THE MEASUREMENT OF ROAD RACE COURSES
Road Running & Race Walking

REVISED EDITION, 2023

WORLD ATHLETICS

AIMS Association of International Marathons and Distance Races
The home of world running™

WORLD ATHLETICS
in co-operation with AIMS

ACKNOWLEDGEMENTS

World Athletics wish to acknowledge the use of material first published in 1985 by The Athletics Congress of the USA in their booklet *Road Race Course Measurement and Certification Procedures*.

World Athletics would like to take this opportunity to thank the Association of International Marathons and Distance Races (AIMS) for its invaluable work in developing responsible attitudes to road race course measurement among its members, and for developing the measuring techniques first instigated by John Jewell of the Road Runners Club (GBR) and Ted Corbitt of the Road Runners Club of America.

The first edition of this book was published in 1989. A revised edition was written in 2002 and 2008 by Dave Cundy (World Athletics Area Measurement Administrator) and Hugh Jones (World Athletics Area Measurement Administrator and Secretary of AIMS).

Dave Cundy and Hugh Jones, assisted by International Grade A Measurers David Katz and Norrie Williamson have greatly contributed to this 2023 edition.

Measurement procedures outlined in this booklet are those prescribed by World Athletics and AIMS for the measurement of road races. World Athletics will only recognise times achieved in road races for which the course has been measured according to this system.


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AIMS PRESIDENT'S MESSAGE

AIMS was established 40 years ago in response to the burgeoning popularity of the then-new sport of mass participation road running. Recreational running was growing fast and organisers were often having to improvise when they addressed questions which were important for the integrity of these new kinds of events.

Accurate measurement of the course was one of the fundamental requirements. At that time there was no specific rule governing measurement of road races although a reliable method had been developed by John Jewell of the Road Runners Club (GBR) and Ted Corbitt of the Road Runners Club of America.

The 'calibrated bicycle' method was in existence, but it was not universally applied. AIMS adopted this method of measurement and made it a requirement for members to have their courses measured in this way by a trained and accredited measurer.

One of AIMS' founding principles was to exchange information, knowledge, and expertise among the members of the Association. The spread of an accurate, fast, and economical method of measurement was a perfect example of this co-operative approach.

Another of AIMS' founding principles was "to work with the International Association of Athletic Federations (now World Athletics) on all matters relating to international road races". It took time for the popularly adopted method of measurement to become enshrined within World Athletics rules. Once this had been achieved race organisers increasingly saw the advantages of using the prescribed method. It enhanced the international reputation of the race for the organisers to be able to say that their course was measured in exactly the same way that an Olympic or World Championships Marathon would be.

The first edition of this booklet was published in 1989 – some years after the calibrated bicycle method was becoming widely used by races aspiring to international status. It was revised in 2002, 2008 and now in 2023. Over the decades this method of measurement has remained the most reliable, practical, and economical way of measuring courses. Through these advantages it has become established as the only method recognised by the rules of World Athletics.

This publication is intended as an instructional manual for people interested in serving the sport of road running in one of the most fundamental ways possible: delivering accurately measured courses to race organisers. By following the text of the booklet anyone with an interest in the subject and possessed of a logical mind and a pocket calculator will very quickly be able to acquire the skills required.

Sportive greetings,

Paco Borao
President of AIMS

WORLD ATHLETICS PRESIDENT'S MESSAGE

The accurate measurement of road race courses is a fundamental and essential part of our sport. Without precise measurement of road race courses, and the development of accurate timing for road races, it would never have been possible for World Athletics (WA) to recognise the many awe-inspiring world records for performances on the road.

Indeed, no true running enthusiast wants to learn, after struggling to achieve a personal best performance over a distance, that the course they ran was short of the mark.

Therefore, World Athletics (WA), along with our partners at the Association of International Marathons and Distance Races (AIMS) came together to create The Measurement of Road Race Courses booklet. This booklet – which has now been updated for the fourth time – is an excellent introduction to the principles of accurate measurement. From selecting and measuring a calibration course, to making final adjustments, every step of the measurement process is described in detail chapter by chapter.

The booklet also provides all of the information necessary for a trainee measurer to develop the skills that will enable them to become, through practice and application, competent in the science of road course measurement using a bicycle equipped with a measurement Counter, which is still, to this day, the only method accepted by WA for the accurate measurement of road race courses.

The authors are to be commended for the excellent work that they have done in producing this latest updated version of the booklet and for their commitment to the cause of accuracy in course measurement and road running in general.

I am sure that this work will lead to the qualification of more certified measurers around the world, especially in those areas where this competence is lacking; and this, in turn, will contribute to the continued growth of road running and all of the benefits that this branch of our sport brings to individuals and society as a whole.

I take this opportunity to invite all race organisers to have their courses WA-certified. The certification is free of charge, and without such certification, no performance can be considered official.

Finally, World Athletics and its Area Associations strongly encourage the organisation of training activities for course measurers. At the time of writing, we have 220 international WA-accredited measurers and we hope to increase that number substantially – making sure effective course measurement is as convenient and affordable as it can be.

Happy reading,

Sebastian Coe
World Athletics President

I. EXTRACT FROM WORLD ATHLETICS RULES

Knowledge of the technical rules pertaining to course measurement along with the qualifying requirements for the various World Athletics Series, Olympic Games and World Rankings are helpful when designing and measuring road courses. This information can be valuable when advising competition organizers to help develop road courses that maximize the results of athletes' performances.

Athletes can only achieve qualifying standards, ranking points or set records on courses that are WA/AIMS Certified.

Measuring Rules

Technical Rule 55 Road Races

Race Walking – please refer to Technical Rule 54.11

Distances

55.1 The standard distances shall be: 5km, 10km, 15km, 20km, Half-Marathon, 25km, 30km, Marathon (42.195km), 50km,100km and Road Relay.

Note: It is recommended that the Road Relay race be run over the Marathon distance, ideally over a 5km loop course, with stages of 5km, 10km, 5km, 10km, 5km, 7.195km. For an U20 Road Relay, the recommended distance is a Half-Marathon with stages of 5km, 5km, 5km, 6.098km.

Course

55.2 The races shall be run on made-up roads. However, when traffic or similar circumstances make it unsuitable, the course, duly marked, may be on a bicycle path or footpath alongside the road, but not on soft ground such as grass verges or the like. The start and finish may be within an athletic Field of Play.

Note (i): It is recommended that, for Road Races staged over standard distances, the start and finish points, measured along a theoretical straight line between them should not be further apart than 50% of the race distance. For approval of Records, see Rule 31.21.2 of the Competition Rules.

Note (ii): It is acceptable for the start, finish and other segments of the race to be conducted on grass or other non-paved surfaces. These segments shall be kept to a minimum.

55.3 The course shall be measured along the shortest possible route that an athlete could follow within the section of the road permitted for use in the race. In all competitions under paragraphs 1.1 and, where possible, 1.2, 1.3 and 1.6 of the International Competition definition, the measurement line should be marked along the course in a distinctive colour that cannot be mistaken for other markings. The length of the course shall not be less than the official distance for the event. In competitions under paragraphs 1.1, 1.2, 1.3 and 1.6 of the International Competition definition, the uncertainty in the measurement shall not exceed 0.1% (i.e. 42m for the Marathon) and the length of the course should have been certified in advance by a World Athletics approved course measurer.

Note (i): For measurement, the "Calibrated Bicycle Method" shall be used.

Note (ii): To prevent a course from being found to be shorter than the official race distance on future re-measurement, it is recommended that a "short course prevention factor" be built in when laying out the course. For bicycle measurements this factor should be 0.1% which means that each km on the course will have a "measured length" of 1001m.

Note (iii): If it is intended that parts of the course on race day will be defined by the use of non-permanent equipment such as cones, barricades, etc. their positioning shall be decided not later than the time of the measurement and the documentation of such decisions shall be included in the measurement report.

Note (iv): It is recommended that for Road Races staged over standard distances, the overall decrease in elevation between the start and finish should not exceed 1:1000, i.e. 1m per km (0.1%). For approval of Records, see Rule 31.21.3 of the Competition Rules.

Note (v): A course measurement certificate is valid for 5 years, after which the course shall be re-measured even when there are no obvious changes to it.

World Records

World Athletics recognises the following distance as World Records for road running and race walking events. Other events not listed may be considered as World Best or National Records but require similar specification as for world record road courses.

The International Association of Ultrarunners (IAU) recognises additional distances for records. Please refer to their website for more information: www.iau-ultramarathon.org

Competition Rule 32

5km, 10km, Half Marathon (21.0975 km), Marathon (42.195 km)

50km, 100 km, and Road Relay (Marathon Distance Only).

Race Walking (on the roads)

20km, 35 km, & 50km

Measurement requirements for World Records

World Athletics Competition Rule 31.21

For World Records in Road Running Events (these rules can also be applied to race walk courses):

31.21.1 The course must be measured by an "A" or "B" grade World Athletics/AIMS approved measurer who shall ensure that the relevant measurement report and any other information required by this Rule is available to World Athletics upon request.

31.21.2 The start and finish points of a course, measured along a theoretical straight line between them, shall not be further apart than 50% of the race distance

31.21.3 The overall decrease in elevation between the start and finish shall not exceed 1:1000, i.e. 1m per km (0.1%).

31.21.4 Any course measurer who originally measured the course or other suitably qualified official designated by the measurer (after consulting the relevant body) with a copy of the documentation detailing the officially measured course shall in advance of the race check that the course is laid out in conformity with the course measured and documented by the official course measurer. They shall then ride in the lead vehicle during the competition or otherwise validate that the same course is run by the athletes.

31.21.5 The course must be verified (i.e. re-measured) as late as possible before the race, on the day of the race or as soon as practical after the race, by a different "A" grade measurer from any of those who did the original measurement.

Note: If the course was originally measured by at least two "A" grade or one "A" and one "B" grade measurers, no verification (re-measurement) under this Rule 31.21.5 will be required.

Additional interpretation of the above note:
An "A" grade measurer can verify the measurement of a "B" grade measurer but the "B" measurer cannot verify the measurement of an "A" measurer.

It is recommended that for races that anticipate the possibility of world record or for any major road event that the course be "pre-verified.

31.21.6 World Records in Road Running Events set at intermediate distances within a race must comply with the conditions set under Rule 31 of the Competition Rules. The intermediate distances must have been measured, recorded and subsequently marked as part of the course measurement and must have been verified in accordance with Rule 31.21.5 of the Competition Rules.

31.21.7 For the Road Relay, the race shall be run in stages of 5km, 10km, 5km, 10km, 5km, 7.195km. The stages must have been measured, recorded and subsequently marked as part of the course measurement with a tolerance of ± 1% of the stage distance and must have been verified in accordance with Rule 31.21.5 of the Competition Rules.

Note: It is recommended that national governing bodies and Area Associations adopt similar rules to the above for the recognition of their own records.

II. CURRENT APPROVED MEASUREMENT COUNTERS

These are currently the two main suppliers of counters:

The Jones Counter (USA)

http://www.jonescounter.com/

This counter mounts on the right-hand side of the front wheel and is capable of being fitted on most wheel configurations including the 14mm through bolt hubs. 15mm bolt hubs can be a special order.

The Cook Jones Counter (UK)

http://www.cookjonescounter.com

There are two versions of the Cook-Jones counter.

The first is a single unit that is easily swapped between bikes and the second a two-piece unit where the cog is fitted to the spokes of the front wheel and so is more suitable for measurers who will normally use their own bike or take a front wheel with them for out-of-town measurements.


CANADA
QNB
SEXTON
QNB
LINDHOLM
OREGON22
CRAFT
BULGARIA
OREGON22


QNB
HARVEY
OREGON22
AUSTRALIA
QNB
KLEIN
OREGON22
QNB
MIDDLETON
OREGON22
QAZ

III. MEASUREMENT PROCEDURES - HOW IT IS DONE

A calibrated bicycle fitted with an approved mechanical counter ('the Counter') is the only approved method of measuring road race courses. The Counter, which is mounted at the hub of the bicycle's front wheel, was originally named the Jones Counter, after its inventor Alan Jones and the original manufacturer, his son Clain Jones.

The Counter does not measure distance directly. It measures the revolutions and part-revolutions of the bicycle (front) wheel. Current models of the Counter, of which there are several versions, have a gearing through which they register 260/11 counts (23.6363) for each revolution of the wheel. Because the circumference of bicycle wheels normally used in measurement is about 2.1m this means that each count represents approximately 9cm on the ground.

Counters are available in five- or six-digit configurations. Current versions are designed for use on the right side of the wheel hub. They may be purchased from: www.jonescounter.com

Another approved counter is the Cook-Jones counter, available from www.cookjonescounter.com

The basis of the method of measurement is to compare the number of revolutions of the bicycle wheel (recorded in 'counts') needed to cover the race course with the number of revolutions needed to cover a standard 'calibration course' of known length. The method is simple and direct, but there are many important details to follow in order to obtain an acceptable measurement.

The following eight steps are necessary to measure a road race course:

1. Define the road race course
2. Select and measure a calibration course
3. Calibrate the bicycle on the calibration course
4. Measure the road race course
5. Re-calibrate the bicycle on the calibration course
6. Calculate the length of the road race course
7. Make final adjustments to the road race course
8. Document the measurement.

Each step is discussed in greater detail in the following pages. The main text contains all basic information required to undertake a course measurement.

Further information and more detailed explanations appear in the appendices and are referenced from the main text.

1. DEFINE THE ROAD RACE COURSE

The road race course is the route to be taken by participants in the event. Defining the course is the most important step in measuring a road race course because the measurement is irrelevant if participants in the event follow a different route.

Before you can measure something, you must know what to measure. The race organiser will probably have a rough route in mind. Make sure that this route has been agreed with the highway authorities and the police. The race organiser, the police and the highway authorities must also decide what part of which streets will be available to the runners. Will they be able to use the entire road, from kerb to kerb? Will they be kept to the right or left-hand side? Are there any places where the course crosses a grass or gravel area? You must know the answers to such questions before you start to measure.

If runners are expected to stay to one side of the road this may cause uncertainty in measuring at corners. The precise route around each restricted corner must be defined prior to the measurement and set up in exactly the same way on race day.

The easiest way to define a course is to say that the runners will have full use of the entire road, from kerb to kerb, or from kerb to solid central divider, if one exists. This leaves no doubt where the measurer should measure. See Riding the shortest possible route in step 4 below.

On race day the race director may put up barriers for safety but, even if these intrude into the roadway, they will only lengthen the course slightly.

If you lay out a course with many restrictions and barriers it may measure short if the race organiser omits or misplaces the barriers. If a record performance is involved a short course can be extremely embarrassing to the race organiser and to the measurer. Encourage the race organiser to keep the course design simple.

The end result of your work will include a map that shows the entire road race course. The map should be good enough to allow a perfect stranger, using the map alone, to measure exactly where you did. If your course has any restrictions, they must be clearly documented on the map. If there are very many restrictions the map may be hard to draw and hard to understand.

2. SELECT AND MEASURE A CALIBRATION COURSE

What is a calibration course?

A calibration course is an accurately measured base line used to calibrate the bicycle. It will be straight, paved, level and on a lightly-travelled section of road, free of parked vehicles. It should be at least 300m in length. A calibration course near to, or on, the race course is best. Try to avoid calibrating very far from where you are going to measure.

The effectiveness of the calibrated bicycle method of measurement depends on good calibration procedure, which demands quick access from the calibration course to the race course and vice-versa. Calibrations are best used when 'fresh' before conditions can change much.

Selecting a location for a calibration course

Choose a location that will be safe and convenient for calibrating the bicycle. Every time you measure a road race course you will ride the calibration course eight times (four times before the measurement and four times afterwards) and you will need to ride in both directions.

Calibration courses are often measured along the edge of a straight road, the same distance from the kerb as you would ride the bicycle when measuring (30cm). Bicycle paths next to roads may provide suitable locations but the surface of the calibration course should be similar to that of the road race course you are going to measure. If you select a road where it is too busy for you to ride against the traffic you may need to measure two parallel calibration courses on opposite sides of the road.

The marks defining the endpoints of your calibration course must be in the roadway where your bicycle wheel can touch them, not off to the side somewhere. The endpoints should be marked by nails driven into the road. Urban areas often have numerous permanent objects in the street (drain gratings, manhole covers, etc.) which may serve as one or both endpoints of a calibration course.

Your calibration course will be most resistant to obliteration if both endpoints are permanent objects, which will mean that the calibration course will be an odd distance such as 327.56m. This is perfectly acceptable. You can also make your calibration course an even distance where both endpoints are close to permanent landmarks, and where you have precisely located the endpoints relative to such landmarks. See the map in Appendix 4 for an illustration showing the referencing of the endpoints of a calibration course.

The end points defined should be marked with nails. If the nails cannot be found at the time of a future measurement the calibration course should be re-measured.

When measuring a short on-site calibration course, which you will probably use only once, convenience is more important than durability. Lay out a whole number of tape lengths – 6 lengths of a 50m tape.

Equipment required to measure a calibration course

The standard method of measuring a calibration course is with a steel tape. Any steel tape may be used but to be confident of accuracy use a tape made by a well-known manufacturer of surveying and construction equipment, with temperature and tension specifications (usually 20°C, 50N) printed on the blade of the tape near to the zero point.

Your steel tape should be at least 30m in length, preferably 50m. You will also need (preferably white or yellow) adhesive tape that will stick to the road and pens, for marking tape lengths on the road, and a notebook for recording data. A spring balance for checking the tension of the tape and a thermometer for checking roadway temperature are recommended.

Measuring the calibration course

You can measure a calibration course with just two people, but it will be easier with a third person who can watch for traffic and take notes. In some locations, particularly where there are no kerbs by which to align the tape, the third person can sight the taping positions of the other two in order to maintain a straight-line measurement.

Check your steel tape carefully to be sure you know where the zero point is. Not all tapes are the same.

Pull the steel tape firmly to stretch it flat and straight, without twists, before marking.

Use pieces of adhesive tape to stick to the pavement for marking. Put numbers on the roll before you tear pieces of tape off for marking. This will help you to keep count of the tape lengths. Once you have stuck the tape down in the approximate position, apply the correct tension to the steel tape using the spring balance. Then use a narrow pen to make distance marks on the adhesive tape. Do not lose count. This is the most common source of error.

It is recommended that you use a spring balance to apply the correct tension but if one is not available a strong pull on the tape is sufficient.

