product qualification.

e. When supplying components (Base Bars) for use by customers on their equipment, provide recommended fastener attachment values to match the component's design and material type.

John Baker, AM

FRAeS MIEAust CP Eng NER APEC Engineer Int PE(Aus)

Investigator

Its Not Your Fault! Pty Ltd

21st January 2022

Annexes and Appendices

Annex A: Authorities consulted in preparing INYF! Report 9/21
Annex B: Presentation seeking Australian Institute of Support Assistance
Annex C: Australian Cycling Team Specification email dated 6th May 2019
Annex D: Bastion Cycles response to the Australian Cycling Teams request for quotation
Annex E: Bastion Cycles CA-06 Base Bar Quality Reports
Annex F: Bastion Advanced Engineering Test Report TR-CA-06-001 dated 17 July 2019
Annex G: Material Certificate No: MC-21-0287 for Ti-6Al-4V Titanium Powder
Annex H: CA-06 Base Bar Standing Start Force Analysis
Annex I: Australian Cycling Teams Isometric Force Case
Annex J: Base Bar to steering fork bolt torque analysis
Annex K: Representative Bastion Quotations and Invoices
Annex L: Paint Plan supplied to Bastion Cycles for the Number One Base Bar

Appendix A: AusCycling Terms of Reference – Equipment Failure
Appendix B: AusCycling Bastion Base Bar Failure Investigation Data Collection
Appendix C: Australian Transport Safety Bureau
Appendix D: Handlebar Service Schedule
Appendix E: Process for the Introduction of New Componentry
Appendix F: Bicycle Build Book V1.0

INVESTIGATION INTERVIEWS WITH AUSCYCLING STAFF

Date	Name	Org & Title	Notes	Time
10/09/21	John Baker John Pitman	Investigator AusCycling, Engineer	Investigation discussion - background information	2.23-3.33pm
15/09/21	John Baker John Pitman	Investigator AusCycling, Engineer	Investigation Interview - John Baker lead	10-11.41am
20/09/21	John Baker Will Dickeson	Investigator AusCycling, Workshop Manager	Investigation Interview - John Baker lead	1.30-2.34pm
20/09/21	John Baker Michael Devitt	Investigator ex - AusCycling, Graduate Engineer	Investigation Interview - John Baker lead	5.30-7.01pm
22/09/21	John Baker Andy Richardson	Investigator AIS, Engineer	Investigation Interview - John Baker lead	12-12.25pm
24/09/21	John Baker Simon Jones	Investigator ex AusCycling, HPD	Investigation Interview - John Baker lead	12.00-1.04pm
27/09/21	John Baker Jade Lean	Investigator AusCycling Mechanic (Tokyo - Lead Mec)	Investigation Interview - John Baker lead	11.05-12.14pm
28/09/21	John Baker Paul Brosnan	Investigator AusCycling, Director of Operations	Investigation Interview - John Baker lead	1.30-2.17pm
30/09/21	Tim Decker Alex Porter Leigh Howard Lucas Plapp Sam Welsford	AusCycling, Track Endurance Coach AusCycling, Men's track pursuit team (Kell O'Brien not on call-O/S)	Information session with team on Investigation Investigation Interview - John Baker lead	4.00-5.00pm
30/09/21	John Baker Tim Dekker	Investigator AusCycling, Track Endurance Coach	Investigation Interview - John Baker lead	5.00-5.25pm
25/10/21	John Baker John Pitman	Investigator AusCycling, Engineer	Clarification around isohold testing	9.30-10.20am
27/10/21	John Baker Paolo Menaspa	Investigator ex AusCycling Head of Perf Solutions	Investigation Interview - John Baker lead	9.59-10.30am

Note. All interviews conducted in the presence of Ms Cumpston. Thanks to Ms Cumpston for this listing

INVESTIGATION INTERVIEWS WITH BASTION CYCLES AND BASTION ADVANCED ENGINEERING STAFF

	Date	Name	Org & Title	Notes	Time
	Many	Ben Schultz	GM Bastion Cycles	Technical Investigation	In four hour blocks
	Many	James Woolcock	Chief Engineer Bastion Advanced Engineering	Technical Investigation	In four hour blocks
	Many	Dean McGeary	Director, Bastion Cycles	Technical Investigation	In four hour blocks

Alex Porter Basebar

31/10/18

Overview

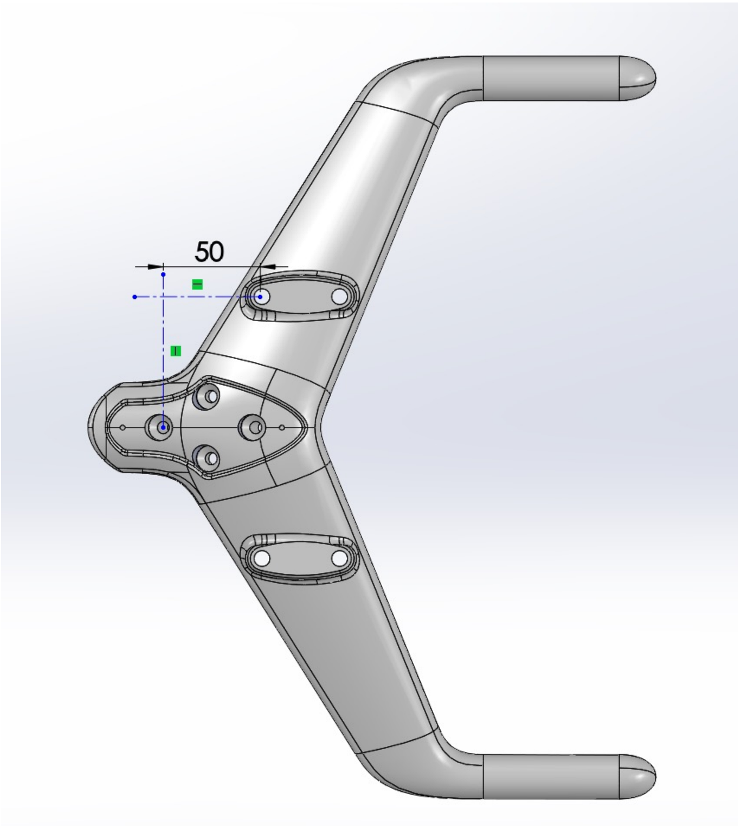
- Alex Porter the Men Team Pursuit starter hits his legs on the handlebar basebar when starting from the gate
- Coach and sport scientist doesn’t want Alex to go up a bike size
- Argon require $32.5K to manufacture a new basebar

- Proposed Solution
  - Make a one off 3D printed Ti basebar for Alex Porter
  - Keep the design the same, move the aero profiles forward 35mm
  - The rest of the design remains the same. Will have to try and accommodate the best position for the pads and extensions from adjustments available.

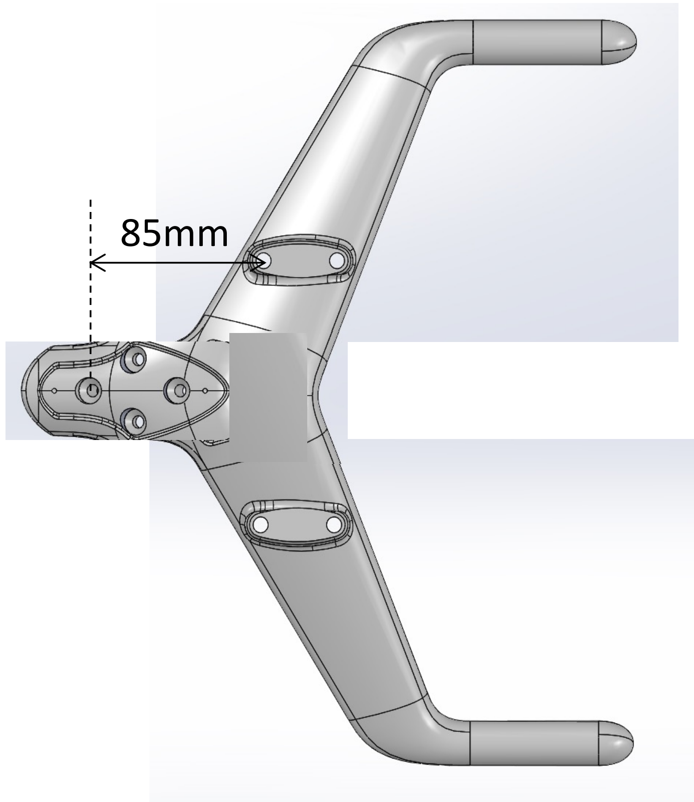
Current Situation

Alex hits his the top of knee/front of thigh on the rear edge of the basebar. The hitting causes the front wheel to lift and could cause a fall.

Proposed Solution



Current Argon Basebar



Alex Porter Basebar. Move the two arms forward 35mm relative to the rear mounting holes

Plan

- AIS Engineering to modify the design, moving arms 35mm forward
- Carbon 3D print a AP basebar
- Test the 3D print on the rollers with AP to check clearance
- Supply CAD file to Bastion for printing in Ti
- ISO fatigue test (no of cycles to be confirmed)
- AP to track test

- Timescale
  - CAD design – 2 weeks
  - 3D print – 3 weeks (end Nov)
  - Test with AP – early December
  - Modifications – end December
  - Supply CAD to Bastion – Jan
  - ISO and Track test – early Feb
  - Ride at World Champs first week in March

james@bastionadvanced.com

From:	Andrew Warr <a.warr@cycling.org.au>
Sent:	Monday, 6 May 2019 5:03 PM
To:	james@bastionadvanced.com
Subject:	Alex Porter Pursuit bar quote
Categories:	Only James, To James

James, hi,

For Alex Porter we need additional clearance on the basebar for his thighs during the start; therefore we have pushed the basebar forward 35mm. We 3D printed in Markforged a test piece and he is happy. Therefore we need to move to a rideable version. So please, could you provide me with a quote to 3D print in Ti, 2 off, Alex Porter specific pursuit basebar. Attached is the CAD model that we had the prototypes 3D printed. The bars would also need to be ISO tested, static and in and out of phase for racing bikes.

Delivery would be September.

Thanks

Best Regards

Andrew Warr
Performance Systems Manager | Cycling Australia

P +61 8 8360 5888 **M** +61 437 881 252
A 50 Anna Meares Way, Gepps Cross, SA, 5094
andrew.warr@cycling.org.au | www.cycling.org.au

BASTION
ADVANCED ENGINEERING

QUOTE

Cycling Australia

Date
6 May 2019

Expiry
20 May 2019

Quote Number
QU-0110

Reference
CA-06 BASE BAR

ABN
53 604 585 640

Bastion Advanced Engineering
412 Heidelberg Road
Fairfield VIC 3078
AUSTRALIA

[CA-06] BASE BAR - TI64 PRINT

Description	Quantity	Unit Price	Discount	GST	Amount AUD
[CA-06] BASE BAR & STEM 35mm OFFSET | TI64 PRINT	2.00	[redacted]	[redacted]	10%	[redacted]
[CA-06] ISO & STRENGTH PROOF TESTING | 6hrs Runtime + Reporting	6.00	[redacted]		10%	[redacted]
Engineering Hours - [CA-06] Surface Data Cleanup and Prep for Print	2.00	[redacted]		10%	[redacted]
Engineering Hours - [CA-06] Internal Structure Development	8.00	[redacted]	[redacted]		[redacted]
Engineering Hours - [CA-06] FEA Iterations	4.00	[redacted]	[redacted]		[redacted]
				INCLUDES GST 10%	[redacted]
				TOTAL AUD	[redacted]

TAX INVOICE

Cycling Australia

BASTION
ADVANCED ENGINEERING

Invoice Date
24 Mar 2021

Invoice Number
INV-1357

Reference
CA-06 BASE BAR #4

ABN
53 604 585 640

Bastion Advanced Engineering
412 Heidelberg Road
Fairfield VIC 3078
AUSTRALIA

Description	Quantity	Unit Price	Discount	GST	Amount AUD
[CA-06] BASE BAR & STEM 35mm OFFSET | TI64 PRINT | Includes PAINTED PER #2	1.00	[redacted]	0.00%	10%	[redacted]
[CA-06] ISO & STRENGTH PROOF TESTING | 4hrs Runtime + Reporting	4.00	[redacted]		10%	[redacted]

INCLUDES GST 10%	[redacted]
TOTAL AUD	[redacted]
Less Amount Paid	[redacted]
AMOUNT DUE AUD	0.00

Due Date: 8 Apr 2021
Domestic Electronic Funds Transfer (EFT) :
Account: BASTION PTY LTD
BSB: 013332
ACN: 455485956

Overseas Electronic Funds Transfer (EFT):
SWIFT Code/BIC: ANZBAU3M
Bank: AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED
Branch: GLENFERRIE
Address: 687 GLENFERRIE ROAD GLENFERRIE VIC 3122 AUSTRALIA
Account No.: 455485956

Terms & Conditions:
Net 7days

BASTION
ADVANCED ENGINEERING

TAX INVOICE

Cycling Australia

Invoice Date
23 Feb 2021

Invoice Number
INV-1306

Reference
CA-06 BASE BAR #3

ABN
53 604 585 640

Bastion Advanced Engineering
412 Heidelberg Road
Fairfield VIC 3078
AUSTRALIA

Description	Quantity	Unit Price	Discount	GST	Amount AUD
[CA-06] BASE BAR & STEM 35mm OFFSET | TI64 PRINT | Includes PAINTED PER #2	1.00	[redacted]	[redacted]	10%	[redacted]
[CA-06] ISO & STRENGTH PROOF TESTING | 4hrs Runtime + Reporting	4.00	[redacted]		10%	[redacted]
				INCLUDES GST 10%	[redacted]
				TOTAL AUD	[redacted]
				Less Amount Paid	[redacted]
				AMOUNT DUE AUD	**0.00**

Due Date: 10 Mar 2021
Domestic Electronic Funds Transfer (EFT) :
Account: BASTION PTY LTD
BSB: 013332
ACN: 455485956

Overseas Electronic Funds Transfer (EFT):
SWIFT Code/BIC: ANZBAU3M
Bank: AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED
Branch: GLENFERRIE
Address: 687 GLENFERRIE ROAD GLENFERRIE VIC 3122 AUSTRALIA
Account No.: 455485956

Terms & Conditions:
Net 7days

BASTION
ADVANCED ENGINEERING

TAX INVOICE

Cycling Australia

Invoice Date
10 Sep 2020

Invoice Number
INV-1140

Reference
CA-06 BASE BAR #2

ABN
53 604 585 640

Bastion Advanced
Engineering
412 Heidelberg Road
Fairfield VIC 3078
AUSTRALIA

Description	Quantity	Unit Price	Discount	GST	Amount AUD
[CA-06] BASE BAR & STEM 35mm OFFSET | TI64 PRINT | Includes PAINTED LIVERY	1.00	[redacted]	[redacted]	10%	[redacted]
[CA-06] ISO & STRENGTH PROOF TESTING | 6hrs Runtime + Reporting	6.00	[redacted]		10%	[redacted]
[CA-06] DESIGN MODIFICATIONS #2 - Engineering Hours	3.00	[redacted]	[redacted]		0.00

INCLUDES GST 10%	[redacted]
TOTAL AUD	[redacted]
Less Amount Paid	[redacted]
AMOUNT DUE AUD	0.00

Due Date: 25 Sep 2020
Domestic Electronic Funds Transfer (EFT) :
Account: BASTION PTY LTD
BSB: 013332
ACN: 455485956

Overseas Electronic Funds Transfer (EFT):
SWIFT Code/BIC: ANZBAU3M
Bank: AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED
Branch: GLENFERRIE
Address: 687 GLENFERRIE ROAD GLENFERRIE VIC 3122 AUSTRALIA
Account No.: 455485956

Terms & Conditions:
Net 7days

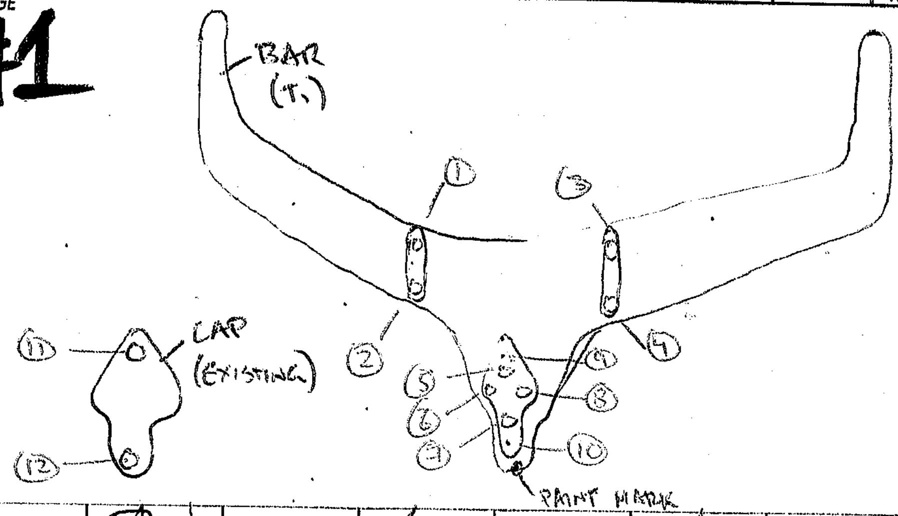
Annex E
to An Investigation into the Handlebar Failure that Occurred in the Australian Men's Team Pursuit race at the Tokyo 2020 Olympics
November 2021

BASTION ADVANCED ENGINEERING

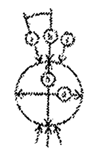
		PREPARED	23/04/2019
CLIENT	CA	PART	CA-06 BAR
PROJECT CODE	CA-06	QTY	1
DUE DATE	—	FINISH	PAINT SHEET

IMAGE

#1



MEASUREMENT METHOD REF



042

CAD	SUPPORT	SLICE	PRINT	DATE
TW	EY	EY	EY	26/07/2019

<FUNCTIONAL DIAMETER INSPECTION STANDARD> GEN. TOLERANCE ± 0.2

ITEM	TARGET	MEASURED	JUDGE
1	8.2	7.8	OK
2	↑	7.6	↑
3		7.7	
4		7.7	
5	6.4	6.3	OK BOLT ASSY
6	↑	6.3	
7		6.3	
8		6.3	
9	M3	M3	OK
10	M3	X BROKEN TAP	
11	REF	—	—
12	REF	—	
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			

<PART PROCESSING>

PROCESS	ITEM	COMPLETED	CHECKED
L	VISUAL GO/NO-GO		
	MACHINE		
	BEARING ID		
	TAP/DRILL		
	FINISH		
	VF1		
	GRIND		
	VF2		
	BLAST		
	POLISH		
	WASH		
	DRY		
B	BLAST BOND SURF. (<24H)		
	BLOW DOWN		
	ACETONE		
	PRE-TREAT AC130	PART A	PART B
		MIX TIME	TEMP/HUMIDITY
	PRE-TREAT APPLY		
	EPOXY K138	RESIN	HARDENER
		APPLY TIME	TEMP/HUMIDITY
	EPOXY APPLY		
	AMBIENT CURE TIME		
	SCHEME/COLOUR		
OTHER			

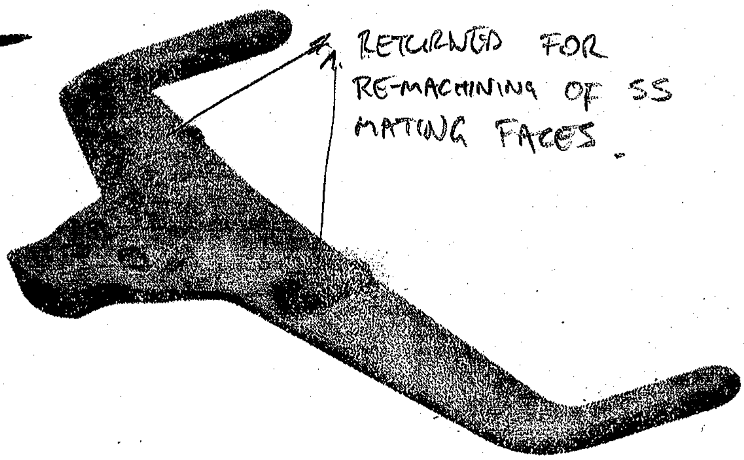
BASTION		
	JAMES WOOLCOCK ENGINEERING DIRECTOR 13/9/2019	ETHAN YORK DESIGN ENGINEER 2019/09/13
SHIPPING APPROVAL	APPROVED	PREPARED

BASTION ADVANCED ENGINEERING

REVISION	R01
PREPARED	01-10-20

CLIENT	CA	PART	CA-06 BASE BAR
PROJECT CODE	CA-06	QTY	1
DUE DATE	MID OCTOBER 2020	FINISH	REFER PAINT SHEET

#2



RETURNED FOR RE-MACHINING OF SS MATING FACES.

HORNS	V1.2	Repeat Data
BASE	V1.3	New Data

Post Machine Towers 13-JAN-21	CW ✓
Bond	[illegible]
Mini Durability	CC + JW
Paint	VC ✓

CAD		SUPPORT		SLICE		PRINT	[illegible]	DATE [illegible]

<FUNCTIONAL DIAMETER INSPECTION STANDARD> GEN. TOLERANCE ± 0.2

ITEM	TARGET	MEASURED	JUDGE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
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14			
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22			
23			
24			
25			
26			
27			

<PART PROCESSING>

PROCESS	ITEM	COMPLETED	CHECKED
L	VISUAL GO/NO-GO		
	MACHINE		
	BEARING ID		
	TAP/DRILL		
	FINISH		
	VF1		
	GRIND		
	VF2		
	BLAST		
	POLISH		
	WASH		
	DRY		
B	BLAST BOND SURF. (<24H)		
	BLOW DOWN		
	ACETONE		
	PRE-TREAT AC130	PART A	PART B
		MIX TIME	TEMP/HUMIDITY
	PRE-TREAT APPLY		
	EPOXY K138	RESIN	HARDENER
		APPLY TIME	TEMP/HUMIDITY
	EPOXY APPLY		
	AMBIENT CURE TIME		
	SCHEME/COLOUR		
OTHER			

BASTION

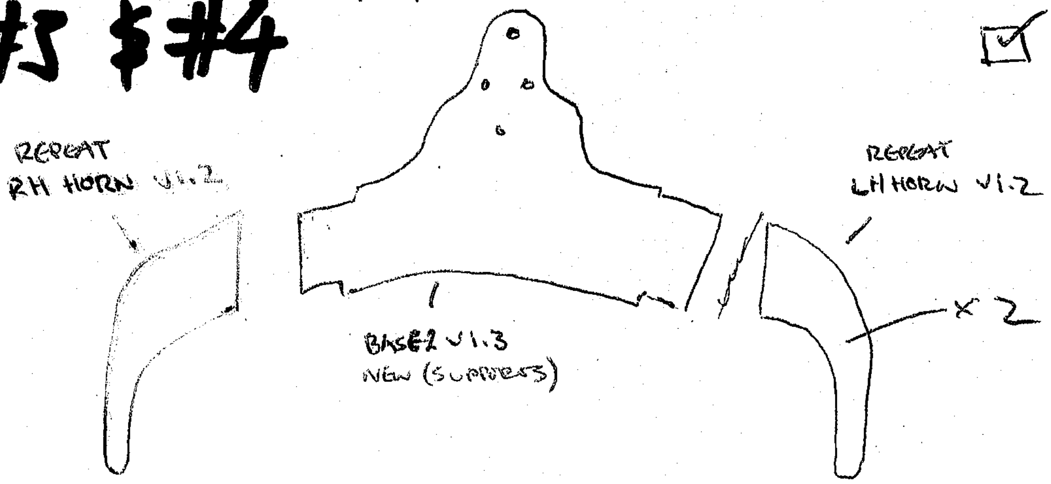
SHIPPING APPROVAL	APPROVED	PREPARED
	JAMES WOOLCOCK	ETHAN YORK
	ENGINEERING DIRECTOR	DESIGN ENGINEER

BASTION ADVANCED ENGINEERING	REVISION	R01
	PREPARED	19-03-20

CLIENT	CYCLING AUS	PART	BASE BAR
PROJECT CODE	CA-06	QTY	~~4~~ x2
DUE DATE	2021/03/12	FINISH	PAINTED BLACK

#3 & #4

☑ PROOF TEST JW



CAD	JW	SUPPORT	EY	SLICE	EY	PRINT	EY (299)	DATE 21/03/24

<FUNCTIONAL DIAMETER INSPECTION STANDARD> GEN. TOLERANCE ± 0.2

ITEM	TARGET	MEASURED	JUDGE
1			
2			
3			
4			
5			
6			
7			
8			
9			
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11			
12			
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19			
20			
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22			
23			
24			
25			
26			
27			

<PART PROCESSING>

PROCESS	ITEM	COMPLETED	CHECKED
L	VISUAL GO/NO-GO	1 x RH HORN REPRINT	JW
	MACHINE	✓ ✓ JW	JW
	BEARING ID		
	TAP/DRILL M4x2		
	FINISH		
	VF1	✓	JW
	GRIND	✓	JW
	VF2	✓	JW
	BLAST		✓
	POLISH		
	WASH		
	DRY		
B	BLAST BOND SURF. (<24H)	MH, TQ	
	BLOW DOWN		
	ACETONE		
	PRE-TREAT AC130	PART A	PART B
		MIX TIME	TEMP/HUMIDITY
	PRE-TREAT APPLY		
	EPOXY K138	RESIN	HARDENER
		APPLY TIME	TEMP/HUMIDITY
	EPOXY APPLY		
	AMBIENT CURE TIME		
	SCHEME/COLOUR	BLACK	
OTHER			

BASTION	JAMES WOOLCOCK	ETHAN YORK
	ENGINEERING DIRECTOR	DESIGN ENGINEER
	24/5/21	
SHIPPING APPROVAL	APPROVED	PREPARED

SHIPPED 24/5/21

BOSTION — <AM250/400 CONTROL SHEET>

BUILD RUN

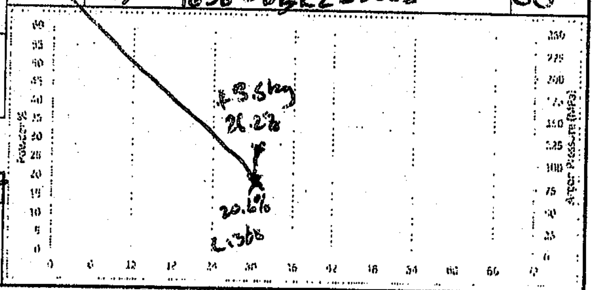
CHAMBER VISUAL CHECK → TOOL CHECK → LENS DUST CHECK → WIPER INSTALLED → CHILLER WORKING?

VALVES OPEN → FLASKS EMPTY? → HEAT SOAK START → BUILD SELECT → AIRCON WORKING?

DOSING %: 54 % → DOSE CHECK & TUNED PLATE t: —— mm → SET DATUM → POWDER LEVEL: 87 %

OXYGEN % TOP&BOTTOM >17%: 21/21 → ARGON PRESSURE (ON AM250) 1500–1700 mBar: 1658 → ENOUGH POWDER FOR THIS BUILD? → BUILD LAUNCH SAT 1:20 26/9 AM / PM

BUILD NAME: 213 235_246_256_HBL2_161B 1638_DBR2_302_ — 66 µm



RECOVER

HOME? VISUAL CHECK → VACUUM BURNED POWDER (OPEN) → BRUSH SPATULA 4mm HEX (CLOSE) → BULK POWDER RECOVERY (ABS TOP) → UNFASTEN PLATE → INVERT & SHAKE (OPEN) → FINAL ROTATE & TAP (CLOSE) → FURNACE START 13:45 AM / PM MON 28/9

CLEAN DOWN

SEIVE START (CTR POS) → WIPER REMOVE → FULL VAC DOWN → FULL IPA WIPE DOWN → FILTER UNLOAD & DISPOSE: E7 → NEW FILTER LOAD (CLOSE)

SETUP

MEASURE BUILD PLATE t: 11.536 mm → INPUT t & PLATE 4mm HEX → NEW WIPER INSTALL 5mm HEX → SET WIPER HEIGHT 5mm HEX → LENS CLEAN (CLOSE) → ALL POWDER SEIVED?

11.532 11.536

11:507 – 11.484

BUILD RUN

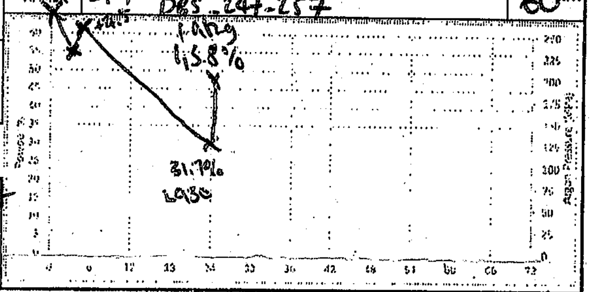
CHAMBER VISUAL CHECK → TOOL CHECK → LENS DUST CHECK → WIPER INSTALLED → CHILLER WORKING?

VALVES OPEN → FLASKS EMPTY? → HEAT SOAK START → BUILD SELECT → AIRCON WORKING?

DOSING %: 56 % → DOSE CHECK & TUNED PLATE t: — mm → SET DATUM → POWDER LEVEL: 67 %

OXYGEN % TOP&BOTTOM >17%: 21/22 → ARGON PRESSURE (ON AM250) 1500–1700 mBar: 1581 → ENOUGH POWDER FOR THIS BUILD? → BUILD LAUNCH 15:30 MON 28/9 AM / PM

BUILD NAME: 219 505D_267_SETnoBB_215_HBL DBS_247_257 — 60 µm



RECOVER

HOME? VISUAL CHECK → VACUUM BURNED POWDER (OPEN) → BRUSH SPATULA 4mm HEX (CLOSE) → BULK POWDER RECOVERY (ABS TOP) → UNFASTEN PLATE → INVERT & SHAKE (OPEN) → FINAL ROTATE & TAP (CLOSE) → FURNACE START 12:30 1/10 THURS NEXT DAY AM / PM: E7

CLEAN DOWN

SEIVE START (CTR POS) → WIPER REMOVE → FULL VAC DOWN → FULL IPA WIPE DOWN → FILTER UNLOAD & DISPOSE → NEW FILTER LOAD (CLOSE)

SETUP

MEASURE BUILD PLATE t: 14.920 mm → INPUT t & PLATE 4mm HEX: E7 → NEW WIPER INSTALL 5mm HEX → SET WIPER HEIGHT 5mm HEX → LENS CLEAN: E7 (CLOSE) → ALL POWDER SEIVED?: E7

14.920 14.920

14.880 14.880

ZERO CHAMBER PRESSURE

BUILD RUN

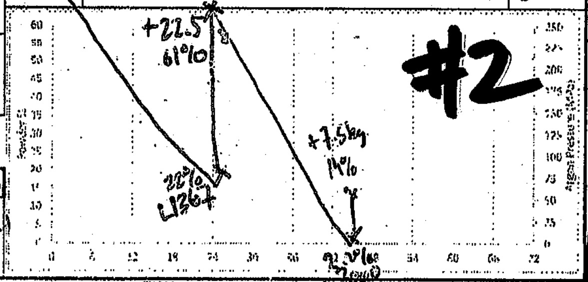
CHAMBER VISUAL CHECK: E7 → TOOL CHECK: E7 → LENS DUST CHECK: E7 → WIPER INSTALLED: E7 → CHILLER WORKING?: E7

VALVES OPEN: E7 → FLASKS EMPTY?: E7 → HEAT SOAK START: E7 → BUILD SELECT: E7 → AIRCON WORKING?: E7

DOSING %: 54 %: E7 → DOSE CHECK & TUNED PLATE t: 14.940 mm: E7 → SET DATUM: E7 → POWDER LEVEL: 90.2 80.5 %: E7

OXYGEN % TOP&BOTTOM >17%: 21.5: E7 → ARGON PRESSURE (ON AM250) 1500–1700 mBar: 1570: E7 → ENOUGH POWDER FOR THIS BUILD?: E7 → BUILD LAUNCH 1130 10/02 FRI AM / PM: E7

BUILD NAME: 221 – 220 BB – PC48 – CA.08415 — 60 µm



#2

#1

RECOVER

HOME? VISUAL CHECK → VACUUM BURNED POWDER (OPEN) → BRUSH SPATULA 4mm HEX (CLOSE) → POWDER RECOVERY (ABS TOP) → UNFASTEN PLATE → INVERT & SHAKE (OPEN) → FINAL ROTATE & TAP (CLOSE) → FURNACE START 12:50 AM / PM MON 5/10

CLEAN DOWN

SEIVE START (CTR POS) → WIPER REMOVE → FULL VAC DOWN → FULL IPA WIPE DOWN → FILTER UNLOAD & DISPOSE → NEW FILTER LOAD (CLOSE)

SETUP

MEASURE BUILD PLATE t: 11.015 mm → INPUT t & PLATE 4mm HEX → NEW WIPER INSTALL 5mm HEX → SET WIPER HEIGHT 5mm HEX → LENS CLEAN (CLOSE) → ALL POWDER SEIVED?