Even where a spring balance is available, once the measurer has determined the 'feel' of the correct tension it is possible to dispense with the spring balance and apply the estimated tension by firmly pulling on the tape end.

To avoid twisting the tape when walking from one taping position to the next maintain some tension in the tape and hold it in a consistent position.

You must tape the course at least twice. Normally the second measurement will be done in the reverse direction from the first. Use a new set of intermediate taping points displaced by (e.g.) one metre from those used earlier. This will require new pieces of adhesive tape to be laid down.

Treat the second measurement as a check of the distance between the same endpoints that you measured the first time. The second measurement will result in a second number indicating the distance between your original endpoints, and not a new set of endpoints. Your final result will be based on the average of both measurements.

If the second measurement is significantly different to the first measurement, further measurements should be undertaken until reasonable agreement is reached. As a guide, a discrepancy of more than 3cm on a 300m calibration course would be regarded as a significant difference.

At this stage you may wish to use the bicycle to check that you have not made any major mistake. The counts obtained on the calibration course should be very close to the counts obtained on other calibration courses of the same length. If you are riding an unfamiliar bike, obtain the counts between the ends of a single tape length. Multiply this by the number of tape lengths you measured and use it as a check of the length of the entire calibration course. Any error in the measurement process at this stage will lead to serious consequences later.

If you are using a GPS device, a ride over the entire calibration length will provide basic confirmation of overall distance.

You may then adjust the corrected length of the course to obtain a desired even distance.

Before driving in the nails to mark the endpoints your measurements should be adjusted for temperature, although this will have relatively little impact on the overall measurement procedure. See Appendix 1 for a full explanation of how to adjust the length of a calibration course to account for temperature.

3. CALIBRATE THE BICYCLE ON THE CALIBRATION COURSE

The aim in calibrating the bicycle before doing the road race course measurement is to calculate the number of counts registered on the Counter for every kilometre ridden on the bike. This figure is called the working constant.

To calibrate the bicycle, follow these ten points:

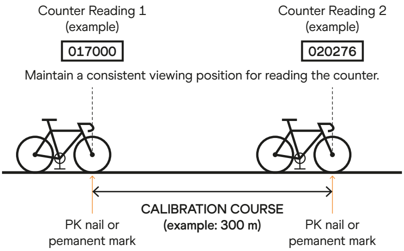
1. Check the condition of your bicycle's tyres. They should be firmly inflated. You should ride the bicycle for several minutes just before beginning to calibrate. This will ensure that the tyres are at air temperature and

reduce the variation in the counts recorded in your series of calibration rides. Do not calibrate immediately after taking the bicycle out of a vehicle.

2. At one endpoint of the calibration course slowly roll the front wheel forward through to the count at which you will begin the calibration ride. This will ensure that the spoke of the wheel is driving the 'finger' of the counter. Lock the front wheel with the brake and place the axle directly over the endpoint of the calibration course. Record the counter reading. Whenever a reading is taken, this should always be done in the same way (for example, always sight downward from directly above the hub of the wheel). This is best achieved by adopting a standard standing position when the bike is stopped and a reading taken.

3. Ride the bicycle over the calibration course in as straight a line as possible and with the same weight and equipment on the bicycle as will be used during the measurement of the road race course. A calibration ride should be one non-stop ride. Try to maintain a constant riding posture. Changing your position will change the pressure on the front tyre and affect the calibration readings. See in Appendix 2 – Riding techniques – for a full explanation.

4. Stop the bicycle just before reaching the other endpoint of the calibration course and roll it slowly forward until the axle of the front wheel is directly over the endpoint. Adopt your standard standing position, lock the front wheel and record the counter reading.



5. With the front wheel still locked by the brake, turn the bicycle around and place the axle of the front wheel directly over the endpoint of the calibration course. After you have repositioned the bike and before you start the next calibration ride check that there has been no change to the counter reading recorded at the end of your previous ride.

6. Repeat steps 3, 4 and 5 until you have made a total of four calibration rides (two in each direction).

7. For each ride, subtract the counter reading taken at the start of the ride from that at the end. Compare the four rides. If the number of counts on any ride is very different to the number of counts on other rides, discard that ride and undertake an additional ride until four reasonably consistent rides are obtained. The inconsistent ride may have been caused by swerving to avoid a person, dog, vehicle, etc.

8. Add the number of counts obtained for the consistent rides. Divide the total number of counts for the calibration rides by the number of rides you have made (in most cases, four). This will give you an average number of counts for one calibration ride.

9. Divide this average by the length of the calibration course in kilometres to obtain the number of counts per kilometre (multiply this by 1.609344 if you wish to obtain the number of counts per mile).

10. Multiply the number of counts per kilometre by 1.001 to obtain the **working constant**. The **'short course prevention factor' (SCPF)** of 1.001 is applied to recognise the error in measurement by the calibrated bicycle method (one part in a thousand). Applying the SCPF is intended to result in road race courses which are at least the distances stated, within the limits of measurement precision. It may also mean that very slight variations in the course layout on race day will not invalidate the measurement.

Once you have calculated the working constant you can go to measure the road race course. When you are finished, return to the calibration course, and repeat the same process as a Post calibration.

4. MEASURE THE ROAD RACE COURSE

Overview

Once you have calibrated the bicycle you will have determined a working constant. Use this constant to measure the road race course.

Go to one end of the race course. Either end will do – as long as you follow the proper line the direction of measurement does not matter. If the race director has a fixed position for the finish line you may need to start there and measure in reverse; if the start is fixed you should begin the measurement there.

For safety considerations the direction of measurement should be the same as that of the normal traffic flow for as much of the route as possible.

Look at your counter. Rotate the wheel until it shows a figure (say a round thousand) which will be convenient to use as a starting count, and then lock the front wheel with the brake.

Calculate how many counts it will take to reach the various split points you wish to note along the course (eg. every kilometre, every mile, or every 5km). Add these to the starting count. When you have finished calculating you will have listed the appropriate count for each split point (in marathons, don't forget the halfway split). Remember that if you are measuring from the finish to the start your first split in the marathon will be after 195m and in the half marathon after only 97.5m.

Ride along the course stopping either at or near the pre-calculated counts. Then **either** make a mark on the road, using paint or waterproof crayon, when the counter records the calculated numbers, or record the count at a nearby permanent landmark, such as a numbered lamp post (this will be different from the pre-calculated count, but not by very much).

It can be useful to use a GPS device on the bike as a guide to the location of Km marks or key distances and then to stop and record the actual digital number at a nearby lamp post or fixed landmark. This can save critical calculation time prior to commencing the measurement.

Record the location of the paint or crayon mark for later documentation or note a description of the permanent landmark. Such descriptions should be precise and unambiguous (e.g. if you stop at a road junction, note with which kerb of the road you are aligned).

In rural areas, where there may be fewer permanent landmarks along the roadside, you may have to use paint marks.

It may prove impossible or too dangerous to do the measurement in an unbroken ride from start to finish (or finish to start); for example - if the race course uses sections of one-way streets or carriageways where there is oncoming traffic. In these cases you may need to break off and reverse the direction of your measurement ride before resuming at the end of this section.

Make sure you select identifiable points at which to break the ride, preferably corresponding to permanent landmarks which can be mentioned in the course documentation. Making additional marks with paint in these locations will allow you to sight them in good time as you approach from the opposite direction.

When you reach the end of your list of pre-calculated counts, you will have established a tentative race course.

Riding the shortest possible route

The road race course is defined by the shortest possible route that a runner could take without being disqualified. Any particular runner is most unlikely to follow the shortest possible route, just as a track runner cannot always hold the inside kerb for the length of the race but must move out in order to overtake other runners. The actual path of any given runner is irrelevant. The shortest possible route is theoretically well-defined and unambiguous. Defining a road race course in this way ensures that all runners will run at least the declared race distance.

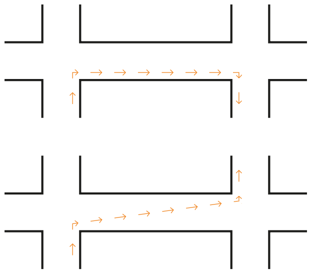
Your measured path must be the **shortest possible route (SPR)** within the limits of the course boundaries. Imagine how a stretched string would fit within the boundaries of the course. Follow that imaginary string when you measure. Runners may swing wide to take corners but do not attempt to measure what you think they will do. The exact SPR is the proper route to follow.

Measuring the SPR means hugging the inside edges of bends. The path you should attempt to measure officially lies 30cm from the kerb or other solid boundaries to the running surface. Attempt to maintain this distance on bends and at corners.

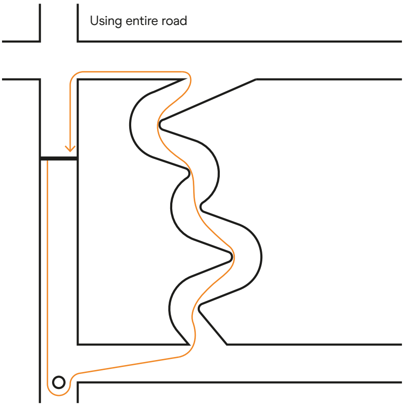
On stretches between bends the SPR takes the shortest possible straight path. It will cross from one side of the road to the other, whenever necessary, to minimise the distance.

The shortest possible route in various different road configurations is shown below:

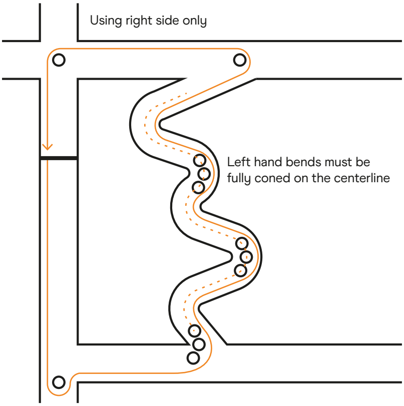
Turns



Winding roads – use of full width of road



Winding roads – use of half of the road only (runners may not cross the centre line)

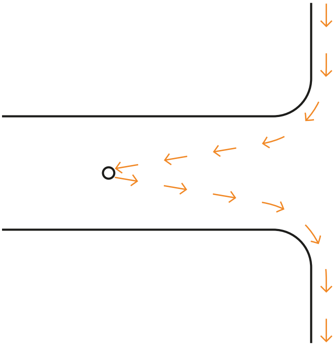


Lap courses

The above illustrations show a lap course. A multi-lap course is not suitable for mass races. If thousands of runners (or even hundreds) are competing the course should consist of no more than two laps.

Ultra-distance races are often run on multi-lap courses. Relatively few runners complete many laps (e.g. 50 runners may complete 20 x 5km laps in a 100km race). In such circumstances it is very important that the lap length is measured accurately. Any under-estimate of the lap length will be multiplied many times over in calculating the full race distance. Several measurements of the lap should be made (two at minimum; three is recommended) and the shortest lap length recorded should be used as the official lap distance.

Turnaround points



Most races featuring turnaround points mark these with a single cone which runners must keep always on their left or right side. The simplest way to measure such a layout is to ride up to the position of the turn, lock the front wheel, record the count, turn the bicycle around and then continue the measurement back in the other direction.

Where turnarounds are not “points” but are more elaborately laid out with an arc of cones at a specific radius from the centre of the turnaround, this is still the best way to measure them. You can calculate the amount by which such a defined turn increases the running path and add it to your measured course length.

If a course features a turnaround point you have the option to dictate how runners may negotiate the turn by specifying how the turn should be laid out.

When you measure to a point, reverse direction, and then measure back from it no allowance has been made for how runners will turn. Most such turnaround points will be marked with a single cone. The measurement therefore ignores the small semi-circular turnaround path that the runner takes around the cone. This is extra distance. If the cone has a 20cm x 20cm base, then the runners’ path can be assumed to lie 30cm beyond it – that is, at a radius of 40cm from the point itself. The turnaround path will therefore be 0.4m x pi = 0.4m x 3.1416 = 1.25m.

This is a trivial distance, but if enough road width is available significantly larger-radius turnaround points can be designed using a semi-circular arc of cones. This will mean that the runners do not have to slow so much at the turn and bunching of runners will be reduced.

For example, if a turnaround is designed with an arc of cones laid out at a 2m radius centred on the turnaround point to which you have measured, this will add 2.3m x pi to the shortest possible route (7.22m). The length of the arc of cones is 2m x pi, but the running path is further offset 30cm from the line of cones, just as it is from the kerb of the road.

Distance added by such turnaround designs may be cut from the course in other places but can be removed at the same turnaround by moving the centre of the turning circle back by half of the distance added (in this case, 3.61m).

Walks courses

Walks courses, typically 1km or 2km in length, usually feature two turnaround points. To reduce the need to slow at the turns, and so continually disturb the competitors’ walking rhythm, such turns should be of the maximum radius possible within the available road width.

If a walks course is set up on one straight road, then the width of that road must accommodate the field of play when walkers are passing in both directions. Apart from when there are very few competitors this will require a 4m-wide passage in each direction. This in turn means that only the road width in excess of 8m can be used to accommodate the diameter of the turn.

For example: if the road to be used has a width of 12m then the middle 4m allows for a turn radius of only 2m and this may be too tight a turn. If so, then an alternative location must be found.

Further details can be found in Appendix 2.

Obstructions

The course must be measured as it will be when the race is run. If you detour around parked cars, or other obstructions which will not be present on race day, your measurement may make the course too short. You can measure around obstructions, such as a car parked on the inside of a bend, using an offset manoeuvre - measuring on the pavement if necessary.

See Appendix 2 – Offset Manoeuvre around an Obstacle – for a full explanation.

Repeatedly doing this is time consuming. Moving gradually out into the road to avoid a line of parked cars will add little distance to your measurement on relatively straight sections. For example, moving out 20m before will add about 20cm to your measurement; if you observe a 50m approach the additional distance will be 8cm.

Course restrictions

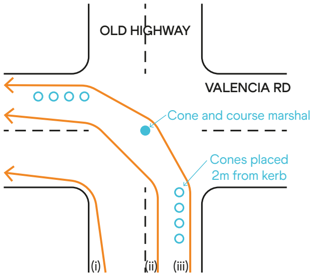
Remember the warning about course restrictions: if cones and barricades are not in position on race day, runners may cut distance from the course as it was measured. Race marshals, even if they are in position, will find it impossible to enforce a longer route than that allowed for by the physical barriers in place.

Road races are run on the road but if there is nothing to stop runners cutting over sidewalks or grass verges at particular corners then they are very likely to do so. If they do, they will then run shorter than the measured route. Your measurement report should make it very clear what must be done to prevent short cutting by runners in such locations.

You may have to specify the placement of barriers, or state where plastic tape should be stretched between lamp posts or stakes. The positioning of cones is not sufficient to prevent corner cutting unless a course marshal is available to note race numbers of runners who do not observe the coned route. If you cannot be sure that race restrictions will be enforced, you should measure the shortest possible route according to whatever permanent boundaries do exist and are likely to be observed by runners.

If the definition of the course does depend on the use of barriers, cones etc. the correct position of these must be indicated on the course map.

If runners are restricted to one side of the road only, you must be sure to specify exactly where they will run when turning corners. This can vary greatly and make a significant difference to the measured length of the course (see below). There should be no doubt about the measured path.



Shortest possible route:	If roads are 10m wide:
(i) Using entire road width	shortest
(ii) Using half road width but shortest possible route on intersection	+ 7m
(iii) keeping within 2m of kerb and keeping right of centre of intersection	+ 12m

Sometimes the sides of roads are poorly defined, and you must decide whether to measure on the road itself or a dirt shoulder. It is probably best to remain on the hard road surface unless the route on the dirt is obviously shorter.

5. RE-CALIBRATE THE BICYCLE ON THE CALIBRATION COURSE

The purpose of re-calibrating the bicycle after the measurement is to check whether there has been any change in the number of revolutions and part-revolutions of the bicycle wheel which correspond to the length of the calibration course during the measurement. This is to be expected, mainly due to temperature variations.

If the temperature has increased the calibration constant will be smaller.

A slightly larger calibration constant may result when the temperature has dropped.

Unexpected changes, and increases in particular, could indicate that there is some other reason for it, such as a slow puncture of the tyre.

It is best to complete the post-measurement calibration as soon after the measurement as possible, before there is time for conditions to change.

Repeat steps 2 – 6 as in the pre-measurement calibration. Again, four rides are required for the post-measurement calibration.

The average post-measurement count obtained should be divided by the length of the calibration course in kilometres and multiplied by 1.001 to obtain the **finish constant**.

Remember that each day's measurement must be preceded and followed by calibration rides. You may measure as much as you can in a day, so long as calibration closely precedes and follows measuring. Frequent re-calibration 'protects' the previous measurement. A smart measurer will re-calibrate frequently – you never know when a flat tyre is coming.

6. CALCULATE THE LENGTH OF THE ROAD RACE COURSE

To calculate the length of the road race course, you must first calculate the **Constant for the Day**. This is the average of the working constant and finish constant. Calculate it by adding those constants and dividing by two.

The next step is to calculate the total number of counts recorded in riding the shortest possible route between the start and finish along the prescribed race route. This figure is then divided by the constant for the day. The result obtained is the length of the road race course.

For example, if your measurement counter has registered 110526 counts when riding the shortest possible route, and the constant for the day is 11059, the distance of the road race course is 110526 divided by 11059 = 9.9942km. This would require an additional 5.8 metres to be added to get a standard 10km route.

In some circumstances it may be appropriate to use the larger of the working constant and finish constant, rather than the average of those constants, as the constant for the day. See in Appendix 2 – When to use the larger constant – for a further explanation.

7. MAKE FINAL ADJUSTMENTS TO THE ROAD RACE COURSE

It is only after calculating the length of the course using the constant for the day that final adjustments can be made to the road race course. You will most probably need to add or subtract some distance to make the road race course the desired length.

Depending on the configuration of the race course, adjustments can be made at the start, at the finish, or at a turnaround point. If more radical adjustments are required, like re-routing along different roads, then these will have to be done using the calibrated bicycle.

Further use of the calibrated bicycle renders the post-measurement calibration insufficient: it was done before the adjustments were measured. Therefore another set of calibration rides must be done after using the bike to make any further adjustments.

Relatively short adjustments can be made using a steel tape. Remember that intermediate split points will also have to be re-positioned to take the adjustments into account unless these are made at the finish line. If you adjust the start, all other points will require adjustment.

If you adjust at a turnaround point, remember that any extension or retraction of the turnaround position will increase or decrease the race distance by double that amount.

If the road race course is a multi-lap course with a turnaround point, any adjustment of that turnaround point will increase or reduce the race distance by four times the adjustment if it is a two-lap course; six times the adjustment if a three-lap course, and so on.

Converting a turnaround point marked with a single cone into an arc of cones which enforces a defined running path can add distance, as mentioned above in the section on Riding the shortest possible route and described further in Appendix 2.

8. DOCUMENT THE MEASUREMENT

Overview

It makes no sense to measure something unless you document what you measured.

If you do not do this properly you will be the only person who can say where the course is supposed to go, or where it begins and ends. Paint on the road is not enough. The documentation must be sufficient to allow the course to be checked in the event of a re-measurement being required (as mandated, for example, after a world record has been set).

Within the documentation you must include a map of the road race course which is clear enough to allow the race director to re-establish the course even if the roads were re-surfaced.

Drawing clear maps of the road race course

The course map is the most important part of the documentation of the course. It should provide all the information needed to run the race using the course as certified.

The map must clearly show the course route, indicating all the streets and roads it uses. Include any annotations which are necessary to make the route completely clear and unambiguous (such as what part of each road is available to the runners).

Good maps are usually not drawn to scale. Portions may be enlarged or distorted to show particular details, such as when a race starts or finishes in a stadium, or when a turnaround point must be established.

There are many maps and software available to allow maps to be produced by computer or from satellite or street maps. These are completely acceptable and can be easier particularly if a GPS tracking device was used in the measurement ride. These will still require annotations to clarify any obstructions or restrictions on road use (see appendix 9 for more guidance on software available)

The locations of start, finish and any turnaround points must be precisely described using taped distances from nearby permanent landmarks. These descriptions must be clear enough to allow a complete stranger to accurately re-locate the points with no assistance other than from the information supplied on the course map. This may require you to draw enlarged details of these points.

The use of annotated digital photographs in the report can provide even more explicit information of locations and some will even carry GPS readings.

If the course is laid out so that runners have use of the entire road, the map will be easier to draw. If there are restrictions to the use of particular roads the map must show exactly how the runners will be guided onto the prescribed path. All those objects (barriers, cones etc.) which may be used to do this must have their location indicated precisely on the map.

The actual measured path – the shortest possible route - should be indicated on the map by an unbroken line. Use arrowheads to indicate the direction of the race. This line should show how the measurer negotiated the bends in a road, how each turn was taken, and how any turnaround point or restricted turn should be set up. Road widths on the map will have to be exaggerated in order to show this information clearly.

Photographs are also useful to show precise lines at any particular point and can be annotated with clear dimensions for junction turns and or turnaround points.

Your drawn map should use black and white only, to allow for easy copying. If using digital reports this should be undertaken in a format and size that will allow it to be easily shared. A PDF or other secure format is preferable such that the data cannot be accidently changed or deleted.

If the course is complicated, or the map very detailed, you may wish to produce it on a larger sheet of paper and reduce the finished product down to a single A4 sheet.

If you have located split points along the road race course these should also be documented so that they can be re-located when necessary. To avoid clutter on your course-length map, you may wish to prepare a separate list describing each split location (with or without individual sketch maps). It will still be helpful to the race organiser if the number of the split appears on the course-length map in the approximate location.

See Appendix 5 for examples of course maps, and Appendix 9 for use of digital applications that may assist in report and map production.

Supporting documentation

The course map must be accompanied by a written measurement report which includes notes about how the measurement was undertaken, highlighting any unusual aspects. Documentation that must be included with the report includes:

- Application for Certification of a Road Race Course
- Summary of Measurements
- Overview of the Measurement Procedure [describe what you did in your own words]
- Detail of the Calibration Course
- Steel Taping Data Sheet
- Bicycle Calibration Data Sheet
- Course Measurement Data Sheet
- Course Map [the map is mandatory but not standard: you produce it yourself]

See Appendix 3 for copies of standard forms.

This also includes digital templates for calculations and a PDF format report template which can be downloaded to assist in report and in application for certification.

You may use these standard forms or design your own forms for inclusion in your measurement report. If designing your own forms, it is important that you follow the format provided in the standard forms and do not omit any information.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IV. APPENDICES

1. ADJUSTMENTS TO THE CALIBRATION COURSE FOR TEMPERATURE

You can ensure a high level of accuracy for your calibration course if you adjust the measured length to account for the temperature. This is because most steel tapes are properly accurate at 20°C. At colder temperatures they contract, becoming shorter. At warmer temperatures they expand, becoming longer. A short calibration course will lead to a short race course.

To correct for temperature, you can use the following table or the formula below:

CORRECTION FACTORS FOR CALIBRATION COURSES

Correction factors are in centimetres

LENGTH OF CALIBRATION COURSE

Temp	300m	400m	500m	600m	700m	800m	900m	1000m
35°C	-5	-7	-9	-10	-12	-14	-16	-17
30°C	-3	-5	-6	-7	-8	-9	-10	-12
25°C	-2	-2	-3	-3	-4	-5	-5	-6
20°C	0	0	0	0	0	0	0	0
15°C	2	2	3	3	4	5	5	6
10°C	3	5	6	7	8	9	10	12
5°C	5	7	9	10	12	14	16	17
0°C	7	9	12	14	16	19	21	23
- 5°C	9	12	15	17	20	23	26	29
- 10°C	10	14	17	21	24	28	31	35

Example: You lay out a 600m calibration course at 10°C. To correct for temperature, add 7cm to the length before you put down permanent marks. If temperature is 25°C, remove 3cm before putting down final marks.

Temperature Correction Formula

Corrected average length = average length [(average temperature - 20) x 0.0000116 + 1]

If the average temperature is more than 20°C the correction factor is more than one. The corrected length will be longer than the measured length.

If the average temperature is less than 20°C the correction factor is less than one. The corrected length will be shorter than the measured length.

2. SUPPLEMENTARY TIPS

Fitting the Counter to the wheel

The Counter is mounted on the left or right-hand side of your front wheel where it can be seen while riding. The Counter fits between the wheel hub and the fork. Remove the wheel, and then take off any nuts or washers (or the quick-release mechanism) from the axle.

Please refer to the individual manufacturers: http://www.jonescounter.com and http://www.cookjonescounter.com for more information.

After replacing the wheel on the bike with the counter fitted to it, you may find that the whole counter rotates with the wheel. To free up the counter from the wheel place a washer between the hub and the counter. If your front wheel is fitted with a mudguard, the nuts that hold the mudguard may press on the rotating disc of the counter and push it out of alignment. A spacing washer fitted between the counter and the fork should prevent this.

We would need other counters for MTB hubs and bikes with thick axles where a central hole can be drilled out.

Reading the Counter

Both electronic odometers, which are fitted to the front wheel and provide digital readouts, or GPS units fitted to the handlebars, although insufficiently accurate for measuring, are useful for finding the approximate distance along the route, after which the measurer can focus more closely on the digital number on the counter. This prevents the measurer from having to strain continuously to read the Counter, which promotes inaccurate riding. (see appendix 6 for more information on GPS use).

GPS units are roughly accurate to around 5 metres per km when placed directly on the bicycle handlebars but read and add distance irrespective of the direction travelled so its important to appreciate that the error increases as the measurement progresses. If the lap distance is reset each km (or mile) then the accuracy increases.

With or without one of these aids, it may be helpful to list the target counter readings for intermediate stops on a folded sheet of paper and attach this to the brake cables, or small clipboard, where you can refer to it easily.

Lock the front wheel with the brake before reading the Counter. If you overly overshoot a kilometre point, it is best to make a mark where you happen to be, or preferably to note the counter reading at a nearby permanent landmark. You can then precisely locate the split point by measuring backwards with a tape later. Try to avoid wheeling the bicycle backwards, over 4 or more metres.

If you do have to back up, be sure you move the bicycle forward again before taking a counter reading. This eliminates the 'backlash' effect which arises when the 'finger' of the Counter is free to move back and forward slightly between the spokes of the wheel.

Riding techniques

OVERVIEW

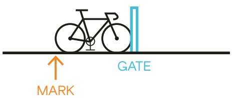
Try to keep a relaxed, consistent riding position and ride in as straight a line as possible. Don't worry about slight wobble. If you ride the road race course in the same way that you ride the calibration course, you will get good results. Try to use only the back wheel brake. If the front wheel locks and skids you will be covering distance without the Counter registering that distance.

To assist in riding a straight line locate a distant point in a direct line to where you need to ride and aim for it. If you cannot see which way the road turns over the brow of a hill, look at which way roadside light or telephone poles go and use this as an indicator. Be aware of a natural tendency to track diagonally across the road too abruptly, reaching the other side before the shortest possible route would do so. Watch for slight bends in the road so that you do not stay too close to the kerb when the shortest possible route would be cutting across the road markings to the crown of the next bend.

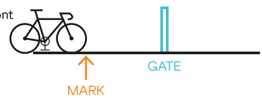
When you see potholes or bumps do not swerve to avoid them. Slow down or, if it is a bad one, stop, dismount, and walk the bike through. Changes of pressure on the front tyre will not matter for such short distances. You will also have to dismount whenever you come to a barrier blocking the road (see below).

MEASURING AROUND A BARRIER OR GATE

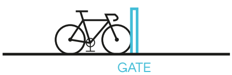
Stop at the gate.
Mark the roadway at the back of the rear wheel.
Lock the front wheel.
Pick up the bike.



Place the front of the front wheel over the mark.
Unlock the front wheel.



Roll the bicycle forwards to the gate.
Lock the front wheel.
Pick up the bike.



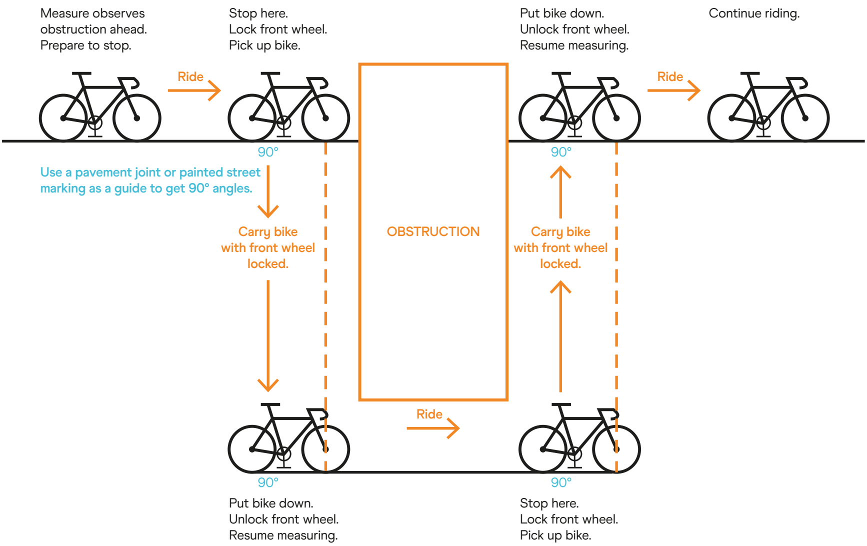
Carry the bicycle around the gate (or ride to the other side and re-set the counter).
Set the bicycle down so that the rear wheel touches the gate.

Unlock the front wheel.
Resume measuring.

If an obstruction stretches for some distance but does not block the whole road width – the most common example of this is a single awkwardly-parked car – you can do one of two things: measure around it, or perform an "offset manoeuvre". If the obstacle is on a long, straight section of the course, gradually move sideways to clear it. If it is on the inside of a bend ride to a point before it, lock your wheel and move the bicycle sideways until you have clear space ahead of you. Roll the bicycle forward until you are clear of the obstruction.

Lock the wheel again and move sideways back to the shortest possible route of the road race course. Then resume measuring.

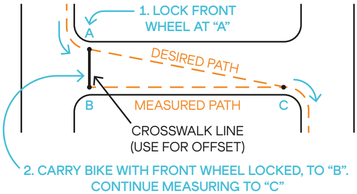
OFFSET MANOEUVRE AROUND AN OBSTACLE



OFFSET MANOEUVRE ACROSS A ROAD

It may not be possible to measure some sections of a road race course with reasonable safety at any time. An escort, whether of police vehicles or a truck equipped with arrows and flashing lights used for traffic control, is the best way to deal with this.

If there is no escort, and you have to measure a section of the course by tracking diagonally across traffic (especially oncoming traffic), a similar offset manoeuvre can be used. Simply lock the wheel when you arrive at a convenient mark running at right-angles across the roadway - such as a pedestrian crossing or an expansion joint. Pick the bike up and carry it across the road. Resume measuring at the same joint or crossing line on the other side. This will slightly increase the length of the course (if you cross a 10m wide road in 100m of road length, you will have measured 100m, but the actual distance will be 100.5m).



HUMAN OBSTACLES

Human obstacles may also present a problem. Pedestrians, runners, e-scooter riders and other cyclists may block the shortest possible route you are trying to measure. Slow down, and stop if necessary. Unlike inanimate obstacles they will most likely soon change position and move out of your way. You may need to explain that you are measuring a race course and have to ride in a straight line. If you are polite they will nearly always make room for you. It is best to choose a time to measure when traffic of all kinds is at a minimum.

MULTIPLE RIDERS

If two or more people are measuring together, then they should all measure the same thing. They should take counter readings at the same permanent landmarks or a single set of paint marks made by the lead rider. No other rider should pre-calculate the counter readings for the intermediate points. It is best if the riders, although stopping at the lead rider's marks, do not simply follow the leader but make their own independent judgement of where the shortest possible route lies. This may require long gaps between the riders. If measuring with a police escort, it will not be possible to allow such large gaps to open up.

How bicycle tyres affect calibration change

Calibrating the bicycle wheel before and after measurement establishes the calibration constant on which the measurement depends. This procedure will usually get good results, but the measurer should be aware of three main factors which are continually changing the precise calibration of the wheel.

TYRE PRESSURE

Any reduction in pressure as the air leaks from a pneumatic tyre will cause the calibration constant to increase. A flat tyre dramatically increases the calibration constant and will be immediately obvious. If you get a flat front tyre before you have re-calibrated all your measurement is void. You must start again. For this reason, it is best to re-calibrate as frequently as possible. This protects the measurement already done. If you get a flat rear tyre you can fix it and go back to the last point at which you took a counter reading before puncturing. The rear tyre has no effect on the calibration of the front tyre.

If you get a slow leak, you may not realise that you have punctured before you recalibrate. The large increase in constant should alert you to the leak, particularly if you are re-calibrating at a higher temperature than that at which your pre-measurement calibration was done (when you would expect a smaller constant). Even a slow leak invalidates all the measurement done since the previous calibration.

Do not take tyre pressure between calibrations. Using the pressure gauge lets some air out of the tyre and changes its calibration.

All pneumatic tyres demonstrate very slow leakage by diffusion of air through the rubber inner tube. The calibration constant may increase by between one and five counts/km each day due to this slow diffusion. For this reason we need to complete measurements and calibrations promptly, and always within a 24-hour period.

Importantly, different sizes and styles of tyres react differently to the same temperature changes. Knobbly MTB tyres, slick MTB, and road tyres, for example, may all change to different extents under the same temperature changes. This is a result of surface contact, surface roughness, tyre width, and air volume. This means that two measurers working on the same course may experience different levels of change on working and day constants if they are using different bikes and or tyre types.

Using a solid front tyre will stop you getting any flats. Temperature change affects the calibration of solid tyres much less than it does with pneumatic tyres. The disadvantage in using a solid tyre is that it is sensitive to variations in the road surface. See below in 'Response to Surface Variation'.

RESPONSE TO TEMPERATURE CHANGE

The most common reason for calibration change is temperature variation. Even without any change to the air temperature, a wet tyre will chill as the water is evaporated by air rushing past. With pneumatic tyres this can change their calibration by an amount equivalent to the whole of the SCPF (0.1%, or about 10 counts per kilometre). There are some precautions which can be taken to minimise the variation of the constant:

Calibrate immediately before and after the course measurement. This will keep temperature changes to a minimum. Using the average constant will even out the variation (but see also below: 'When to use the larger constant').

Measure on overcast days. The temperature is more even than when there is alternating sun and shade.

Measure at a time of day when temperature has stabilized. Avoid measuring between sunrise and mid-morning or late afternoon and dusk. Temperature is most stable during the middle of the day and the middle of the night.

RESPONSE TO SURFACE VARIATION

The texture of the road surface affects the calibration constant of tyres. If we calibrate on a smooth surface (for example, the fine-grained asphalt often used for pedestrian or bicycle paths) and then measure on the rougher surface typically used for roads, we would find that our calibration constant had changed.

Most pneumatic tyres will have a smaller calibration constant on a rough surface. When measuring with pneumatic tyres, smooth calibration courses and rougher race surfaces yield longer courses.

The effects of surface variation can be quite large and could reach the 1 in 1000 SCPF on normal roads. Still larger changes occur on off-road surfaces

When measuring on off-road surfaces it is acceptable to ignore calibration change only for very short sections. For longer sections use a tape measure.

Off-road surfaces may be as different from each other as they are to a paved surface. Off-road surface variations are too great to allow measurement to the same known degree of accuracy that applies for road race courses.

If the road surface is very rough it may only be practicable to use a thicker mountain bike tyre. In such circumstances refer to the precautions above ('Response To Temperature Change') to minimize, when possible, the effects of temperature variation on the calibration constant.

When to use the larger constant

The average of pre- and post-measurement calibration constants usually provides the most accurate basis from which to calculate course length. This is true whether the temperature may be rising, falling or constant. But sometimes a simple average is unrepresentative of conditions prevailing during the measurement. A record of temperature variation during the measurement, and close attention to changes in the road surface, allows the measurer to recognise such circumstances.

For example:

i. It starts to rain after pre-measurement calibration and the road surface is wet for the rest of the measurement, and for recalibration. The cooling effect of evaporation from the tyre will increase the calibration constant. This effect may outweigh that of a higher air temperature. The 'wet' calibration (yielding a larger constant) is then clearly more representative of measurement conditions.

ii. The measurement is done as temperature is falling. There is a significant drop in temperature after pre-measurement calibration (for example, after sunset) followed by stable temperatures. The post-measurement calibration constant will be the larger of the two and will probably be the best one to use.

In the unusual event of all calibrations being done in dry conditions, but the measurement itself being done on a wet surface, the course length could be significantly underestimated. In such circumstances, if the measurer is using a pneumatic tyre, it may be advisable to increase the short course prevention factor to 0.2%.