11.013 11.015

10.995 – 10.964

BOSTION <AM250/400 CONTROL SHEET>

Build 1

BUILD NAME: 299 - CA - 06 _ BASEBAR _ V1.3 _ SET x 2 | 60 µm

BUILD RUN

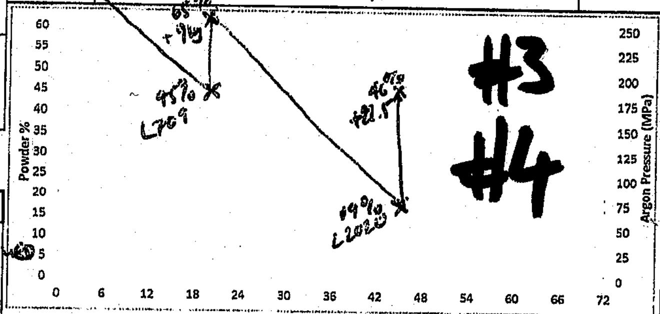
CHAMBER VISUAL CHECK	TOOL CHECK	LENS DUST CHECK	WIPER INSTALLED	CHILLER WORKING?
Ly	Ly	Ly	Ly	Ly

VALVES OPEN	FLASKS EMPTY?	HEAT SOAK START	BUILD SELECT	AIRCON WORKING?
Ly	Ly	Ly	Ly	Ly

DOSING %	DOSE CHECK & TUNED PLATE t	SET DATUM	POWDER LEVEL
50 %	14.32 mm Ly	Ly	85.5 Ly / 77.9 % Ly

OXYGEN % UPPER&LOWER >17%	ARGON PRESSURE (ON AM SCREEN) 1500~1700 mBar	AIR PRESSURE ON REG (AM400 ONLY) 0.2MPa	BUILD LAUNCH
23 / 18 Ly	1509 Ly	Ly	1900 03/24/24 AM / PM Ly

* MANUAL CONTROL SUCK DOWN



RECOVER

HOME? VISUAL CHECK	VACUUM BURNED POWDER	BRUSH SPATULA 4mm HEX	BULK POWDER RECOVERY	UNFASTEN PLATE	INVERT & SHAKE	FINAL ROTATE & TAP	FURNACE START
Ly	OPEN Ly	Ly CLOSE	Ly ABS TOP	Ly	Ly	OPEN Ly CLOSE	Ly AM / PM — 1130 03/27 SAT * SOFT LID

CLEAN DOWN

SEIVE START	WIPER REMOVE	FULL VAC DOWN	FULL IPA WIPE DOWN	FILTER UNLOAD & DISPOSE	NEW FILTER LOAD	
Ly CTR POS	Ly	Ly	Ly	Ly	Ly CLOSE	14.323 14.320 / 14.854 14.330

SETUP

MEASURE BUILD PLATE t	INPUT t & PLATE 4mm HEX	NEW WIPER INSTALL 5mm HEX	SET WIPER HEIGHT 5mm HEX	LENS CLEAN	OXYGEN % TOP&BOTTOM >17%	ZERO CHAMBER PRESSURE	ALL POWDER SEIVED?
14.384 mm Ly	Ly	Ly	Ly	Ly	21/18 Ly	Ly CLOSE	ll

Build 2

BUILD NAME: 29 + 31 + 302 LASER PARAMETERS | 60 µm

BUILD RUN

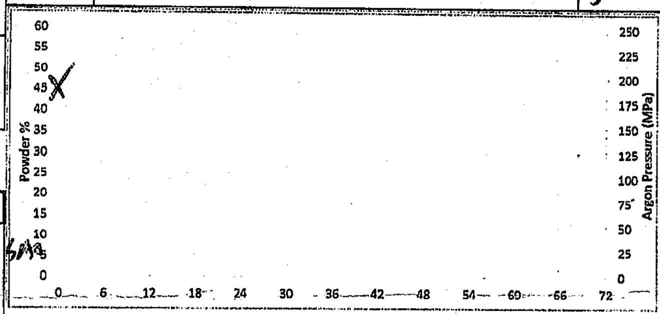
CHAMBER VISUAL CHECK	TOOL CHECK	LENS DUST CHECK	WIPER INSTALLED	CHILLER WORKING?
Ly	Ly	Ly	Ly	Ly

VALVES OPEN	FLASKS EMPTY?	HEAT SOAK START	BUILD SELECT	AIRCON WORKING?
Ly	Ly	Ly	Ly	Ly

DOSING %	DOSE CHECK & TUNED PLATE t	SET DATUM	POWDER LEVEL
40 % Ly	mm	Ly	47.8 % Ly

OXYGEN % TOP&BOTTOM >17%	ARGON PRESSURE (ON AM SCREEN) 1500~1700 mBar	AIR PRESSURE ON REG (AM400 ONLY) 0.2MPa	BUILD LAUNCH
21 / 15 Ly	1499 Ly	Ly	14:00 03/27 SAT AM / PM Ly

MANUAL SUCK DOWN



RECOVER

HOME? VISUAL CHECK	VACUUM BURNED POWDER	BRUSH SPATULA 4mm HEX	BULK POWDER RECOVERY	UNFASTEN PLATE	INVERT & SHAKE	FINAL ROTATE & TAP	FURNACE START
ll	OPEN ll	ll CLOSE	ll ABS TOP	ll	ll	OPEN ll CLOSE	AM / PM

CLEAN DOWN

SEIVE START	WIPER REMOVE	FULL VAC DOWN	FULL IPA WIPE DOWN	FILTER UNLOAD & DISPOSE	NEW FILTER LOAD	
ll CTR POS	ll	ll	ll	ll	ll CLOSE	13.90 13.897 / 13.904 13.91

SETUP

MEASURE BUILD PLATE t	INPUT t & PLATE 4mm HEX	NEW WIPER INSTALL 5mm HEX	SET WIPER HEIGHT 5mm HEX	LENS CLEAN	OXYGEN % TOP&BOTTOM >17%	ZERO CHAMBER PRESSURE	ALL POWDER SEIVED?
13.91 mm ll	ll	ll	ll	ll	22 22	ll CLOSE	ll

Build 3

BUILD NAME: 301 515A 384 SB 515C 392 SB KANBAN SPL RD | 60 µm

BUILD RUN

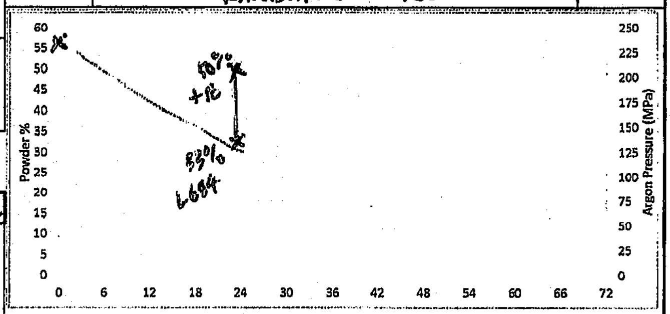
CHAMBER VISUAL CHECK	TOOL CHECK	LENS DUST CHECK	WIPER INSTALLED	CHILLER WORKING?
ll	ll	ll	ll	ll

VALVES OPEN	FLASKS EMPTY?	HEAT SOAK START	BUILD SELECT	AIRCON WORKING?
ll	ll	ll	ll	ll

DOSING %	DOSE CHECK & TUNED PLATE t	SET DATUM	POWDER LEVEL
50 % ll	13.92 mm ll	ll	56 % ll

OXYGEN % TOP&BOTTOM >17%	ARGON PRESSURE (ON AM SCREEN) 1500~1700 mBar	AIR PRESSURE ON REG (AM400 ONLY) 0.2MPa	BUILD LAUNCH
24 / 18 ll	1513 ll	ll	SUN 28/03 17:15 AM / PM ll

AUTO SUCK DOWN



RECOVER

HOME? VISUAL CHECK	VACUUM BURNED POWDER	BRUSH SPATULA 4mm HEX	BULK POWDER RECOVERY	UNFASTEN PLATE	INVERT & SHAKE	FINAL ROTATE & TAP	FURNACE START
ll	OPEN ll	ll CLOSE	ll ABS TOP	ll	ll	OPEN ll CLOSE	ll AM / PM — TUE 30/3 15:15

CLEAN DOWN

SEIVE START	WIPER REMOVE	FULL VAC DOWN	FULL IPA WIPE DOWN	FILTER UNLOAD & DISPOSE	NEW FILTER LOAD	
ll CTR POS	ll	ll	ll	ll	ll CLOSE	14.28 14.27 / 14.337 14.339

SETUP

MEASURE BUILD PLATE t	INPUT t & PLATE 4mm HEX	NEW WIPER INSTALL 5mm HEX	SET WIPER HEIGHT 5mm HEX	LENS CLEAN	OXYGEN % TOP&BOTTOM >17%	ZERO CHAMBER PRESSURE	ALL POWDER SEIVED?
14.337 ll	ll	ll	ll	ll	22 17	ll CLOSE	ll

BOSTION <AM250 CONTROL SHEET>

BUILD RUN

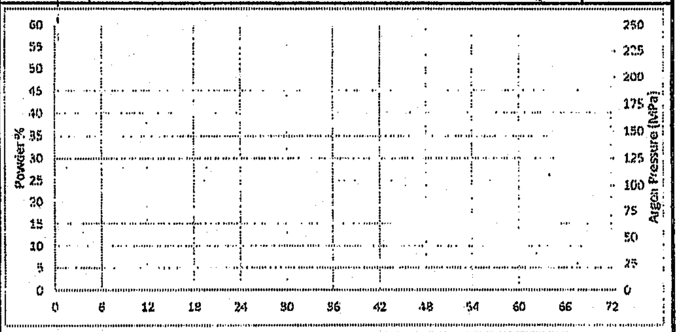
BUILD NAME: PC434445_SCPT1-17_121021 — 60 µm

CHAMBER VISUAL CHECK	TOOL CHECK	LENS DUST CHECK	WIPER INSTALLED	CHILLER WORKING?
EJ	EJ	EJ	EJ	EJ

VALVES OPEN	FLASKS EMPTY?	HEAT SOAK START	BUILD SELECT	AIRCON WORKING?
JW	EJ	EJ	JW	EJ

DOSE CHECK	TUNED PLATE t	SET DATUM	DOSING %
JW	12.965 mm JW	JW	46 % JW

POWDER LEVEL	ARGON PRESSURE (ON AM250) 1500~1700 mBar	ENOUGH POWDER FOR THIS BUILD?	BUILD LAUNCH
76.9 VAC 68.5 % JW	1484 JW	JW	11:40 AM / PM JW



RECOVER

HOME? VISUAL CHECK	VACUUM BURNED POWDER (OPEN)	BRUSH SPATULA 4mm HEX (CLOSE)	BULK POWDER RECOVERY (ABS TOP)	UNFASTEN PLATE	INVERT & SHAKE (OPEN)	FINAL ROTATE & TAP (CLOSE)	FURNACE START
EJ	EJ	EJ	EJ	EJ	EJ	EJ	11:00 AM / PM EJ

CLEAN DOWN

SEIVE START (CTR POS)	WIPER REMOVE	FULL VAC DOWN	FULL IPA WIPE DOWN	FILTLER UNLOAD & DISPOSE	NEW FILTER LOAD (CLOSE)
EJ	EJ	EJ	EJ	EJ	EJ

SETUP

MEASURE BUILD PLATE t	INPUT t & PLATE 4mm HEX	NEW WIPER INSTALL 5mm HEX	SET WIPER HEIGHT 5mm HEX	LENS CLEAN (CLOSE)	ALL POWDER SEIVED?
14.134 EJ	EJ	EJ	EJ	EJ	EJ

(14.134) 14.127
14.098 14.107

BUILD RUN

#1

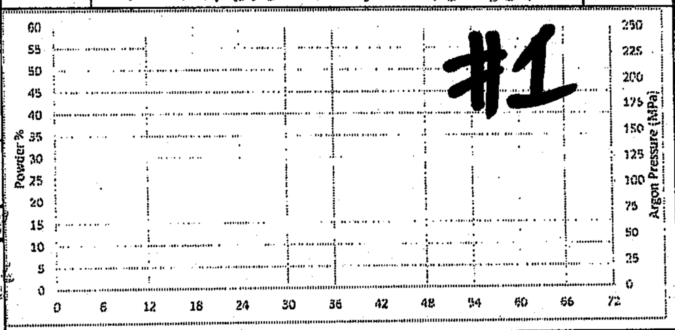
BUILD NAME: LA-06_V1.2_SET_505A_135_SET — 60 µm

CHAMBER VISUAL CHECK	TOOL CHECK	LENS DUST CHECK	WIPER INSTALLED	CHILLER WORKING?
EJ	EJ	EJ	EJ	EJ

VALVES OPEN	FLASKS EMPTY?	HEAT SOAK START	BUILD SELECT	AIRCON WORKING?
EJ	EJ	EJ	EJ	EJ

DOSE CHECK	TUNED PLATE t	SET DATUM	DOSING %
EJ	14.262 mm EJ	EJ	46 % EJ

POWDER LEVEL	ARGON PRESSURE (ON AM250) 1500~1700 mBar	ENOUGH POWDER FOR THIS BUILD?	BUILD LAUNCH
84.1 % VAC 63.9 % EJ	1632 EJ	EJ	12:30 24/08 AM / PM EJ



RECOVER

HOME? VISUAL CHECK	VACUUM BURNED POWDER (OPEN)	BRUSH SPATULA 4mm HEX (CLOSE)	BULK POWDER RECOVERY (ABS TOP)	UNFASTEN PLATE	INVERT & SHAKE (OPEN)	FINAL ROTATE & TAP (CLOSE)	FURNACE START
CC	CC	CC	CC	CC	CC	CC	12:00 AM / PM CC

CLEAN DOWN

SEIVE START (CTR POS)	WIPER REMOVE	FULL VAC DOWN	FULL IPA WIPE DOWN	FILTLER UNLOAD & DISPOSE	NEW FILTER LOAD (CLOSE)
CC	EJ	EJ	EJ	EJ	EJ

SETUP

MEASURE BUILD PLATE t	INPUT t & PLATE 4mm HEX	NEW WIPER INSTALL 5mm HEX	SET WIPER HEIGHT 5mm HEX	LENS CLEAN (CLOSE)	ALL POWDER SEIVED?
14.098 mm EJ	EJ	EJ	EJ	EJ	EJ

14.030 13.016
(14.098) 14.020

BUILD RUN

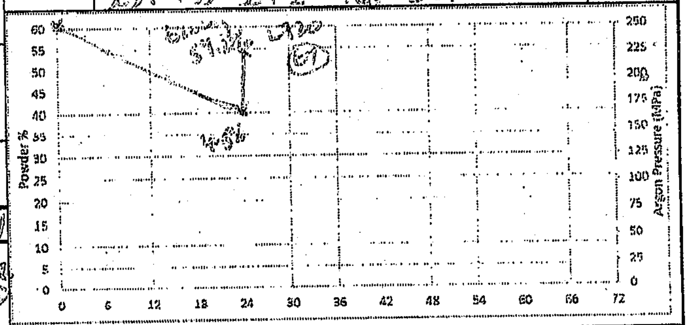
BUILD NAME: 505A 135 SET 2 166 SET — 60 µm

CHAMBER VISUAL CHECK	TOOL CHECK	LENS DUST CHECK	WIPER INSTALLED	CHILLER WORKING?
EJ	EJ	EJ	EJ	EJ

VALVES OPEN	FLASKS EMPTY?	HEAT SOAK START	BUILD SELECT	AIRCON WORKING?
EJ	EJ	EJ	EJ	EJ

DOSE CHECK	TUNED PLATE t	SET DATUM	DOSING %
EJ	14.016 mm EJ	EJ	41 % EJ

POWDER LEVEL	ARGON PRESSURE (ON AM250) 1500~1700 mBar	ENOUGH POWDER FOR THIS BUILD?	BUILD LAUNCH
61.0 % EJ	1915 EJ	EJ	17:00 27/08 AM / PM EJ



RECOVER

HOME? VISUAL CHECK	VACUUM BURNED POWDER (OPEN)	BRUSH SPATULA 4mm HEX (CLOSE)	BULK POWDER RECOVERY (ABS TOP)	UNFASTEN PLATE	INVERT & SHAKE (OPEN)	FINAL ROTATE & TAP (CLOSE)	FURNACE START
EJ	EJ	EJ	EJ	EJ	EJ	EJ	11:45 01/09 AM / PM EJ

CLEAN DOWN

SEIVE START (CTR POS)	WIPER REMOVE	FULL VAC DOWN	FULL IPA WIPE DOWN	FILTEER UNLOAD & DISPOSE	NEW FILTER LOAD (CLOSE)
EJ	EJ	EJ	EJ	EJ	EJ

SETUP

MEASURE BUILD PLATE t	INPUT t & PLATE 4mm HEX	NEW WIPER INSTALL 5mm HEX	SET WIPER HEIGHT 5mm HEX	LENS CLEAN (CLOSE)	ALL POWDER SEIVED?
14.300 mm EJ	EJ	EJ	EJ	EJ	EJ

14.300 14.299
14.300 14.300

Annex F

to An Investigation into the Handlebar Failure that Occurred in the Australian Men's Team Pursuit race at the Tokyo 2020 Olympics
November 2021

TECHNICAL REPORT

TR-CA-06-001

Confidential	Y ✓	N
Retention Date	16 Jul 2026	

PROJECT	CA-06 BASE BAR	DATE	17 July 2019

TITLE: ***ISO 4210-2:2015 4.7 Safety Requirements for Bicycles (Steering) Testing***

SUB TITLE: **CA-06 Base Bar ISO Bench Strength and Fatigue Testing**

Distribution List

Copy	Qty
Internal	1
CA	1
Total	2

AIM:

To assess the strength and durability performance of the CA-06 design base bar when subjected to the relevant ISO standard bench tests.

CONCLUSION :

The base bar completed ISO tests in sequence with no permanent deformation or structural damage.

TEST APPLICABILITY:

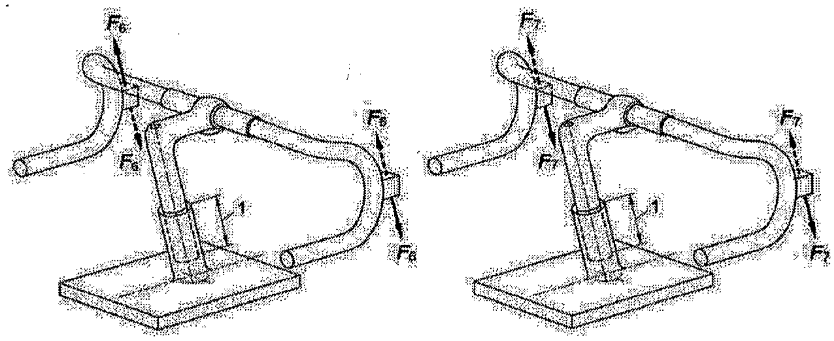
Applicable tests conducted as requested from the client below:
Number of cycles was conducted as "mini-durability". 6 Hours of runtime, comprising 25k + 25k cycles.

ISO 4210-2:2015

4.7	**Steering**	**Applicable**
4.7.1	Handlebar - Dimensions	N
4.7.2	Handlebar grips and plugs	N
4.7.3	Handlebar stem - Insertion-depth mark or positive stop	N
4.7.4	Handlebar stem to fork steerer - Clamping requirements	N
4.7.5	Steering stability	N
4.7.6	Steering assembly - Static strength and security tests	-
4.7.6.1	Handlebar stem - Lateral bending test	N
4.7.6.2	Handlebar & stem assemble - Lateral bending test	N
4.7.6.3	Handlebar stem - Forward bending test	N
4.7.6.4	Handlebar to handlebar stem - Torsional security test	N
4.7.6.5	Handlebar stem to fork steerer - Torsional security test	N
4.7.6.6	Bar end to handlebar - Torsional security test	N
4.7.6.7	Aerodynamic extensions to handlebar - Torsional security test	N
4.7.7	**Handlebar and stem assembly - Fatigue test**	Y

TEST METHOD:

Custom test jigs were manufactured and setup at BAED in the following configurations:
4.7.7: Fatigue Test:



a) Stage 1 — Out-of-phase loading

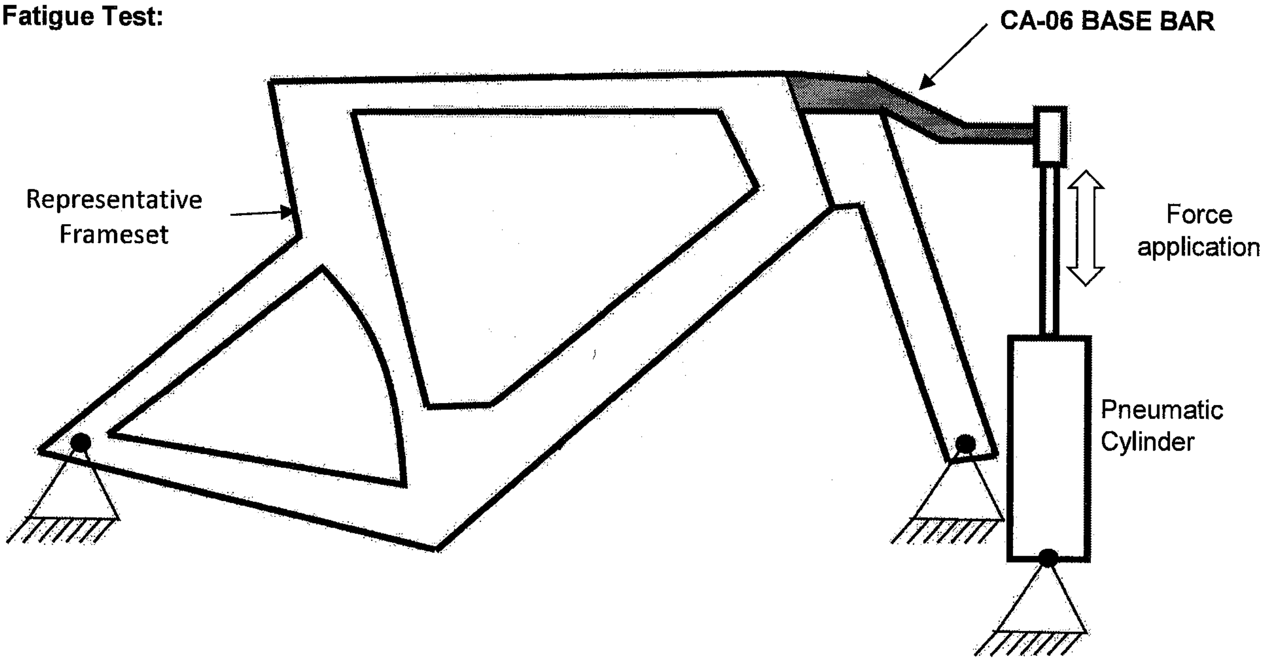
b) Stage 2 — In-phase loading

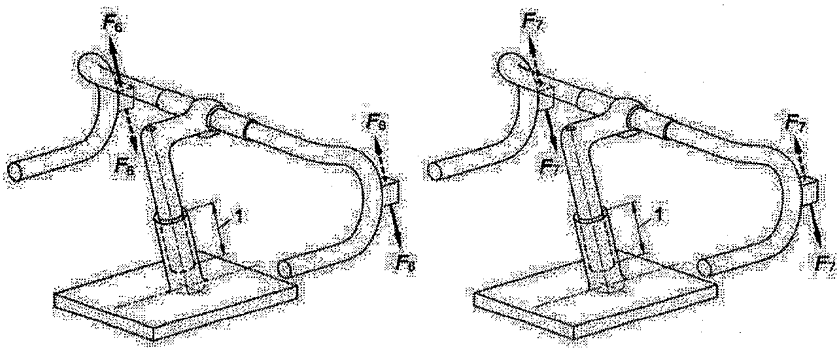
Bicycle type		Racing bicycles
Stage 1	Force, F_6	280
Stage 2	Force, F_7	400

BASTION ADVANCED ENGINEERING & DESIGN
TECHNICAL DEPT.

This report has been produced for the purpose of internal reporting and record keeping only. Do not copy or distribute without the express permission of Bastion Advanced Engineering & Design.	**ENDORSED**	**ENDORSED**	**PREPARED**
	Ben Schultz	James Woolcock	James Woolcock
	Date:18/7/2019	Date:18/7/2019	Date:17/7/2019

4.7.7: Fatigue Test:

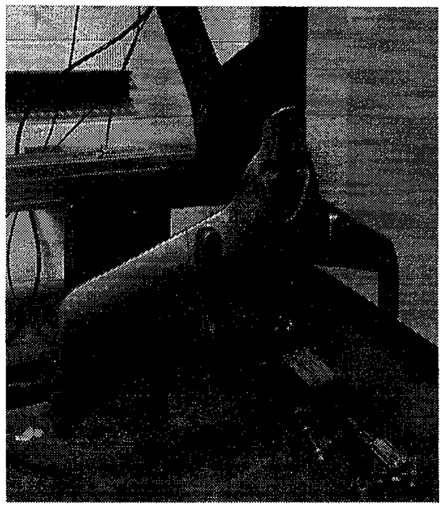




a) Stage 1 — Out-of-phase loading   b) Stage 2 — In-phase loading

Bicycle type		Racing bicycles
Stage 1	Force, F_6	280
Stage 2	Force, F_7	400

Test Article



REQUIREMENTS & RESULTS:

Test	ISO 4210-2:2015 Boundary Conditions	Result	Judge
4.7.7 Fatigue Test	No cracking after: 25,000 cycles at Stage 1, followed by 25,000 cycles at Stage 2	No damage observed	OK

NOTES:

MATERIAL CERTIFICATE No: MC-21-0287

Customer: BASTION Advanced Engineering, 412 Heidelberg Road, Fairfield VIC 3078, Australia
Purchase Order: PO-0099
Material Description: Ti-6Al-4V Grade 5 Powder
Size: 15-45 µm
Specification: ASTM F2924

Laboratory No:
Internal Order:
Lot #: 192-G2127
Quantity: 40 kg

Item	Unit	Min. limit	Max. limit	Measured value	Specification	Testing Method	Status
			POWDER COMPOSITION				
Al	Wt. %	5.50	6.75	6.26	ASTM F2924	ASTM E2371-13	Conforming
V	Wt. %	3.50	4.50	4.01	ASTM F2924	ASTM E2371-13	Conforming
N	Wt. %	-	0.05	0.02	ASTM F2924	ASTM E1409-13	Conforming
C	Wt. %	-	0.08	0.02	ASTM F2924	ASTM E1941-10 (R2016)	Conforming
Fe	Wt. %	-	0.30	0.21	ASTM F2924	ASTM E2371-13	Conforming
H	Wt. %	-	0.015	0.002	ASTM F2924	ASTM E1447-09 (R2016)	Conforming
O	Wt. %	-	0.20	0.18	ASTM F2924	ASTM E1409-13	Conforming
Y	Wt. %	-	0.005	< 0.001	ASTM F2924	ASTM E2371-13	Conforming
Other Total	Wt. %	-	0.40	< 0.20	ASTM F2924	ASTM E2371-13	Conforming
Other Each	Wt. %	-	0.10	< 0.10	ASTM F2924	ASTM E2371-13	Conforming
Ti	Wt. %	Balance	Balance	Balance	ASTM F2924	-	-
			PARTICLE SIZE DISTRIBUTION				
> 63 µm	Wt. %	-	-	0.0	-	ASTM B214-16	NA
> 45 µm	Wt. %	-	-	5.8	-	ASTM B214-16	NA
< 45 µm	Wt. %	-	-	94.2	-	ASTM B214-16	NA
D10	µm	-	-	23	-	ASTM B822-20*	NA
D50	µm	-	-	35	-	ASTM B822-20*	NA
D90	µm	-	-	47	-	ASTM B822-20*	NA
< 15 µm	Vol. %	-	-	1	-	ASTM B822-20*	NA
			FLOW RATE				
FR Hall	s/50g	-	-	28	-	ASTM B213-20	NA
			DENSITY				
AD Hall	g/cm³	-	-	2.57	-	ASTM B212-17	NA

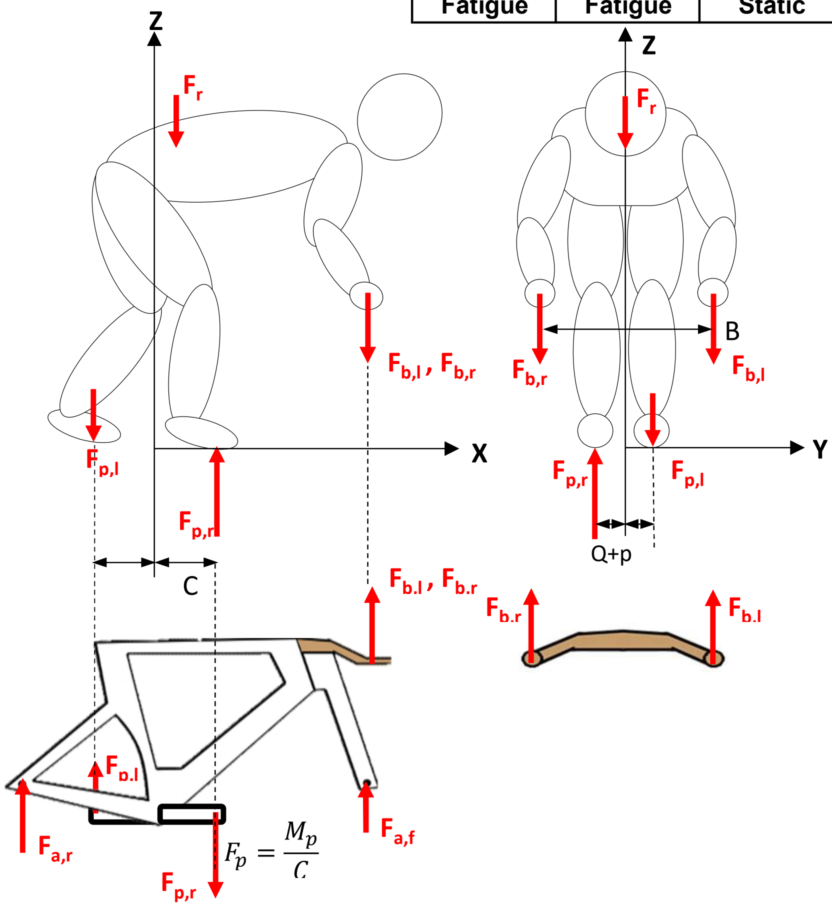
* Particle size distribution as per ASTM B822 (Coulter® LS Particle Size Analyzer)

CA-06 Base Bar Standing Start Load Analysis

Aim: Calculate Loads & Stresses using Crank Torque measurements from Glaetzer and compare to supplied load cases.

Conclusion: Calculated loads are significantly higher than supplied design load cases. The resultant stresses are up to 371% higher than with the supplied requirements. Worst Safety Factor reduces from 2.97 to 0.65.