Elevation Change & Separation

The "elevation change" and "separation" are essential to determine the validity of a road course for World Athletics' records, qualifying standards, and world ranking points.

Elevation Change

Elevation change is the difference in elevation between the start of the race and the finish. This does not take into any consideration any fluctuations in elevation along the course. Elevation Change is expressed as metres/ kilometer (m/km).

Separation

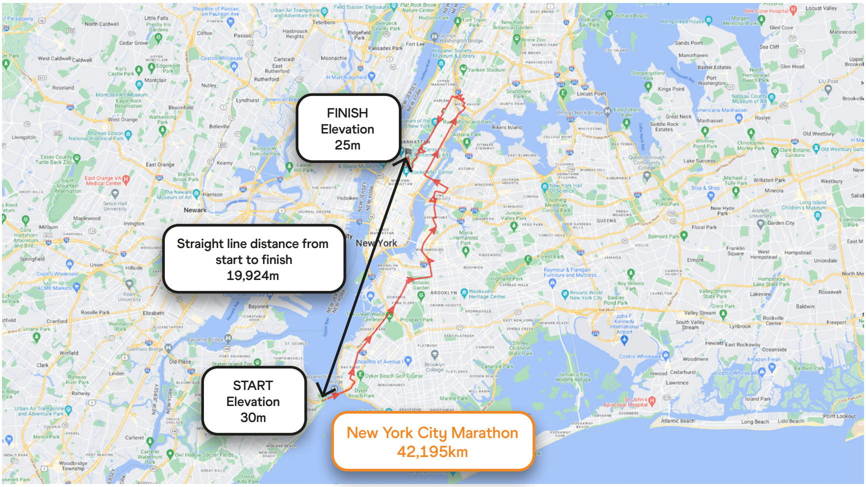
Separation is the straight line distance from start to finish. Separation is expressed as a percentage of the total distance of the race course.

Calculating Elevation Change & Separation

When calculating elevation change and separation, reliable data sources such as government websites or online mapping programs where the information can be confirmed should be used. World Athletics & AIMS has determined that the online mapping website – Google Earth is acceptable as a data source when properly used. It is advisable to use additional sources to confirm the separation when it narrowly exceeds 50% or/and elevation change above 1.0 m/km. World Athletics assesses penalty points for every 0.1m /km above 1.0m/km.

The following is a summary of the minimum course requirements:

Competition	ELEVATION CHANGE	SEPARATION	WA/AIMS CERTIFIED	VERIFICATION MEASUREMENT
World Record	Less than 1 m/km	Less than 50%	Yes	Yes
Olympic Games Qualification	Less than 1 m/km	Any separation	Yes	No
World Championships	Less than 1 m/km	Any separation	Yes	No
Ranking Points	Any Elevation change	Any separation	Yes	No



Elevation change = start elevation (m) – Finish elevation (m) /Race distance (km)

Elevation change = 30m – 25m /42.195 km

Elevation change = minus 0.12 m/km

Elevation change can be negative (-) or positive (+)

***It is important to calculate to the tenth to determine the appropriate World Athletics ranking points for courses exceeding 1.0 m/km.**

When calculating separation all distances are expressed in metres.

Separation = [straight line distance (m) / Race distance (m)] x 100

Separation = (19924 / 42195) x 100

Separation = 47.2 %

USATF- RRTC Elevation Change and Separation Calculator

The Road Running Technical Council of USATF offers an online calculator to calculate the elevation change and separation: https://certifiedroadraces.com/calc

Walks courses

Race walk courses have unique requirements mainly due to the fact that the athletes are judged throughout the competition for style. Because of this, races are contested on a circuit that must not be shorter than 1 km or longer than 2km in length.

Most of the road race walk circuits are designed on roads that are relatively straight, flat and wide enough to accommodate competition on each side of the roadway. This configuration provides for the most efficient method of judging the athletes.

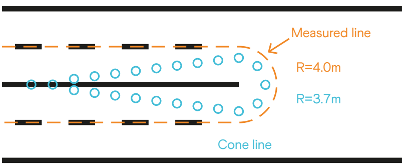
Typically, each end of the course includes a "u-turn" but some courses incorporate a wider turn around municipal monuments or even around a city block.

When designing and measuring a race walk course it is important to know some of the limiting factors which include the number of athletes, distance to the first turn, timing/results requirements, integration of broadcast, proposed placement of signage and other factors.

One of the major goals is to incorporate the maximum turn radius to enable the athletes to maintain their speed. This along with the anticipated number of athletes is part of the equation to determining the optimum radius along with sufficient room entering and exiting turns.

A turning radius of 4m or more is recommended but shorter radii have been used when there is not sufficient road width. For example: The 2016 Rio Olympics 2km race walk course included two turning points with a radii of 2m each while the Tokyo/Sapporo Olympic 2km loop included turning points of 4m and 8m. The 8m radius was designed to help the athletes avoid turning across lite rail tracks.

The measurement report & map should clearly identify the competition line and the cone line. As per the measuring rules, the measured line is 0.30m from cones, kerb, or other objects that would indicate the parameters of the course.



3. STANDARD FORMS FOR INCLUSION WITH MEASUREMENT REPORTS

Seven standard forms and a course map are required to accompany each measurement report:

- Application for Certification of a Road Course
- Summary of Measurements
- Overview of the Measurement Procedure [what you did in your own words]
- Detail of the Calibration Course
- Steel Taping Data Sheet
- Bicycle Calibration Data Sheet
- Course Measurement Data Sheet
- Course Map [the map is mandatory but not standard; you produce it yourself]

You may use these standard forms or design your own forms for inclusion in your measurement report. If designing your own forms, it is important that you follow the format provided in the standard forms and do not eliminate any information.

The purpose of World Athletics/AIMS measurement is to ensure that road race courses are of the advertised length. The documentation that you prepare, and in relevant situations send to the World Athletics/AIMS administrator, should show this in defining the course by:

i. Defining the precise start and finish points of the course, and any turnaround points that may be used. These should be referenced to permanent landmarks and indicated on the course map. For the purpose of course certification by the administrator, photographs are NOT required. They may be helpful for the race organiser, but do not need to be supplied for certification.
ii. Defining the precise route that is followed between start and finish. This should be shown on a **course map** which indicates all streets used by the course (named on the map or in a separate list) and the parts of the street that runners will be allowed to use. If only one side of the street is to be used for a particular section, then this should be indicated on the map. Likewise, if restrictions apply at certain turns then these must also be detailed on the map. No other documentation should be necessary to define the route. Another measurer who may later be required to check the measurement (for example, in the event of a world record being set) should be able to measure exactly the same course simply by consulting the original measurer's map.
iii. The measurement data supplied to the administrator [on the **Course measurement data sheet, or a separate spreadsheet**] should record the counter readings that correspond to the start and finish locations. If the measurement has been performed in sections, then the counter reading at the start and finish of each section will be required. Alongside the counter reading the counts elapsed from the start should be recorded,

and alongside this the counts should be converted into distance using the Constant for the Day. The final piece of information on each line entry should be a short written description of where the reading was recorded (eg "lamp-post 27, High Street"). This information is arranged on the course measurement data sheet as follows:

Location	Counter Reading	Elapsed Counts	Elapsed Distance
START – lp115, Main St	54000	000000	0.0m

The first line entry will define the start position and the last line entry will define the finish position. Any number of intermediate lines may be inserted to indicate where distance splits are located, but these are not necessary for the purpose of international certification (although they will be very useful for the race organiser). The intermediate line entries are required where the measurement was discontinuous for any reason (for example, the direction of measurement was reversed for safety reasons).

iv. The calibration data supplied to the administrator should show exactly how the Constant for the Day was derived. This can easily be shown on the **Bicycle calibration data sheet (or a separate spreadsheet)** by recording the counter reading at the start and finish of each calibration ride for both pre- and post-measurement calibrations. Along with the length of the calibration course this is the essential raw information required. All other figures on the calibration data sheet can be derived from these.

v. A sketch map of the calibration course should be provided, along with details requested on the form **Detail of the calibration course.**

vi. Details of steel-tape measurement of the calibration course should be recorded on the **Steel taping data sheet.**

vii. In addition to the data listed above two cover sheets should also be completed, the **Summary of measurements and the Application for certification.**

viii. Apart from the information supplied on downloaded standard forms, measurers should remember that they should also provide:

Overview - a description in your own words of how you did the measurement

Course map - indicating which roads the course follows, what section of the road is available and whether there are any restrictions in how the road is used at turns.

MEASUREMENT REPORT Page 1

APPLICATION FOR CERTIFICATION OF A ROAD COURSE

Name of event:

City/Town:

Country:

Advertised race distance(s):

Race date:

Race director:

Phone:

Email:

Name of measurement team leader:

Phone:

Email:

Precise location of start:

Precise location of finish:

Precise location of turn points:

Type of terrain (Flat/Undulating/Hilly):

Type of course (Loop/Lap/Point to Point/Out & Back):

Elevation (in metres above sea level): Start Finish

Distance, in a straight line, between start and finish:

MEASUREMENT REPORT Page 2

SUMMARY OF MEASUREMENTS

Date(s) of measurement:

How many measurements of the course were made?

Names of measurers:

How much of the road width is available to runners throughout the length of the road race course?
(Describe here if the full width of the road is available, half width, right lane, left lane, etc.)

If the route at turns cannot be described as the 'shortest possible route', explain what restrictions will apply, and how these will be enforced?

Length of course after any adjustment:

Difference between longest and shortest measurement:

Which measurement was used to establish the final course length and WHY?

MEASUREMENT REPORT Page 3

OVERVIEW OF MEASUREMENT PROCEDURE

(Provide an overview below of the processes and procedures you followed when undertaking this measurement.)

MEASUREMENT REPORT Page 4

DETAIL OF THE CALIBRATION COURSE

Name of event:

City/town:

Location of calibration course:

Length of calibration course:

Date(s) measured:

Method used to measure calibration course:

How many times did you measure the calibration course?

Measurement team leader:

Phone contact of team leader:

Email address of team leader:

List names and duties of team members:

Is the calibration course: STRAIGHT? Yes ☐ / No ☐ **PAVED?** Yes ☐ / No ☐

How are the start and finish points marked?

Are the start and finish points located on the road where a bicycle wheel can touch them, or elsewhere?

Bicycle check. *(This is a check against miscounting the number of tape lengths. If you use a gross measurement check other than a bicycle, please explain.)*

A. Counts for full calibration course

B. Counts for one tape length

C. Divide A by B

D. Number of full tape lengths

Submit a map of this calibration course, showing direction of north, the name of the road (and relevant cross streets), and the exact locations of start and finish points, including taped distances from nearby permanent locations.

MEASUREMENT REPORT Page 5

STEEL TAPING DATA SHEET

For measuring a calibration course

Name of calibration course:

City/town:

Measurement date:

Start time: **Finish time:**

Steel Tape Temperature: **Start** **Finish** **Average**

(thermometer shaded from direct sun)

Measurements and calculations:

1 First measurement. (This establishes tentative start and finish marks which should not be changed until the final adjustment on line 6 below.)

	x		+		=	
# tape lengths		distance per tape length		partial tape length		measured distance

2 Second measurement. (This checks the distance between the SAME tentative start and finish points marked in the first measurement, but use new intermediate taping points.)

	x		+		=	
# tape lengths		distance per tape length		partial tape length		measured distance

3 Average raw (uncorrected) measurement of course:

4 Temperature correction. (Use the average tape temperature during measurement. Work out answer to at least seven digits beyond the decimal point.)

Correction factor = 1.0000000 + (0.0000116 x [Celsius temperature – 20])

Correction factor =

NOTE: For temperatures below 20°C, factor is less than one

For temperatures above 20°C, factor is greater than one

5 Multiply the temperature correction factor by the average raw measurement of the course (line 3):

	x		=	
correction factor		avg. raw measurement		corrected measurement

6 If you wish, you may now adjust the course to obtain an even distance, such as 300 metres. This is not necessary as you may choose instead to use an odd-distance calibration course whose endpoints are pre-existing permanent objects in the road to guard against hazards such as repaving. If you adjusted the course, explain why you did it.

Final (adjusted) length of calibration course:

MEASUREMENT REPORT Page 6

BICYCLE CALIBRATION DATA SHEET

This data may be included on a separate spreadsheet

Name of event:

Date of measurement:

Name of measurer:

Length of calibration course:

PRE-CALIBRATION – ride the calibration course four times, recording data as follows:

Ride	Start count	Finish count	Difference
1			
2			
3			
4			

Time of day: **Temperature:**

WORKING CONSTANT = number of counts in one kilometre, calculated from the pre-measurement average count, and multiplied by 1.001 – the 'short course prevention factor'

Pre-measurement average count =

Counts per km = pre-measurement average count x 1000/length of calibration course in metres

Working Constant = counts per km x 1.001 =

POST-CALIBRATION - ride the calibration course four times, recording data as follows:

Ride	Start count	Finish count	Difference
1			
2			
3			
4			

Time of day: **Temperature:**

FINISH CONSTANT = number of counts in one kilometre, calculated from the post-measurement average count, and multiplied by 1.001 – the 'short course prevention factor'

Post-measurement average count =

Counts per km = post-measurement average count x 1000/length of calibration course in metres

Finish Constant = counts per km x 1.001 =

CONSTANT FOR THE DAY = the average of the working constant and the finish constant =

MEASUREMENT REPORT Page 7

COURSE MEASUREMENT DATA SHEET

This data may be included on a separate spreadsheet

Name of event:

Name of measurer:

Date of measurement:

Start time: Temperature:

Finish time: Temperature:

Constant for the Day:

MEASUREMENT DATA

Measured point	Counter reading	Cumulative counts	Cumulative distance in metres	Adjustment in metres

Desired length of course:

Length of course as measured:

Describe all adjustments made to the course after measurement:

4. EXAMPLE OF A COURSE MEASUREMENT AND SAMPLE REPORT

Course survey

Mary has been contracted to measure a city based 10km course – the Clean Green City 10km. She has completed all preliminary arrangements with the race organiser and arrives on a Saturday morning with the intention of measuring the course early on Sunday morning when the volume of traffic is low and police assistance is available.

The 10km course is a loop through city and suburban streets. The start and finish lines are in the same vicinity but separated by approximately 100m. The start line is fixed but there is some flexibility at the finish to adjust the distance. The course director has completed a rough measurement of the course by using a GPS device while driving the course in a car.

On Saturday afternoon Mary surveys the course with the course director. They travel the route in a car whilst following the layout of the course from maps supplied by the course director. They stop several times to discuss the route participants will follow at certain intersections and corners along the course. Mary makes notes as she goes, which will help her during her measurement and also when drawing the official measurement map.

There is one street within the city (Zatopek Rd) where runners will run against the flow of traffic. Mary notes that it will be necessary to measure this sector 'with traffic' so she will not be able to ride the course non-stop from start to finish. She will have to stop her measurement at one point, move her bicycle to another point and ride back along the course with traffic.

While driving the course, Mary notes a reference point where she will stop the bicycle, calls this point A and notes the adjacent landmark. She does the same at the other end of the one-way street, calling that point B and noting the adjacent landmark. Mary puts a small piece of adhesive tape on the road at points A and B as a reminder of where she will stop and start when measuring on Sunday.

Mary notes a side street reasonably close to the start/finish line which appears suitable for a calibration course. At the completion of the course survey she inspects this potential calibration course. It is straight, flat and the surface is similar to the 10km course. It has no parked cars and she will be able to ride close to the kerb during calibration. There is one cross street but it is a minor one with little traffic. The course director drives the length of the side street and, using the car odometer, determines that a 300m calibration course will fit.

Setting up and measuring the calibration course

Mary decides to measure the calibration course on Saturday afternoon to allow an early start to the bicycle calibration and course measurement on Sunday morning. The course director assists.

Mary has a 50m steel tape which is marked as accurate at 20°C with 50 Newtons of tension. She will need to lay out six lengths of this tape for the 300m calibration course planned.

The calibration course is in Dixon Street. There is a numbered light pole just south of the intersection of Dixon St with Moller Avenue. This will make a good reference point. Mary drives a PK nail into the road, half a metre west of the eastern edge of Dixon St and in line with the mid-point of light pole #64920. The light pole is located in front of #22 Dixon St. This will be the permanent northern endpoint of the calibration course (point C).

Mary lays the thermometer on the steel tape, in the shadow of the light pole so that the thermometer is in the shade. After three minutes, the temperature seems to have stopped changing. It reads 15°C. Mary records the start time and temperature.

The course director holds the 50m mark of the tape over the PK nail at point C. Mary takes hold of the 'zero' end and extends the tape southward to its full extension of 50m. Mary uses the zero end because that is the end with a ring to which she attaches a spring balance. Mary sticks a piece of adhesive tape on the roadway at the approximate end of the tape.

Mary and the course director jiggle the tape as needed until it lies straight and flat, and Mary checks that her end is still half a metre from the kerb. Then Mary pulls on the spring balance until it reaches 50 Newtons-force, moving the tape slowly forward. When Mary has the tape under steady tension and the course director signals that his end is over the mark, Mary draws a thin black mark on the adhesive tape alongside the zero mark of the measuring tape. Mary then numbers the piece of masking tape with a '1' to indicate that this is the first tape length. Mary and the course director continue in this manner until they have marked six 50m sections.

The point marked on the final piece of adhesive tape (point D) is now provisionally 300m south of point C. Mary and the course director now start measuring back (northward), using a new start point which is exactly one metre north of point D. This creates a new set of taped marks, separate from the previous set of marks. Note that Mary and the course director had to turn the tape around at point D since only the zero end has a ring to which Mary can attach the spring balance.

Mary and the course director lay out only five full tape lengths of 50m. They measure the sixth tape length to the PK nail at point C. This is 48.97m. This means that according to their second measurement the distance between the permanently marked point C and temporary point D is 3cm shorter than 300m. Mary repeats the temperature reading as before and finds it to still be 15°C. Mary records this reading, along with the time of the day.

Mary calculates the average length of the two measurements and determines that the course, without any adjustment for temperature, is 299.985m. It is acceptable practice simply to extend point D 1.5cm to the south and determine that the length of the calibration course is 300m.

Mary is an experienced measurer and decides to adjust the length of the calibration course to take into account the variation in the length of the tape because of the temperature. This procedure (see Appendix 1) can increase the accuracy of the calibration course so that error is reduced to a few millimetres. However, the error in setting out the calibration course (even without temperature correction) is probably no more than 0.01 per cent. This is a small proportion of the overall error in the measurement process (0.1 per cent).

The adjustment can be calculated in two different ways:

1. Mary can refer to the table in Appendix 1. They will note that when the average temperature is 15°C, it is necessary to add 2cm to a 300m course. As the course is 299.985m, Mary would add 1.5cm to bring the course up to 300m, and then add another 2cm for the temperature adjustment. That is, they would move point D 3.5cm south.
2. Mary can use the Temperature Correction Formula (also shown in Appendix 1).

Corrected average length

Corrected average length = average length [(average temperature - 20) x 0.0000116 + 1]

= 299.985[(15 – 20) x 0.0000116 +1]

= 299.985 x 0.999942

= 299.96m

Using this formula, Mary would move point D 3.4cm to the south.

The slight difference between the adjustment using the table and the adjustment using the formula is because of rounding errors. After adjustment as described above, the calibration course length is fixed at 300m.

Using the tape measure once more, Mary finds that the corrected point D is 6.35m north of pole number 26543. This light pole is located in front of #128 Dixon St. They are now almost finished but, before permanently marking point D, Mary checks to make sure they haven't missed a whole tape length somehow.

Attaching the measurement counter to her bicycle, Mary rides it around for a few minutes to warm up the tyres. She places the front axle over the northern endpoint (point C) and records a count of 52500. She then rides southward one 50m tape length and stops with the front axle over the mark. She records a count of 52975. The difference, corresponding to one 50m length, is 475 counts.

Mary now returns to the northern endpoint (point C) and, pointing the bike southward again, notes a counter reading of 54000 with the front axle over the nail. She rides the bicycle over the full calibration course, stopping with the front axle over the corrected southern endpoint. She records a count of 56852. The difference is 2852 counts. Dividing the full course count of 2852 by the 50m count of 475 yields a course length of 6.004 tape lengths. For such a rough check this is in excellent agreement with the intended course length of six tape lengths.

Finally, Mary puts a PK nail at the corrected endpoint (point D) of the 300m course. Mary thanks the course director and arranges to meet him at 6am the following morning to calibrate her bicycle, before moving to the start line of the 10km course to meet the police at 6.30am.

Mary heads back to her hotel to draw a map of the calibration course and fill out the standard forms 'Detail of the Calibration Course' and 'Steel Taping Data Sheet' - see Appendix 3.

Calibrating the bicycle

Obtaining a Working Constant

Mary arrives at the calibration course at 5.45am. She unloads her bicycle and rides around for several minutes to warm up the tyres. Before beginning her calibration rides at the northern end of the calibration course, she notes that the temperature is 12°C. She will make four rides - two in each direction. She sets her counter to a convenient starting number and records it.

She starts with this recorded count and rides to the other end of the calibration course. There she stops, and records the count again. She locks the wheel with the brake, turns the bike around, and sets it down exactly on the mark at which she stopped. She rides back to where she started and records the count again. She repeats this operation until she has made four rides.

Now she is back where she started and has five recorded numbers. She obtains a calibration value as follows:

	Recorded count	Elapsed count
Start count	340200	
End 1st ride	343603	3403
End 2nd ride	347005	3402
End 3rd ride	350407	3402
End 4th ride	353809	3402

Mary now calculates the working constant applicable to her bicycle. She will use this working constant to establish a provisional 10km course.

Average counts for 300m	3402.25
Counts for one kilometre	11340.83333
Counts/km with 1.001 SCPF	11352.174167
Working constant	11352.174167

Measuring the 10km course

Mary goes to the start of the course where she meets the police who are to assist with a safe ride. She notes a reference point for the race start.

Mary has agreed to locate and document each kilometre point along the route. So her next task is to use her working constant to calculate provisional kilometre points. She notes that her counter reads 359767. She rolls her wheel forward to 360000 so she can start her measurement with a round number. Mary finds recording a rounded number decreases the likelihood of a recording error.

Mary calculates the following counts for the first three kilometre points and records these in her notebook. This gives her a rough count for the first three kilometre points as per the following table:

Start	360000
1km	371352
2km	382704
3km	394056

Mary only calculates for the first three kilometres because she has to stop her bicycle prior to the fourth kilometre (at point A) and measure back from point B to point A.

Before starting her measurement ride, Mary again notes the temperature which is unchanged at 12°C. As she positions herself at the start line, she checks that her counter remains on 360000. She is now ready to start the measurement.

Mary now rides along the course from the start towards point A, stopping at landmarks near to the provisional kilometre points. She does not stop at the exact counts as in her notebook but is always on the lookout for landmarks, like a numbered light pole, sign post or letterbox. At these landmarks Mary notes details of the landmark and her counter reading, and also sticks a piece of adhesive tape on the roadway.

When Mary reaches point A, she stops her bicycle and records the counts. Her notebook now has the following data:

Start	360000	Pole #624476
1km reference	371402	Front door of building #245
2km reference	382688	Pole #736544
3km reference	394199	Letterbox #654
Point A	394710	Pole #628745

She then rides with the traffic to point B. Mary then checks her counter, noting that the counts are 405845. She rolls her wheel forward to 406000 so that she resumes measuring with a rounded number as a starting point.

Mary measures with the traffic, but in the opposite direction to runners, from point B to point A. She records her counts as per the following table:

Point B	406000	Pole #628777
Point A	416376	Pole #628745

Mary again stops measuring and rides her bicycle back to point B where she will resume the measurement. So that Mary can continue to locate approximate kilometre points, she calculated the rough distance from the start to point B.

Mary notes that the counts from the start to point A = 394710 minus 360000 = 34710.

She also notes that the counts from point A to point B, ridden in reverse = 416376 minus 406000 = 10376.

So from the start to point B = 34710 plus 10376 = 45086. Mary divides this by the working constant and calculates that the distance to point B = 3971.5m.

Mary then checks her counter reading and, as before, rolls it forward to a rounded number. Her next step is to calculate the rough counts for kilometres four through to nine, as per the following table. She starts by calculating the number of counts from 3971.5m to 4000m – using her working constant that is stored in the memory of her calculator, Mary multiplies the working constant by 0.0285 (28.5m until 4km) = 323 counts. She adds this to her starting counts and that's the rough count for 4km. Using her stored working constant, Mary then notes counter readings for five through to nine kilometres.

Point B (3971.5m)	430000
4km	430323
5km	441675
6km	453027
7km	464379
8km	475731
9km	487083

Mary resumes riding along the course from point B, again stopping at landmarks close to the provisional kilometre points. At these landmarks Mary notes details of the landmark and her counter reading, and also sticks a piece of cloth tape on the roadway.

When Mary reaches the finish line, she stops her bicycle and notes her counter reading and the temperature, which is now 16°C.

Mary's counter readings at each landmark are in the following table:

Point B	430000	Pole #628777
4km reference	430401	Jones St signpost
5km reference	441798	Pole #629364
6km reference	453007	Letterbox #44
7km reference	464505	Lopes Rd signpost
8km reference	475662	Pole #629532
9km reference	487227	Front door Golden Bakery
Finish	497042	Pole #624461

Re-calibrating the bicycle on the calibration course

Obtaining a Finish Constant

Mary returns to the calibration course to recalibrate her bicycle and determine the finish constant. The temperature remains at 16°C.

	Recorded count	Elapsed count
Start count	499000	
End 1st ride	502401	3401
End 2nd ride	505801	3400
End 3rd ride	509202	3401
End 4th ride	512602	3400

Average counts for 300m	3400.5
Counts for one kilometre	11335.0
Counts/km with 1.001 SCPF	11346.335
Finish constant	11346.335

Calculating the Constant for the Day

Use the average of the working and finish constants 11349.25458 (counts/km) or 11.34925458 counts per metre

Calculating the length of the 10KM course

Mary now calculates the length of the course as measured. She calculates the length by dividing the number of counts elapsed while riding the whole course by the Constant for the Day. That is:

(Start to point A + point A to point B + Point B to Finish)/Constant for the Day = length of course

Mary's distance =

[(394710 – 360000) + (416376 – 406000) + (497042 – 430000)]/11349.25458

= [34710 + 10376 + 67042]/11349.25458

= 112128/11349.25458

= 9,879.7km

= 9,879.7m

The official length of the course prior to any adjustment is 9,879.7m.

Length of course before final adjustment	=	9,879.7m
Desired length of course	=	10,000m
Final Adjustment: (10,000 – 9,879.7)m	=	Add 120.3m to course

Mary also calculates the distance at each kilometre reference point, using the Constant for the Day.

Constant for the Day = 11349.25458

Point	Reading	Cumulative Counts	Cumulative Distance (m)
Sector 1 – start to point A			
Start	360000		
1km reference	371402	11402	1004.6
2km reference	382688	22688	1999.0
3km reference	394199	34199	3013.3
Point A	394710	34710	3058.3
Sector 2 – point A to point B			
Point A	416376		
Point B	406000	10376	3972.5
Sector 3 – point B to Finish			
Point B	430000		
4km reference	430401	401	4007.8
5km reference	441798	11798	5012.0
6km reference	453007	23007	5999.6
7km reference	464505	34505	7012.7
8km reference	475662	45662	7995.8
9km reference	487227	57227	9014.8
Finish	497042	67042	9879.7

Adjusting the length of the 10KM course

The adjustment point was to be the finish line but the adjustment at that point was limited and an adjustment of 120.3m was not possible. After discussion with the course director, a decision was made to add an out and back section in the same street as the finish line. At the finish, runners were to turn right out of Benoit Rd into Roe St. Now runners will turn left into Roe St, do a u-turn at the appropriate spot, and run to the original finish line.

Mary needs to use her bicycle to make this adjustment. As she had just calibrated her bicycle, she used the finish constant when calculating the adjustment. Adding 120.3m is not as simple as going 60.15m along Roe St, turning and coming back.

First Mary located a point in Benoit Rd that was common to the originally measured course and the adjusted course. She located an appropriate pole as a good reference point and called this point P. She then measured from point P to the finish, noting her counts at P and the finish, as per the following table:

Point P	515000	Pole #624440
Finish	516816	Pole #624461

Mary's next step was to measure from point P to the finish line via a new provisional turning point in Roe St. As Mary was already at the finish line, she measured back from the finish to point P, turning at an estimated turn point. As always, Mary collected her data for this measurement, as per the following table:

Finish	517000	Pole #624461
Turn	518021	Letterbox #48
Point P	520405	Pole #624440

Mary then calculated the distances, using her finish count, and compared the distance from point P direct to the finish with point P to the finish via the new turn point.

The distance from P to the finish via the direct route was (516816 – 515000)/finish constant = 1816/11346.335 = 160.0m.

The distance from P to the finish via the new turn point was (520405 – 517000)/finish constant = 3405/11346.335 = 300.1m. In addition, Mary added 1.5m for turning around a single cone at the new turn point, giving a total distance of 301.6m.

By running to the finish via the new turn point, the course is 301.6 – 160.0 = 141.6m longer than the original course.

As the course was originally short by 120.3m, after adjustment it is now long by 21.3m. Given that Mary had calibrated her bicycle less than 30 minutes earlier, and was using the finish constant for her adjustment calculations, she did not again calibrate her bicycle. If there was a more involved adjustment that took a greater degree of time, Mary would have done a final calibration.

Mary and the course director were satisfied with this outcome and made a final adjustment to the turn point using a steel tape. They simply measured back 10.65m from the provisional turn point, painted an appropriate mark on the road and added a nail to assist in the future identification of this turn point.

Mary noted that all kilometre points were within a short distance of her identified reference points, and could easily be adjusted by steel tape. The course director undertook to make these small adjustments in race week.

Adjustments for all splits

Mary provided this table so that the course director could make final adjustments to the kilometre points:

Point	Distance (m)	Reference for km/turn point
Start		At pole #624476
1km reference	1004.6	4.6m < front door of building #245
2km reference	1999.0	1m > pole #736544
3km reference	3013.3	13.3m < letterbox #654
4km reference	4007.8	7.8m < Jones St signpost
5km reference	5012.0	12m < pole #629364
6km reference	5999.6	0.4m > letterbox #44

Point	Distance (m)	Reference for km/turn point
7km reference	7012.7	12.7m < Lopes Rd signpost
8km reference	7995.8	4.2m > pole #629532
9km reference	9014.8	14.8m < front door Golden Bakery
Turn reference		10.65m < letterbox #48
Finish	10000	Pole #624461

Mary has now finished her on-course adjustments. She retires to her hotel to complete the appropriate forms and draw the course map.

SAMPLE REPORT

MEASUREMENT REPORT Page 1

APPLICATION FOR CERTIFICATION OF A ROAD COURSE

Name of event:	Clean Green City 10km
City/Town:	Clean Green City
Country:	Australia
Advertised race distance:	10km
Race date:	23 October 2022
Course director:	Steve Martin
Mobile:	+61 442 147xxx
Email:	steve68@marathon.com
Name of measurer:	Mary Dent
Phone:	+61 419 396xxx
Email:	mary73@measurer.com
Precise location of start:	Smith St – at pole #624476
Precise location of finish:	Roe St – at pole #624461
Precise location of turn point:	Roe St – 10.65m < letterbox #48
Type of terrain:	Flat
Type of course:	Loop
Altitude (in metres above sea level):	Start: 43m – Finish: 43m
Distance, in a straight line, between start and finish:	110m

MEASUREMENT REPORT Page 2

SUMMARY OF MEASUREMENTS

Date(s) of measurement: 31 July 2022

How many measurements of the course were made? One

Names of measurer: Mary Dent

How much of the road width is available to runners throughout the length of the road race course?
Full width of road or carriageway

If the route at turns cannot be described as the 'shortest possible route', explain what restrictions will apply, and how these will be enforced?
Always shortest possible route

Length of course after any adjustment: 10km

Difference between longest and shortest measurement: Not applicable

Which measurement was used to establish the final course length and WHY?
Not applicable

MEASUREMENT REPORT Page 3

OVERVIEW OF THE MEASUREMENT PROCEDURE

The 10km course was a loop within city and suburban streets. There was one street between 3km and 4km where the running course is against traffic. I was not able to measure into oncoming traffic at this point so I had to stop my measurement at this point (A), relocate to the other end of the one way street (point B), and measure back from B to A with traffic.

Other than at this point, I was able to measure from start to finish, with protection from a police motor cyclist to ensure my safety and ensure I was able to ride the shortest possible route.

During my ride I noted appropriate reference points at landmarks so that I could identify kilometre points.

The course was short by 122.8m. The plan had been to make any adjustment at the finish line but the area would not accommodate a shift of the finish line by 100+m.

An alternate plan was put in place and I added an out and back sector immediately prior to the finish line. I made this adjustment using my calibrated bicycle. As I had post calibrated less than 10 minutes prior to making this adjustment, I used the finish constant in my adjustment calculations. Full details of the adjustment are included in my spreadsheet.

MEASUREMENT REPORT Page 4

DETAIL OF THE CALIBRATION COURSE

Name of event:	Clean Green City 10km
City/town:	Clean Green City
Location of calibration course:	Dixon St
Length of calibration course:	300m
Date(s) measured:	30 July 2022
Method used to measure calibration course:	50m steel tape
How many times did you measure the calibration course?	2
Measurement team leader:	Mary Dent
Phone contact of team leader:	+61 419 396xxx
Email address of team leader:	mary73@measurer.com

List names and duties of team members:

The course director Steve Martin held one end of the tape while Mary extended, tensioned and marked the tape ends.

Is the calibration course: STRAIGHT? Yes **PAVED?** Yes

How are the start and finish points marked? Yellow paint and nails

Are the start and finish points located in the road where a bicycle wheel can touch them, or elsewhere?

Yes

Bicycle check. (This is a check against miscounting the number of tape lengths. (If you use a gross measurement check other than a bicycle, please explain.)

E. Counts for full calibration course = 2852

F. Counts for one tape length = 475

G. Divide A by B = 6.004

H. Number of full tape lengths = 6

End points:

Northern end – at pole #64920

Southern end - 6.35m north of pole number 26543

MEASUREMENT REPORT Page 5

STEEL TAPING DATA SHEET

For measuring a calibration course

Name of calibration course: Dixon St
City/town: Clean Green City
Measurement date: 30 July 2022
Start time: 3.30pm **Finish time:** 4.00pm
Steel Tape temperature: **Start:** 15°C **Finish:** 15°C **Average:** 15°C
(thermometer shaded from direct sun)

Measurements and calculations:

1 First measurement. This establishes tentative start and finish marks which should not be changed until the final adjustment on line 6 below.

6	x	**50m**			=	**300.00m**
# tape lengths		distance per tape length		partial tape length		measured distance

2 Second measurement.

5	x	**50m**	+	**49.97**	=	**299.97m**
# tape lengths		distance per tape length		partial tape length		measured distance

3 Average raw (uncorrected) measurement of course: **299.985m**

4 Temperature correction. Use the average steel tape temperature during measurement. Work out answer to at least seven digits beyond the decimal point.