			SUPPLIED REQUIREMENTS			NEW INFORMATION		
			ISO 4210 Out-of-Phase 280N	ISO 4210 In-phase 400N	Proof Load 100kgf	Max Single Leg Torque	Two Leg Torque Static	Two Leg Torque Fatigue
Pedal Torque, right	$M_{p,r}$	Nm	-	-	-	410	410	410
Pedal Torque, left	$M_{p,l}$	Nm	-	-	-	0	95	95
Pedal Torque, total	M_p	Nm	-	-	-	410	505	505
Rider weight	W_r	kg	-	-	-	95	95	95
Crank length	C	mm	-	-	-	175	175	175
Bar width	B	mm	360	360	360	360	360	360
Crank Width (Q-factor)	Q	mm	-	-	-	72	72	72
Pedal Length	p	mm	-	-	-	53	53	53
Force, pedal right	$F_{p,r}$	N	-	-	-	2,342.9	2,342.9	2,342.9
Force, pedal left	$F_{p,l}$	N	-	-	-	0.0	542.9	542.9
Force, rider	F_r	N	-	-	-	932.0	932.0	932.0
Force, bar right	$F_{b,r}$	**N**	**280**	**400**	**981.0**	**1,518.9**	**1,436.0**	**1,436.0**
Force, bar left	$F_{b,l}$	**N**	**-280**	**400**	**-981.0**	**-108.0**	**-568.0**	**-568.0**
Net Bar Bending Force	F_b	**N**	**0.0**	**800.0**	**0.0**	**1410.9**	**868.1**	**868.1**
Net Bar Torsion	T_b	**Nm**	**-50.4**	**71.9**	**-353.2**	**-292.9**	**-360.7**	**-360.7**
Max Stresss (FEA)	σ	**MPa**	**79**	**23**	**97**	**359.5**	**305.2**	**305.2**
% Change	△	**%**	-	-	-	**371%**	**315%**	**315%**
Design Safety Factor			**2.97**	**10.22**	**8.87**	**0.65**	**2.82**	**0.77**
Design Stress Limit		**MPa**	235	235	860	235	860	235
			Fatigue	**Fatigue**	**Static**	**Fatigue**	**Static**	**Fatigue**



Rider Free-Body Equations

$$\Sigma F_z = 0$$

$$F_{p,r} - F_{p,l} - F_r - F_{b,r} - F_{b,l} = 0$$

$$F_{b,l} = F_{p,r} - F_{p,l} - F_r - F_{b,r}$$

$$\Sigma M_{x\,@\,b,l} = 0$$

$$F_{b,r}.B + F_r.\frac{B}{2} + F_{p,l}.\left(\frac{B}{2} - Q - p\right) - F_{p,r}.\left(\frac{B}{2} + Q + p\right) = 0$$

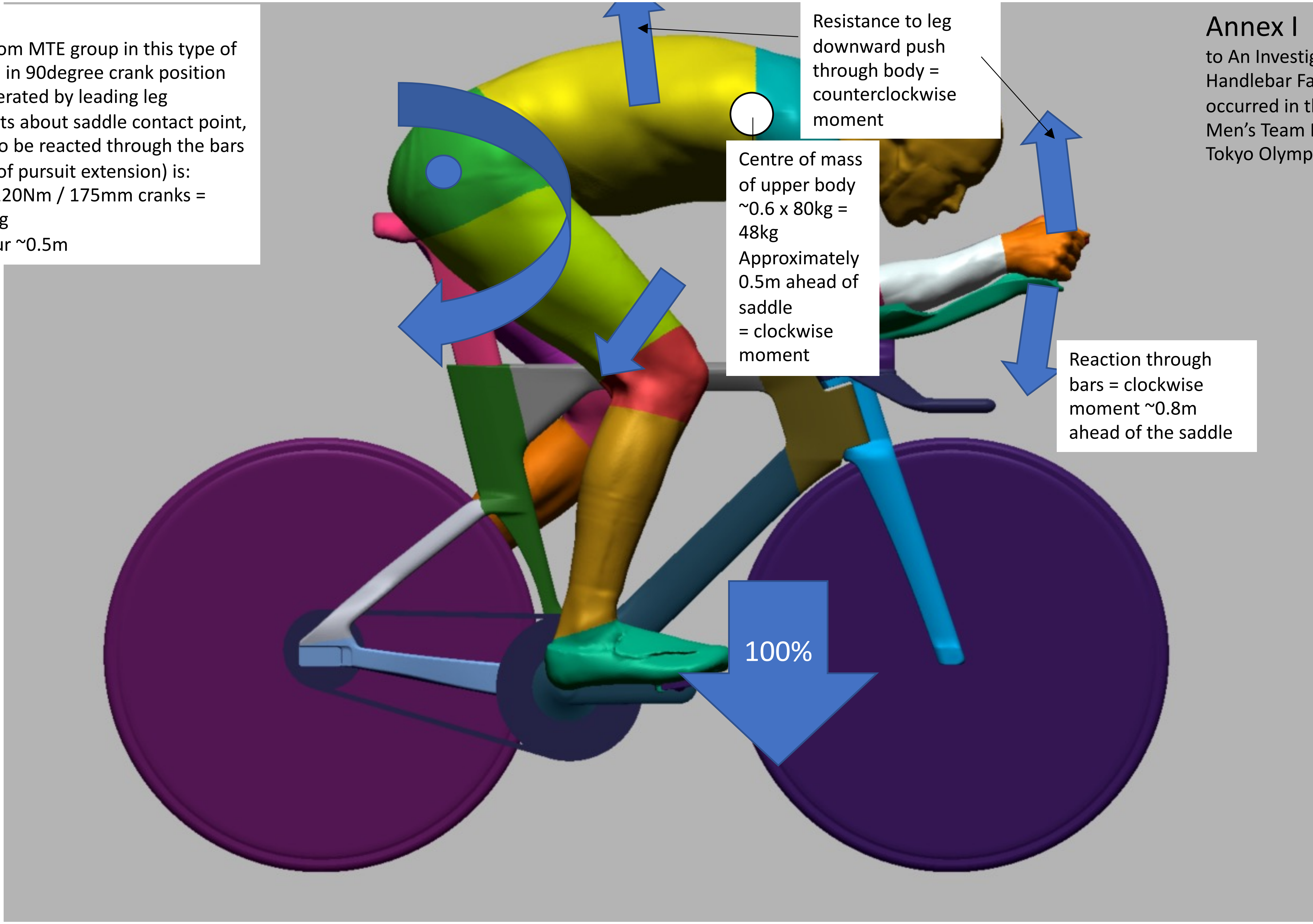
$$F_{b,r} = \frac{F_{p,r}.\left(\frac{B}{2} + Q + p\right) - F_{p,l}.\left(\frac{B}{2} - Q - p\right) - F_r.\frac{B}{2}}{B}$$

Annex I

to An Investigation into the Handlebar Failure that occurred in the Australian Men's Team Pursuit race at the Tokyo Olympics

Worst case:

- Peak torque from MTE group in this type of effort ~220Nm in 90degree crank position
- All torque generated by leading leg
- Taking moments about saddle contact point, load that has to be reacted through the bars (via hand grip of pursuit extension) is:
- pedal force = 220Nm / 175mm cranks = 1,257N = 128kg
- Length of femur ~0.5m



Moment calcs about saddle (~ hip joint)

- Counterclockwise

= Pedal force * femur length = 1257N * 0.5m = 628Nm

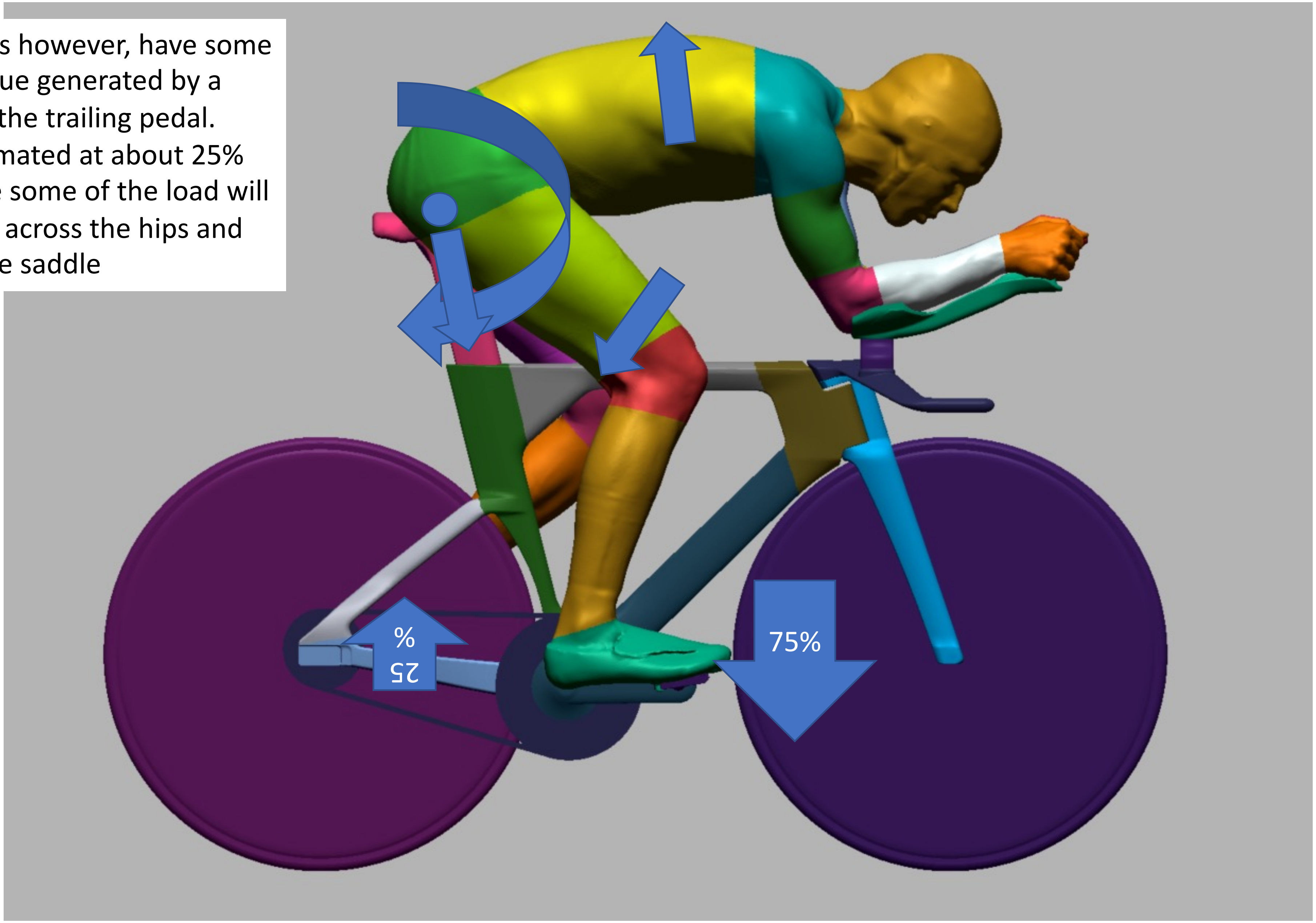
- Clockwise

= mg_upper body * 0.5m = 48*9.81*0.5 = 235Nm

So ~394Nm needs to be balanced out by a reaction at the handlebars at a distance of ~0.8m from the saddle

Therefore upward pull worst case on the extensions is ~490N, ~50kg

Other cases however, have some of the torque generated by a pull up on the trailing pedal.
This is estimated at about 25%
In this case some of the load will be reacted across the hips and through the saddle



AUSCYCLING INVESTIGATION – BOLT TORQUE

AIM: CLAMPING FORCE FOR 6Nm, 8Nm, 12Nm BASE BAR TO FORK TORQUE

GIVEN: Bolt Type AZ-10 (304 Stainless Steel) 6mm ϕ ·5mm pitch

From trfastening Ltd 6mm ϕ ·75mm pitch Root ϕ 4.9mm

From The Engineering Tool Box Eqla

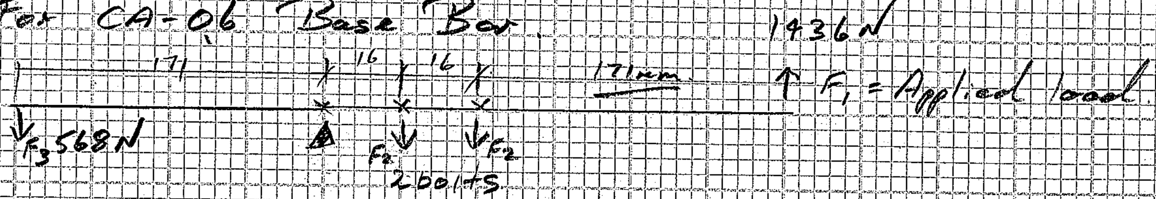
$$F = T/(Kd(1 - l/100))$$

K = friction factor = ·2 40% red for lube

d = dia in metres = ·006

T = 12Nm	F = 16,667N
8Nm	11,111N
6Nm	8,333N

For CA-06 Base Bar.



First Approximation, Worst case Σ M about ▲

Mating bolts are sufficiently close so that force is the same in each bolt – Units Nmm

$$\Sigma M_▲ \quad (568 * 171) + 1436 * (171 + 16 + 16) = 2F_2 * 16 + F_2 * 32$$

$$F_2 = \frac{(1436 * 203) + (568 * 171)}{2 * 32} = 6072N$$

$$f.o.S. = \frac{8333^{\,6Nm}}{6072} = 1.37$$

Given least bolt torque of 6Nm equates to 8,333N, a tension of 6072N gives INSUFFICIENT safety factor ∴ may cause Base Bar to steering fork movement. Using 12Nm gives 2.7 safety factor

Annex K
to An Investigation into the Handlebar Failure that Occurred in the Australian Men's Team Pursuit race at the Tokyo 2020 Olympics
November 2021

BASTION
ADVANCED ENGINEERING

TAX INVOICE

Cycling Australia

Invoice Date
9 May 2019

Invoice Number
INV-0629

Reference
CA-06 BASE BAR - Initial 50%

ABN
53 604 585 640

Bastion Advanced Engineering
412 Heidelberg Road
Fairfield VIC 3078
AUSTRALIA

Description	Quantity	Unit Price	Discount	GST	Amount AUD
[CA-06] BASE BAR & STEM 35mm OFFSET | TI64 PRINT	2.00	[redacted]	[redacted]	10%	[redacted]
[CA-06] ISO & STRENGTH PROOF TESTING | 6hrs Runtime + Reporting	6.00	[redacted]		10%	[redacted]
Engineering Hours - [CA-06] Surface Data Cleanup and Prep for Print	2.00	[redacted]		10%	[redacted]
Engineering Hours - [CA-06] Internal Structure Development	8.00	[redacted]	[redacted]	10%	[redacted]
Engineering Hours - [CA-06] FEA Iterations	4.00	[redacted]	[redacted]	10%	[redacted]
[CA-06] FINAL 50% to be settled in FY19-'20	1.00	[redacted]		10%	[redacted]
				INCLUDES GST 10%	[redacted]
				TOTAL AUD	[redacted]
				Less Amount Paid	[redacted]
				AMOUNT DUE AUD	0.00

Due Date: 24 May 2019
Domestic Electronic Funds Transfer (EFT) :
Account: BASTION PTY LTD
BSB: 013332
ACN: 455485956

Overseas Electronic Funds Transfer (EFT):
SWIFT Code/BIC: ANZBAU3M
Bank: AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED
Branch: GLENFERRIE
Address: 687 GLENFERRIE ROAD GLENFERRIE VIC 3122 AUSTRALIA
Account No.: 455485956

Terms & Conditions:
Net 7days

Annex 4
to An Investigation into the Handlebar Failure that
Occurred in the Australian Men's Team Pursuit race at the
Tokyo 2020 Olympics
November 2021

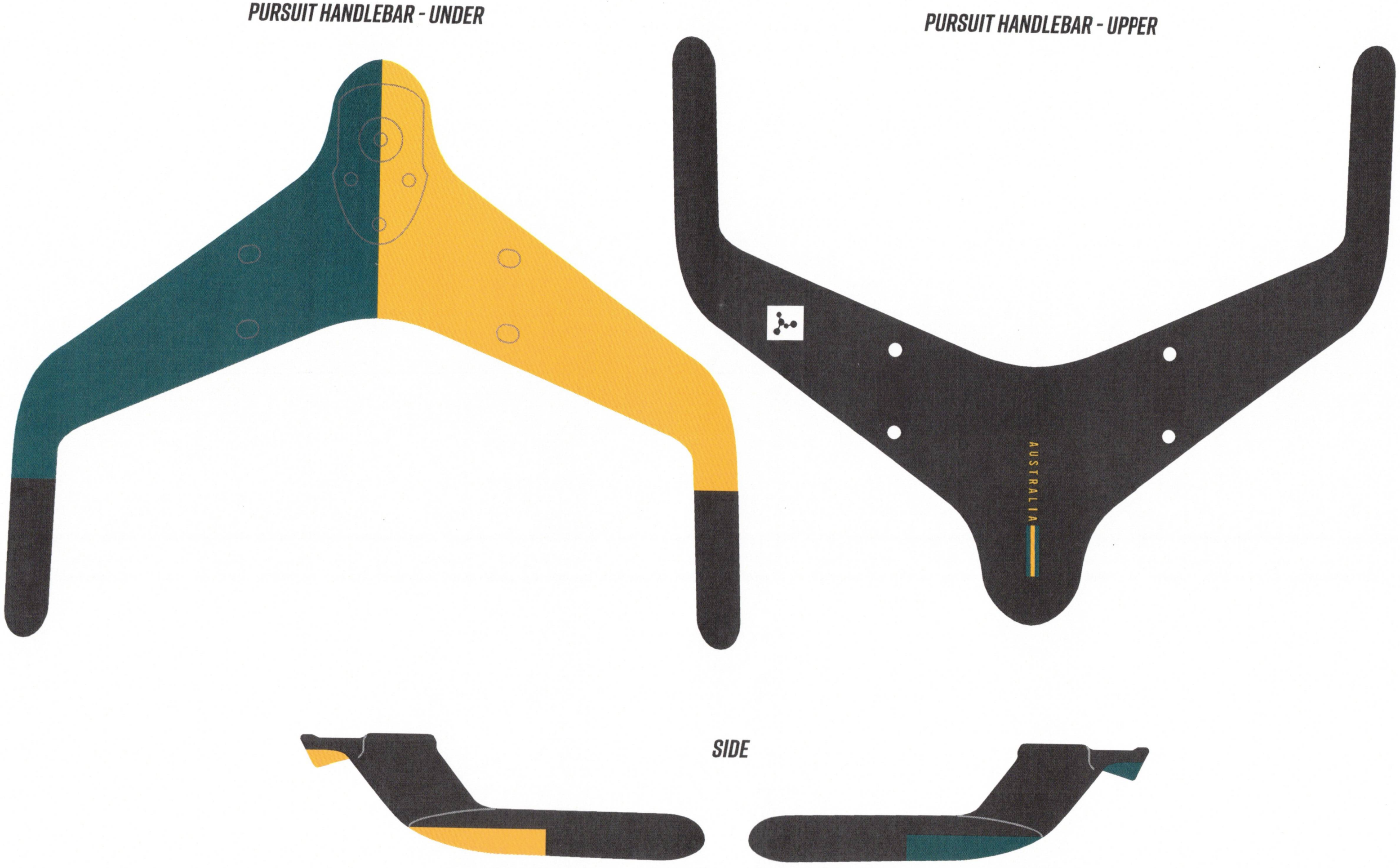
der paint of the handlebar
the inside colors of the
reen on the left side
low on the right side).
al is to keep the bike
but with subtle details
nside. The bike will look
nt from the inside Vs
of the track.

CALS
phics

- FROZEN BLACK
- COLORS UNDER SATIN VARNISH

COLOURS
Based on Santini Artwork.

330 C
7548 C



ARGON 18

AUSCYCLING TERMS OF REFERENCE – EQUIPMENT FAILURE

This document forms the terms of reference of an investigation into the handlebar failure that occurred in the Australian Men's Team Pursuit race at the Tokyo 2020 Olympics.

Background
On 2 August 2021, Alex Porter crashed whilst competing in the qualifying ride of the men's team pursuit event in the Track Cycling competition at the Tokyo Olympics. The Australian team were just over 1km in to the 4000m race when Porter, riding at the rear of the four riders, crashed to the track. The handlebars of Porters bike disconnected from the bike resulting in the athlete crashing to the track and sustaining injuries to his face and body.

Overview
The Board and Management of AusCycling considers the safety of our athletes one of our highest priorities and as such, will undertake a thorough and independent investigation to determine the cause of the 'failure of equipment' that led to the accident involving Alex Porter at the 2020 Tokyo Olympics.

Scope
The investigation will consider all elements that could conceivably have contributed to the equipment failure that occurred at the 2020 Tokyo Olympics.

AusCycling seeks to determine the following:

- What was the failure that resulted in the handlebar disconnecting from the bike?
- What was the cause of the failure?
- Why the equipment failed?
- What we need to do in future to mitigate the risks of a similar incident occurring.

Positioning
AusCycling will engage an expert independent investigator to lead the investigation and provide a report that will outline the findings and insights from the investigation and make recommendations that can be adopted by AusCycling to mitigate risks of future episodes of equipment malfunction.

The independent investigator will reach out directly to key stakeholders to gather information and insights including but not limited to the following groups:

- Australian Cycling Team Track Cycling Team athletes
- Australian Cycling Team Track Cycling Team coaches, engineer and staff
- Bastion Cycling
- Australian Institute of Sport

At the conclusion of the investigation the investigator will provide a detailed report to Australian Cycling including insights, findings and recommendations from the investigation.

A peer review of the investigation into the equipment failure will be considered to verify findings.

Investigator

John Baker, AM - Mechanical and Aeronautical engineer currently working for Copernicus Technology.

John’s background in fault finding and investigations, including conducting several aircraft crash investigations, provides the necessary experience in targeted investigations to identify cause and effect of the equipment failure.

As a qualified aeronautical and mechanical engineer John has been called as a technical expert witness in court proceedings relating to investigations.

John is independent of the cycling industry.

Bastion base bar failure investigation data collation

John Pitman, Head of Aerodynamic solutions, Australian Cycling Team

13/09/2021 v1

Distribution: Toni Cumpston, John Baker

Contents

Introduction ... 1
Definitions, terminology ... 1
Background ... 4
Information requested ... 6
Individual component information ... 6
Summary of individual component use ... 8
Bastion base bar usage @ Brisbane camp ... 8

Introduction

This document aims to present relevant, factual information related to the usage of the Bastion CA06 base bar in team pursuit cycling, from the point of view of the Australian Cycling Team. The specific motivation being the failure of one of these parts during use by Alex Porter on 2nd August 2021 in the qualifying round of the Tokyo 2020 Olympic games at Izu Velodrome.

Definitions, terminology

See Figure 1

- Base bar
    - The part that failed – subject of this study.
    - Bolts directly onto the top of the fork
- Spacer stack
    - Bolts onto the base bar, to support the extensions
    - 3D printed titanium, made by Bastion
- Extension
    - 2x pieces that fix onto the top of the spacer stack
    - Come in 4x different lengths
    - Made by Argon 18
    - Carbon fibre
- Arm rest
    - 3D printed (with carbon filament, by the AIS) ergonomic part that bolts onto the top of the extension
- Fork

    - Mounts to front of frame. Aluminium alloy + carbon
- Frame
- ACT – Australian Cycling Team – high performance division of AusCycling
- Team pursuit: 4x men/women timed event. Standing start, 4km distance (16 laps of the 250m velodrome)
- Argon 18: Bike partner of the Australian Cycling Team. Canadian based. Manufacturing done by 3rd party factory in China. Provided frames, forks, sprint handlebars, standard pursuit base bars

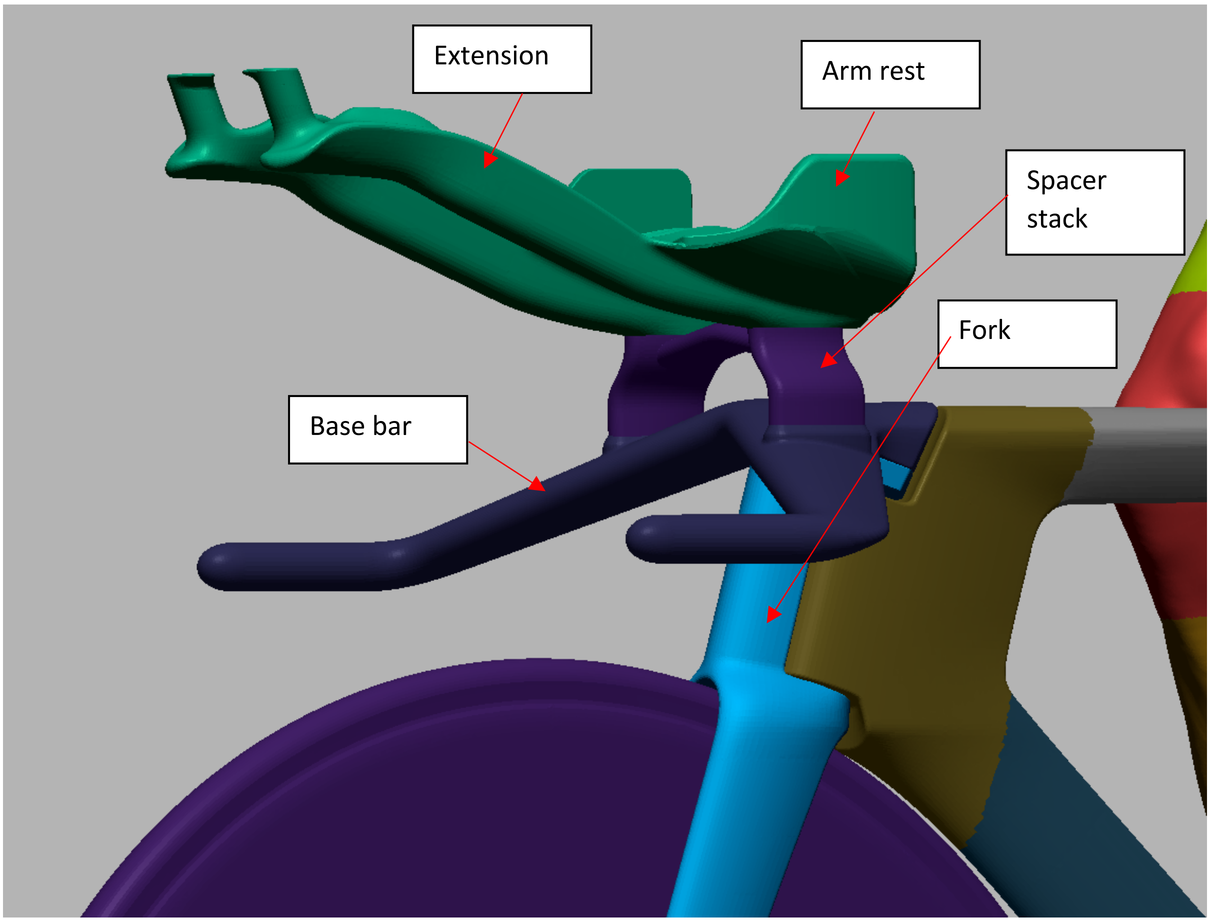


Figure 1 - Argon 18 pursuit bike front end assembly

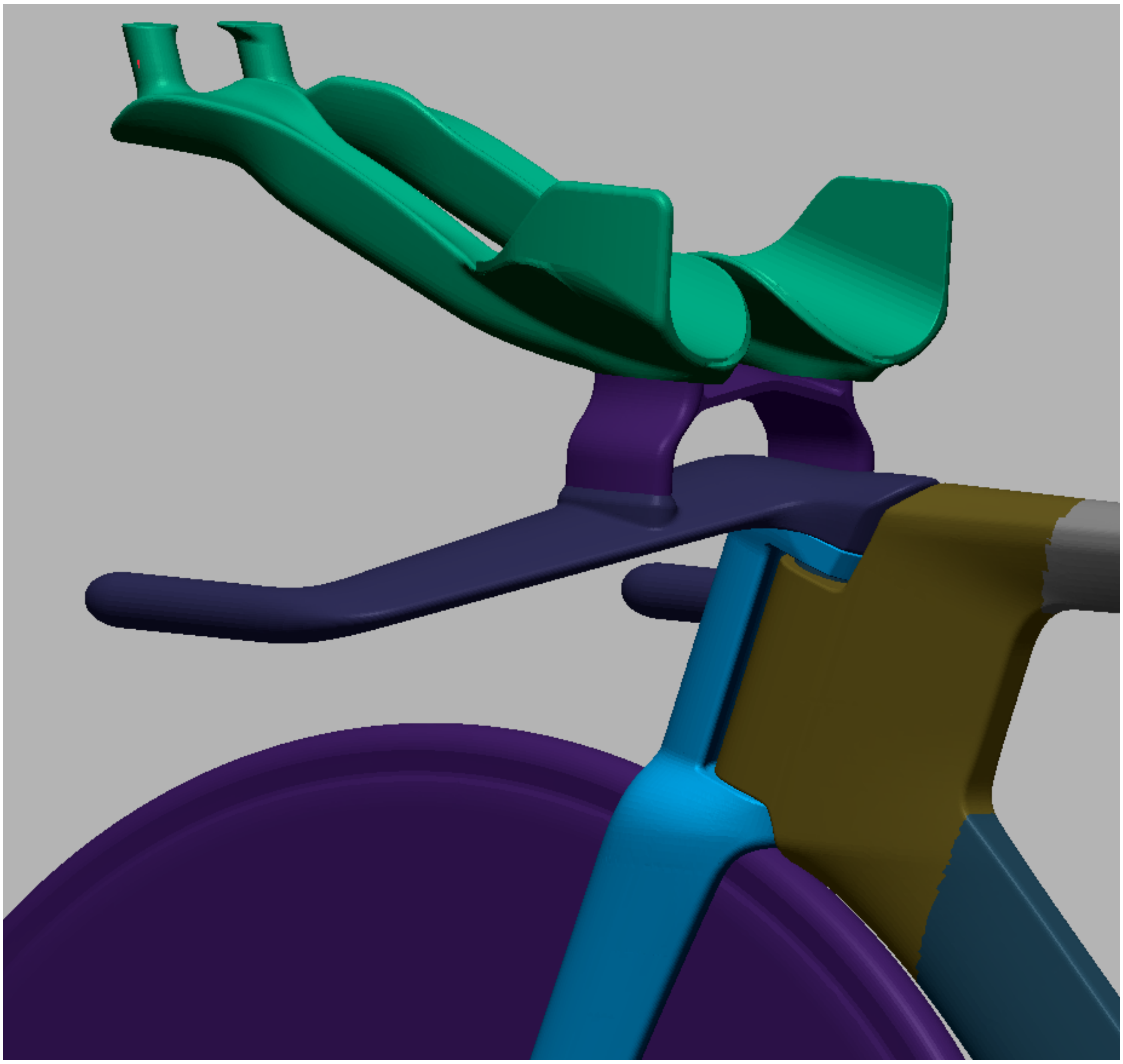


Figure 2 - Argon 18 pursuit bike front end assembly, rear iso view

Background

To gain an advantage at the start of the team pursuit, the start is anticipated and the riders throw their weight forwards at the optimal moment to begin the movement of their body mass before the bike starts moving. Alex Porter is considered one of the best in the world at this technique and in 2018, 2019, it was requested by the coach that the clearance of the base bar be increased to avoid the rider hitting their knees during the throw forwards.

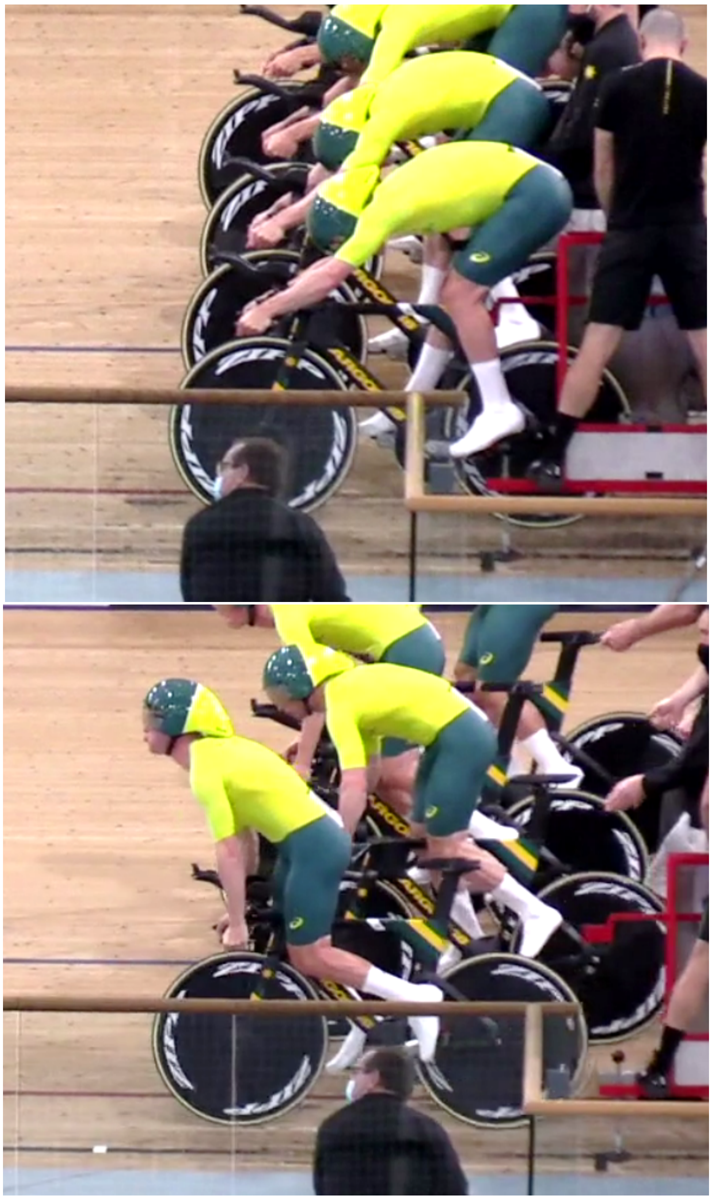


Figure 3 - Team pursuit start technique (Alex Porter closest to the camera)

The Tokyo bike project with Argon 18 had commenced in early 2018 and modifications to the base bar design were not included in the scope at the time, so the existing design was carried over. The request for more clearance came in 2019, at which point the default route for getting it implemented (Argon 18) was not feasible due to the time and cost constraints associated with carbon manufacturing with the China factory, coupled with the low quantity required. As Alex Porter was the only athlete requiring this change, a request was made in May 2019 for 2x bars to Bastion in Melbourne, with whom a successful project had been implemented – a stem for sprint handlebars, also made in 3D printed titanium. At this point in time the Tokyo Olympics was still scheduled to go ahead in 2020. Further time pressure related to the need to have finished parts in time for UCI presentation by November 2019 and the desire to get practice on the bike in the correct position.

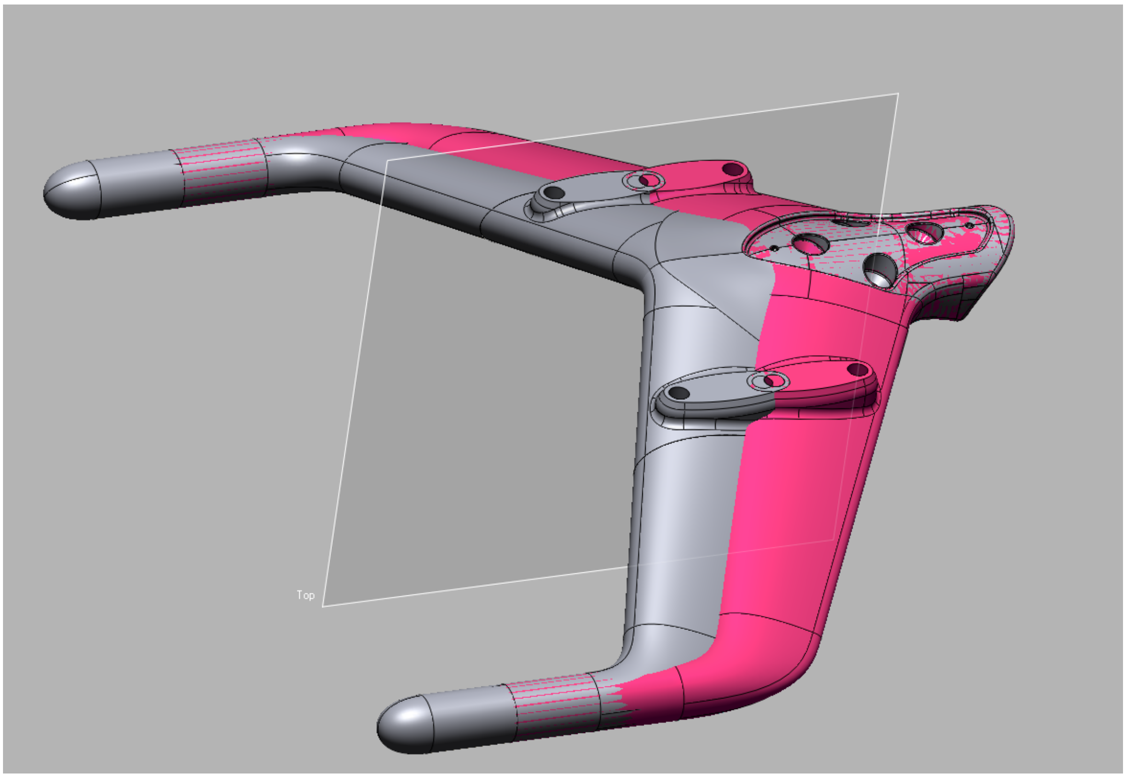


Figure 4 - Overlay of Argon18 standard pursuit base bar (pink) vs. Bastion CA06 design (grey)

Information requested

Item	Description	Motivation	Suggested Source
1	Run time (hrs) for each BASE BAR - Best Estimate	Fatigue estimation	Coaching Staff
2	No. of Hard Starts for each BASE BAR - Best Estimate	Fatigue estimation	
3	Load re-estimation for AP Hard Start	Confirm design loads	
4	Power data / measured torques for AP - last 3 months	Confirm design loads	
5	Transport Conditions of BASE BAR + confidence judgement	Confirm no damage	Mech Staff
6	Torque Check Sheet | Install SOP | Procedure Confirmation	Confirm install condition	
7	First hand account of failure.	Interpret failure mode	AP
8			

Figure 5 - Bastion info request list

Individual component information

PART REFERENCE

	#1	#2	#3	#4
				
Print Date	26-Jul-19	20-Oct-20	24-Mar-21	24-Mar-21
Shipped Date	13-Sep-19	***22-Dec-20**	24-May-21	24-May-21
Paint Spec	Green/Gold Livery	Charcoal Matte	Charcoal Matte	Charcoal Matte

Figure 6 - Bastion part identification table (from M1 memo)

Bar 1 – original part delivered, used by Alex Porter from Sept 2019 onwards. Green/yellow painted underside

Bar 2 – Initially delivered 22 Dec 2020. Found to have incorrectly machined extension mounting surfaces (see Figure 7, Figure 8). This bar was returned for re-machining in February and re-received on 10 Feb (contrary to info in Figure 6). Fitted to a number of different bikes (KO, LH whilst waiting for final parts).

Bar 3, bar 4 – Delivered May 2021 and fitted to KO, AP bikes for beginning of pre-Olympic training camp in Brisbane from June-August.

Figure 7 - Bastion bar #2 extension mounting surface issue

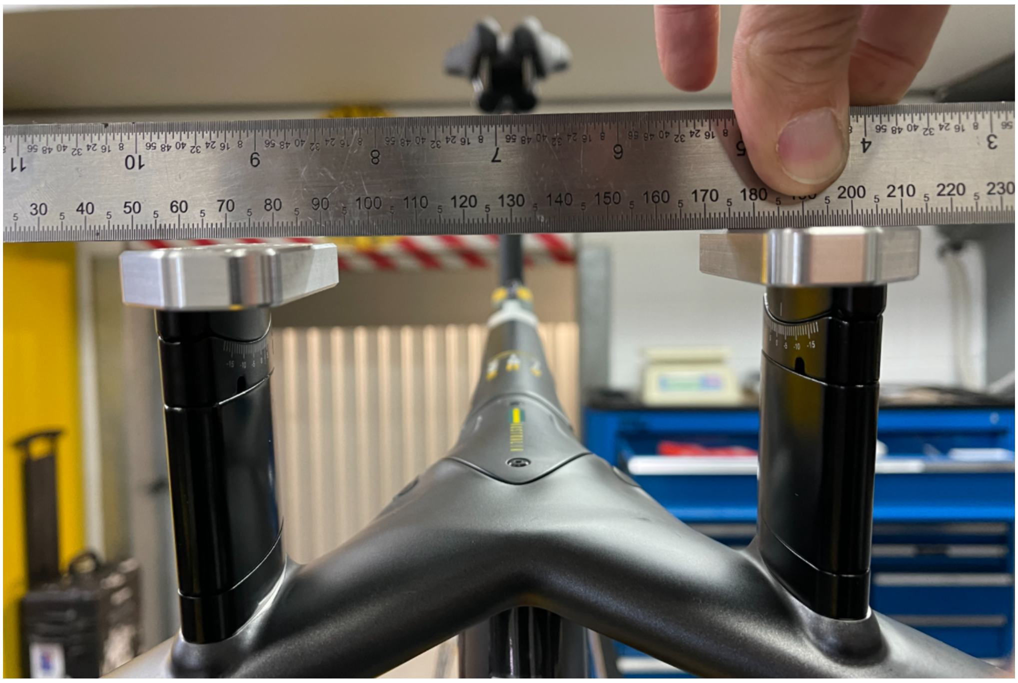


Figure 8 - Bastion bar #2 initial extension mounting surface issue

Bastion base bar usage @ Brisbane camp

Use = discrete session on the track, typically between 1-4km

Start = standing start. Most extreme forces through bike.

Note – sessions not standing start are flying/rolling start

	AP Bar #4		LH Bar #2		KO Bar #3	
	Use	**Start**	**Use**	**Start**	**Use**	**Start**
07-Jun	10	6	10	6	10	2
14-Jun	12	5	12	5	12	1
21-Jun	14	7	14	7	14	3
28-Jun	11	0	11	0	11	0
05-Jul	11	2	10	2	10	2
12-Jul	10	3	10	3	10	3
19-Jul	2	2	2	2	1	1
26-Jul	7	1	7	1	7	1
02-Aug	2	1	3	2	3	2
total	**79**	**27**	**79**	**28**	**78**	**15**

Table 2 - Brisbane camp Bastion base bar usage

Summary of individual component use

	#1	#2	#3	#4
Used in Tokyo by	Spare	Leigh Howard	Kelland O'Brien	Alex Porter
Date of first use	Sept 2019	Feb 2021	June 2021	June 2021
Number of rides pre-Brisbane camp	240(est)	40 (est)	-	-
Number of starts pre-Brisbane camp	100(est)	20 (est)	-	-
Number of rides Brisbane camp	-	79	78	79
Number of standing starts Brisbane camp	-	28	15	27
Total rides	240 (+/-20)	119 (+/-10)	78 (+/-5)	79 (+/-5)
Total standing starts	90 (+/-20)	48 (+/-10)	15 (+/-5)	27 (+/-5)

Table 3 - Summary of total Bastion base bar usage

Figure 9 - Bars #1 (top) and #2 (bottom) showing rear surface, no breather holes. Inspection holes drilled by ACT after Tokyo qualifying incident to confirm oxidisation

Figure 10 - Bars #3 (top) and #4 (bottom) showing presence of additional breather holes. Drilled hole in bar #3 by ACT to inspect oxidisation. Bar #4 is that which failed under Alex Porter

Base bar weight comparison

Figure 11 - Bastion (L) vs. Argon standard (R) base bar weights

Images of broken bar #4

Figure 12 - Bar #4 both parts held together

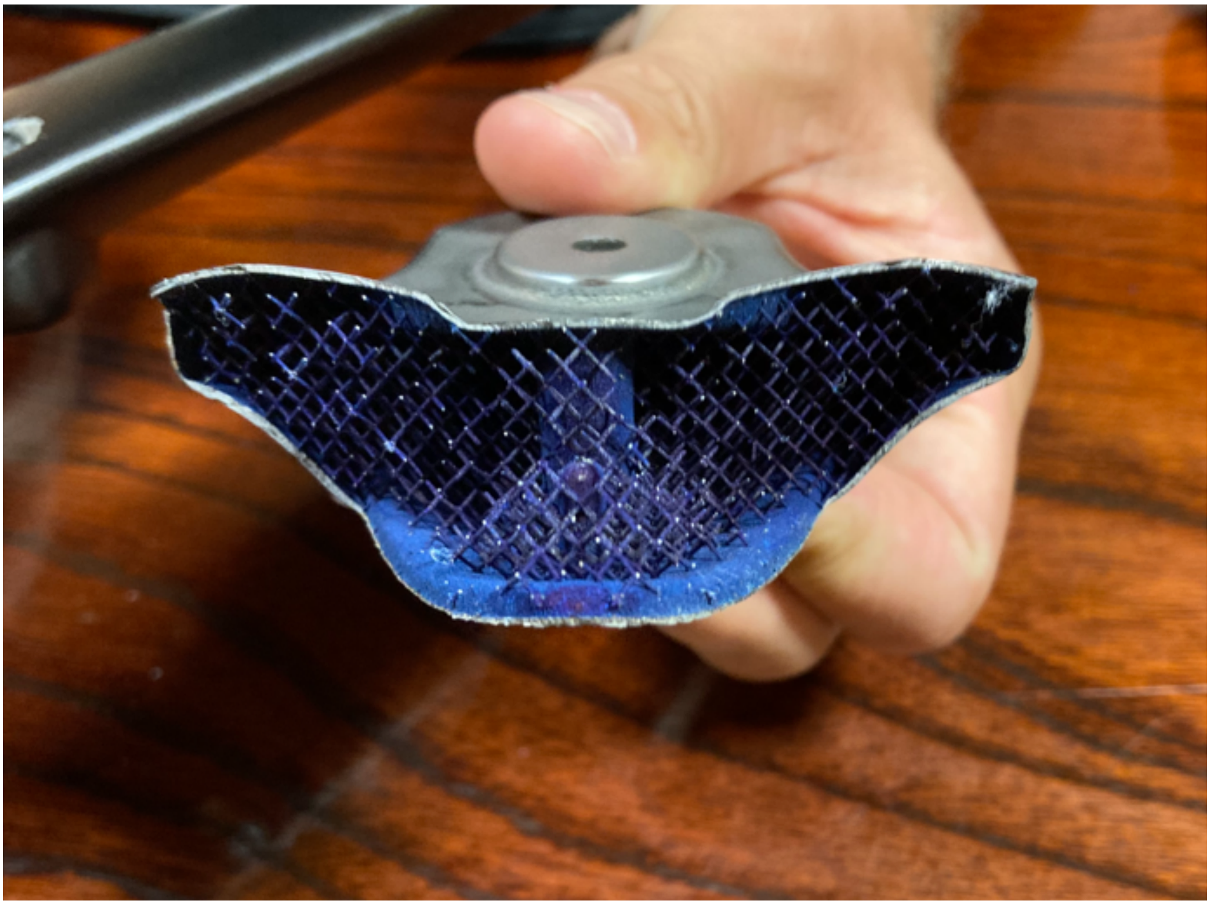


Figure 13- Bar #4

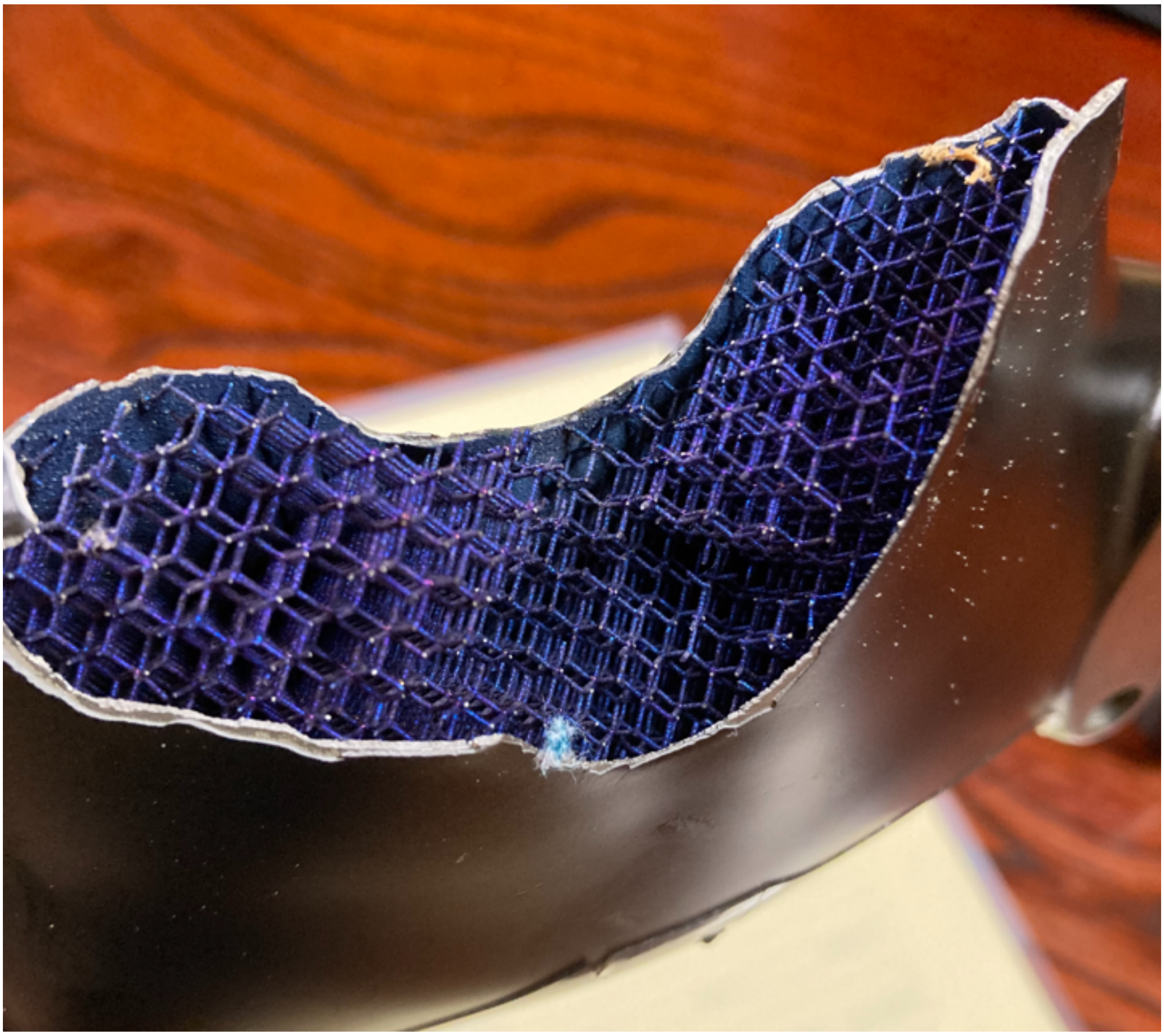


Figure 14 - Bar #4

Figure 15 - Bar #4

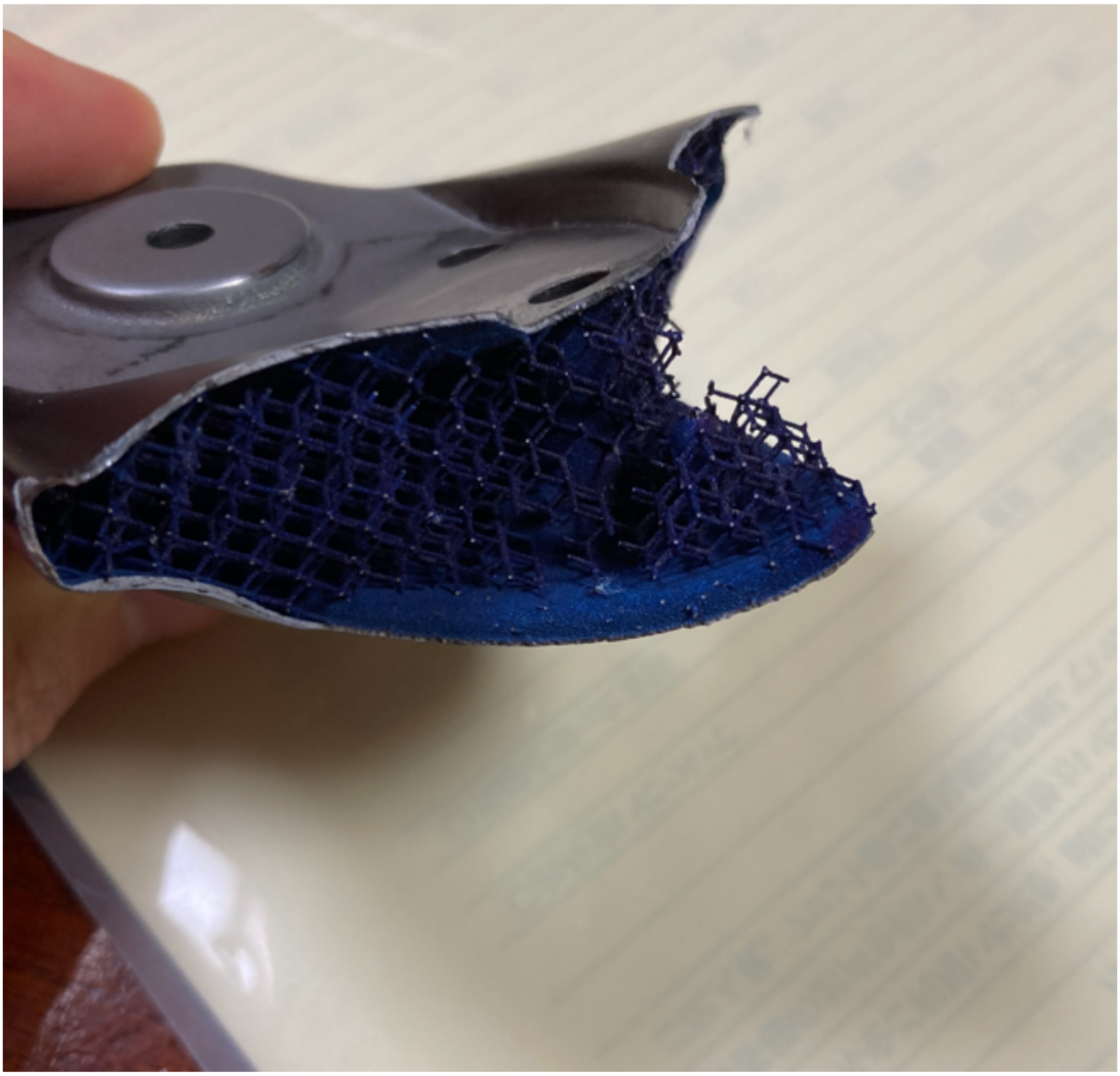


Figure 16 - Bar #4

Images of bar #1

Figure 17 - Bar #1 - original, delivered in 2019. Painted underside to match livery of standard Argon 2020 base bars. Note paint worn away at front of mounting face with fork crown. Kept as a spare and used only by AP in 2nd attempt at qualifying ride

Figure 18 - Closeup of paint worn away on bar #1

Figure 19 - Bar #1 oxidisation inspection hole

Images of bar #2

Figure 20 - Bar #2. Used by Leigh Howard in Tokyo. Note there appears to be beginning of crack forming at front of mounting face

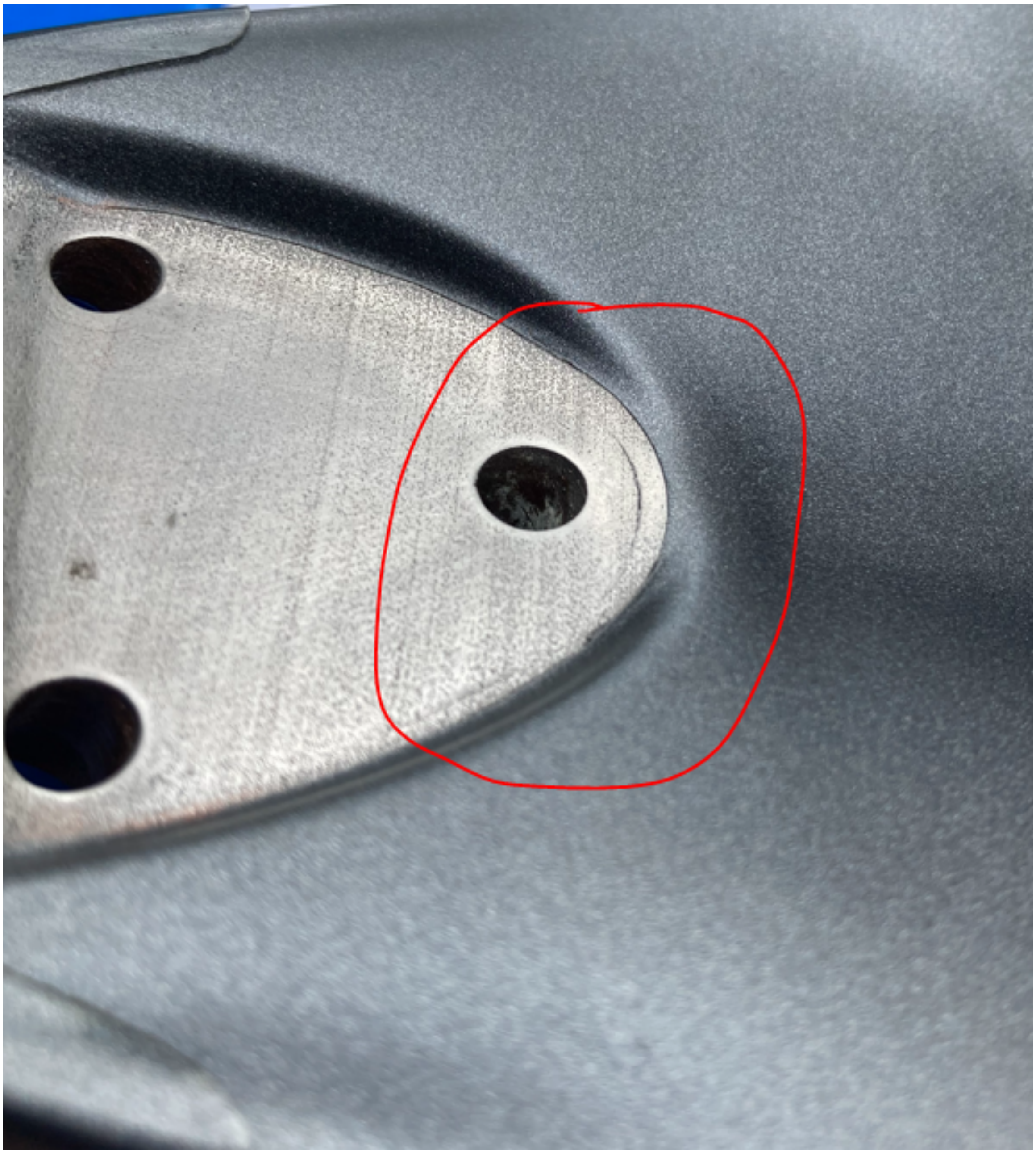


Figure 21 - Close-up of apparent crack beginning to form on bar #2

Figure 22 - Bar #2 oxidisation inspection hole

Images of bar #3

Figure 23 - Bar #3 used by Kell O'Brien in Tokyo

Figure 24 - Apparent crack beginning to form at same location on bar #3

Figure 25 - Bar #3 oxidisation inspection hole

Misc pictures

Figure 26 - Cut-through samples of Bastion Madison bars used as example of 'expected' level of oxidisation (ref Bastion)

Loading information

Two types of loading cases considered, relevant to different phases of the race:

1) – 'Pull-up' load – where athlete performs a standing start and is pulling up on the outboard base bar grips (Figure 3), reacting the forces through the pedal.
2) – Vertical load downwards through pursuit extensions. The proportion of their mass not supported by the saddle is supported by the pursuit extensions. The riders vary in how much they pull up on the hand grips when in this position, so the sign of the moment about the base bar may be positive or negative. Further, there is additional centrifugal loading when going around the velodrome banking.

Figure 27 - Alex Porter during skinsuit fitting session in Brisbane, on Tokyo cockpit assembly

Mass distribution information

Most recent mass measurement of Alex Porter was at Brisbane rehearsal ride on July 20th:

89kg including bike

Bike weight is ~8.2kg, so Alex Porter weight including clothing and helmet was ~80.8kg.

Expect Tokyo race-day mass to be within 2kg of this value.

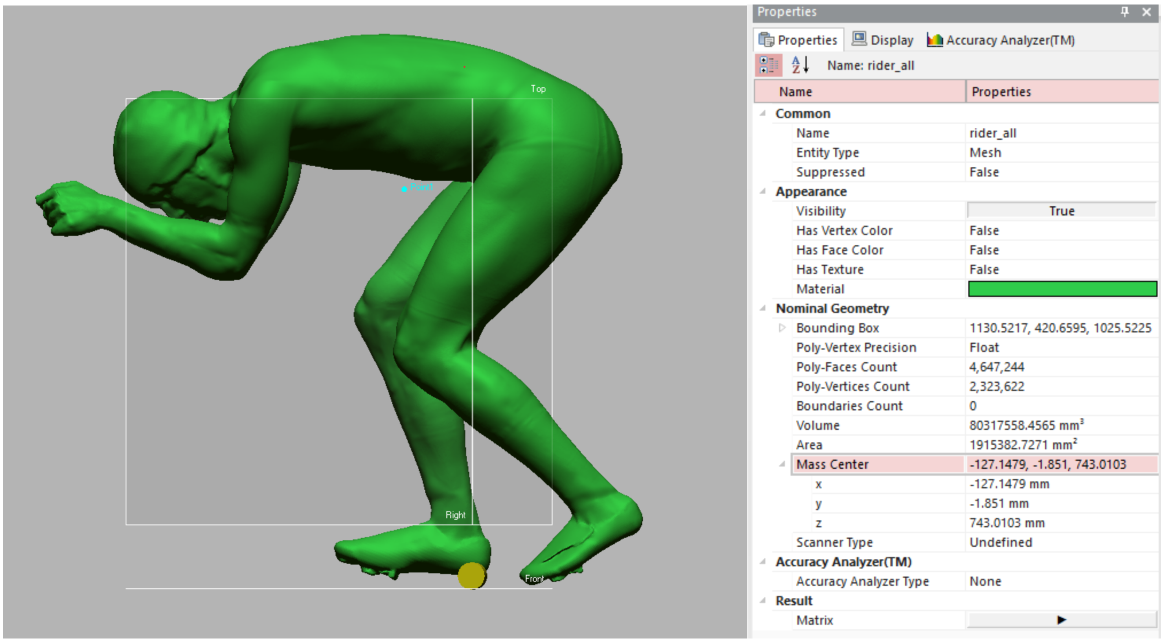


Figure 28 - Alex Porter 3D scan (from 2019) used to calculate CoM position in Geomagic DesignX

Values are relative to the bottom bracket location;

X = -127.2mm (i.e. forwards of bottom bracket)

Y = -2mm (i.e. lateral of centreline)

Z = 743mm (i.e. vertical of bottom bracket)

Bottom bracket centre is <u>279mm</u> from the ground.

Id:	1892
Published	
Athlete:	Alex Porter
Bike type:	Track
Cycling Discipline:	MENS PURSUIT
Description:	CA 2020 Argon18
Part Number:	
Serial Number:	312ASML00012MJ
Weighted Weight:	0 (kg) (0)
Measure Date:	14/07/2021
Model:	2020 Electron pro
Size:	53
Version No:	40
Is Current:	No
Comments	New frame, pre olympics 2021
Record Status:	Active
Created:	JadeL, 14/07/2021 10:00:00 AM
Modified:	JadeL, 15/07/2021 9:34:59 AM

Save athlete bike

Clone Setting to new Version

Dimension Setting | Component Setting | Service History

Save Dimension Setting

	Dimension Data	
(A) Seat Height : BB Axle to Centre of Seat ; Diagonal	762	(mm)
(Q) Seat Height Additional New Datum 50mm from nose	745	(mm)
(B) Saddle Setback from BB	51	(mm)
(D) Setback Check: Tip of Seat to Centre of Steerer Bolt ; Diagonal	490	(mm)
(C) Crank Length: Centre to Centre	175	(mm)
(E) Reach: Tip of Seat to End of Aerobar ; Diagonal	849	
(I) Reach: BB to back edge of arm pad (Centre)	514	(mm)
(F) Drop: 50mm from nose of Seat to Base of Armpad ; Vertical	150	(mm)
(G) UCI Reg: Centre of BB to End of Aero Extension ; Horizontal	794	
(G) UCI Reg: Drop from Top Extension/Shifter to Elbow Pad	95	(mm)
(I) Argon18 Pursuit Extension Size/Setting	260mm forward	(mm)
(I) Handlebar Extension Width: Outside to Outside at tips	100	(mm)
(I) Handlebar Pad Width : Centre to Centre	115	
(I) Handlebar Pad Width: Outside to Outside	200	(mm)
(H) Armrest Spacers : Vertical (* plus plate)	30 + Bastion riser	
(H) Armrest Angle (Degrees)	13.0	
(J) Steerer Spacers (Headset top-cap = 5mm)		(mm)
(K) Steerer Length		(mm)
(L) Headset		
(M) Pedals	DA w. carrier only	
(N) Shoe : Type		
(S) Shoe : Size		
(Z) Cleat : Type		
(O) Crank and Bottom Bracket Brands	FSA, SRM Imperium	
(P) Seat: Brand	Askil	
(P) Seat : Model	3D print	
(P) Seat : Angle	-2.0	
(X) RFID tag serial number		
(H) Helmet Size		
(BC) Gear ratio check		
(BC) Chain: Tension (2 spots)		
(BC) Chainring: screw torque		(Nm)
(BC) Wheel: Front Bolt (2) Torque		(Nm)
(BC) Tyre: Condition		
(BC) Tyre: Pressure		(psi)
(BC) Wheel: Valve covers		
(BC) Wheel: Rear Nut (2) Torque		(Nm)

Figure 29 - Workshop measurement record of Alex Porter's pursuit bike prior to Tokyo departure

Alex Porter power data from Tokyo qualifying ride

Notes:

- Typically, the SRM power meter and PC7 head-unit combination takes a few crank cycles to ‘wake up’ and so the first few pedal strokes from a standing start are missing from the data file
- The speed trace in Figure 30 below is for the wheel-speed. It can be seen to oscillate up and down as the bike travels through the bends. This is due to the centre of mass being leant over, and that upon which the majority of the resistive forces (inertial and aerodynamic) act. The ‘centre-of-mass’ speed remains relatively constant by comparison.
- The data in the following figures has been extracted from the native power meter software into Matlab for greater clarity

Speed at point of crash was 18.5 m/sec.