Correction factor = 1.0000000 + (.0000116 x [Celsius temperature – 20])
Correction factor = **0.999942**
NOTE: For temperatures below 20°C, factor is less than one
For temperatures above 20°C, factor is greater than one

5 Multiply the temperature correction factor by the average raw measurement of the course (line 3)

0.999942	x	**299.985**	=	**299.96m**
correction factor		avg. raw measurement		corrected measurement

6 Final distance = **300.00m**

MEASUREMENT REPORT Page 6

BICYCLE CALIBRATION DATA SHEET
COURSE MEASUREMENT DATA SHEET

See spread sheet for full details

Desired length of course: **10,000m**

Length of course as measured: **9,877.2m**

Note any adjustments made to the course after measurement:
See full details on spreadsheet (following page) and 'Overview' page

REFERENCE POINTS

Start	Smith St	At pole #624476
1km	Smith St	4.6m < front door of building #245
2km	Mota Rd	1m > pole #736544
3km	Baldini St	13.3m < letterbox #654
4km	Moneghetti Dr	7.8m < Jones St signpost
5km	Moneghetti Dr	12m < pole #629364
6km	Ondieki St	0.4m < letterbox #44
7km	Ondieki St	12.7m < Lopes Rd signpost
8km	Ondieki St	4.2m > pole #629532
9km	Benoit St	14.8m < front door Golden Bakery
Turn point	Roe St	10.65m < letterbox #48
Finish	Roe St	At pole #624461

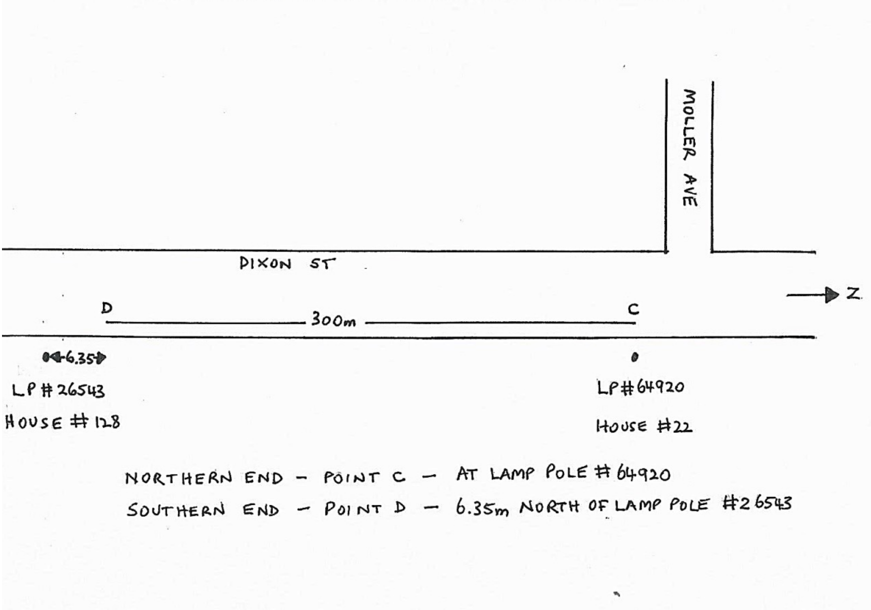
Clean Green City 10KM 2022							
Date:	31/07/2022						
300m Dixon St Calibration Course				311.586m Regent St Calibration Course			
Time	5:55AM	Temp.:	12°C	Time	1:15PM	Temp.:	15°C
Pre-Cal	Counts	Start	Finish	Post-Cal	Counts	Start	Finish
Ride 1	3403	340200	343603	Ride 1	3401	499000	502401
Ride 2	3402	343603	347005	Ride 2	3400	502401	505801
Ride 3	3402	347005	350407	Ride 3	3401	505801	509202
Ride 4	3402	350407	353809	Ride 4	3400	509202	512602
Average	3402.25			Average	3400.5		
WC	11352.174167			FC	11346.335		
				DC	11349.254584		
				Counts per metre	11.34925458		

Start Measurement Time:	6:40AM
Temperature:	12°C

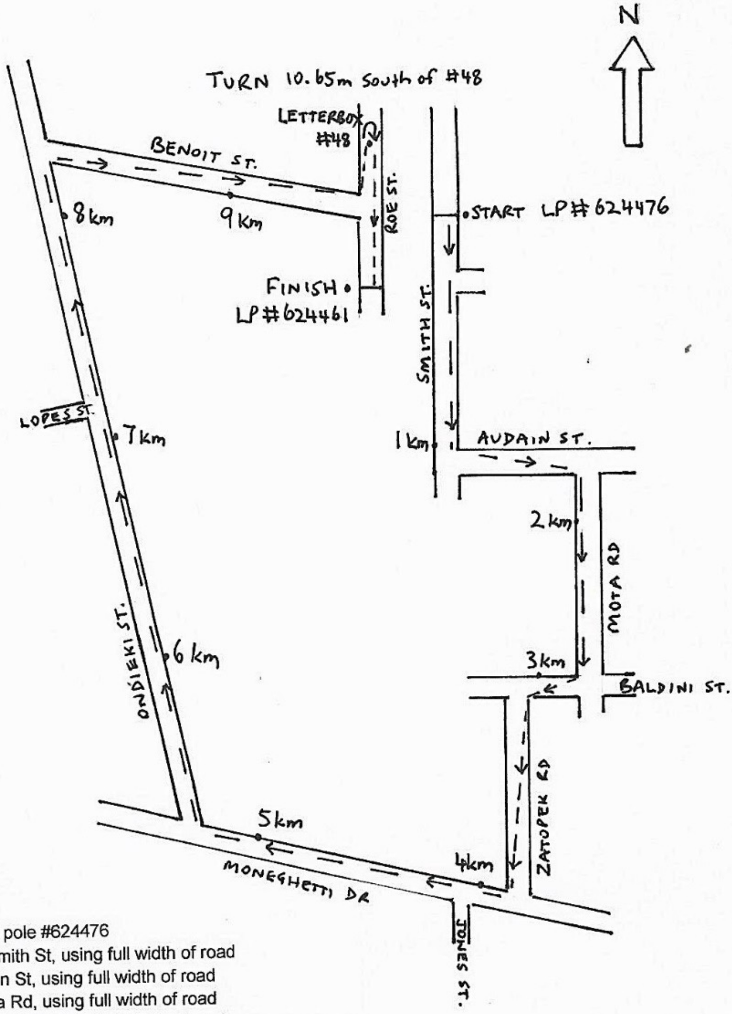
Point	Counter	Cumulative Counts	Sector Distance	Cumulative Distance	Adjustment	Adjusted Distance	Reference Point
Sector 1 - Start to Point A							
Start	360000						Smith St - Pole #624476
1KM Reference	371402	11402	1004.6				Smith St - Front Door of Building #245
2KM Reference	382688	22688	1999.1				Mota Rd - Pole #736544
3KM Reference	394199	34199	3013.3				Baldini St - Letterbox #654
Point A	394710	34710	3058.4	3058.4			Baldini St - Pole #628745
Sector 2 - Point A to Point B, measured in reverse							
Point A	416376						Baldini St - Pole #628745
Point B	406000	10376	914.2	3972.6			Moneghetti Dr - Pole #628777
Sector 3 - Point B to Finish							
Point B	430000						
4KM Reference	430401	401	35.3	4007.9			Moneghetti Dr - Pole #628777
5KM Reference	441798	11798	1039.5	5012.1			Moneghetti Dr - Jones St Signpost
6KM Reference	453007	453007	2027.2	5999.8			Moneghetti Dr - Pole #629364
7KM Reference	464505	464505	3040.3	7012.9			Ondieki St - Letterbox #44
8KM Reference	475662	475662	4023.3	7995.9			Ondieki St - Lopes Rd Signpost
9KM Reference	487227	487227	5042.4	9015.0			Ondieki St - Pole #629532
Finish	497042	497042	5907.2	9879.8	120.2	10000.0	Roe St - Pole #624461
Short by				120.2			

Adjustment - Add out and back near finish							
Point P to finish on original course							
Point P	515000						Benoit St - Pole #624440
Finish	516816	1816	160.0	160.0			Roe ST - Pole #624461
Point P to via new turn point, measured in reverse							
Point P	520405						Benoit St - Pole #624440
Turn Point	518021	2384	210.1				Roe St - Letterbox #48
Plus Semi Circle			1.5	211.6			
Turn Point	518021						Roe St - Letterbox #48
Finish	517000	1021	90.0	301.5			Roe St - Pole #624461
Adjusted Course is longer by				141.5			
Course was short by				120.2			
Final Adjustment - Course Long by				21.3			
Delete at Turn				10.6			

CLEAN GREEN CITY Calibration Course Map

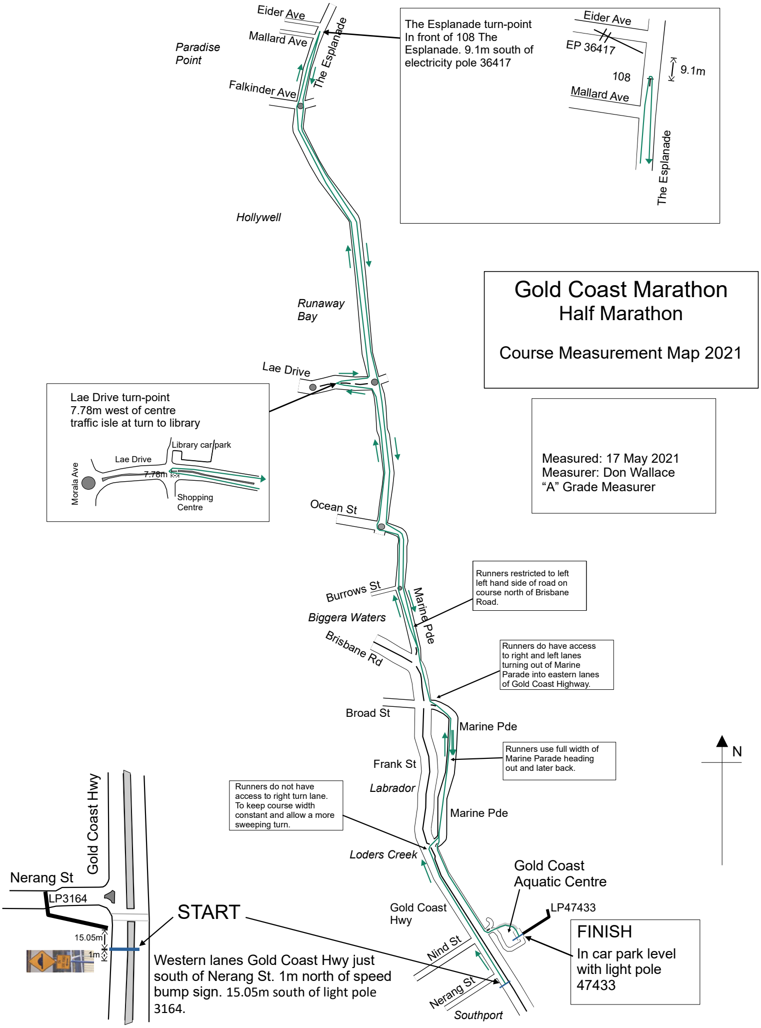


CLEAN GREEN CITY 10km Course Map



Start in Smith St at pole #624476
Run south along Smith St, using full width of road
Turn left into Audain St, using full width of road
Turn right into Mota Rd, using full width of road
Turn right into Baldini St, using full width of road
Turn left into Zatopek Rd (against traffic), using full width of road
Turn right into Moneghetti Dr, using right lane only
Turn right into Ondieki St, using right lane only
Turn right into Benoit St, using full width of road
Turn left into Roe St
U-turn 10.65m before letterbox #48
Continue south along Roe St
Finish at pole #624461

5. EXAMPLE OF COURSE MAPS

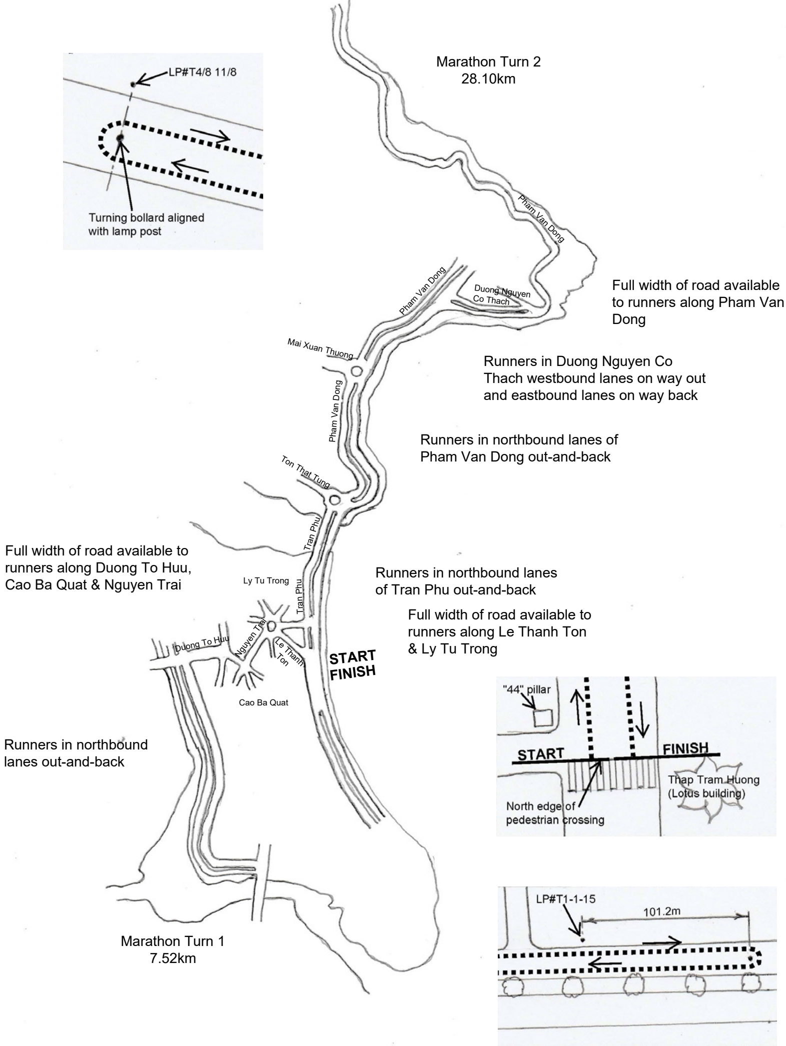


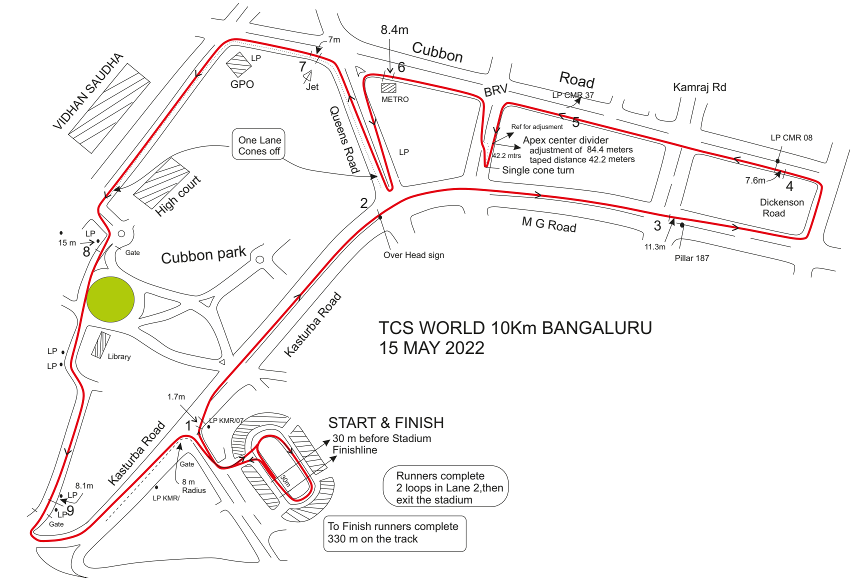
VnExpress Marathon Marvelous Nha Trang

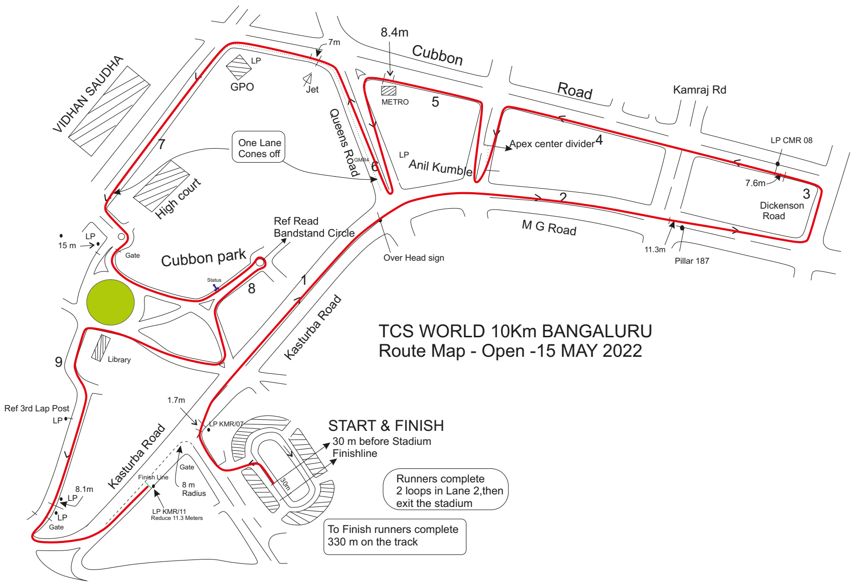
Full Marathon Course

Nha Trang, Vietnam

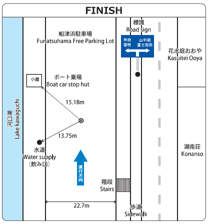
28th August 2022

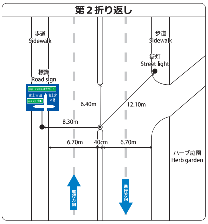


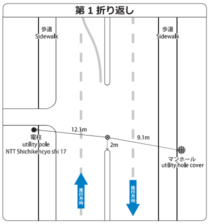

TCS WORLD 10Km BANGALURU
15 MAY 2022
START & FINISH
30 m before Stadium Finishline
Runners complete 2 loops in Lane 2,then exit the stadium
To Finish runners complete 330 m on the track
VIDHAN SAUDHA
GPO
Jet
7m
8.4m
Cubbon
Road
BRV
LP CMR 37
METRO
Kamraj Rd
LP CMR 08
Queens Road
One Lane Cones off
High court
Ref for adjusment
Apex center divider
adjustment of 84.4 meters
taped distance 42.2 meters
42.2 mtrs
Single cone turn
7.6m
Dickenson Road
M G Road
11.3m
Pillar 187
Over Head sign
Cubbon park
Gate
15 m
Library
Kasturba Road
1.7m
LP KMR/07
8.1m
8 m Radius
LP KMR/
30m

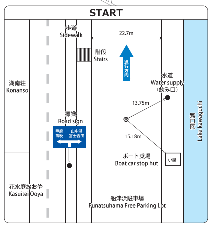

TCS WORLD 10Km BANGALURU
Route Map - Open -15 MAY 2022
START & FINISH
30 m before Stadium Finishline
Runners complete 2 loops in Lane 2,then exit the stadium
To Finish runners complete 330 m on the track
VIDHAN SAUDHA
GPO
Jet
7m
8.4m
Cubbon
Road
METRO
Kamraj Rd
LP CMR 08
Queens Road
One Lane Cones off
High court
Anil Kumble
Apex center divider
7.6m
Dickenson Road
M G Road
11.3m
Pillar 187
Over Head sign
Ref Read Bandstand Circle
Cubbon park
Gate
15 m
Library
Ref 3rd Lap Post
Kasturba Road
1.7m
LP KMR/07
8.1m
Finish Line
8 m Radius
LP KMR/11
Reduce 11.3 Meters
30m

富士山マラソン　コース
Mt.FUJI Marathon Course Map









6. MEASURING EQUIPMENT

Bicycle

The bicycle should be in good condition and comfortable to ride. A touring bike is safer to ride than a racing bike and the slightly thicker touring tyres should respond less sensitively to changes in road surface than thin racing tyres. See Appendix 2 for a short discussion of how different tyres perform during measurement.