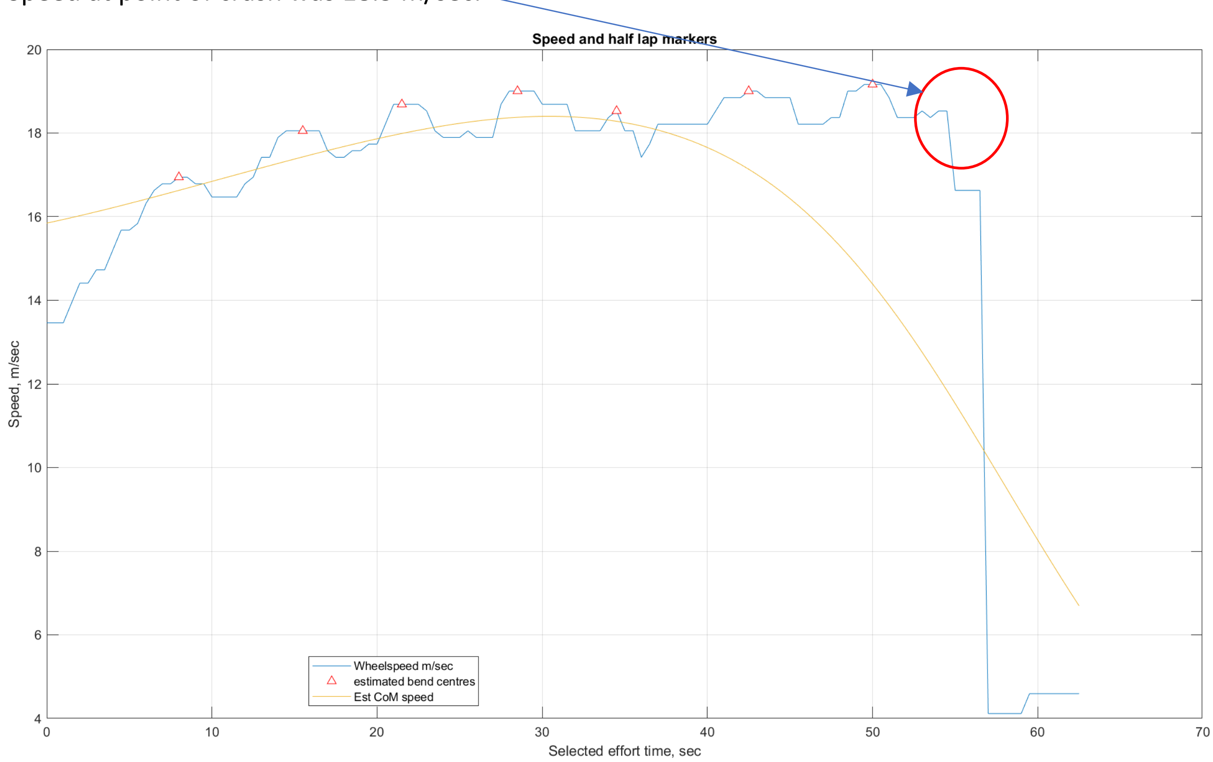


Figure 30 - Alex Porter Qualifying ride speed trace

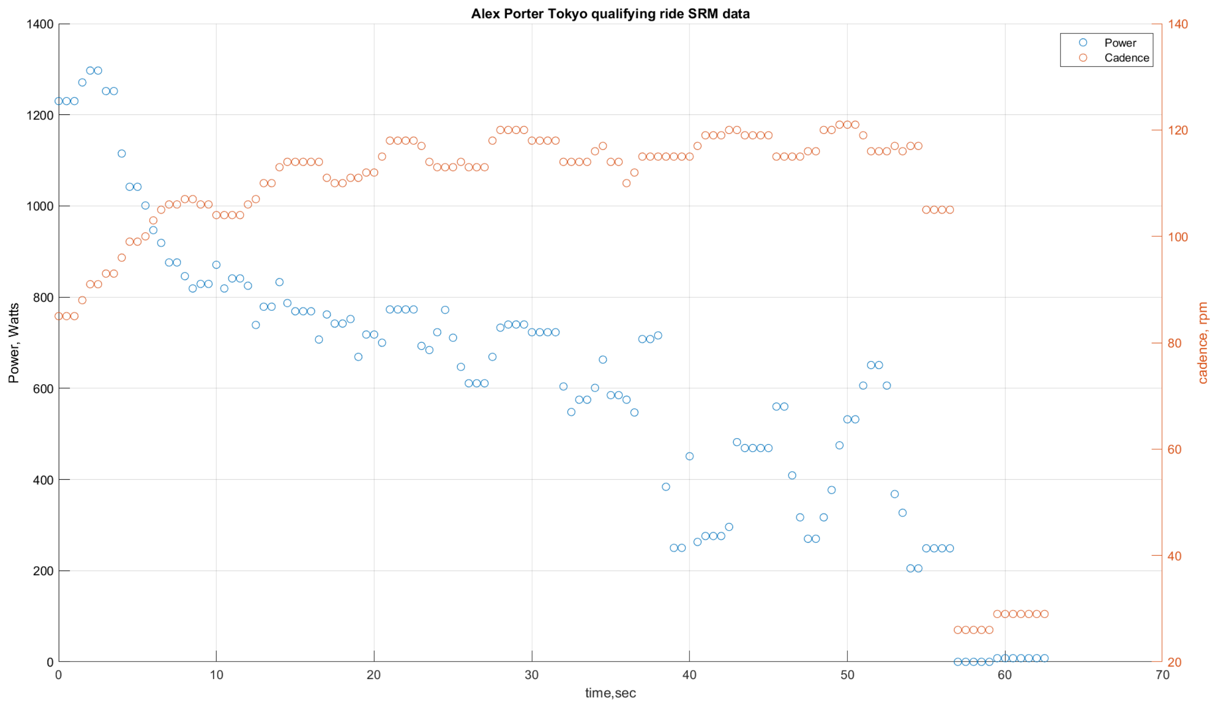


Figure 31 - Alex Porter qualifying ride SRM data - discrete data points (sampled @ 2Hz)

The data in the figure below is from the ACT performance analysis team. Key data here is the split time to the first quarter, 62.5m (i.e. the middle of the first bend).

Time to 62.5m = 8.04 sec

Assuming constant acceleration

- Velocity at 62.5m = 15.54 m/sec
- Acceleration (const) = 1.93 m/sec^2

Therefore the power meter data is beginning at just before the first quarter lap.

Team Pursuit Report: 2021-08-02 IZU OLY MTP Qual 1062 AUS

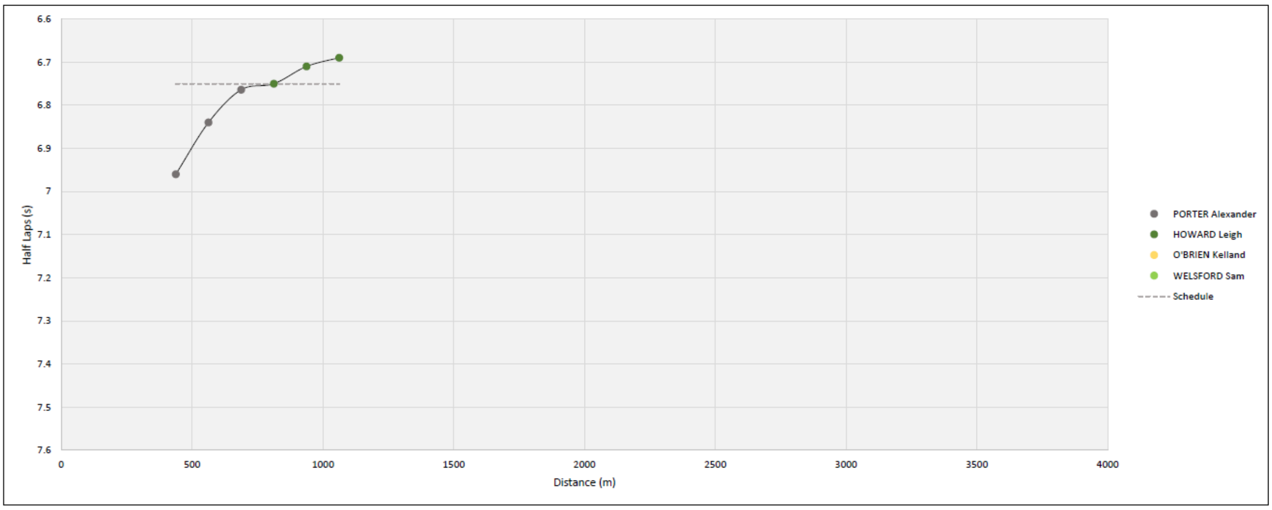
Date	2021/08/02
Season	2020
Event	OLY
Category	M
Round	Qual
Type	
Country	AUS
Team	
Air Density	1.1276
Total Time	1:04.580
Corrected Time	1:05.205
Kilometre Splits From	Video
Distance	1062.5

	PORTER Alexander	HOWARD Leigh	O'BRIEN Kelland	WELSFORD Sam
Age at Event	25.27	31.84	23.24	25.58
Gear Inch	122.40	124.20	124.20	124.20
Lead Laps	2.75	1.50		
Avg Split	6.85	6.72		
Norm Split				
Min Split	6.76	6.69		
Max Split	6.96	6.75		
Line Score %				

Start	RT	62.5m	125.0m	187.5m	250.0m	312.5m	375.0m
Individual	0.02	8.04	4.48	3.90	3.74	3.62	3.50
Elapsed	0.02	8.06	12.54	16.44	20.18	23.80	27.30

Kilometre Splits	KM1	KM2	KM3	KM4
Corrected	1:01.802			
Individual	1:01.220			
Elapsed	1:01.220			

Schedule
13.5



	PORTER Alexander		HOWARD Leigh		O'BRIEN Kelland		WELSFORD Sam	
Distance	Split	Internal Delta	Split	Internal Delta	Split	Internal Delta	Split	Internal Delta
437.5	6.96	-0.04						
562.5	6.84							
687.5	6.76							
812.5			6.75					
937.5			6.71					
1062.5			6.69					
1187.5								
1312.5	D		D		D		D	

Figure 32 - ACT performance analysis from Tokyo qualifying ride

Matt Glaetzer infocrank measurement

It can be seen from the preceding data that the peak torque bike inputs (the first few pedal strokes) are missing from the data, which does not begin until the bike is travelling at over 13 m/sec.

The following data is from a standing start by Matt Glaetzer, one of the ACT sprinters (who is approx. 10% heavier than Alex Porter and more powerful), using an Infocrank power meter, which records constant torque data at 196Hz. Each crank side has a separate measurement channel, which enables the torque applied through that crank to be seen.

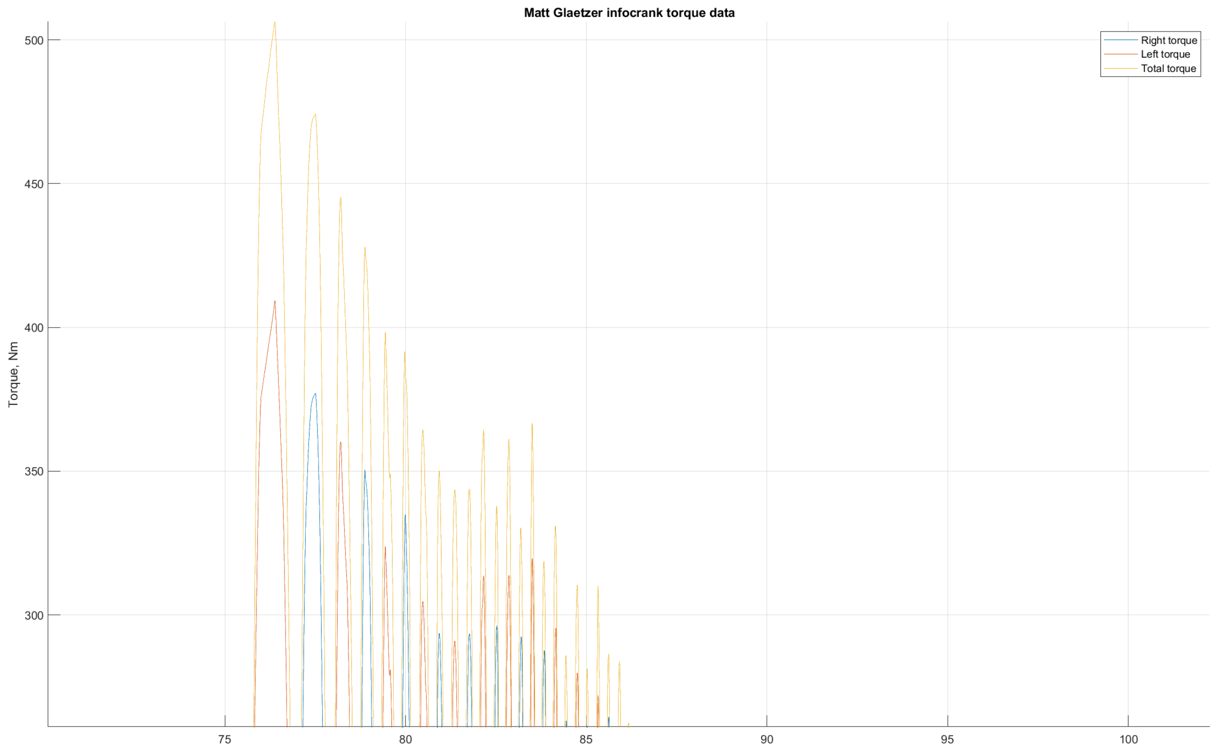


Figure 33 - Matt Glaetzer infocrank data

This is training data (and hence not full race intent) however, as Matt Glaetzer is larger and more powerful than Alex Porter, this can be considered to be a reasonable book-end estimate for a full race-effort loading case by a male team pursuit rider.

Brisbane trial ride – start technique illustration

The following data was captured with a notio konect device (which samples the same SRM power meter independent of the PC7 headunit that was used in the Tokyo recording) in the final race rehearsal in Brisbane prior to departure. It samples at 20Hz however the ANT+ radio frequency it operates across to talk to the power meter only sends data @ 1Hz.

The speed of this ride was very similar to that ridden in the Tokyo qualifying ride.

Date of this ride was 19 July 2021.

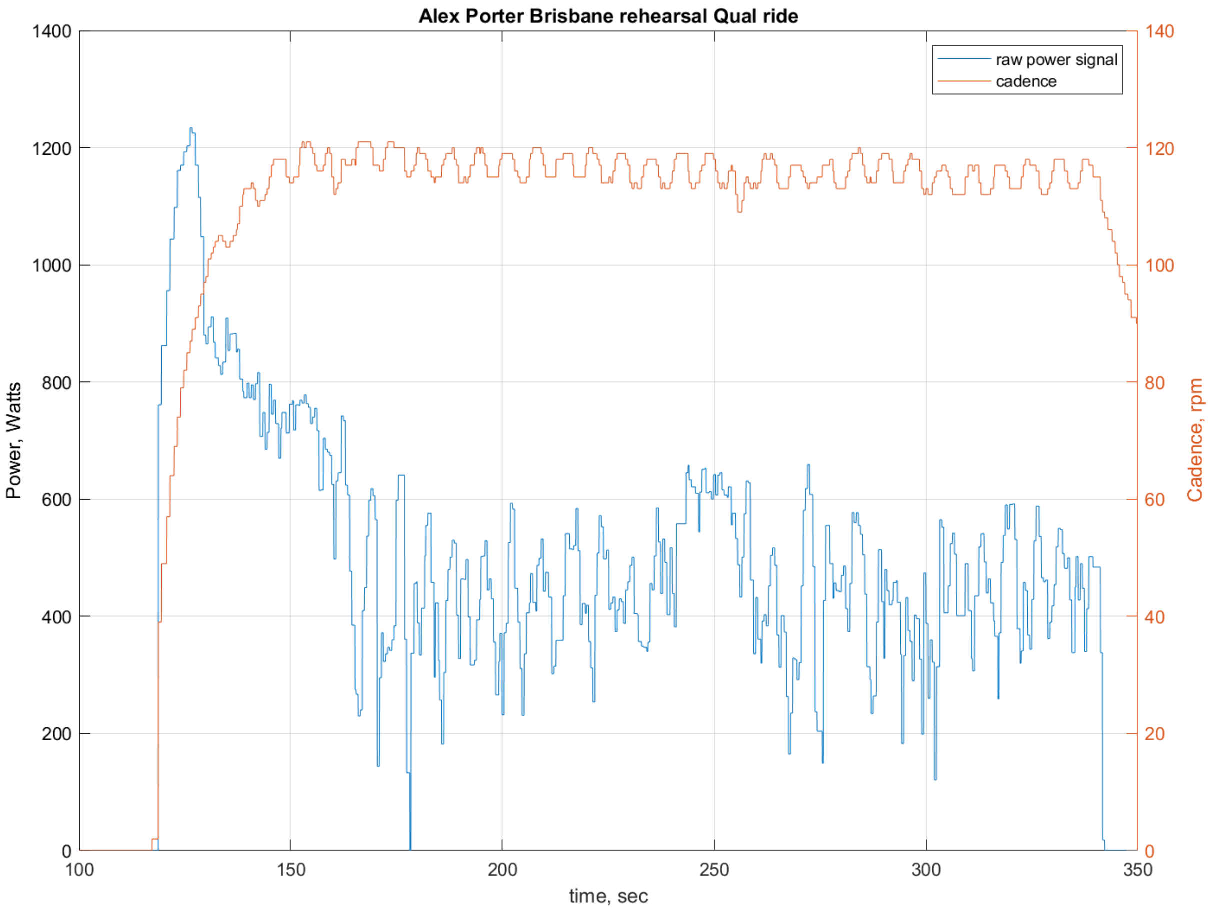


Figure 34 - Notio Konect Brisbane rehearsal ride data - Power, cadence

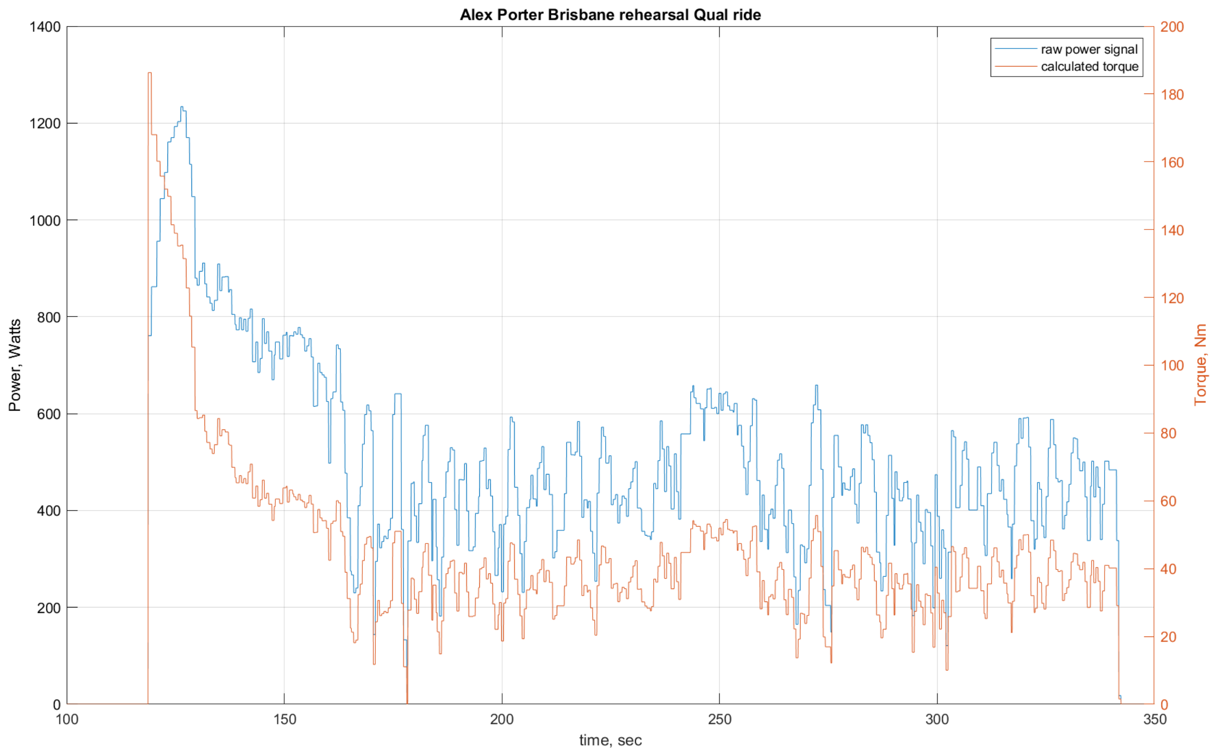


Figure 35 - Notio Konect Brisbane rehearsal ride data - Power, calculated Torque

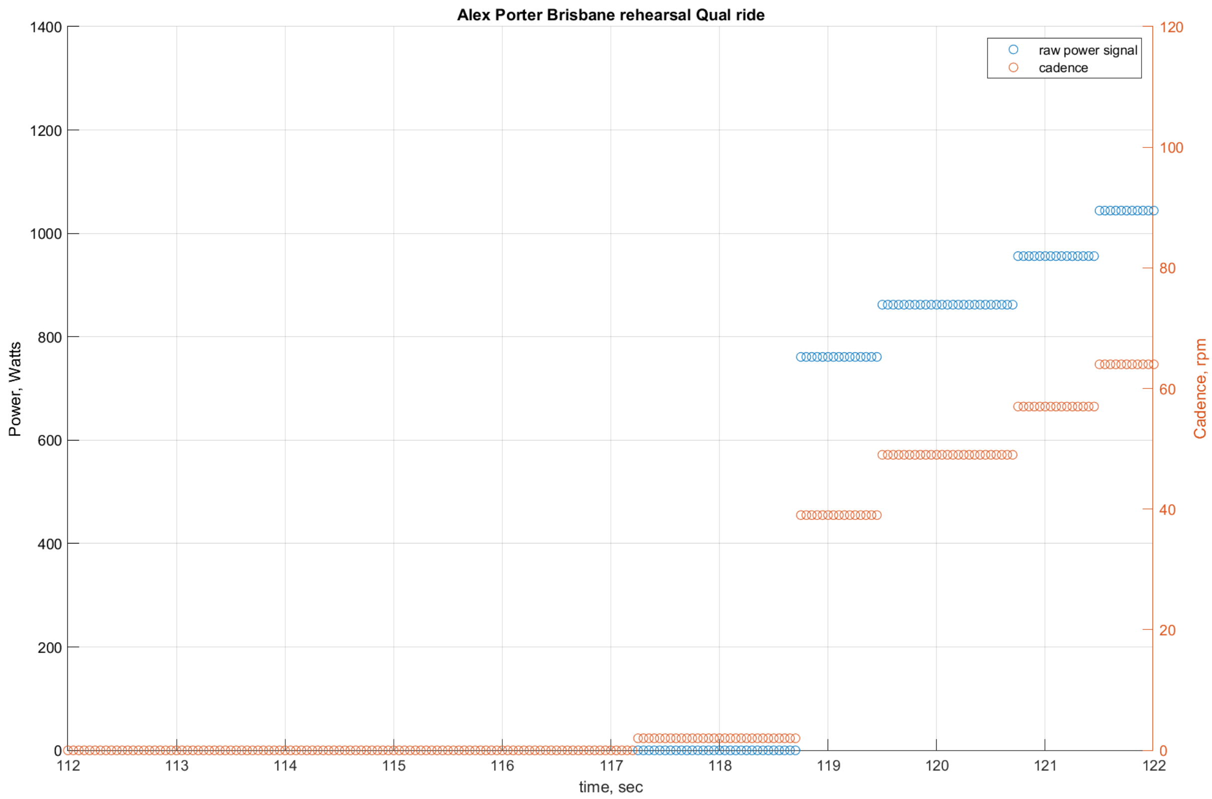


Figure 36 - Notio Konect Brisbane data zoom-in to start, discrete data points

The Notio konect has an on-board IMU with 3-axis accelerometer and gyroscope. This enables direct measurement of the vertical acceleration (in the plane of the bike) through the ride.

It can be seen from Figure 39 that the peak 'g' in the bends at these race speeds is approx. 1.8g.

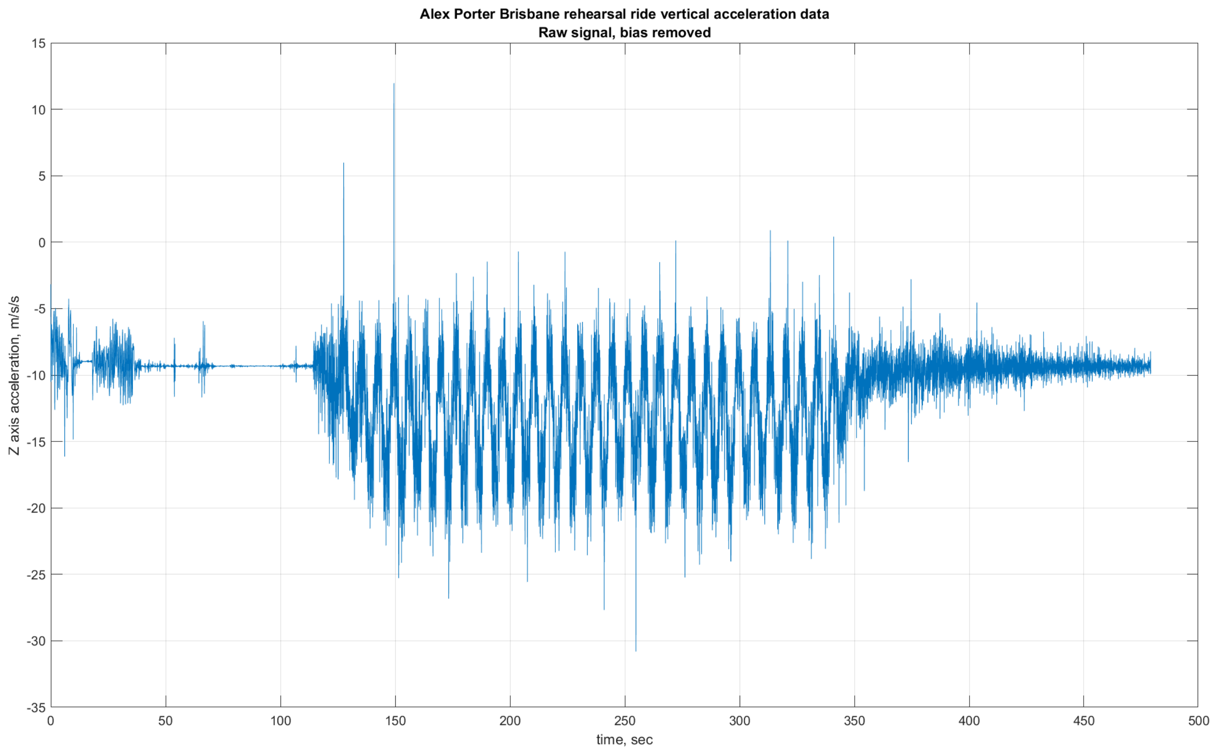


Figure 37 - Notio Konect rehearsal ride data - Z-axis acceleration

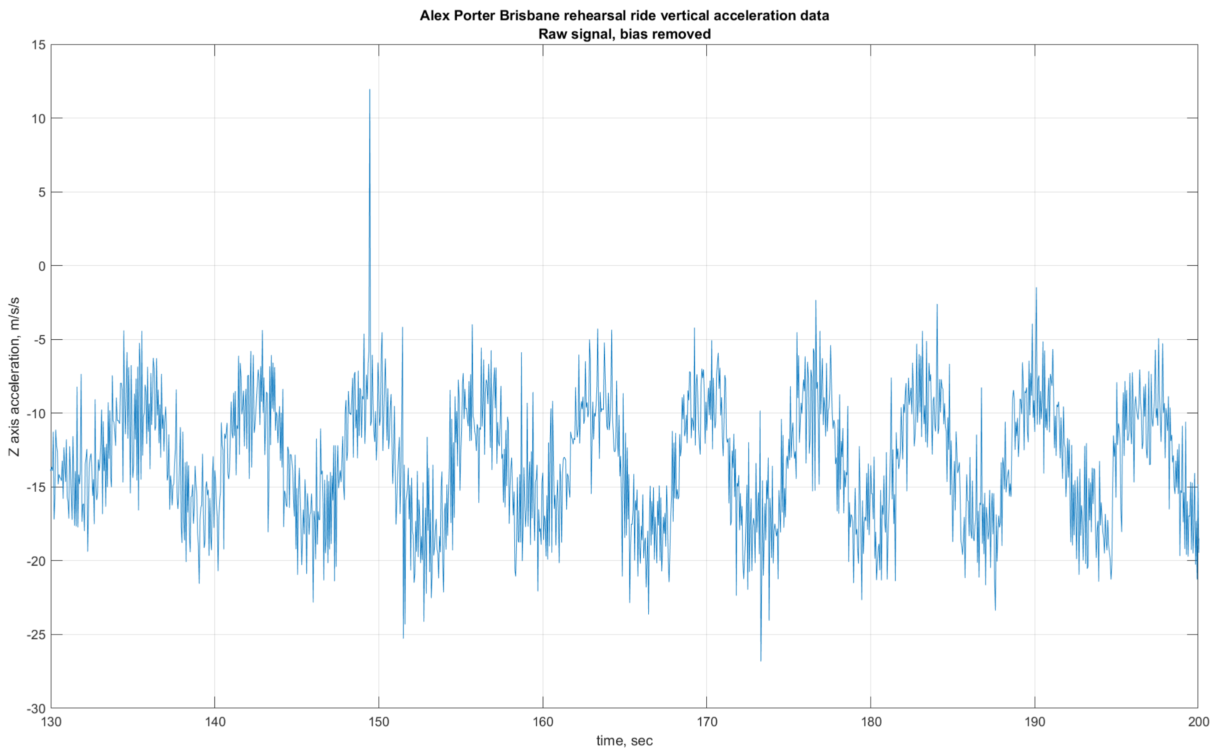


Figure 38 - Notio Konect rehearsal ride data - zoom-in

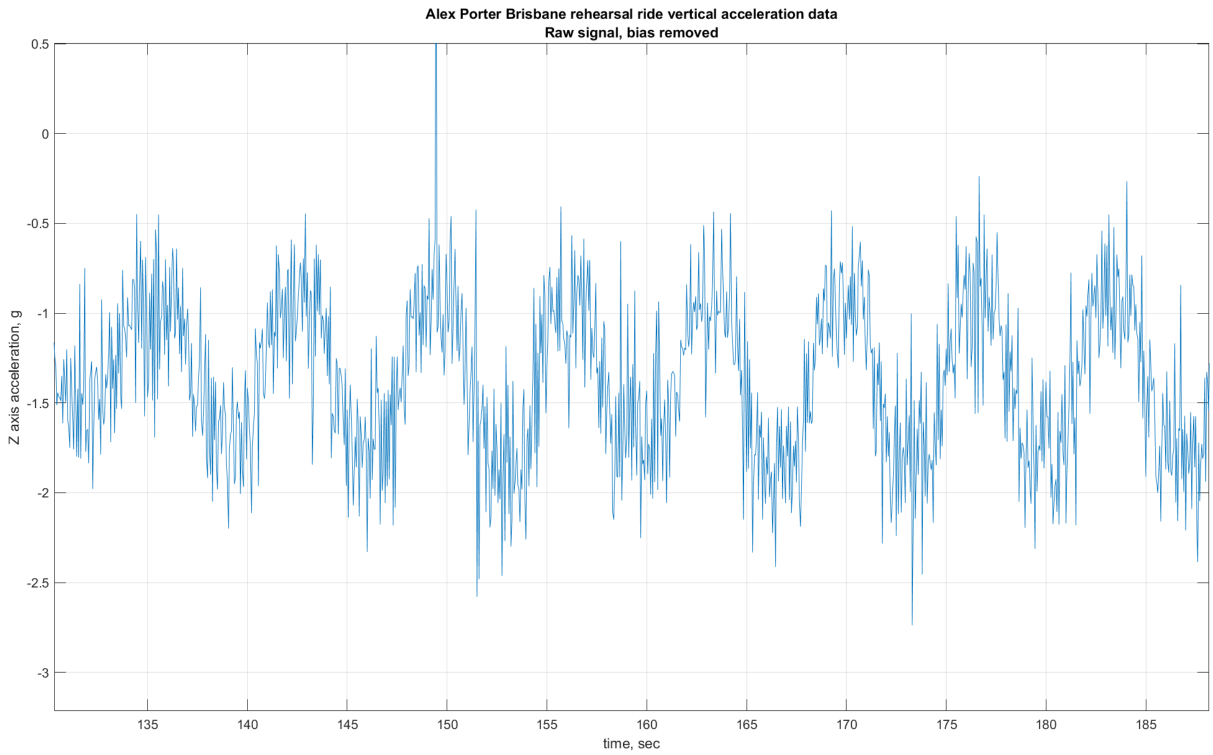


Figure 39 - Notio Konect rehearsal z-axis acceleration data zoom-in, g

Bicycle forces

For calculation of resultant loads through the handlebars, it is recommended that the procedure used in (Soden & Adeyefa, 1979) be used as a guide.

References

Soden, P., & Adeyefa, B. A. (1979). Forces applied to a bicycle during normal cycling. *Journal of Biomechanics*, 527-541.

Australian Transport Safety Bureau

The investigation process

Initiating an investigation

Each year the ATSB receives more than 17,000 notifications of transport incidents and accidents.

To prevent future transport safety occurrences—especially those with the potential for a large-scale loss of life or serious injury to the travelling public—the ATSB directs its investigation resources to those incidents and accidents with the greatest potential of identifying systemic issues in aviation, marine and rail transport operations.

This is consistent with the function of the ATSB, as stipulated in the *Transport Safety Investigation Act 2003* (TSI Act) and *Ministerial Statement of Expectations.*

The size and scope of an investigation also impacts its expected timeframe. Timeframes for the completion of an investigation are an estimate, based the initial facts of the occurrence. Timeframes can change as the investigation progresses and its level of complexity is revealed.

Occurrence Brief

If a transport safety occurrence doesn't warrant an investigation under the TSI (Act), the ATSB can produce an Occurrence Brief. Occurrence Briefs are a one-page factual summary of the event that provides an opportunity for transport operators and participants to learn from transport safety occurrences in the absence of an investigation.

Safety Studies

The ATSB also produces Safety Studies. Safety Studies use ATSB transport safety information over a longer timeframe, often up to ten years, to provide insights into current and future trends in transport safety. Safety Studies can be used by industry, manufacturers, policy makers and the general public to understand more about transport safety.

Evidence collection phase

The evidence collection phase of an investigation helps investigators build a detailed picture of the transport safety occurrence or safety issue being investigated. During this phase, the primary task of investigators is to gather the initial evidence from or related to the occurrence or safety issue. This may include:

- site observations (including wreckage distribution, witness marks on ground, parts and components and line-of-sight measurements)
- gathering relevant wreckage, materials and recorded data (including on-board flight, voyage and event recorders, GPS, images, video, system equipment data, and voice recorders)
- gathering human performance related information such as work and rest patterns and time awake, workload, perceptual limitations, communications, and social norms

- undertaking or procuring test and examination reports (such as fuel quality-tests, toxicology, functional tests, manufacturer's test procedures, simulation studies, meteorological analyses)
- interviewing involved parties, witnesses and subject matter experts
- obtaining operational records (such as log books, technical logs, maps or charts, trip reports, weather observations, job sheets, repair records, training records and performance checks, audit reports)
- obtaining technical documentation (such as procedures and manuals, training manuals, maintenance manuals, troubleshooting guides, design drawings and system safety assessments), and
- obtain data on similar occurrences in Australia and overseas and other occurrence data.

Examination and analysis phase

The cause of a transport safety occurrence or safety issue is often multilayered and complex. ATSB investigators aim to use the collected evidence to build a detailed understanding of the circumstances surrounding a transport safety occurrence or issue.

During this phase, evidence is reviewed and evaluated to determine its relevance, validity, credibility and relationship to other evidence and to the occurrence. ATSB investigators may:

- undertake detailed data analysis
- create simulations and reconstruct events
- examine company, vehicle, government and other records
- examine selected wreckage in the laboratory and test selected components and system
- research scientific literature related to human factors associated with the evidence
- review specialist reports (such as meteorology, component examination, post-mortem report and toxicology reports)
- conduct further interviews, and
- determine the sequence of events.

Examination and analysis requires reviewing complex sets of data, and available evidence can be vague, incomplete and or contradictory. This may prompt the collection of more evidence, which in turn needs to be analysed and examined, potentially adding to the length of an investigation.

Once the examination of the evidence is complete, the investigation team will test a series of hypotheses to arrive at a number of safety factors that could have contributed to the transport safety occurrence or issue, or otherwise increased safety risk.

The investigation team then convenes a Safety Factor Review with ATSB management. This is a rigorous internal review of the progress of the investigation, its preliminary findings and focus. The Safety Factor Review involves the investigation team presenting their evidence and analysis to reach consensus on the investigation findings. Once consensus is achieved, the report drafting phase of the investigation can begin.

Final investigation report

The ATSB produces a final report for all of its investigations. Reports communicate important safety issues, actions and information, and provide transparency into the ATSB investigation process.

Through web updates and the release of preliminary and interim reports, the ATSB can make information publicly available during an active investigation. This can only be done where appropriate. For example, preliminary reports are only released for those investigations that are expected take at least 12 months due to their level of complexity. Interim reports are released if it is deemed necessary by the ATSB to provide an update during an investigation.

The ATSB publishes its investigation reports as quickly as possible, but also takes the time it needs to conduct a thorough investigation and produce a report that enhances transport safety and meets the expectations of the transport industry and the Australian public. If a critical safety issue is identified during the course of an investigation, the ATSB will immediately communicate it to relevant parties so that appropriate safety action can be taken.

Final report: Drafting phase

Most ATSB reports contain the following sections:

- Safety summary—a one-page summary of the transport safety occurrence, the findings and any safety action taken as a result, as well as any broader safety messages.
- The occurrence—a description of the sequence of events related to the occurrence and, if relevant, the consequences in terms of injuries and damage.
- Context—of evidence collected as part of the investigation that is necessary to help the reader understand the occurrence and safety analyses, or the broader safety issues for research purposes.
- Safety analysis—a demonstration of how the evidence justifies the investigation findings
- Findings—a list of contributing factors and other safety factors identified during the safety analysis.
- Safety issues and actions—a summary of safety issues that were identified during the investigation and details of what safety action has been taken, or is planned to be taken by relevant parties to address those issues.

The dynamic and complex nature of investigations means that during the drafting of the report it may be necessary to return to the evidence collection or examination and analysis phases of an investigation. There will often be significant overlap in time between the evidence collection, examination and analysis and final report drafting phases.

Final report: Internal review

Final ATSB investigation reports undergo a rigorous internal review process to ensure the report adequately and accurately reflects the evidence collected, analysis, and agreed findings of the Safety Factor Review. Final investigation reports also undergo other technical and administrative reviews to ensure the reports meet national and international standards for transport safety investigations.

If a review identifies any issues with a report, such as information that needs to be expanded or findings that need to be modified, investigators will look to collect new evidence or conduct additional examination and analysis of existing evidence.

Final report: External review phase

To check factual accuracy and ensure natural justice, Directly Involved Parties (DIPs) are given the opportunity to comment on the final report before it is approved to ensure their input has been accurately reflected.

DIPs are individuals or organisations outside the ATSB who possess direct knowledge of the circumstances surrounding the incident or accident. DIPs can only comment on the factual accuracy of an investigation, not its analysis and findings.

This process is consistent with international transport safety investigation conventions, including those published by the International Civil Aviation Organization, International Maritime Organization as well as the *Transport Safety Investigation Act 2003*. DIPs are provided from five to 28 days to provide their comment and present evidence in support of their comments. This timeframe can be extended to allow DIPs based overseas to provide comment.

Feedback from the DIPs could prompt an investigation to return to the evidence collection, examination and analysis, and report drafting phases of an investigation.

Final report: Approval phase

Following the DIPs process, the report is approved by management before being sent to the ATSB Commission for final approval. Once approved, the final report is prepared for publication and dissemination and released to DIPs prior to its public release.

Final report: Dissemination phase

Once an ATSB report is approved, it is prepared for its public release and approved safety issues and recommendations are formally communicated to the relevant parties. The report is then released publicly on the ATSB website and communicated on social media channels. The progress of safety action to address ATSB recommendations is tracked and communicated, on an ongoing basis, via the ATSB website.

It is important to note that the ATSB does not wait until its investigations are complete or the final report is published to address critical safety issues. If a critical safety issue is identified during the course of an investigation, it is brought to the attention of the relevant parties immediately so that safety action can be taken.

- **More about investigation levels**

https://www.atsb.gov.au/about_atsb/investigation-process/

Handlebar Service Schedule

Frequency:
This service is to be carried out at the **Track Bike Service – Bi/Tri Annual**

Background:
This service serves as an inspection for unreported damage and safety check of the Handlebar.

- Record all bike measurements in Bespoke before removing components.
- Remove handle bar from the bike and remove any bar tape, grip tape or other attachments.
- Use Isopropyl Alcohol to remove sticky residue etc from the handlebar.
- Visually check that the handlebar is aligned correctly ie. No bends, angle of drops is even. This can be done by resting handlebars on a flat surface such as a work bench.
- For Pursuit handlebars, disassemble completely. Where possible, mark position of adjustable extensions etc with a wax pencil to aid reassembly.
- For Pursuit handlebars, clean and inspect all bolts and hardware for damage to threads etc and replace as required.
- In good light, inspect the Handlebar for any signs of damage (ie. Cracks in carbon fibre or paint work or evidence of metal fatigue such as white stress marks). Pay particular attention to any clamping points such as head stem for crush damage.
- Reinstall handlebar according to any specific instructions (such as torque settings) for the particular product.
- Fit new handlebar/grip tape, following relevant build guide.

Effective life for Handlebars:

- The effective life span for Drop-style Handlebars is 2 years in the Australian Cycling Team environment.
- The effective life span for Pursuit Handlebars is 4 years in the Australian Cycling Team environment.

- At the end of the life span, Handlebars can be on-sold at the discretion of the Stock Controller.

Process for the introduction of new componentry into the ACT Daily Training Environment

Step 1: Create an individual folder for the particular component in:
\Dropbox\Australian Cycling Team Information\16. Workshop\Equipment Risk Management
This is the location for relevant documentation to be stored.

Step 2:
Determine if component is covered by a relevant ISO standard and assess if this standard is sufficient for our requirements.
If there is no relevant ISO Standard or our requirements exceed the ISO standard, agree with the manufacturer a testing protocol that exceeds our worst-case requirement by 1.4x.

Step 3:
Obtain documentation showing component has passed relevant ISO Standard or the testing protocol agreed on.

Step 4:
Graduate Engineer or Mechanic Staff member to visually inspect and test fit initial production unit of the component. Note any issues or irregularities and liaise with manufacturer to agree on a solution.

Step 5:
If component passes inspection and test fit, it enters an 'on track' testing phase. This phase consists of 10 training sessions with the Graduate Engineer or Mechanic Staff member present. The component is inspected following every session and **Component Testing Record form** completed.
The component can be tested by Podium Athletes during this phase however consultation is to be held between Engineering, Workshop,

Coach and athlete to ensure that the training and component considerations are understood.

Step 6:
Following the successful completion of the 'on track' testing phase, the workshop manager is to review the component in relation to the ACT Equipment Risk Management Plan and ensure that it is covered by an appropriate service schedule.

Step 7:
The component is free to be used in the Daily training Environment and Competition without restriction.

AUS TRA LIAN CYCLING TEAM

Argon 18 Electron Pro Build Standards Book

Release Date: 05/05/2020

Revision History:

Date	Initial	Ver.	Description
05/05/2020	MD	1.0	Initial Release

Executive Summary

This document aims to provide instructions to a level of detail which would allow anyone with a basic level of mechanical knowledge, to build an Argon 18 Electron Pro to the *Australian Cycling Team*'s Zero Failures Standard.

The form to request changes, updates and additions to be added in the next revision, can be found here: https://forms.gle/X7B23ADr3NZX23Mt5

Glossary of Terms

BHCS	Abbreviation of Button Head Cap Screw, Hex Key Operated
FHCS	Abbreviation of Countersunk Screw, Hex Key Operated

Table of Contents

Executive Summary 2
Glossary of Terms 3
Table of Contents 4
List of Tables 6
1. Post-Delivery Inspection and Approval 7
1.1. Delivery Frame and Fork Check 7
1.2. Preparation of Rear Dropouts 9
1.2.1. 2018 – Using CA-ACT-E-02-002_RETRO_DROPOUT 9
1.2.2. 2018 – Using Factory Supplied Dropouts 10
1.2.3. 2020 – Using Factory Supplied Dropouts 10
1.3. Frame Protective Stickers 12
1.4. Blocker Installation 13
1.4.1. 2018 Electron Pro – Frame Blocker 13
1.4.2. 2020 Electron Pro- Seat Tube Plug 13
2. Mainframe Subassembly 15
2.1. Fork Installation 15
2.1.1. 2018 – Electron Pro 15
2.1.2. 2020 – Electron Pro 16
2.2. Bottom Bracket Installation 18
2.2.1. Using Internal Bearing Cranksets 18
2.2.1.1. Installing BB-7710 19
2.2.1.2. Installing BB-5500 19
2.2.2. Using External Bearing Cranksets 20
2.3. Crankset Installation 21
2.3.1. Internal Bearing Cranksets 21
2.3.1.1. SRM (Octalink) Crankset 21
2.3.1.2. Shimano Dura-Ace 7710 23
2.3.2. External Bearing Cranksets 24
2.3.2.1. Bf1Systems 24
2.3.2.2. SRM Imperium 26
2.3.3. Chainring Installation 28
3. Seatpost Subassembly 29
3.1. Blocker Installation 29
3.1.1. 2018 – Electron Pro 29
3.1.2. 2020 – Electron Pro 29
3.2. Seatpost Sizing and Cutting 29
3.2.1. Using a Standard Seat Clamp 30
3.2.2. Using an ASKIL Saddle 30
3.3. Seat Clamp Assembly 31
3.3.1. 2018 – Electron Pro 31
3.3.2. 2020 – Electron Pro 32
3.3.3. 2018/20 – ASKIL Seats 33
3.3.3.1. Flat 33
3.3.3.2. Angled Wedge 34

3.4. Post Plug Installation 35
3.4.1. 2018 – Electron Pro 35
3.4.2. 2020 – Electron Pro 36
3.5. Final Measurement Check 36
4. Cockpit Subassembly 37
4.1. Pursuit Handlebar 37
4.1.1. Basebar Fitting 37
4.1.2. Pursuit Extensions 38
4.1.2.1. Integrated Extensions 39
4.1.2.2. Standard 22.2 mm Round Extensions 41
4.2. Integrated Stem or Handlebar 43
4.2.1. Bastion Sprint Stem 43
4.2.2. Bastion Madison Handlebar 46
4.2.3. Argon 18 Sprint Handlebar 47
4.3. Standard Headstem 49
5. Finishing Steps 51
5.1. Attached Accessories 51
5.1.1. MyLaps Chip 51
5.1.2. SRM Headunit Mount 52
5.1.3. Internal WSL Cradle 53
5.1. Handlebar Grips/Tape 54
5.1.1. Sprint Bikes 54
5.1.2. Pursuit Bikes 54
5.1.3. Bunch Bikes 55
5.1.4. Speed Sensor 56
5.1.4.1. Integrated Giant RideSense 56
5.2. Positioning of Stickers 57
5.2.1. Stock QR Code 57
5.2.2. Measurements QR Code 57
5.2.3. Name Sticker 57
Appendix A : Cutting Template for Frame Protectors 58
Appendix B : Consulted Staff 59
Appendix C : Example Images of Tools 60
Appendix D : CA-ACT-E02-006-03/7P Drawing (Not to Scale) 62

List of Tables

Table 1: Serial Number Reference Table 7
Table 2: Required Components for 2018 Dropout Plate Installation 9
Table 3: Required Components for Dropout Plate Installation 10
Table 4: Required Components for 2020 Dropout Plate Installation 10
Table 5: Required Components for Frame Protective Sticker Installation 12
Table 6: Sizes of Seat tube Blocker for 2018 Frame 13
Table 7: Required Components for 2020 Seat Tube Plug Installation 13
Table 8: Required Components for 2018 Fork Installation 15
Table 9: 2018 Fork Crown Spacing Size Reference Table 15
Table 10: 2018 Steerer Tube Length Reference Table 16
Table 11: Required Components for 2020 Fork Installation 16
Table 12: 2020 Fork Crown Spacing Size Reference Table 17
Table 13: 2020 Steerer Tube Length Reference Table 17
Table 14: Crankset Type 18
Table 15: Octalink Bottom Bracket Installation 18
Table 16: Required Components for Dropout Plate Installation 20
Table 17: Required Components for SRM (Octalink) Crankset Installation 21
Table 18: Required Components for Shimano Dura-Ace 7710 Crankset Installation 23
Table 19: Required Components for BF1Systems Crankset 24
Table 20: Required Components for SRM Imperium Crankset Installation 26
Table 21: Required Components for 2018 Seat Clamp Installation 31
Table 22: Required Components for 2020 Seat Clamp Installation 32
Table 23: Required Components for flat ASKIL Saddle Installation 33
Table 24: Required Components for angled ASKIL Saddle Installation 34
Table 25: Required Components for Seatpost Plug Installation 35
Table 26: Required Components for Seatpost Plug Installation 36
Table 27: Required Components for Pursuit Basebar Installation 37
Table 28: Required Components for Integrated Extension Installation 39
Table 29: Correct Fastener Lengths for Extension Installation 39
Table 30: Required Components for Standard Extension Installation 41
Table 31: Correct Bastion Stem Bolt Lengths 43
Table 32: Required Components for Installation of Bastion Stems 43
Table 33: Required Components for Installation of Integrated Sprint Handlebars 46
Table 34: Correct Bastion Madison Handlebar Bolt Lengths 46
Table 35: Required Components for Installation of Integrated Sprint Handlebars 47
Table 36: Integrated Sprint Bar Fit Dimensions 47
Table 37: Correct Integrated Sprint Bar Bolt Lengths 47
Table 38: Required Components for Installation of Steerer Modules 49
Table 39: Required Components for Timing Tag Fitment 51
Table 40: Required Components for SRM Mount Fitment 52
Table 41: Required Components for Internal WSL Fitment 53
Table 42: Required Components for Handlebar Finishing 54
Table 43: Required Components for Handlebar Finishing 56
Table 44: Required Components for Handlebar Finishing 57

1. Post-Delivery Inspection and Approval

- To be carried out upon delivery of the frame from the factory, skip to *Section 2* if these sections have been completed.

1.1. Delivery Frame and Fork Check

- If the frame and fork has already completed the delivery checks in Section 1.1, progress to the *Section 1.2*.
- Remove all packaging and inspect the parts for any damage which may have occurred during shipping, or visual defects from the factory.
- Confirm frame size and layup (HV if sprint configuration) match on frame stickers and serial number (lower seat tube and under BB).
- 2020 sprint framesets will have an ‘S’ marked in a white circle under the bottom bracket shell.

2020 Sprint Designation

Figure 1: Under bottom bracket frame identifiers

Table 1: Serial Number Reference Table

Serial Example	Size	Year	Description
288AXSMnnnnnUH	XS	2018	Electron Pro - Standard
288ASMLnnnnnNH	S	2018	Electron Pro - Standard
288ASMLnnnnnNH-HV	S	2018	Electron Pro - Sprint
288AMEDnnnnnNH	M	2018	Electron Pro - Standard
288AMEDnnnnnNH-HV	M	2018	Electron Pro - Sprint
288ALARnnnnnNH	L	2018	Electron Pro - Standard
288ALARnnnnnNH-HV	L	2018	Electron Pro - Sprint
312ASMLnnnnnMJ	S	2020	Electron Pro - Standard
312AMEDnnnnnMJ	M	2020	Electron Pro - Standard
AG10XXJ05FBnnnn	M	2020	Electron Pro - Sprint
312ALARnnnnnMJ	L	2020	Electron Pro - Standard
AG10XXJ06FBnnnn	L	2020	Electron Pro - Sprint

- C1) Check Lateral alignment of fork top plate (using Jig A, see *Figure 2*). the point on the end of the rod attached to the steerer must be within **+/- 2 mm** from the centreline of the jig to be accepted.
- Weigh the bare frame and fork separately using accurate scales.
- Enter weight, serial number, size, pass/fail of C1, rider allocation into EZOfficeInventory, see *Stock Controller, Andy Rogers*.

Install Alignment Scale　　　　Insert Steerer

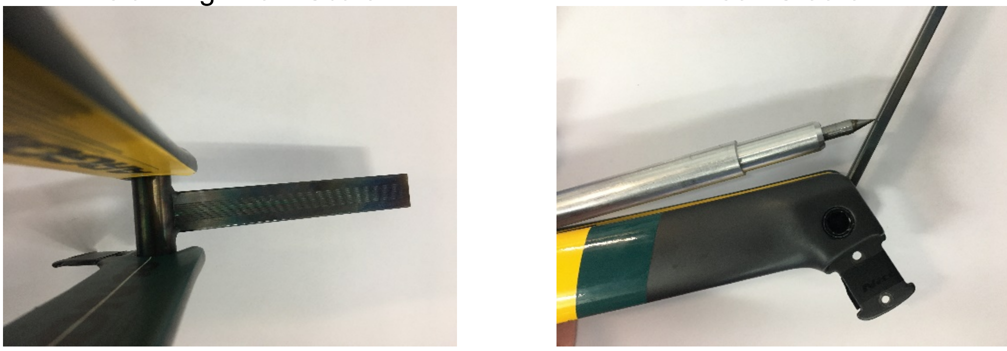


Figure 2: Measuring fork alignment

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1.2. Preparation of Rear Dropouts

- The dropout plates may be installed from the factory; however, it is important to follow the below procedures to ensure they are adequately affixed.

Standard Dropouts

CA-ACT-E-02-002_RETRO_DROPOUT

Figure 3: Comparison of Dropout Plate Assemblies.

1.2.1. 2018 – Using CA-ACT-E-02-002_RETRO_DROPOUT

- The CA-ACT-E-02-002_RETRO_DROPOUT increased thread engagement which reduces the likelihood of screws falling out. The increased dropout length of the newer X-Small frame size does not allow these dropout plates to be fitted.

Table 2: Required Components for 2018 Dropout Plate Installation

Description	**Parts**
Part	CA-ACT-E-02-002_Retro_Interior_V3
Part	CA-ACT-E-02-002_Retro_Exterior_V3
Screws	5x M4 x 8 mm FHCS
Lubricant	Aquaproof Grease
Adhesive	Loctite 243 – Medium Strength (Blue)
Tools	2.5 mm Hex
Torque: Dropout Screws	1.5 Nm

- With all the components removed from the frame, apply a small amount of *Aquaproof grease* to the underside of the heads of the countersunk screws.
- Ensure the outer plate with thread standoffs fits flush to the dropout.
- Apply a small amount of *Loctite 243* thread locker to all 5 threads in *CA-ACT-E-02-002_Retro_Exterior_V3*.
- Fit the inner plate and finger tighten the screws (2.5 mm Hex), install a rear wheel or hub and ensure it can slide all the way into the dropouts. If not, loosen the screws and install the hub and ensure it can access all the dropout, retighten the screws.
- Starting with the forward most screw, and torque all the screws to **1.5 Nm** (2.5 mm Hex).
- Check the hub fit as above until acceptable, if not consult the *Workshop Manager, Will Dickeson*.

1.2.2. 2018 – Using Factory Supplied Dropouts

Table 3: Required Components for Dropout Plate Installation

Description	Parts
Screws	3x M4 x 8 mm FHCS
Lubricant	Aquaproof Grease
Adhesive	Super Glue
Tools	2.5 mm Hex
Torque: Dropout Screws	1.5 Nm

ATTENTION: The standard build procedure requires the installation of dropout plates outlined in Section 1.2.1 above. If these are not available, factory supplied dropout plates should be used only with the approval of the Workshop Manager and installed using the following procedure.

- With all the components removed from the frame, apply a small amount of *Aquaproof grease* to the underside of the heads of the countersink screws.
- Apply a small amount of *Super Glue* to the threads in the outside dropout plates.
- Fit the plates to the frame with the textured plate on the outside and the countersunk plate on the inside of the dropout. Install the screws starting with the forward most screw, and torque all the screws to **1.5 Nm** (2.5 mm Hex).
- Install a rear wheel or hub into the dropouts, the axle should slide freely all the way to the front of the dropout. If not, the plates are misaligned, loosen the screws and install the wheel to align the plates. Remove the wheel and repeat the above glue and torque procedure one screw at a time, checking the wheel can still be installed correctly.

1.2.3. 2020 – Using Factory Supplied Dropouts

Table 4: Required Components for 2020 Dropout Plate Installation

Description	Parts
Lubricant	Light Chain Lube
Adhesive	Loctite 243 – Medium Strength (Blue)
Tools	2.5 mm Hex
Torque	Dropout Screw: 1.5 Nm

- If the dropout plates are fitted to the frame on delivery, remove each screw (2.5 mm Hex) one at a time, and apply a small amount of *Loctite 243* to the threads. Reinstall the screws and torque to **1.5 Nm**.
- Unscrew each dropout adjuster all the way, being careful not to lose the dial when the threaded rod is removed. Run a small bead of *light chain lube* along the length of the thread and reinstall, ensuring the thread turns freely and the half-moon part fully returns. The half moon section should not overhang the sides of the dropout plate, if this is the case, unscrew and rotate **180 deg** to ensure clearance on both sides.

Inside Outside

Figure 4: 2020 Dropout Plate Orientation

1.3. Frame Protective Stickers

- Protective stickers prevent some damage and premature wear from occurring around the dropouts.

Table 5: Required Components for Frame Protective Sticker Installation

Description	Parts
Tape	3M 8591 – 50 mm Width
Magnet	Small Rectangular 10 x 5 x 2 mm
Solvent	Isopropyl Wipe
Tools	Sharp Scissors

- Using *3M 8591 tape* and the cutting template at Appendix A, cut sections to size, making intermediate cuts where marked. All corners should be rounded with a radius of approximately **5 mm** and placed with the specifications on the template.
- Ensure the frame surface where the stickers will be placed is clean and free of grease, dust and contaminants by wiping with *Isopropyl wipe* and allowing to dry.
- Follow the refences on the cutting guide and *Figure 5.*

DS Inside / DS Rear NDS Inside

Figure 5: Positioning of Protective Frame Stickers

- Using a 40 x 20 mm rectangle of *3M 8591 tape* position the small rectangular magnet horizontally on the left of the drive-side of the bottom bracket shell, **40 mm** from the centre of the shell.

Figure 6: Correctly positioned SRM Magnet.

1.4. Blocker Installation

- A seatpost blocker is required to prevent seat height slippage during cornering.

1.4.1. 2018 Electron Pro – Frame Blocker

- Collect the correct length blocker for the frame, listed in *Table 6*. These are referred to by the CA ACT Engineering part numbers *CA-ACT-E02-006-04P* to *-07P*, refer to the drawing at *Appendix D* or as per *Figure 7*.
- Drop this part down the seat tube, check it is resting on the rear wheel cut-out on the back face of the seat tube at the height of the seat stays. It may require to be pushed through the controlled diameter section; the part will sit loose in the frame.

Table 6: Sizes of Seat tube Blocker for 2018 Frame

	X-Small	Small	Medium	Large
Blocker Length (mm)	70	80	90	110

Figure 7: Original version of 2018 Electron Pro Seat Tube Blocker

1.4.2. 2020 Electron Pro- Seat Tube Plug

- This section is only required for 2020 Electron Pro Framesets.

Table 7: Required Components for 2020 Seat Tube Plug Installation

Description	Parts
Tool	Disposable Stirrer (pop-stick or similar)
Tool	Long M6 Thread
Adhesive	5-minute Epoxy
Solvent	Isopropyl Alcohol

- All 2020 Electron Pro framesets are supplied with the same plug part pictured below.

<u>Upward</u> Orientation — Underside

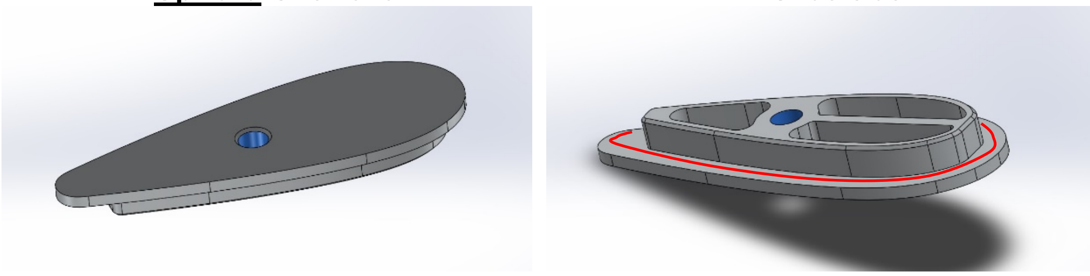

Figure 8: CAD image of 2020 Seat Tube Plug

- Clean the plug using *isopropyl alcohol* and if possible, the shelf at the bottom of the controlled diameter section of the seat tube.
- Thread the plug onto a long section of M6 thread such that the plug can be easily lowered to the shelf in the bottom of the seat tube.
- On a piece of disposable card or similar, mix a small amount of *5-minute Epoxy* and spread a bead of epoxy around the perimeter of the plug underside (red line in *Figure 8*). Make sure no epoxy overhangs the edges of the plate.
- Lower the plug down the seat tube until it rests on the shelf, ensure the plate is correctly aligned (the threaded rod should run parallel to the seat tube in both plates) and hold there for 30 sec.
- Gently unthread the threaded section from the plug, ensuring it does not shift the plate and wait 5-10 minutes before installing the seatpost.

2. Mainframe Subassembly

2.1. Fork Installation

- If the fork is already installed, progress to *Section - below*.

ATTENTION: There are two different versions of steerer tube for the relevant model year frames, care should be taken to ensure the correct one is selected.

2018

2020

Figure 9: Comparison of Steerer Tube Components

- The 2018 steerer tube can only be installed using the 19.5mm 3D Headtube Tool.
- The 2020 steerer tube can only be installed using an 8 mm Hex.

2.1.1. 2018 – Electron Pro

Table 8: Required Components for 2018 Fork Installation

Description	Parts
Upper Bearing	1" IS MR055E– SKU: 80475
Lower Bearing	1-1/8" IS MR054E– SKU: 80476
Tool	Argon 18 19.5 mm 3D Headtube Tool
Tool	4 mm Hex
Lubricant	Aquaproof Grease
Torque: Pinch Bolt	5.5 Nm

- Apply a thin smear of *Aquaproof grease* in the upper and lower headset seats of the frame.
- By hand, firmly press the headset bearings into the frame, the lower bearing is the larger of the two. If the lower bearing falls out of the frame, wait until installing the fork to insert the bearing.
- Ensure the selected fork is for the correct size for the frame, the spacing between the upper and lower fork crown is correct for the frame.

Table 9: 2018 Fork Crown Spacing Size Reference Table

Frame Size	Year	Crown-Crown Length (mm)
X- Small	2018	66
Small	2018	91
Medium	2018	104
Large	2018	114

0 mm 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

- The steerer which matches the fork and frame size is of the following length:

Table 10: 2018 Steerer Tube Length Reference Table

Frame Size	Year	Steerer Tube Length (mm)
X- Small	2018	91
Small	2018	118
Medium	2018	123
Large	2018	140

- Apply a thin smear of *Aquaproof grease* to the lower bearing race of the fork and the thread of the steerer.
- Remove the pinch bolt (4mm Hex) on the right-side of the upper fork crown, apply a thin smear of *Aquaproof grease* to the threads and the underside of the bolt head.
- By hand and then using the 19.5mm 3D Headtube Tool, tighten the steerer such that it is tight, without any increase in force required to turn the fork.
- Check for play by gripping the middle of the fork legs and the down tube and gently rocking the fork fore and aft, if play is detected, tighten the steerer slightly until it is no longer noticeable.
- Torque the side pinch bolt (4mm Hex) to **5.5 Nm**.
- The frame can now be installed in a fork mounted work stand.

2.1.2. 2020 – Electron Pro

- There are two forks for the 2020 Electron Pro, the installation process is the same for both. However, it is assumed pursuit bikes will be fitted with the narrow fork of disc wheels and sprint and bunch bikes with the wide fork.

Table 11: Required Components for 2020 Fork Installation

Description	Parts
Upper Bearing	1” IS MR055E
Lower Bearing	1-1/8” IS MR054
Tool	4 mm Hex
Tool	8 mm Hex
Lubricant	Aquaproof Grease
Torque: Pinch Bolt	5.5 Nm

- Apply a thin smear of *Aquaproof grease* in the upper and lower headset seats of the frame.
- Insert the headset bearings into the frame, the lower bearing is the larger of the two. If the lower bearing falls out of the frame, wait until installing the fork to insert the bearing.
- Ensure the selected fork is for the correct size for the frame, the spacing between the upper and lower fork crown is correct for the frame.

Table 12: 2020 Fork Crown Spacing Size Reference Table

Frame Size	Year	Crown-Crown Length (mm)
Small	2020	100
Medium	2020	112
Large	2020	129

- The steerer which matches the fork and frame size is of the following length:

Table 13: 2020 Steerer Tube Length Reference Table

Frame Size	Year	Steerer Tube Length (mm)
Small	2020	121
Medium	2020	132
Large	2020	147

- Apply a thin smear of *Aquaproof grease* to the lower bearing race of the fork and the thread of the steerer.
- Remove the pinch bolt (4mm Hex) on the right-side of the upper fork crown, apply a thin smear of *Aquaproof grease* to the threads and the underside of the bolt head.
- By hand and then using the 8 mm Hex, tighten the steerer such that it is tight, without any increase in force required to turn the fork.
- Check for play by gripping the middle of the fork legs and the down tube an gently rocking the fork fore and aft, if play is detected, tighten the steerer slightly until it is no longer noticeable.
- Torque the side pinch bolt (4mm Hex) to **5.5 Nm**.
- The frame can now be installed in a fork mounted work stand.

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2.2. Bottom Bracket Installation

- Ensure the bottom bracket and frame threads are clean and undamaged. Apply a moderate smear of *Aquaproof grease* to the threads of the bottom bracket shell of the frame.
- Refer to *Table 14* below for the appropriate section on bottom bracket and crank installation.