A well maintained, comfortable to ride bicycle is critical to good measurement so the rider's focus is on selecting the correct line and the traffic rather than concerned with gears, braking, or the mechanics of the bike.

[The following is not intended to be an all-encompassing run down on bicycles but rather some pointers in selection for measurement particularly when travelling to measure where you cannot take your own bike]

Bike standard:

Initially measurers will tend to use their own bikes and so are in control of the above, but as measurers are requested to undertake 'out of town' measurements they have to rely on race organisers to supply a bike and it's important to be clear on the standard of bike.

In some countries well-meaning organisers will buy new 'budget-supermarket' bikes for the measurement but these are rarely suitable, and fail during the measurement.

Rather be clear upfront with the organiser as to the requirements and normally it's good to suggest that they rent or borrow a bike from the local cycling or triathlon club.

E-bikes are acceptable as long as the counter can be fitted correctly.

Tyres and Types of Bicycle:

Generally we measure road races and so a road bike is normally the most suitable and the selection of tyres is not a major concern as long as you ensure they are pumped up to the recommended pressure to reduce the risk of punctures. Soft or low pressured tyres can often get punctured if you have to ride through holes, bridge expansion joints, or other sharp changes in surface. Check your tyre pressure before calibration.

The wider the tyre the less it tends to vary with changed of temperature, but the longer it tends to take to warm up.

Some events are significantly hilly and, particularly in developing countries, there can be some short sections off-road, both of which can make the selection of a MTB or hybrid bicycle more logical.

Generally it's not the frame and gearing that makes the difference for measurement, it's the selection of tyres that has the highest impact both on ease of cycling and the impact of temperature.

First prize is a smooth thin tyre which will take the least effort to ride but has the disadvantage of being most susceptible to puncture either from thorns or glass.

Given that measurers go in close to corners both thorns and glass are major concerns and the risk of puncture is reduced as tyre thickness, width and tread increases. However, the effort of the ride increases with these changes. Try to assess the level of puncture risk and route profile prior to commencing the measurement and select the best 'tool' (bike and tyres), for the job.

Solid Tyres:

A solid front tyre can be a great selection for routes that have high risk of punctures such as the season when thorns are shed from local vegetation and trees.

It is important to note that solid tyres will often react differently with temperature changes.

While a pneumatic (air filled) tyre will expand with heat and increases its circumference, a solid tyre may become softer and so allow more penetration of the irregular road tar surface into the tyre, which effectively reduces the circumference of the tyre.

When there is one measurer on the course this is easily handled by the normal pre and post calibrations and the course length adjusted as normal. Make a note on the measurement report when using a solid tyre in hot conditions.

Where there are two or more measurers working together on the same course at the same time be aware of the potential differences in tyre type.

This can result not only from the difference between solid and pneumatic tyres, but also the temperature and the roughness of the road surface.

Pedals:

When using your own bike the selection of pedals is personal and shoes will match the selection. When being provided with a bike for measurement the first choice would normally be a flat pedal so that normal running shoes can easily be used. The clip in shoes will normally result in increased pedalling difficulties and distraction from the main measurement focus of 'running line' and traffic.

Pumps and adaptors

It is important to ensure tyres are at high pressure prior to commencing any measurement so access to a pump is essential, and ensure it has the correct fitting for both the normal Schrader car type valve and Presta racing cycle valve.

It is possible to buy a convertor from Presta to Schrader and this is something that the travelling measurers should consider as part of their standard kit.

Most garage (filling station, gas stations) have facilities to check or inflate car tyres. These use the standard Schrader fitting. With the above adapter it's possible to rely on these venues to maintain tyres at the correct pressure.

In parts of Europe and Asia it is quite common to have the Dunlop valve, particularly on commuting bicycles and this will tend to require a flexible tube to connect to a hand pump.

Some of the adaptors mentioned above will also work on the Dunlop valve using the Presta fitting.

Ensure you have a suitable pump accessible prior to measurement, and remember that after calibration only rear wheel punctures can be repaired without restarting the entire measurement process.

Bike tools

The selection and number of tools will depend on the bike. Bikes without quick release from wheels will require a spanner / wrench and additional spanners or / and Allen keys to adjust the saddle or brakes or other challenges that may occur along the road. A spare inner tube and puncture repair kit is useful but remember that any puncture of the front tyre will require a complete re-start of the measurement process.

If the bicycle is well maintained prior to the measurement, then after the counter is fitted to the wheel the number of mechanical issues tend to be minimal.

Always check that the front wheel spins freely after the counter is fitted. If there is any rubbing of the front wheel after fitting the counter, then problems can be expected later in the day.

Keep some washers in the tool kit as some bikes will require these either on inside or outside of the counter to assist in freedom of wheel rotation.

Pliers and steel wire are useful particularly with the older side driven counters but can also of general use in emergency repairs for other problems.

Safety, Escorts and Helmets

Safety should be top priority to the measurer as this is a naturally dangerous activity particularly as following the shortest running line can be considered as unpredictable riding to motorists who are unaware of what the measurer is attempting to do.

Frequently this also means cycling in the middle and also the opposite side of the road facing traffic. While an official escort is ideal, it is often not possible or provided.

In many cases there will simply be a single support vehicle from the organisation that will follow behind when riding with traffic and attempt to warn other vehicles when riding into traffic.

Ideally the organisers will have police or authorities arranged to protect you on both sides of the road throughout the route. In some cases your measurement may have to be split to measure on sections with the traffic and then add the segments up to get the overall distances.

Keep in mind that it's your call, (only), as a measurer as to what conditions you are willing to measure with. Do not accept pressure to measure where you do not feel confident in the traffic conditions.

Helmets:

Helmets are a legal requirement in some countries. Irrespective it is always better to wear a helmet no matter what speed you are cycling.

Travelling with a helmet is not always practical so arranging for a loan at the venue is a good move.

Some companies now make collapsible cycle helmets, and older riders may have the previous leather or strap helmets. Although not meeting racing standards they provide some protection for normal measurement speeds and conditions.

Cycling vest, reflective vest, jacket:

Your choice of clothing will depend on the weather but the first essential is that it is bright and distinctive.

The first priority is to 'Be Seen' and stand out in the traffic. The second priority is combining the practicality of carrying everything you need in a comfortable fashion with the need to match weather conditions.

Remember what you wear can 'communicate' with the traffic approaching you.

For example: if you are measuring in a foreign country then wearing your national flag cycling vest tells drivers that you are from outside and they can be more tolerant of your unusual move on the road.

A “route measurement” or “road measurement” sign on back of your reflective / bright vest assists people to understand and be tolerant of your speed.

Cycling vests with full length zips are most useful in very hot climates such as Africa, Middle East and Asia, while they can prove totally lacking in winter in northern hemisphere countries, where it’s necessary to layer the clothing to protect against the cold, rain or even snow.

It will be necessary to build up an armoury of clothing options for different conditions and times of day, but the basic principles of bright visibility and reflective for the outer layer, followed by weather and practicality remain constant.

Flashing Lights, Warning Triangles, and Cones:

The bike:

Firstly, on the bike front and rear bike lights will be required for night riding but can also be usefully deployed on day rides. Choose the highest lumen lights that can practically be applied to the bike.

An easily removable front white light is particularly useful for reading the counter at night.

Clothing:

Next consider clothing and helmet. It’s possible to get very lightweight flashing lights that will fit on your vest or helmet and just add to your visibility.

Vehicles:

Then also consider the protection vehicle with a removable (normally magnetic) roof flashing light (orange is generally allowed in most countries) as a warning. The driver can also activate the four indicators using the standard hazard button in the car.

The use of blue and red roof lights is normally restricted to official emergency vehicles.

Road:

Calibration frequently requires riding contraflow to traffic.

Placing a traffic cone, (flashing or standard), or a warning triangle about 1.5m out from the curb helps to move the traffic out from the road side and gives space for when you measure over the calibration length.

In ideal situation having such a warning every 60-100 metres gives best protection but in worst situation have one at the start for oncoming traffic. If there are no cones have the protection vehicle park 2-3 metres ahead of the start. This forces other traffic to move out, then get the driver to stand half way down the calibration distance to indicate to drivers to continue to stay out of the curb.

Cones and warning triangles are useful for any sustained stop during the measurement. By example this could be: the start, finish, or where a specific point is being located. In most ongoing measurements where a single reading is concerned and the measurer stays astride the bicycle, it's sufficient for the support vehicle to stop with hazard lights and perhaps a second person behind the vehicle guiding traffic.

Signage / Communication:

The more you inform the traffic as to what is being done the more you reduce the danger.

Again, do not underestimate the power of clothing signage "Course Measurer" on the rear of your reflective vest, shirt or jacket as it communicates with others.

Magnetic car signs are useful on the rear of the protection vehicle with simple "ROUTE MEASUREMENT – PLEASE SLOW" or similar.

These signs assist other drivers to be patient and tolerant of the measurers seemingly erratic behaviour.

Measurement counters

These are currently the two main suppliers of counters, the Jones Counter and the Cook Jones Counter.

Which Counter?

Both suppliers have moved to the right-hand side of the wheel, primarily because of the introduction of disk brakes which tend to be only on the left side of the front wheel.

Some bikes now have a 'bolt through' hub which may require a slight modification to the counter, but both suppliers can provide for this.

There are pros and cons for both devices and it is worth engaging with both suppliers prior to making your personal selection as there is, (at time of writing), minimal difference in cost.

Older Counters:

It is sometimes possible to get your hands on older or second-hand counters. These may even be the wired side driven counter. It is important to check the side-play on the older models as there was a tendency for this wear around the central mounting hole. When excessive this resulted in erroneous readings, which is why the newer versions used more direct or machined drives. These will generally fit on the left side of the wheel and will not necessarily work with disk brakes and other such recent bicycle developments.

Travelling with Counters:
Although some airport securities will allow small tools such as Allen keys and counters in hand luggage, others will not and it is generally safer to put all such items, (counters, Allen keys, steel tapes, nails, etc) into a bag in the hold. The confiscation of counters and steel tapes by security, who may not even speak your language, is expensive and can prevent your measurement from being completed.

Taxes & Import Duties:
It is worth checking the custom and import regulations prior to shipping and using the correct description and code for your customs. This, and ordering two or three at a time, can make significant savings on total costs per counter. Try not to leave the import coding to the customs department as few officers understand the use of these specialist items.

Steel tape

A standardised steel tape (often referred to as a land surveyors' tape) is required and typically comes in 30m, 50m or 100m versions.

These tapes are graduated under tension at a set temperature (typically 50 N tension and 20°C) which is generally stated close to the start of the tape.

The steel tape is required for accurate measurement of the calibration courses and as mentioned below.

It may be possible to borrow one from the local athletics stadium as they often used for record ratification in Shot, Discus and Hammer events.

A steel tape may be coated with nylon to protect the figures and gradations. Always check the 'zero point' on a tape as sometimes it is the 'hook' end of the blade, but zero may also be a distance into the tape. This is very important particularly when an assistant is not a trained measurer or aware of the importance and accuracy of what is being undertaken.

The steel tape, calibrated bicycle, (or calibrated surveyor wheel), would be used for final adjustment to course length, but defining a point from permanent landmarks can be done using second shorter tape.

Steel tapes are very vulnerable to being damaged if vehicles cross them so alternative means of measurement, appropriate to required accuracy, should be employed for defining a point from landmarks or similar dimensions.

Thermometer

A small thermometer will provide the information required to allow the steel tape measurement to be corrected for temperature. It will also allow insight into how the calibration constant changes and help the measurer to decide which constant should be applied most appropriately. Handheld electronic thermometers are also acceptable.

Spring balance

Needed to ensure that the steel tape is under the correct tension when laying out calibration courses. Once the experienced measurer has determined the 'feel' of the correct tension it may be possible to dispense with the spring balance and apply the estimated tension by firmly pulling on the tape end.

Pocket calculator

A pocket calculator is essential for determining the counts needed for specific splits.

If using the "Memory button" for working constant, then check that the calculator will keep adding the correct number each time you press the button.

It's generally best to avoid solar powered calculators as measurement is often done at night or early morning when it may still be dark. Dual powered calculators or a smart phone calculator is a good option, and many smart phones also include a powerful light for reading the counter in dark.

The use of laptop, or tablets with excel or similar programs is discussed elsewhere but unless this is portable for use on the bike a calculator will be essential.

Torch

If measuring at night, it will be extremely difficult to read the measuring counter without a torch. See above: some mobile phones may also be used for this purpose. Be aware of battery life in all cases.

Notebook, pens, pencils etc.

A small notebook will fit into a pocket in bad weather. More than one pencil or pen is essential. Use pens with clips to clip over your vest or in some other way.

Some outdoor equipment shops sell paper which can be written on even when wet.

Another option is to have a small A6 type clip board on a lanyard which can be around your neck and slipped under the reflective vest while cycling.

Crayon or chalk

Useful for making temporary marks on the road. Consider these as only having the lifespan of the measurement. If you want to reuse even the following day make a more sustainable mark, or take readings to a close by landmark, signpost or similar as a point of reference.

Spray paint

Useful for marking distances on the road. Do not rely on such marks lasting from one year to the next. In adverse weather, spray paint marks may disappear within a few weeks or months. If the road surface is wet, the paint will not adhere.

Masonry nails and hammer

Used for making permanent course marks and marking the endpoints of calibration courses.

The best nails for this purpose have a large head and are short stocky bodies: These will vary from country to country.

In USA 'PK' nails (made by Parker Kalon Division, Campbellsville, Kentucky 42718, USA) or 'Magnails' (made by ChrisNik Inc., Cincinnati, Ohio 45053, USA) are good examples but relatively expensive.

By comparison in India the local hardware outlet will provide suitable nails by the kilo and ideally put a washer under them to help them stick out.

Despite their long slender appearance some nails will go into the softer tarmacadam surfaces, but concrete is the most difficult surface to 'nail' and short nails are best.

Adhesive tape (or nail use in calibration)

Used for making temporary marks while laying out a calibration course. Note that the tape will not stick on damp surfaces and you will instead have to use chalk or nails to mark the intermediate tape lengths.

If using nails, drive them in firmly to three-quarters of their length and then measure. It is more difficult to accurately drive a nail in at the end of an already-measured tape length.

Using nails as intermediate measuring points is easier when the zero of the steel tape is at the hooked end, but remember that the nail should be put so that the edge of the tape hook is against the circumference of the nail so that the tape can be pulled against the nail.

Food and drink

Measurers, like runners, need to keep their blood sugar and fluid levels up.

Measurements may take up to six hours with little opportunity to break for refreshment. Take your choice of rehydration drinks or tablets to add to water and some easy to carry food or energy snack. Don't rely on energy / hydration drinks only if the measurement is over about 4 hours, something solid becomes important.

Bum bag

Will allow quick access to equipment used while measuring which may not fit into your pockets. Where possible try to avoid any bags that will interfere with your cycling style or comfort. The use of a runners' shoe bag or small backpack may not have the same convenience as a waist bag but may be more comfortable long measurements. It's all about personal choice, comfort, and free riding.

GPS

Handheld, wearable, or bicycle mounted GPS device.

Using a GPS device that fits on the bike is very useful in several ways.

When laying intermediate distances along the route, (say kilometre marks), it allows the measurer to focus on taking the shortest line and traffic without constantly having to look down to the counter reading. Then when closer to the required distance the focus can move to the counter. This certainly improves the accuracy of the line taken between these intermediate points.

GPS devices serve as overall confirmation of where along the route the measurer is and provides an easy reference for distance of landmarks etc.

Any GPS device will generally overread by around 4-6m per km along the route even when placed directly above the counter and will increase in distance irrespective of any direction moved. Any additional moves or adjustment around objects during the measurement process will therefore add to the distance shown.

GPS devices can also prove useful in providing navigational readings to identify the location of points, but always keep in mind the accuracy of these readings can be around 10m (or more) out. These are really an indication of the point rather than an exact location.

After measurement is completed, the ride can be downloaded to one of the mapping systems and used at various levels of zoom for route maps or even photos at street level. This may save considerable time in report writing.

It is possible to have a very simple GPS device mount which can be applied to the handlebar or stem of the handlebar to move the GPS device between measurement bikes.

7. THE WORLD ATHLETICS / AIMS MEASUREMENT SYSTEM

INTERNATIONAL MEASUREMENT ADMINISTRATORS

World Athletics and AIMS recognise four 'International Measurement Administrators', each responsible for the administration of measurement matters in one of the following geographical areas:

- French- & Spanish-speaking Europe and Africa
- English-speaking Europe and Africa
- Asia & Oceania
- The Americas

The measurement administrators:

- appoint measurers for road race courses within their areas
- issue World Athletics-AIMS International Measurement Certificates
- set up, or are otherwise involved in, course measurement seminars held in their areas
- recommend re-grading of course measurers as detailed below.

GRADES OF MEASURERS

World Athletics and AIMS recognise two grades of international course measurers as competent to measure road races and race walking events held under World Athletics rules: Grade A and Grade B.

For World Athletics Series Events, Olympic Games' courses and ratification of World Records, it is necessary to have a Grade A measurer.

Member Federations may have their own national course measurers: they will measure local courses, including national championship courses, but no races in the AIMS or World Athletics calendars.

APPOINTMENT OF MEASURERS

Race organisers wishing to have courses measured by any other than a national measurer – and this is necessary if the race is to be included in the World Athletics or AIMS calendars – should contact the appropriate International Measurement Administrator, who will appoint a course measurer (see Appendix 8).

GRADING OF MEASURERS

Grading of measurers is at the discretion of the International Measurement Administrator, who will make recommendations for the approval of the annual joint meeting of World Athletics and AIMS. The basic guidelines for grading measurers are as follows:

National measurers are graded as 'national' on successful completion of a bona fide World Athletics/AIMS course measurement seminar which was managed by an A grade measurer, plus the completion of several independent measurements with full documentation.