Table 14: Crankset Type

Crankset	Bearing Type
SRM (Octalink) (2.3.1.1)	Internal
Shimano Dura-Ace 7710 (2.3.1.2)	Internal
Bf1Systems (2.3.2.1)	External
SRM Imperium (2.3.2.2)	External
Bastion SRM Titanium	External
Bastion RS Titanium	External

SRM (Octalink)

Shimano Dura-Ace 7710

Bf1Systems

SRM Imperium

Figure 10: Example Images of Cranksets

2.2.1. Using Internal Bearing Cranksets

- Installation of these bottom brackets will require the following parts:

Table 15: Octalink Bottom Bracket Installation

Description	Parts
Bottom Bracket	Shimano BB-7710 or BB-5500
Tool	Pedro's Flat Wrench – Shimano 6-Notch
Tool	20-notch Bottom Bracket Tool
Lubricant	Aquaproof Grease
Torque: Cups	50-70 Nm

ATTENTION: The correct side of bottom bracket will be printed on the cup; the cup should tighten toward the rear dropouts on both sides. This indicates a reverse thread (left-hand) on the Drive-Side and normal thread (right-hand) on the Non-Drive-Side.

- The tools required are dependent on the model of bottom bracket being installed, see *Figure 11*.

BB-7710

BB-5500

Figure 11: Comparison of Shimano Octalink Bottom Brackets

2.2.1.1. Installing BB-7710

- Note: The central sleeve with model and orientation markings is not required and is not pictured in *Figure 11*.
- Separate the non-drive-side cup from the drive-side and spindle.
- Thread the drive-side bearing cup into the frame by hand, the cup should thread in with a small amount of resistance, tighten to **70 Nm** using the Pedro's Flat Wrench – Shimano 6-Notch.
- Unthread the lock-ring on the non-drive-side cup and apply a small amount *Aquaproof grease* to the lockring threads.
- Using the 20-Notch Bottom Bracket tool, thread the non-drive-side bearing cup into the frame such that it lightly contacts the bearing.
- Turn the axle to check the bearing is adequately preloaded. If the axle has additional resistance, the cup has been tightened too far.
- If the axle has vertical or horizontal play when wiggled by hand, it is too loose, and the non-drive-side cup needs to be wound further into the frame.
- Reinstall and tighten the non-drive-side lock-ring (same direction as cup threading) until it stops turning. Using the Pedro's Flat Wrench – Shimano 6-Notch, tighten the lock-ring to **50-70 Nm** against the frame.

2.2.1.2. Installing BB-5500

- Remove the non-drive-side cup.
- Thread the driveside body and axle unit into the frame and tighten using the 20-notch Bottom Bracket tool to **50-70 Nm**.
- Thread the non-drive-side cup into the frame until finger tight. Using the 20-notch Bottom Bracket tool tighten the bearing cup into the frame to **50-70 Nm**.

2.2.2. Using External Bearing Cranksets

- Ensure the bottom bracket threads are clean and undamaged. Apply a moderate smear of *Aquaproof grease* to the threads of the bottom bracket shell of the frame.
- Installation of these bottom brackets will require the following parts:

Table 16: Required Components for Dropout Plate Installation

Description	Parts
Bottom Bracket	FSA BB386 BSA
Seal	2x For FSA BB386
Cup Spacer	1 mm thick x 30 mm ID
Tool	16-Notch FSA BB386EVO BSA Tool
Lubricant	Aquaproof Grease
Torque	Cups: 40 Nm

ATTENTION: The correct side of bottom bracket will be printed on the cup; the cup should tighten toward the rear dropouts on both sides. This indicates a reverse thread (left-hand) on the Drive-Side and normal thread (right-hand) on the Non-Drive-Side.

Factory Steel

Factory Ceramic

Cycling Ceramic

Figure 12: Comparison of FSA BB386 Bottom Brackets

- Thread the drive-side bearing cup into the frame by hand, the cups should thread in with little resistance.
- Using the 16-Notch FSA BB386EVO BSA Tool, tighten the drive-side bearing cup into the frame and torque to **40 Nm**.
- Installation of the non-drive-side bottom bracket cup is specific to the crankset.
- If using a Bf1Systems crankset, place the *CA-ACT-E05-012_BB_Ring* cup spacer with magnet over the threads of the non-drive-side bottom bracket cup. Refer to the specific details of correctly orienting the ring in *Section 2.3.2.1*.
- Using the 16-Notch FSA BB386EVO BSA Tool tighten the non-drive-side bearing cup firmly into the frame and torque to **40 Nm**.
- The relevant combinations of spacers etc. will be outlined in the relevant section of *Section 2.3* for the selected crankset.

2.3. Crankset Installation

2.3.1. Internal Bearing Cranksets

- Cranksets requiring an internal bearing bottom bracket as selected in *Section 2.2.1* and shown in *Figure 11*.

2.3.1.1. SRM (Octalink) Crankset

Figure 13: SRM Octalink Crankset

- Ensure the appropriate length crank arms have been selected for the rider and each crank arm is the same length.

Table 17: Required Components for SRM (Octalink) Crankset Installation

Description	Parts
Component	4x SRM Plate Screws (M5 x 10 mm FHCS)
Tool	T25 Torx
Tool	10 mm Hex (or 8 mm Hex)
Tool	Shimano TL-FC21 Peg Spanner
Lubricant	Aquaproof Grease
Adhesive	Loctite 243 (Medium Strength – Blue)
Solvent	Acetone
Torque: Plate Screws	5 Nm
Torque: Crank Arm	35-50 Nm

- Align the SRM Plate onto the crank-arm, using 4x *SRM Plate Screws*, clean the screws threads with *acetone*, apply *Loctite 243* and tighten the bolts (<u>T25</u>) to **5 Nm**.

Correct Orientation Tightening Order

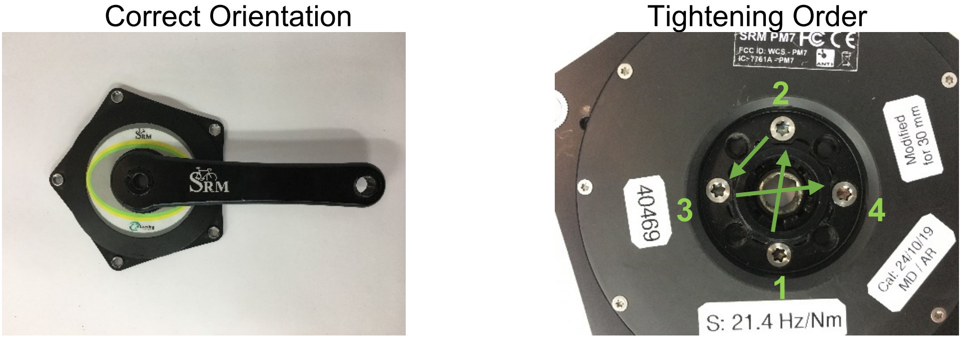


Figure 14: Correctly positioned and tightened SRM plate.

- Apply a small amount of *Aquaproof grease* to the bottom bracket axle.
- Fit the drive side crank arm and ensure the splines in the bottom bracket axle are aligned with those in the crank arm. Gradually tighten the crank bolt (10 mm Hex) to **35-50 Nm** and ensure the threads of the self-extracting cap has a small amount a *Loctite 243* and is firmly tightened using the Shimano TL-FC21 Peg Spanner.
- Note: the crank may also have Shimano Dura-Ace solid crank bolts fitted, in this case an 8 mm Hex is required but the above process is the same.
- Wobble the crank arm along the axis of the of the bottom bracket and ensure there is no lateral bottom bracket play, if there is, return to the previous bottom bracket tightening procedure (*Section 2.2.1*).
- Install the non-drive-side crank arm and tighten the bolt (10 mm Hex) to **35-50 Nm**.
- Note: Some riders prefer a Shimano Dura-Ace 7710 non-drive-side crank arm in place of the standard SRM, see the section below regarding correct installation.

2.3.1.2. Shimano Dura-Ace 7710

Figure 15: Shimano Dura-Ace 7710 Crankset

Table 18: Required Components for Shimano Dura-Ace 7710 Crankset Installation

Description	Parts
Tool	8 mm Hex
Tool	Shimano TL-FC21 Peg Spanner
Lubricant	Aquaproof Grease
Adhesive	Loctite 243 (Medium Strength – Blue)
Solvent	Acetone
Torque: Crank Arm	35-50 Nm

- Apply a small amount of *Aquaproof grease* to the bottom bracket axle.
- Fit the drive side crank arm and ensure the splines in the bottom bracket axle are aligned with those in the crank arm. Tighten the crank bolt (8 mm Hex) to **35-50 Nm** and ensure the self-extracting cap has a small amount a *Loctite 243* and is firmly tightened using the Shimano TL-FC21 Peg Spanner.
- Wobble the crank arm along the axis of the of the bottom bracket and ensure there is no bottom bracket play, if there is, return to the above bottom bracket tightening procedure.
- Install the non-drive-side crank arm and tighten the bolt (8 mm Hex) to **35-50 Nm**.

2.3.2. External Bearing Cranksets

- External bearing cranksets will require the *BB386 Bottom Bracket* installed in *Section 2.2.2* and shown in *Figure 12*.

2.3.2.1. Bf1Systems

Figure 16: Bf1Systems Crankset

- Ensure the appropriate length crank arms have been selected for the rider and each crank arm is the same length.
- In addition, Bf1Systems cranks require to be paired, the table should be printed in the storage box or can be found at: Dropbox\AUSTEAM-Workshop\Process and procedures\Build Book\Supplements\BF1 Cranks.xlsx.

Table 19: Required Components for BF1Systems Crankset

Description	Parts
Cup Spacers	CA-ACT-E05-012_BB_Ring
Axle Spacers	2x 0.5 mm Spacer (30 mm I.D.)
Preloader	1x Wave Washer (30 mm I.D.)
Tool	8 mm Hex
Tool	Bf1 Extraction Thread
Tool	Universal Crank Extractor
Tool	16-Notch FSA BB386EVO BSA Tool
Tool	15 mm Open-Ended Wrench
Tool	22 mm Open-Ended Wrench
Lubricant	Aquaproof grease
Torque: BB Cups	40 Nm
Torque: Crank Bolt	45 Nm

- Place the *CA-ACT-E05-012_BB_Ring* cup spacer with magnet over the threads of the non-drive-side bottom bracket cup.
- Thread the cup in by hand until it is finger tight, position the frame such that the dropouts are aligned horizontally (this can be done by putting wheels in the bike and putting it on the ground). Align the magnet which protrudes from the spacer vertically, perpendicular to the ground, tighten the cup using the 16-Notch FSA BB386EVO BSA Tool to **40 Nm**.

- Apply a thin smear of *Aquaproof grease* to the crankset spindle and press the crankset through the bottom bracket, the axle needs to be precisely aligned but excessive force should not be required.
- Place a *wave-washer* over the axle of the crankset on the Non-Drive-Side, start with 1x *0.5 mm spacer*.
- Install the non-drive-side crank arm onto the axle, ensuring both crank arms are aligned parallel in opposite directions.
- Tighten the crank bolt (8mm Hex) to **45 Nm**.
- Ensure the wave-washer is approximately **75%** compressed.
- If the preload is too tight and causes the bottom bracket to not spin freely, follow the below crank extraction procedure and remove the 0.5 mm spacer. If the wave-washer remained uncompressed, follow the crank extraction procedure and add an additional 0.5 mm spacer.
- To extract the crankarm, remove the crank bolt (8 mm Hex), thread in the Bf1 Extraction thread (6 mm Hex) such that it sits below flush in the axle.
- Thread in the Universal Crank Extractor into the crank arm using the smaller diameter end (for square-taper), ensure it does not protrude from the threaded outer ring.
- Tighten the outer ring (22 mm Open-Ended Wrench) snugly into the crank arm and then wind the inner spindle (15 mm Open-Ended Wrench) into the crankarm until it pops off.

Extraction Thread

Crank Puller Orientation

Tighten

Extract

Figure 17: Extracting Bf1Systems Crankset

- Install the non-drive-side crank arm onto the axle, ensuring both crank arms are aligned parallel in opposite directions.
- Tighten the crank bolt (8 mm Hex) to **45 Nm** and repeat preload check as above.

2.3.2.2. SRM Imperium

Figure 18: SRM Imperium Crankset.

Table 20: Required Components for SRM Imperium Crankset Installation

Description	Parts
Tool	10 mm Hex
Tool	T25 Torx
Tool	Cannondale KT013 or Enduro CT-008
Tool	Razor Blade or Scalpel
Tool	15 mm Open-Ended Wrench
Axle Spacers	2x 0.5 mm Spacer (30 mm I.D.)
Preloader	1x Wave Washer (30 mm I.D.)
Lubricant	Aquaproof Grease
Lubricant	Copper Anti-seize
Adhesive	Loctite 243 (Medium Strength – Blue)
Solvent	Acetone
Torque: SRM Plate	5.5 Nm
Torque: Crank Bolt	40 Nm

- External bearing cranksets will require the BB386 Bottom Bracket installed in *Section 2.2.2* and shown in *Figure 12*.
- Ensure the appropriate length crank arms have been selected for the rider and each crank arm is the same length.
- Apply a small amount of *Copper anti-seize* into the notches in the non-drive-side crank arm and the threads in both sides of the crank spindle. As well as the shoulder of the crank bolt on which the washer sits and the washer itself per *Figure 19*.

Figure 19: Correct application of copper anti-seize for Imperium crank.

- Fit the spindle into the corresponding notches of the non-drive-side crank arm, fit the washer over the crank bolt and thread the bolt into the spindle. Smoothly tighten the bolt (10 mm Hex) to **40 Nm**.
- Clean off any visible *Copper anti-seize* with a rag.
- Fit the *wave-washer* onto the spindle.
- Apply a thin smear of *Aquaproof grease* to the bearing surfaces of the spindle and firmly press through the bearings of the bottom bracket. The spindle has a tight fit and requires to be precisely aligned but should not require excessive force to fit.
- The cataloguing and allocation of SRM plates should be handled by the Stock Controller, ensure the plate being fitted has been correctly allocated to the athlete.
- Using a razor blade or scalpel, scrape any dried Loctite off of the outside face of the SRM plate and its corresponding mating face on the drive-side crank arm.
- Clean any dried Loctite off the threads of the plate screws using *acetone* (M5 x 12 mm Modified FHCS A4-70) and allow any residue to evaporate.
- Apply **1-drop** of *Loctite 243* into each of the 4x M5 plate screw threads on the drive-side crank arm.
- Position the SRM plate on the drive-side crankarm and ensure the chainring bolt holes either side of the crank arm are equidistant and the threads in the crank arm align with countersinks in the plate.
- Thread in the plate screws until finger tight (T25 Torx), then in 1/8th of a turn increments diagonally across the plate (see *Figure 20*), tighten to **5.5 Nm**.

Correct Orientation | Tightening Order

Figure 20: Correctly positioned and tightened SRM plate.

- Apply *Copper anti-seize* to the crankarm and crank bolt as per *Figure 19*.
- Fit the crankarm into the notches of the spindle and ensure the crankarms are parallel. Fit the washer over the crank bolt and thread the bolt into the spindle. Smoothly tighten the bolt (10 mm Hex) to **40 Nm**.
- Ensure the *wave-washer* is approximately **75%** compressed.
- If the preload is too tight and causes the bottom bracket to not spin freely, follow the below crank extraction procedure and remove the *wave-washer* and replace with a *0.5 mm spacer*. If the wave-washer remained uncompressed, follow the crank extraction procedure and add an additional *0.5 mm spacer*.
- To extract the crankarm, remove the non-drive-side crank bolt (10 mm Hex), thread in the smaller part of the Cannondale KT013 (8 mm Hex) such that it sits below flush in the axle.
- Thread in the larger part of the Cannondale KT013 and tighten (15 mm Open-Ended Wrench) into the crank arm, unwind the part threaded into the axle against the outer (8 mm Hex) to remove the crank arm from the spindle.

KT013 Smaller Part Installed

KT018 Outer Part Installed

Figure 21: Extracting Imperium crankarm using Cannondale KT013

- Install the non-drive-side crank arm onto the axle, ensuring both crank arms are aligned parallel in opposite directions.
- Tighten the crank bolt (8 mm Hex) to **40Nm** and repeat preload check as above.

2.3.3. Chainring Installation

- If no chainring bolts are installed in the crank, press the nut portion into the backside of the crank spider or use a small amount of *super-glue* if they are not self-retaining.
- Fit a chainring to the crank, align the marked chainring size between **10 and 11 O'clock** (crank-arm at 12) install the *chainring bolts* (5mm Hex) and tighten to **3Nm**

3. Seatpost Subassembly

3.1. Blocker Installation

- A blocker and seat post plug must be installed to ensure the seat cannot slip downward during riding.

3.1.1. 2018 – Electron Pro

- A seat tube blocker should have been installed in *Section 1.4* and appear as so:

Figure 22: Correctly installed Seat Tube Plug in 2018 Frameset

- If a blocker has not been installed, return to *Section 1.4* before proceeding.

3.1.2. 2020 – Electron Pro

- A seat tube plug should have been installed in *Section 1.4* and appear as so:

Figure 23: Correctly installed Seat Tube Plug in 2020 Frameset

- If a plug has not been installed, return to *Section 1.4* before proceeding.

3.2. Seatpost Sizing and Cutting

- Insert the seatpost into the frame until it stops on the blocker, ensuring the post slides freely and fits snuggly in the controlled diameter section of the frame.
- Measure the effective seat height to the top and centre of the seatpost.

ATTENTION: Care must be taken when cutting carbon fibre components. Always wear the following PPE; safety glasses, a dust mask or respirator, rubber gloves. Use a lot

of soapy water on the blade and part to dampen the spreading of the fine carbon fibre sawdust.

3.2.1. Using a Standard Seat Clamp

- If using a standard seat and rail system:

$$Cut\ Length = Measured - (Seat\ Height + 60)\ \text{mm} \qquad \text{(C.L.S.)}$$

$$e.g. Cut\ Length = 840 - (780 + 60)\ \text{mm}$$

$$e.g. = 120\ \text{mm}$$

ATTENTION: The length to be removed will vary depending on frame size and exposed seatpost length.

- Using the equation (C.L.S.), cut the calculated length of post from bottom.
- Clean the inside and outside surfaces with isopropyl alcohol and allow to dry.

3.2.2. Using an ASKIL Saddle

- If using an ASKIL direct mount seat and rail system:

$$Cut\ Length = Measured - (Seat\ Height + 40)\ \text{mm} \qquad \text{(C.L.A.)}$$

$$e.g. Cut\ Length = 840 - (780 + 40)\ \text{mm}$$

$$e.g. = 100\ \text{mm}$$

ATTENTION: The length to be removed will vary depending on frame size and exposed seatpost length.

- Using the equation (C.L.A.), cut the calculated length of post from bottom.
- Clean the inside and outside surfaces with isopropyl alcohol and allow to dry.

3.3. Seat Clamp Assembly

- For the 2020 framesets, a different seat clamp was selected to save weight, however the clamps are cross compatible if required.

2018

2020

Figure 24: Comparison of 2018 and 2020 seat clamps

ATTENTION: It is best practice to have the clamp assembly as far forward on the seatpost as possible whilst maintaining the correct seat setback.

3.3.1. 2018 – Electron Pro

Table 21: Required Components for 2018 Seat Clamp Installation

Description	Parts
Seat Clamp	Seat Module Kit (Supplied with bike)
Tool	4 mm Hex
Tool	8 mm Open End & Ring Spanner
Lubricant	Aquaproof grease
Torque: Clamp Chariot	6 Nm

- The Argon 18 Electron Pro Seat Module Kit will be required, parts list can be found in the Electron Pro Assembly Guide.
- Slide the *shuttle* through the front of the slot in the top of the seatpost and place the *chariot* on top, aligning the screws with the threads in the shuttle and position in the middle of the slot. Tighten the two screws (4 mm Hex) to **6 Nm**.
- Apply Grease to the four half-moon shaped nuts and under the heads of the M5 hex-bolts and place the threaded parts into the upper cradle of the seat clamp.
- Place the other two half-moon parts over the bolts such the flat faces contact the underside of the bolt heads, thread the bolts in several turns.
- Place this assembly on top of the seat rails, position the underside of the clamp, under the rails and place the whole assembly onto the chariot.
- Hook the half-moon washers into position and finger-tighten the bolts and check the angle and setback of the seat, refer to *Section 3.5*. Seat-angle and setback changes as the bolts are tightened so close attention should be paid when the seat is being adjusted.
- Use the 8 mm Open End & Ring Spanner to tighten the two bolts equally, using the ring-end of the spanner if accessible, until the bolts are firm.
- Flex the seat as firmly as possible to bed-in the assembly, check and readjust the seat angle and setback as necessary until the seat no longer moves. This step may also be necessary after the bike has been ridden for the first time.

Position Chariot | Position Clamp Assm. | Tighten Bolts

Figure 25: 2018 Seat Clamp Assembly Steps

3.3.2. 2020 – Electron Pro

Table 22: Required Components for 2020 Seat Clamp Installation

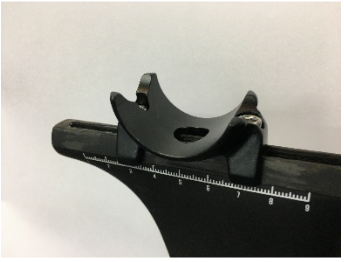
Description	Parts
Seat Clamp	Seat Module Kit (Supplied with bike)
Clamp Ears (7 mm Round Rails)	**W1** Marked
Clamp Ears (7x9 mm Carbon Rails)	**VF** or **CF** Marked
Clamp Ears (7x10 mm Carbon Rails)	**DC** Marked
Tool	4 mm Hex
Tool	5 mm Hex
Lubricant	Aquaproof grease
Torque: Clamp Chariot	6 Nm
Torque: Seat Clamp Ears	16 Nm

- Seat clamps supplied with 2020 Electron Pro Framesets require different ears depending on the different size seat rails. It is important to measure the dimensions of the seat clamp rails to ensure the correct ears for the seat clamp have been selected, ears with serrations on the inside are best to prevent slipping.

Figure 26: Seat Clamp Ear Markings

- Slide the *shuttle* through the front of the slot in the top of the seatpost and place the *chariot* on top, aligning the screws with the threads in the shuttle and position in the middle of the slot. Tighten the two screws (<u>4 mm Hex</u>) to **6 Nm**.
- Install the ears into the clamp assembly with the bolt head for tightening on the drive-side of the bike, tighten the bolt (<u>5 mm Hex</u>) **two turns**.
- Position the clamp assembly on the chariot and hook one ear at a time over the lip on the chariot.
- Position the seat per *Section 3.5* and tighten the clamp (<u>5 mm Hex</u>) to **16 Nm.**

Position Chariot



Position Clamp Assm.

Tighten Bolt

Figure 27: 2020 Seat Clamp Assembly Steps

ATTENTION: If the angle of the seat continually slips using the 2020 seat clamp assembly, the 2018 seat clamp assembly can be used in its place.

3.3.3. 2018/20 – ASKIL Seats

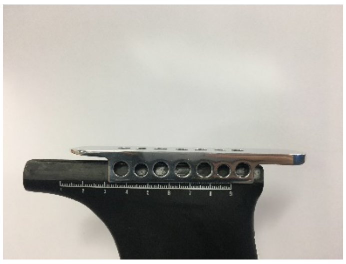
- Hardware for ASKIL saddles can be found in the Workshop storage area in the marked divided container.

Divided Container

Angle Plate Orientation

1 mm and 3 mm Washers

Plate Orientation



Saddle Installed

Washer Orientation

Figure 28: Associated ASKIL Saddle Installation Parts and Steps

3.3.3.1. Flat

- The standard configuration for ASKIL saddles is to run close to flat (+/- 0.5 deg).

Table 23: Required Components for flat ASKIL Saddle Installation

Description	Parts
Fastener	2x M5 x 25 mm A2-70 BHCS
Washer	2x 1 mm ASKIL Saddle Washer
Tool	3 mm Hex
Lubricant	Aquaproof grease
Torque: Saddle Bolts	6 Nm

- Insert the two *1 mm thick washers* through the slot in the top of the saddle, apply a small amount of *Aquaproof grease* the underside of the heads of the two *25 mm*

BHCS screws. Insert them through the washers, one bolt should protrude through each slot in the saddle plate.

- Position the saddle on the rail, the bolts should extend through the two smaller holes in the top of the rail.
- Slide the *shuttle* through the front of the slot in the top of the seatpost and place the rail and seat assembly on top, aligning the screws with the threads in the shuttle.
- Once the saddle has the correct set-back, tighten the two screws (3 mm Hex) to **6 Nm**.

3.3.3.2. Angled Wedge

- ASKIL saddles can be run with a fixed 2 deg downward angle using a wedge (shown in *Figure 28*) slightly different hardware

Table 24: Required Components for angled ASKIL Saddle Installation

Description	Parts
Fastener	1x M5 x 25 mm A2-70 BHCS
Fastener	1x M5 x 30 mm A2-70 BHCS
Washer	1x 1 mm ASKIL Saddle Washer
Washer	1x 3 mm ASKIL Saddle Washer
Tool	3 mm Hex
Lubricant	Aquaproof grease
Torque: Saddle Bolts	6 Nm

- Insert the *1 mm thick washer* through the slot in the top of the saddle and position it over the front slot, position the *3 mm thick washer* over the rear slot. Apply a small amount of *Aquaproof grease* the underside of the heads of the *25 mm* and *30 mm BHCS* screws. Insert them through the washers, the 25 mm at the front and the 30 mm at the back, one bolt should protrude through each slot in the saddle plate.
- Position the saddle on the rail, the bolts should extend through the two smaller holes in the top of the rail.
- Slide the *shuttle* through the front of the slot in the top of the seatpost and place the rail and seat assembly on top, aligning the screws with the threads in the shuttle.
- Once the saddle has the correct set-back, tighten the two screws (3 mm Hex) to **6 Nm**.

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3.4. Post Plug Installation

- There have been several iterations of these components, care should be taken to ensure the correct part is installed.

3.4.1. 2018 – Electron Pro

- The latest specification of post plug is marked '*v3*' on the underside and has a counterbore for the bolt head and has internal part *number CA-ACT-E02-006-03P_2018_Argon_18_Seat_post_blocker_V3*.

Figure 29: 2018 Seat Post Plug

Table 25: Required Components for Seatpost Plug Installation

Description	Parts
Fastener	M6 FHCS of Appropriate Length
Tool	4 mm Hex
Marking	Wax Pencil
Adhesive	ZAP Glue or Super-Glue

- With the seatpost at the correct height, place a small wax pencil mark on the side of the seat post, then loosen he seat clamp, and measure the additional insertion the post can go in.
- Remove the seatpost completely, it is best to use the 4 mm Hex to lift the seatpost wedge out of the pocket before removing the seatpost so it cannot fall into the frame.
- Check the plug fits in the underside of the cut seatpost and the cut edge sits reasonably flush with the flange on the plug, if not, straighten the cut on the seatpost.
- Apply a bead of glue to the edge of the plug, such that it is pushed along the plug length of the plug as it is inserted. And wipe off any excess glue pushed out around the edges and ensure the flange does not overhang the sides of the seatpost.

ATTENTION: Allow 5 minutes for the glue to cure before proceeding.

- Add **20 mm** to the measurement of additional seatpost insertion from before and select a M6 FHCS screw (socket head or hex head if unavailable). Subtract **3 mm** from the original measurement and thread in the screw (4 mm Hex) until it protrudes from the plug by this amount.
- After several turns on the screw, the torque required should increase significantly such that the bolt can't be turned by hand
- Reinstall the seatpost and check the height, angle and setback of the seat, refer to *Section 3.5.* Tighten the seatpost wedge (4 mm Hex) to **5 Nm**.

3.4.2. 2020 – Electron Pro

- The bolt supplied is a loose fit in the thread and can move easily, it is recommended *Loctite 243* or *Teflon Tape* be applied to the thread of the bolt to ensure the bolt can't move during use or in transit.


Figure 30: 2020 Seat Post Plug

Table 26: Required Components for Seatpost Plug Installation

Description	Parts
Tool	4 mm Hex
Tool	5 mm Hex
Marking	Wax Pencil
Adhesive	ZAP Glue or Super-Glue

- With the seatpost at the correct height, place a small wax pencil mark on the side of the seat post, then loosen he seat clamp, and measure the additional insertion the post can go in.
- Remove the seatpost completely, it is best to use the 4 mm Hex to lift the seatpost wedge out of the pocket before removing the seatpost so it cannot fall into the frame.
- Check the plug fits in the underside of the cut seatpost and the cut edge sits reasonably flush with the flange on the plug, if not, straighten the cut on the seatpost.
- The plug may press-fit into the seatpost and not require any glue to retain it. If not, apply a bead of glue to the edge of the plug, such that it is pushed along the plug length of the plug as it is inserted. And wipe off any excess glue pushed out around the edges and ensure the flange does not overhang the sides of the seatpost.

ATTENTION: Allow 5 minutes for the glue to cure before proceeding.

- Subtract **2 mm** from the original measurement and thread in the screw (5 mm Hex) until it protrudes from the plug by this amount.
- Reinstall the seatpost and check the height, angle and setback of the seat, refer to *Section 3.5*. Tighten the seatpost wedge to **5 Nm**.

3.5. Final Measurement Check

- Information of the measurement procedure can be found at: Dropbox\AUSTEAM-Workshop\Process and procedures\Bike measurements\Bikesettings jig instructions.pptx.

4. Cockpit Subassembly

- There are three separate configurations of handlebar which are compatible with the Electron Pro. This section provides guidance as to the correct fitment of the components, however manufacturers instructions may also need to be references.

4.1. Pursuit Handlebar

- Mounting the pursuit handlebar assembly is the same across 2018 and 2020 Electron Pro.

4.1.1. Basebar Fitting

2018 Aus. Standard - Grey

Factory Standard - Red

2020 Aus. Standard - Black

Figure 31: Versions pursuit basebar paint scheme.

- There are three different paint colours of Electron Pro pursuit basebar, see *Figure 31*, for 2018 framesets, a red basebar must not be used. The preference in general is to use a basebar which matches the appropriate paint scheme of the frameset.

Table 27: Required Components for Pursuit Basebar Installation

Description	Parts
Front Bolt	1x M6 x 30 mm FHCS A2-70
Side Bolts	2x M6 x 20 mm FHCS A2-70
2018 Centre Bolt	1x M6 x 40 mm FHCS A2-70
2020 Centre Bolt	1x M6 x 50 mm FHCS A2-70
Cap Bolt	2x M3 x 8 mm FHCS 10.9
Tool	2 mm Hex
Tool	4 mm Hex
Lubricant	Copper anti-seize
Lubricant	Aquaproof grease
Torque: Basebar	8 Nm

ATTENTION: Ensure the correct length centre bolt has been selected, there should be a minimum of 6 turns of thread on a bolt of the correct length.

- Apply a thin smear of Copper anti-seize to the threads and undersides of the heads of the *M6 Countersunk screws* and check the underside of the handle bar and top of the fork are clean.
- Start by threading in the centre-steerer bolt by hand and lightly tighten.
- Then install the forward most bolt and lightly tighten, followed by the two side bolts.

- Follow the correct fastening order in *Figure 32* and tighten the screws (4 mm Hex) to approximately **5 Nm** and then to **8 Nm**.
- Repeat this fastening order at until the torque wrench clicks off on all four bolts without the bolts turning any further.

Figure 32: Correct fastening order of pursuit basebar bolts.

- Apply a small amount of Aqua-proof grease to the *M3 countersunk screws* and position the cover on the stem of the pursuit basebar. Finger tighten the screws (2 mm Hex).

4.1.2. Pursuit Extensions

- There are several important points which are shared when installing any type of pursuit extension to the Argon 18 Basebar.
- Firstly, it is important to ensure the orientation of the T-nuts is correct for the keyway in the basebar. The basebar can be damaged and may need to be replaced if the bolts are tightened with the T-nuts incorrectly oriented and this could result in a failure of the handlebar.
- Once the T-nuts are correctly oriented in the basebar keyway, it is helpful to place a piece of *painter's tape* tightly over the keyways in the underside of the basebar to hold the t-nuts in position during the later assembly steps.
- Place the spacers over the T-nuts in order from smallest to tallest, this will make the amount of stack easy to identify and ensure the T-nut engages with all the spacers for maximum stiffness.

T-nut Orientation

Spacer Order

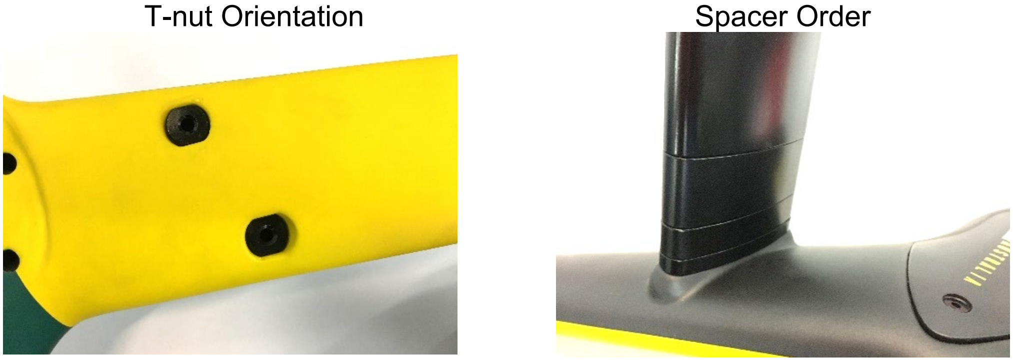


Figure 33: Assembly Notes for Pursuit Extensions

4.1.2.1. Integrated Extensions

- Integrated pursuit extensions require several different pieces of hardware which are shown in *Figure 34* and listed in *Table 28*. Pay careful attention to the orientation of the flip chip and tapered spacer and its effect on the extension length and note the arm cups are different from left to right.

Flip Chip

Tapered Spacer

Arm Cup

Figure 34: Components Specific to Integrated Pursuit Extensions

Table 28: Required Components for Integrated Extension Installation

Description	Parts
Component	2x Arm Cups (L/R)
Component	2x Reversible Tapered Spacer
Component	2x Flip Chip
Component	2x 1 mm Cut Foam
Fasteners	4x M5 FHCS A2-70 per *Table 29*
Fasteners	2x M5 x 12 mm FHCS A2-70
Fasteners	4x T-nut per *Table 29*
Tape	Painters Tape or Masking Tape
Tool	3 mm Hex
Lubricant	Aquaproof Grease
Torque: Extension Bolts	5 Nm
Torque: Arm Cup Screw	5 Nm

Table 29: Correct Fastener Lengths for Extension Installation

Spacer Height	T-nut	M5 FHCS	Spacer Height	T-nut	M5 FHCS
0 mm	15	25	50 mm	45	50
5 mm	15	25	55 mm	45	60
10 mm	25	25	60 mm	75	35
15 mm	25	35	65 mm	75	35
20 mm	25	50	70 mm	75	50
25 mm	25	50	75 mm	75	50
30 mm	45	35	80 mm	75	50
35 mm	45	35	85 mm	75	60
40 mm	45	50	90 mm	75	70
45 mm	45	50	95 mm	75	70

- Apply a thick coating of Aquaproof grease to the underside of the flip chip, if the extension is to be installed in the forward orientation (at the marked length) press the chip in with the overhang pointing to the extension grip. The flip chip should sit flush with the base of the cup of the cup and protrude from the underside of the extension by more than 6 mm.

- Position the *tapered spacer* such that the if the extension is to be installed in the long position, the long overhang is at the front and vice-versa. If the part looks out of place, it may be oriented incorrectly, check both orientations.

Long Position Short Position

Figure 35: Flip Chip and tapered spacer orientations.

- Dip the end of the *M5 FHCS* screws selected from *Table 29* into the *Aquaproof grease* to form a large blob of grease on the end of the threads. Set aside by placing with the head on the bench or table so they stand up on end.
- Place the extension assembly on top of the spacer stack and handlebar assembly, ensure the left/right specific extensions are oriented correctly with finger hold tabs facing in.
- One by one, thread the screws into the T-nuts finger tight, once all are installed, torque to **5 Nm** (3 mm Hex). Once torqued, there should be a minimum of 6 turns of thread engaged to ensure safety.
- Once both sides have been installed, flex the extensions up/down and side-to-side and check there is now play, re-check the torque of **5 Nm** (3 mm Hex).
- If no Velcro and foam has been installed, apply the piece of self-adhesive Velcro (check the piece is on the correct side cup).
- Drop the M5 x 12 mm FHCS screw into the countersink on the centreline of the arm cup. Position the cup, carefully checking alignment and torque to **5 Nm** (3 mm Hex).

Figure 36: Correct Extension Orientation

- Check the extension position using the Bike Setting Jig and correctly reference the instructions document here: Dropbox\AUSTEAM-Workshop\Process and procedures\Bike measurements\Bikesettings jig instructions.pptx.

4.1.2.2. Standard 22.2 mm Round Extensions

Table 30: Required Components for Standard Extension Installation

Description	Parts
Component	2x Arm Cups with Foam (L/R)
Component	2x Lower Aerobar Clamp Assembly
Component	2x Upper Aerobar Clamp Assembly
Component	Aerobar Bridge
Component	2x 22.2 mm Round Pursuit Extension
Component	2x Fixed 14 deg Angled Wedge
Fasteners	4x M5 FHCS A2-70
Fasteners	4x M5 x 12 mm FHCS A2-70
Fasteners	4x M5 x 18 mm FHCS A2-70
Fasteners	4x T-nut
Tape	Painters Tape or Masking Tape
Saw	Hacksaw – Fine tooth blade
Tool	3 mm Hex
Lubricant	Aquaproof Grease
Marker	Black Permanent Marker – Med to Fat Tip
Torque: Angled Wedge to Spacer	5 Nm
Torque: Clamp to Angled Wedge	5 Nm
Torque: Bridge to Upper Clamp	6 Nm
Torque: Arm Cup Screw	5 Nm

Lower Clamp Upper Clamp Arm Cup

Figure 37: Components Specific to Standard Pursuit Extensions

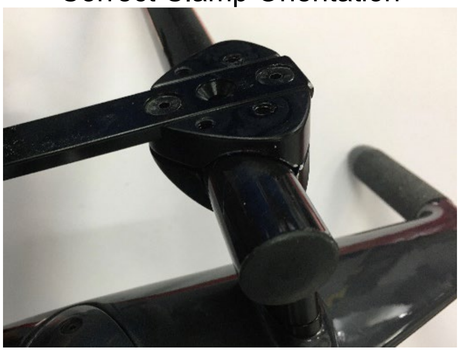
- The extension position should be set up using the Bike Setting Jig by correctly referencing the instructions document here: Dropbox\AUSTEAM-Workshop\Process and procedures\Bike measurements\Bikesettings jig instructions.pptx.
- Dip the end of the *M5 FHCS* screws selected from *Table 32* into the *Aquaproof grease* to form a large blob of grease on the end of the threads. Drop the screws into the countersinks in the *Angled Wedge* parts and position them on to of the spacers, once all are positioned, torque to **5 Nm** (3 mm Hex).
- *Lower Clamp*
- Generally, the extensions are set up in the inward position, however, under certain circumstances; they may be set more widely spaced.

- Position the lower clamp on to of the stack of spacers and align the screws with the holes in the spacers. One by one, thread the screws into the T-nuts finger tight, once all are installed, torque to **5 Nm** (3 mm Hex). Once torqued, there should be a minimum of 6 turns of thread engaged to ensure safety.
- If the extensions are setup in the inward position as above, the *Aerobar Bridge* will need to be trimmed so as not to overhang. There are cut lines stamped on the top of the part to use as a guide, use a fine-toothed blade on a *hacksaw* and colour in the cut with a black permanent marker.

ATTENTION: Care must be taken when cutting. Always wear the following PPE; safety glasses.

- Grease the *4x M5 x 18 mm* as above and drop them into outer- and innermost countersinks in the bridge, position the *Upper Clamp* parts as pictured below. Only screw the screws into the *Lower Clamp* two turns.

Correct Clamp Orientation



Trimmed End

Figure 38: Upper Clamp Assembly.

- The Cycling Australia preference is to use *Argon 18 Ski-bend Pursuit extensions* wherever possible, however, any 22.2 mm round pursuit extension is compatible with this system.
- Use the same application of *Aquaproof grease* to the *4x M5 x 12 mm FHCS screws* and drop them in *Arm Cup*. Place the
- Take the extension and slot it in between the two clamp halves, measure the extension position using the *BikeSetting Jig* and procedure as outline previously.

ATTENTION: Care must be taken when cutting carbon fibre components. Always wear the following PPE; safety glasses, a dust mask or respirator, rubber gloves. Use a lot of soapy water on the blade and part to dampen the spreading of the fine carbon fibre sawdust.

- Cut and then reinstall the extension and re-check it is position correctly, torque the four screws in the upper clamp to **6 Nm** (3 mm Hex).

4.2. Integrated Stem or Handlebar

- Integrated stem and/or handlebar combinations mount directly to the top of the fork in the same way as the pursuit basebar.

4.2.1. Bastion Sprint Stem

Figure 39: Bastion Sprint Stem

- Bastion sprint stems require different bolt lengths depending on their angle, refer to *Table 31* for correct lengths:

Table 31: Correct Bastion Stem Bolt Lengths

	Bolt Lengths (mm)		
Stem Angle	**Front**	**Side**	**Centre**
0 deg	60	35	70

ATTENTION: The optimal centre bolt length for a 2018 Electron Pro is 10 mm shorter than marked, assuming enough thread is available, the above bolt lengths are suitable.

Table 32: Required Components for Installation of Bastion Stems

Description	Parts
Bolt	4x M6 FHCS A2-70
Tool	4 mm Hex
Lubricant	Copper anti-seize
Torque: Handlebar Bolts	5 Nm
Torque: Stem Bolts:	8 Nm

- Ensure the correct faceplate is being used, only *Version 3.1* should be used. It may be permissible to use *Version 2.1* as a spare, only if approved by the *Workshop Manager, Will Dickeson*.

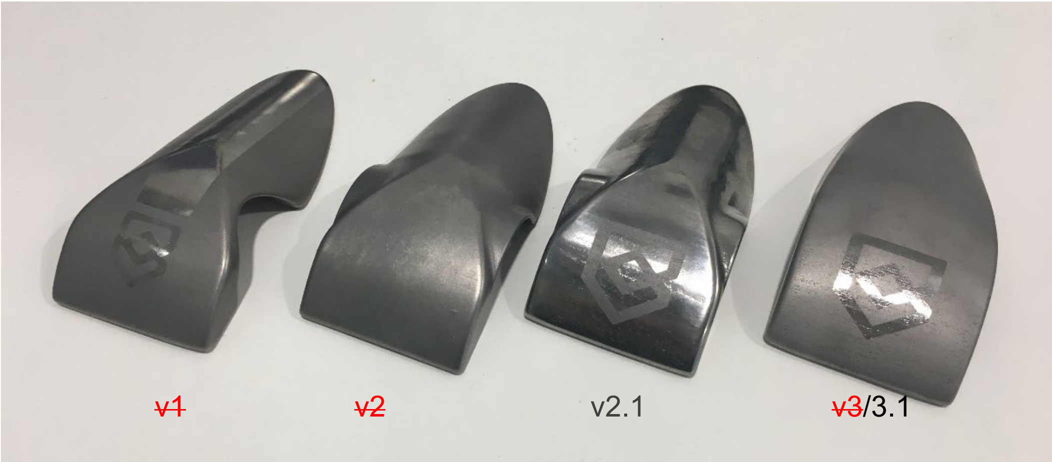


Figure 40: Versions of Bastion Sprint Stem Face Plate

- The bolt lengths should allow **10 mm** of protrusion of the front three *M6 Countersunk bolts* and, for the 2018 bike - **20 mm**, for the 2020 bike – **30 mm**.

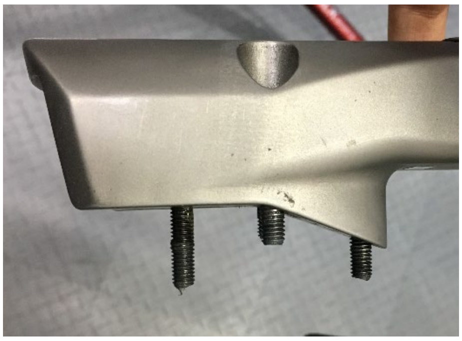
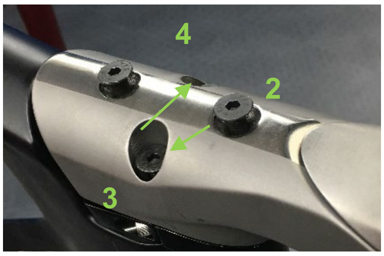


Figure 41: Adequate bolt length for 2018 Electron Pro

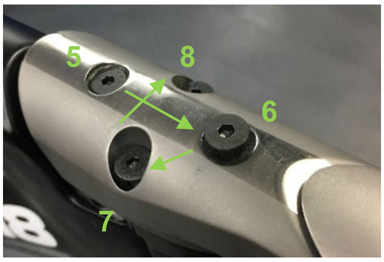
- Ensure the top surface of the fork is clean and free of debris. Check the headset is not loose and the steerer pinch bolt is torqued to **5 Nm** (4 mm).

Figure 42: The Electron Pro fork interface.

- Ensure the threads and the underside of the heads of the 4x *M6 countersunk screws* head and the bolt threads have a thin coating of *copper anti-seize*.
- Place the stem on top of the fork, finger tighten the centre-bolt, then the remaining three, and tighten the centre-bolt to **6 Nm** (4 mm).
- Torque in the following order:



2,3,4: **6 Nm**



5,6,7,8: **8 Nm**

Figure 43:Torquing sequence for stem.

- Ensure the underside of the head and the thread of the *M5 socket head bolts* have a light coating of *copper anti-seize*.
- Install the handlebar into the stem and finger-tighten the four bolts, put the bike on the ground and check the angle by placing an inclinometer on the underside of the drop portion of the handlebar.
- Tighten the bolts (4 mm) in 1/4th of a turn increments to reach the torque of **5 Nm** in the following order:

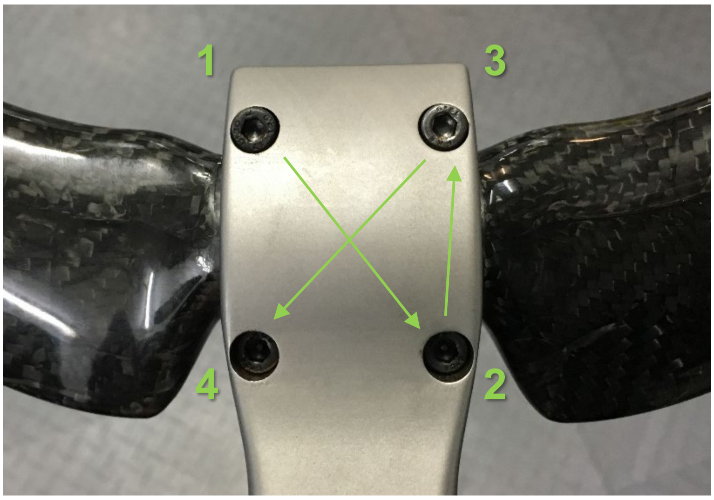


Figure 44: Stem faceplate tightening sequence.

ATTENTION: The face plate must not contact the body of the stem on either side, if this occurs, loosen the bolts on the contacting side and tighten the bolts on the other; always remain below 5 Nm. The gap should be approximately 2 mm between stem body and face plate.

4.2.2. Bastion Madison Handlebar

Figure 45: Bastion Madison Handlebar

Table 33: Required Components for Installation of Integrated Sprint Handlebars

Description	Parts
Bolt	4x M6 FHCS A2-70 per *Table 34*
Tool	4 mm Hex
Lubricant	Copper anti-seize
Lubricant	Aquaproof grease
Torque: Stem Bolts	8 Nm

Table 34: Correct Bastion Madison Handlebar Bolt Lengths

	Bolt Lengths (mm)		
Spacer Height	**Front**	**Side**	**Centre**
0	50	35	60
5	55	40	65
10	60	45	70
15	65	50	75
20	70	55	80
25	75	60	85
30	80	65	90
35	85	70	95
40	90	75	100

4.2.3. Argon 18 Sprint Handlebar

Figure 46: Argon 18 Integrated Sprint Handlebars

Table 35: Required Components for Installation of Integrated Sprint Handlebars

Description	Parts
Bolt	4x M6 FHCS A2-70 per *Table 37*
Bolt	1x M4 x 18 mm BHCS
Tool	2.5 mm Hex
Tool	4 mm Hex
Lubricant	Copper anti-seize
Lubricant	Aquaproof grease
Torque: Handlebar	8 Nm

- The Argon 18 Integrated Sprint Handlebar is manufactured in two sizes termed Short/Shallow (S/S) and Long/Low (L/L), the fit dimensions are outlined in *Table 36.* Taken from the point at the centre of the steerer tube on the top plane of the fork onto which the handlebar is mounted.

Table 36: Integrated Sprint Bar Fit Dimensions

Handlebar	Width	Drop	Reach
Short/Shallow	300	23	228
Long/Low	320	51	255

Table 37: Correct Integrated Sprint Bar Bolt Lengths

	Bolt Lengths (mm)		
Spacer Height	**Front**	**Side**	**Centre**
0	30	20	40
5	35	25	45
10	40	30	50
15	45	35	55
20	50	40	60
25	55	45	65
30	60	50	70

ATTENTION: The maximum number of spacers which can be run under an integrated sprint handlebar is 30 mm.

- Apply a small amount of *Aquaproof grease* to the thread and underside of the head of the 4x *M6 FHCS screws*.
- Thread in the centre bolt, ensure the handlebar is correctly aligned and finger tighten the bolt Install the three remaining bolts and finger tighten.
- In the order depicted in *Figure 47*, tighten the bolts in 1/8th turn increments (<u>4 mm Hex</u>) to **8 Nm**.

Figure 47: Correct fastening order of integrated sprint bar bolts.

- Ensure the torque wrench clicks-off on all four bolts without turning further to confirm all bolts are evenly and completely torqued.

Short

Long

Figure 48: Versions of Integrated Bar Cap.

- The two versions of the handlebar require two different covers, the versions are identified in *Figure 48*.
- Apply a small amount of *Aquaproof grease* to the threads of the *M4 button-head screw* and finger tighten (<u>2.5 mm Hex</u>).

4.3. Standard Headstem

- The use of standard headstems (for 1-1/8” round steerer tubes) and handlebars requires the use of the factory supplied *Steerer Module*.

Table 38: Required Components for Installation of Steerer Modules

Description	Parts
Steerer Module	Unit Supplied
Bolt (Supplied)	2x M6 x 14 mm SHCS A2-70
Bolt (Supplied)	1x M6 x 45 mm SHCS A2-70
Bolt (Supplied)	1x M6 x 12 mm BHCS A2-70
Washer (Supplied)	1 x M6 A2-70
Tool	4 mm Hex
Tool	5 mm Hex
Tool	8 mm Hex
Lubricant	Aquaproof grease
Torque: Module Base	9 Nm
Torque: Module Cover	6 Nm

v1 – 2-Piece

v2 – 3-Piece

Figure 49: Versions of Steerer Module

ATTENTION: Only Version 2 of the steerer module can be used on any bicycle, if found, Version 1 modules must be destroyed.

- Check the expiry date marked on the front and/or rear of the module’s base and, if unsure, check with the Stock Controller about the safety of the part.
- Unscrew the top-cap and set aside.
- Apply a small amount of grease to the underside of the heads and the threads of the 3x *M6 Socket Head screws* and fit the washer to the **45 mm** screw.
- Drop the **45 mm** screw down the centre of the tube and align the *Steerer Module* in position on top of the fork, tighten to **4 Nm** (<u>5 mm Hex</u>).
- Thread in the two front screws and tighten to **4 Nm** (<u>5 mm Hex</u>).
- Starting at the screw in the centre of the steerer tube, tighten the three screws in ¼ turn increments (5 mm Hex) to **9 Nm**.

Figure 50: Steerer Module Assembly Order

- Fit the large cover over the steerer tube and align with the front bolt holt, apply a small amount of *Aquaproof grease* to the *M6 x 12 mm button head screw* (4 mm Hex) and torque to **6 Nm**.
- The thickness of the Steerer Module assembly is **18.5 mm** and can be considered equivalent to the bearing cover thickness on a regular headset.
- Fit the stem with the correct number of spacers underneath, add additional spacers on top of the stem until the top spacer protrudes beyond the top of the steerer tube.
- Install the top cap and tighten to **3 Nm** (8 mm Hex) and compress the spacer/stem stack.
- Ensure the stem is aligned with the front wheel and fork and tighten the steerer bolts as per the stem manufacturers specifications.
- Install the handlebar and follow the manufacturers specifications.

5. Finishing Steps

5.1. Attached Accessories

5.1.1. MyLaps Chip

Table 39: Required Components for Timing Tag Fitment

Description	Parts
Tube	646Q Black Latex Balloon
Tool	Sharp Scissors
Lubricant	Silicone Spray

- The MyLaps (or competition timing tag) should be mounted on the left fork-leg tab wherever possible on 2020 framesets. In the training environment, the tag should be mounted **75 mm** from the centre of the axle on sprint bikes.
- Cut a **40 mm** section from the tip of the balloon, for pursuit bikes, the under of the balloon can also be used and oriented forward.
- A small amount of *silicone spray* on the inside of the balloon can may it easier to install.
- For sprint bikes; with the front wheel removed, stretch the section of balloon and slide it up the fork leg to the correct position. Lift the top edge of the tube and slide the *MyLaps chip* into the middle of the tube with the removable cover oriented towards the ground and ensure it is held snugly.
- For pursuit bikes; slide removable cover end of the tag into the tube, with the front wheel removed, slide the tube over the tab on the left fork leg. If using the closed end of the tube, it or the removable cover should face forward and the loops on the side of the tag should align with the slots in the tab. Pull the tube onto the dropout so there are no wrinkles in the tube.

Sprint Bike: Right Leg

Pursuit Bike: Left Tab

Figure 51: Covered Timing Tag

5.1.2. SRM Headunit Mount

Table 40: Required Components for SRM Mount Fitment

Description	Parts
Component	CA-ACT-E02-001-03P-v07,X
Zip Ties	2x 3.8 mm x 300 mm Black
Tool	Flush Cutters

- The only SRM mounts used should *be CA-ACT-E02-001-03P-v07,X_SRM_ SeatPost_Mount*, which have a matte black finish and 'SRM' written on the top and bottom faces.
- Position the mount such that the recesses for the sip tie heads should be on the non-drive-side of the bike and the curved side of the dovetail should face the drive-side.
- For sprint bikes, the mount should be positioned **50 mm** from the top-rear of the seat post as they use smaller SRM PC7 headunits.
- For endurance bikes, the mount should be positioned **60 mm** from the top-rear of the seat post as they use larger SRM PC8 headunits.

Sprint Bike: PC7

Endurance Bike: PC8

Figure 52: Correct SRM Mount Orientation, NDS View

- Thread the *2x 3.8 mm x 300 mm Black* zip ties through the bracket from the drive-side and tighten each zip tie evenly. Trim the ends square with <u>flush cutters</u> such that no excess protrudes from the head of the zip tie.

ATTENTION: Ensure no sharp edge or corner is left protruding from the head of the zip tie, this could cause a serious injury to staff or athletes.

5.1.3. Internal WSL Cradle

Table 41: Required Components for Internal WSL Fitment

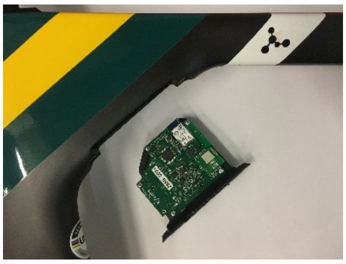
Description	Parts
Component	Internal WSL on Cradle
Tool	2.5 mm Hex
Torque: WSL Screw	2.5 Nm

- The allocation of internal WSL units should be carefully managed by the *Performance Systems Manager, Andy Warr*.
- Remove the *2x M4 x 12 mm BHCS* (2.5 mm Hex) which hold the vanity cover on the upper portion of the seat tube.
- Orient the cradle such that the chamfer faces toward the seat tube, the USB charging port is on the drive-side and the large silver chip is on the non-drive-side.

ATTENTION: Correct orientation is critical for the system to function correctly

- Evenly tighten the two screws (2.5 mm Hex) to **2.5 Nm**.
- If the cradle is oriented upside-down the top edge will produce a lip and the bottom edge will have an undercut to the slight tapered shape of this section of the frame.
- Switch the system on and check a solid light appears, switch the system off and set it on charge using one of the cables installed in the Lower Workshop at the Adelaide Super-Drome or the portable WSL battery system. Check for green and yellow lights to indicate charging.

Removed



Orientation

Charging

Figure 53: Correct Internal WSL Fitment

5.1. Handlebar Grips/Tape

- There are many different preferences for handlebar tape or grips, the coach and athlete should be consulted before fitting. *Table 42* outlines several options and what else may be required to install.

Table 42: Required Components for Handlebar Finishing

Description	Parts
Component	Various Rubber Grips
Component	Renfrew's Hockey Tape
Component	Sandpaper Tape
Component	Black Cork Handlebar Tape
Tool	Sharp Scissors
Tool	Air Compressor
Tape	Nitto 18 mm Black Electrical Tape
Solvent	Isopropyl Alcohol
Adhesive	Hairspray

5.1.1. Sprint Bikes

- Sprint athlete grip preference is very personal and should be replicated from their previous setup or decided through consultation with the coach and athlete. Some Examples could include:
- Various Rubber Grips: Install a handlebar plug and spray *isopropyl alcohol* on the handlebar and inside the grip. If the grip is being fitted to a *2020 Argon 18 Sprint Handlebar*, **~25 mm** will need to be cut from the end. Work the grip onto the end of the handlebar and then use the air compressor to inflate the grip which assists the grip in sliding on. If the grip slides around on the handlebar after the isopropyl alcohol has dried, remove the grip and repeat the previous process but using *hairspray* instead of *isopropyl* alcohol.
- Renfrew's Hockey Tape: Starting at the end of the handlebar, with **50% overhang**, wrap **inwards** (towards the stem) such that the tape hangs off the end of the handlebar end for a full tun. Then, has a **50 % overlap** until enough is applied, cut the tape at a **45 deg angle** and press the tape down firmly.

5.1.2. Pursuit Bikes

- Basebar: The standard specification is for a **74 mm x 74 mm square** of *sandpaper tape* on each horn of the basebar.
- Integrated Extension: Cut **200 mm** of Renfrew's Hockey Tape in **half lengthways** to create two thing stirps.

5.1.3. Bunch Bikes

- Athletes will have a preference of where the handlebar will finish and whether other tapes are added, consult with them and their coach before proceeding.
- Overhang the *cork handlebar tape* by **50%** at the end of the handlebar and wrap inwards with a **30-50% overlap**, ensuring there are no gaps. Stop where is required and take note of where on the tape the will finish on the underside of the handlebar and unwrap by one turn. Cut and diagonal line from this point on the outside to the inside (stem-side) of the tape with a line which should make the cut edge **parallel to the stem** for one revolution.
- Wrap the tape back around and secure with three revolutions of *Nitto 18 mm Black Electrical Tape*.
- Add any additional *Renfrew's Hockey tape* or *Sandpaper Tape* as requested by the athlete or coach.

5.1.4. Speed Sensor

- 2020 Electron Pro framesets are designed to use the integrated *Giant RideSesne* sensor in the non-drive-side chainstay, this unit should be used wherever possible.
- Depending on the configuration, some or all of the components in *Table 43* will be required for installation.

Table 43: Required Components for Handlebar Finishing

Description	**Parts**
Component	Giant RideSense Sensor
Component	SRM Speed Sensor
Component	CR2032 Battery
Fastener	M3 x 14 mm BHCS or Similar
Zip Tie	2x 2.5 mm x 100 mm Black
Tool	Flush Cutters
Tool	2.5 mm Hex
Adhesive	Blu-Tak
Torque: RideSense Screw	2 Nm

5.1.4.1. Integrated Giant RideSense

- Check a CR2032 battery is installed and not flat by removing the cover on the back-side of the sensor.
- Slot the prong of the of the sensor in the hole drilled in the non-drive-side chainstay and press the sensor flat against the chainstay.
- Insert the *M3 x 14 mm screw*, supplied with the sensor or a screw of similar dimensions, into the hole in the sensor and rotate the sensor until the screw pushes into the nutsert in the frame.
- Tighten the screw (2.5 mm Hex) to **2 Nm** and check for play in the sensor.
- If the sensor is being installed for the first time or as a replacement, inform the *Performance Systems Manager, Andy Warr*.

Insert Prong | Screwed in Place

Figure 54: Giant Ride Sense Installation.

5.2. Positioning of Stickers

- Several Identifying stickers will need to be fitted to the frame.
- All frame surfaces should be prepared with *isopropyl alcohol*.

Table 44: Required Components for Handlebar Finishing

Description	Parts
Solvent	Isopropyl Alcohol

Stock | Measurements | Athlete Name

Figure 55: Finishing Stickers

5.2.1. Stock QR Code

- If a stock tracking code is not fitted on the underside of the frame, inform the *Stock Controller, Andy Rogers*.

5.2.2. Measurements QR Code

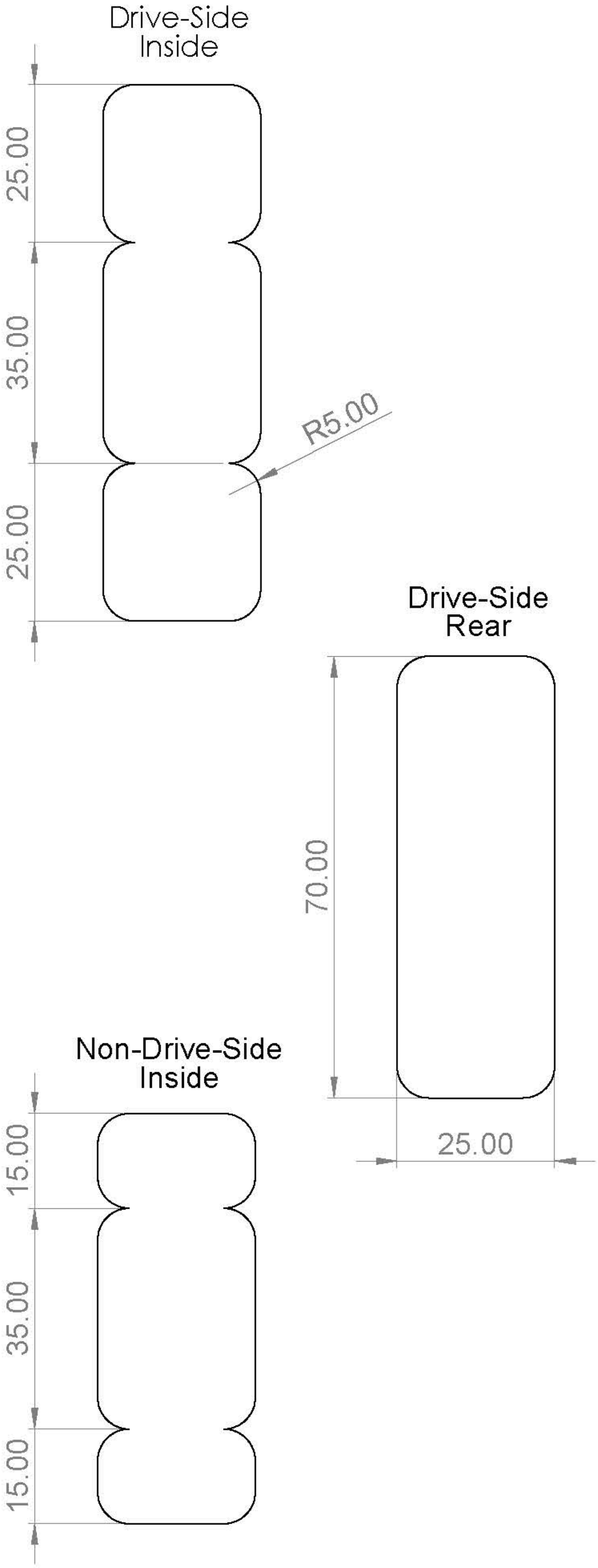
- For endurance riders, a QR code should be stuck to the back of the seat tube to allow riders to check their position measurements.
- This stickers are prepared by B*io-mechanist, Sian Barris*.

5.2.3. Name Sticker

- A rider’s name sticker should be placed on the top-tube, next to the seatpost wedge, such that it can be read from the drive side of the bike.

Figure 56: The Bicycle is Now Complete

Appendix A: Cutting Template for Frame Protectors



Appendix B: Consulted Staff

Component of Process	**Staff Member**
Dropout Plate Fitment	Workshop Manager, Will Dickeson
Bastion Sprint Stem Faceplates	Workshop Manager, Will Dickeson
WSL Allocation	Performance Systems Manager, Andy Warr
Speed Sensor Allocation	Performance Systems Manager, Andy Warr
Frameset Allocation	Stock Controller, Andy Rogers
Bike Measurement QR Code	Bio-Mechanist, Sian Barris
Frameset Signoff	Stock Controller, Andy Rogers

Appendix C: Example Images of Tools

20-Notch Bottom Bracket Tool

16-Notch FSA BB386EVO BSA Tool

Pedro's Flat Wrench – Shimano 6-Notch

Argon 18 19.5 mm 3D Headtube Tool

Hozan P-221 Pliers

Shimano TL-FC21 Peg Spanner

BF1 Extraction Thread

Universal Crank Extractor

Cannondale KT-013 Tool

Flush Cutters

Appendix D: CA-ACT-E02-006-03/7P Drawing (Not to Scale)