Grading as a "National" measurer is a recognition that the person concerned has skills appropriate for measuring road race courses within their own country, for races on the national or regional calendar. This requires two things:

i. the basic technical knowledge of how to measure a course
ii. the ability of the measurer to produce a measurement report that can be easily and unambiguously understood by an informed reader.

The purpose of World Athletics/AIMS training courses is to allow people to understand and perform basic course measurement. A successful outcome at such a course would be that the candidate measurer is able to fulfil criteria (i) above. At these courses there is no attempt to assess candidates' abilities to document their measurements (criteria ii).

Grading as a national measurer is therefore confirmed only after the candidate has performed several measurements and sent documentation of these to the responsible International Measurement Administrator, who will use them as the basis for assessment of criteria (ii) above. At least two measurement reports should be forwarded to the Administrator within 12 months of the seminar for a candidate to be considered for grading as a national measurer.

National measurers seeking B grading should send the documentation of their measurements to the appropriate International Measurement Administrator, who may then organise a further measurement under the observation of an A grade measurer. If the International Measurement Administrator is satisfied with the candidate's suitability, the Administrator will upgrade the candidate to a B grading, subject to later ratification at the annual joint meeting of World Athletics and AIMS.

Grading as a "B" measurer recognises that the person concerned is able to measure courses and document their measurements to the standard required for races on the international calendar, excepting only global championships. It is important that the person concerned is able to demonstrate his or her ability to measure on open roads and/or city streets.

There are several differences between what is required of a national measurer and an international measurer.

Linguistic and cultural differences may make it more difficult for the measurer to communicate. In unfamiliar surroundings the measurer will need to take time to assess local conditions and to listen to advice from local personnel. The measurer will also need to take time to explain what is required for the measurement and what they will be doing during measurement (in particular, any police escort must be warned that the concept of “following the shortest possible route” will in practice mean that the measurer may occasionally be riding into oncoming traffic).

Technical differences arise through working under unfamiliar conditions. The measurer will be using an unfamiliar bike, but as long as the counter fits onto the front fork this should not be a problem. The bike may have no gears, which may make riding steeper sections a problem. There may be no existing calibration course convenient to the start and finish of the course to be measured. The measurer should always take a steel tape with them on international measurement assignments so that they can measure out a calibration course of their own, or check any existing calibration course. The measurer should not rely on local personnel to set out a calibration course, but should always either do this personally from scratch or make a careful check of an existing calibration course.

B Grade measurers are eligible for A grading if they are already B graded and, since being appointed such, have measured the courses of several races in the World Athletics or AIMS calendars. One of these should have been measured under the observation of an A grade measurer, who will report to the International Measurement Administrator. Documentation of all measurements should be sent to the International Measurement Administrator who may upgrade the measurer, subject to later ratification at the annual joint meeting of World Athletics and AIMS.

Grading as an “A” measurer” means that it is more likely that the measurer will be called upon to measure championship events, including walks courses. The main differences in such events are that they may start and/or finish in a stadium, they are usually made up of multiple laps, and they are likely to feature “designed” turns, defined by the placement of cones. The design of turns is dealt with in Appendix 2 of this handbook.

All race walking courses and many marathon courses are designed asin multiple laps. The Sometimes the start and/or finish points are not on the actual lap. In these cases, the measurer must be careful to take into account of the fact that competitors joining the may start the first lap or finish the last lap in a different location to which they depart from it.that is not part of the lap course. This means that the first and/or final lap ismay be longer (or in practice slightlysome cases shorter) than the others.

Here is an example from the 2022 World Championships marathon course in Eugene, Oregon. In this case the course consisted of three laps of 14km, with the extra 195m added at the end. When measuring this course, counter reading should bereadings were taken as soon asat the start and end of the lap is joined, and again at this point after completion of the lap, but before then another reading is required at the point where competitors will depart from the lapthe finish line to ensure that the total distance was recorded.

Measurement on a stadium track is best done by a combination of taking the track surveyor's measurement of the track length on trust and steel-taping. The reason for this is that the accuracy of the calibrated bicycle method depends upon consistency. Calibrating on a road surface and then measuring on a rubberised all-weather track is not consistent procedure.

Tracks are marked out at regular intervals in each lane. It is not difficult to calculate the distance between any two points on a track by simple addition and subtraction. Measure by steel tape to the nearest recorded mark on the track (these marks are often labelled with small steel plates on the inside kerb). The only difficulty arises where runners depart from the track to exit the stadium and vice-versa. At these points the shortest possible route from the kerb of the track to the exit tunnel should be steel-taped. Be careful to identify exactly what part of the exit tunnel will be available to the competitors on the day of the race and what may be sectioned off for service or security purposes. The calibrated bicycle measurement can usually start from the edge of the track, but if construction is still in progress then it may be better to start from outside the stadium and use a steel-tape to measure from this point to the track. It is helpful to perform a back up measurement with the bicycle for those segments that are on the track to prevent gross errors from using the wrong track marking.

Measurers are required to send a copy of their course measurement reports, for each of the courses on the World Athletics or AIMS calendars that they measure, to the appropriate International Measurement Administrator.

Inactive measurers may be downgraded by the International Measurement Administrator.

LABEL RACE CRITERIA

Courses of all World Athletics Label Races must be measured by an accredited A or B World Athletics/AIMS course measurer. If the course changes it must be re-measured by such a measurer. Even if there is no visible change to the course, it must still be re-measured every five years.

AIMS MEMBERSHIP CRITERIA

Courses of all AIMS member events must be measured by an accredited A or B World Athletics/AIMS course measurer. If the course changes it must be re-measured by such a measurer. Even if there is no visible change to the course, it must still be re-measured every five years.

8. GUIDELINES FOR RACE DIRECTORS SEEKING MEASUREMENT OF COURSES

For the attention of the Race Director:

The very basic requirements for road races and credible performances are an accurate distance and accurate time.

The following processes will assist the race organisers to have courses measured and certified to the required standard:

Preparation of a Race Route:

- Before seeking a measurement, you should have a confirmed route for your course which you believe to be approximately the correct length.
- There are several ways to plan and scout a race route:
  - Drive the proposed course to see that it presents what you are trying to achieve with the race: fast and flat; scenic, tourism, challenging etc. This will give you a rough distance using the car milometer. The use of a GPS in the car will give slightly better accuracy but will still require adjustments.
  - An alternative is to ride the route in a normal fashion on a bicycle using either GPS, or the bicycles cyclometer. As they get into the corners on both side they will be more accurate than the car.
  - Running the route with a GPS watch then uploading the route is clearly a good option and one of the most accurate even although it may be impossible to run the shortest route.

- Plot the route on one of the many mapping programmes. Options include: Strava, Google Earth, Plot a Route (www.plotaroute.com), On the go map (www.onthegomap.com) or one of the downloads associated with the smart or running watch. (e.g. Garmin Connect, Suunto etc)
- Throughout the route consider what section of the road will be open for use by the runners on the day of the race.
  - If it is not the entire road width, then clearly state any restrictions. Include the exact route to be taken at turns.
  - Where the runners are not taking “the shortest possible route” indicate the precautions that will be taken to prevent corner cutting.

- Since the Course Measurement is the most accurate there will probably be some change to the route length. The race organiser should identify whether start or / and finish points can move and by how much. It is more difficult to achieve correct distance if both points are fixed. Although every race is unique having plans to accommodate 20-50m tolerance per 10km is useful for changes between the plotted route and the measured route.

- If you already have contact with the course measurer, it can be worthwhile to share this file with them now for comments based on their experience.
- Importantly submit your proposed route to local authority to obtain any necessary permissions and in-principal approvals alternative routes for normal traffic.

Appointment of a Course Measurer:

- Contact the Area Measurement Admnistrator.
  - There are four administrators covering:
    - North and South America and the Caribbean
    - English-speaking Europe and Africa
    - French- and Spanish-speaking Europe and Africa
    - Asia and Oceania.
  - You can find the contacts for the Area Measurement Administrators on the AIMS website: https://aims-worldrunning.org/measurers.html
  - The Administrator will ask a measurer close to your race location to make the measurement and put him or her directly in touch with you.
  - If the intention is for the event to seek AIMS membership, a World Athletics race label or other international recognition then a World Athletics/AIMS A or B grade measurer is required.
  - If your event is designed for record attempts, or a regional, continental championship or higher it is worthwhile using an A grade measurer from the outset, as ideally the event should be verified prior it being held so that performances can be easily ratified.
  - The list of World Athletics / AIMS measurers is on the World Athletics website. (https://worldathletics.org/competitions/world-athletics-label-road-races - Look at the bottom of the page for "World Athletics / AIMS certified road race course measurers")

Arrangements with Course Measurer:

Once in contact with a course measurer it is important to:

- Share the proposed route details with the measurer as this will impact on how he / she will approach the measurement and estimate the time required to complete the measurement.
  - Providing the route in a format that allows the measurer to open in a satellite will assist in understanding the work to be undertaken. For example: .kmz files open in Google Earth and in Google Maps which allows for detailed inspection of the roads.
  - It is important to provide an indication of traffic conditions and whether it's possible to measure during the day or only overnight. This may impact on the provision of the safety escort to the measurer.

- Confirm all travel, accommodation, and payment details with the measurer.

  - Keep in mind that measurers may be working early morning or overnight so accommodation should be of suitable standard to allow for these unusual hours and mealtimes.
  - There are no standard measuring fees, and this may be based on a daily rate or a lumpsum, but will vary with the distance, complexity and number of routes and other such factors. A separate rate may be applied for travel days. The method and date of payment of the fee and reimbursement of travel and other expenses should also be agreed prior to any other progress in measurement.

- Typically, the travelling measurer will not be able to bring a bicycle or various other equipment if flying: (e.g. bicycle, hammer, nails, paint, etc).
  - Request the measurer to confirm exactly what is required to be provided by the organisation, and ensure it is ready for the agreed arrival date.

- Based on arrival date the measurer will agree an outline schedule which will include a route inspection and setting up of a calibration distance of at least 300m length:
  - The organiser assists by suggesting a suitable calibration venue.
    Ideally this is:
    - A minimum 300m straight length
    - Flat or minimum rolling incline:
    - Normally clear of parked vehicles
    - Without intersecting road, or only infrequently used junctions.
  - Ensure the safety of the measurer during the ride by arranging for a police or other escort.

- Courses are measured using a "measurement counter" mounted on the front wheel of a bicycle.
  - Measurements undertaken outside a measurer's hometown often make it impossible for measurers to bring their own bicycles. This means organisers will be required to provide one.
  - It is best to use a standard road bike with a typical tyre diameter of 29 inches / 622mm (typical MTB size) or greater. (please also see the information on tyres under measurement equipment)
  - Organisers will probably be required to provide additional items, including:
    - spray paint,
    - a hammer to use for making road markings,
    - nails and washers

    as these may be prohibited on aircraft.

- A few copies of a detailed map of the course, or a KMZ or similar electronic / digital map link, and details of road width available to runners, and path to be followed through junctions, particularly if this is not the 'shortest possible route' (**SPR**).
- It is useful to provide any travelling measurer with a wifi data connection, not only for communication but also for use of maps such as Google Earth on site away from the hotel or office.

The measurement:

- **SPR and Safety:**
  - The measurer must ride the bike along the SPR to obtain a certified measurement. This involves taking a direct line from one corner to the next – often cutting diagonally across the road, and possibly into on-coming traffic.
  - To allow such a route to be ridden safely you must take precautions. The best precaution is to secure the assistance of a police motorcyclist, who can direct traffic out of the measurer's line. This can be combined with a protection vehicle driving directly behind the measurer when cycling with the traffic.
  - Organisers and measurer together will consider the best time of the day or night for the measurement to be completed and this will relate to the least amount of traffic on the road.
  - If no police protection can be provided then arrange for a vehicle to drive with the measurers, "shielding" them from other traffic.

- **Allow time:**
  - A vital part of the planning is to allow adequate time for the measurement, so that the ride is not rushed, and risks are not taken. The measurer will normally be able to provide a good estimate of time once he/she has seen the route.
  - As a guide expect to cover around 8-10km of measurement per hour, then allow another hour to hour and half for calibration processes.

- **Calibration:**
  - Before the measurement ride can be started the bicycle must be 'calibrated'. This entails repeatedly riding the bicycle over a straight, flat section of road around 300-500m in length. The measurer will measure this distance with a steel tape after arrival, but you should be able to suggest a suitable location (see main text, section 2). It should be close to the start/finish (or lay out separate calibration courses near to both if it is a point-to-point course).

- **Reports and Distribution:**
  - After the measurement the measurer will send one copy of his/her report to the appropriate International Measurement Administrator and another to you, the race director.
  - The Administrator will check the details of the report and, if satisfied, will issue an World Athletics-AIMS Measurement Certificate. The certificate is initially sent to:
    - World Athletic Road Running Manager
    - The AIMS Technical Director
    - The course measurer.
      - The measurer will then send the copy to the race organiser to finalise the process.

- **The Certificate:**
  - When you receive the Certificate, check that all the key details are correct.
  - ***The certification remains valid for five years, or until any change is made to the course.***

Preparation Checklist:

1. Confirm all travel, accommodation, and payment details with the measurer.
2. Provide all necessary equipment requested by the measurer (e.g. bicycle, hammer, nails, paint, etc)
3. Provide, in advance, maps of the course and details of the road width available to runners and the exact route to be taken at turns.
4. Ensure the safety of the measurement ride by arranging for a police or other escort.
5. Suggest suitable locations for laying out calibration courses.

Measurer's assistance and race duties:

The Race Organiser can also benefit from information and knowledge that an experienced course measurer may pick up while undertaking the measurement.

Given the focus on safety, traffic concerns, and need to select the SPR the measurer can become very aware of the challenges of route management and even, as a visitor, the promotional aspects of the route. It may be worthwhile engaging with the measurer to discuss what they see as being the features and challenges for the proposed race.

It is worthwhile remembering that it is always recommended that either the course measurer or a suitably briefed person should be in the lead car on race day whether it is women's or men's race.

Where the measurer is travelling, and he/she are not going to be able to return for race day, try to ensure that there is sufficient time for him/her to fully brief at least one person on the exact lines that were ridden and should be used to indicate the SPR to the athletes.

Never underestimate how easy it is for athletes to be incorrectly directed on the race day. Having the course measurer present for route inspections, checking the course set up, and being in the lead cars is first prize.

9. SOURCES OF FURTHER INFORMATION

Software and Production of Route Maps

Measurement until the 1990's was predominately undertaken with handwritten reports, sketched maps, and detailing.

The massive advances in technology have seen the adoption of many computer, smartphone and tablet applications that make this considerably easier and quicker to convert the figures notes and practical outcome of a measurement into a report that allows anyone to successfully ensure the measured route is correctly and accurately laid out on site.

There is a wealth of different programs for mapping and detailing. These can be quite sophisticated or basic and your choice will depend on many factors not limited to:

- Computing system (MAC, Windows etc)
- Cost or availability / access to programme
- Potential accuracy of plots
- Versatility to provide information such as: elevations, distances, GPS co-ordinates, street photos etc
- Labelling, mark-up, and comment ability
- Copy, paste, screenshot, share options
- Your knowledge of IT, willingness to explore / learn new programs and need to find a new level of production.

Importantly though there are those measurers who still enjoy and prefer to draft the maps with paper and pencil or handwrite reports and while there are basic guidelines on what needs to be achieved, how that is presented is largely open to personal preference.

The key objective is to communicate the validity, accuracy and detail of the route in a way that someone visiting the area for the first time would be able to replicate and lay it out while ensuring the shortest possible running path would be maintained.

Maps and Details:

The basics of a measurement map is ideal to show on one page the overview of the route with the location of start, finish, any turn or key points that define the overall distance, and the direction in which the route is run.

There can be additional drawings, photos to provide more precise details but the single page is the summary to lead the reader to understand the route and put any other specific instructions into perspective.

The route map or detail should clearly state or identify what portions of the road are open for the runner to use and where the route includes, say, roundabout islands or traffic calming measures then where or which side the runners will be directed.

Where the measured line is longer than the shortest possible ensure there is a statement showing how the runners will be directed the measured route: eg by barriers, marshals or other clear instruction.

The start, finish, and turn points should be clearly identified and nailed (with a washer or something of size to make the nail head visible) at least at one point with a minimum of two long-lasting landmarks and dimensions such that the nail / point can be found even if the road is resurfaced or similar removal of the nail.

It's often worthwhile having two reference points for these key route references. (eg a nail in the road and a second mark to the outside of the road. For turns a nail in the centre point and another on the diameter line outside the road surface).

A simple photo of the point, marked up with the dimensions to a couple of landmarks will assist in these points being easily found.

Where the routes are unlikely to be changed over history it can be worthwhile even to mark the kilometre marks and detailing each of them. This was done for the Athens Olympic marathon in 2004 and although the final 3 to 4km was changed, the original route has been used for decades and in some cases there have even been sign posts erected by the city for these distance marks.

The important thing is that the report provides all that information to make it easy for the outsider to come and re-build the exact same route that you measured.

A Few Examples of Programmes and apps

Strava

This is a USA based tracking and location software that links to many and most other tracking equipment particularly focused on cycling and running and therefore a good fit with course measurement.

That said, as with the fitness GPS watches etc, the focus of these apps is towards recording and analysis of physical exercise, whereas the measurers primary focus tends to be towards replication of maps, geographical info and ease of transfer into reports.

GPS Watch and Tracker Downloads:

There are a growing number of devices offering fitness and exercise tracking. These can be from mobile phone or watches and include the main brand names such as: Garmin, Polar, Fitbit, Suunto, Huawei, Samsung, etc...

Most have their own proprietary software, and most will also link into Strava.

As with Strava they will tend to focus on the physical attributes of heart rate, cadence, and the like, but still can produce a map and elevation that will provide a quick and easy method of creating a route map for the measurement report.

Where these tend to fail is their ability to 'design and up-load' a route' prior to measurement. Much depends on the sophistication of the device selected in any product range.

Clearly this is however a cost-effective way to go if the device is already being used for the measurers running / cycling activity.

Google Earth (Pro)

This is a free virtual GIS (geographical information system) programme downloaded from Google that allows the plotting, design, overlay of routes or areas and tools that can assist the measurer in planning and reporting on course measurement.

In addition to the plan, it is possible to find elevations, distances, and view route profiles. In many, but not all, cases a street view of points along the route can also be found.

The ability to switch between satellite and street maps is useful for additional information, as the use of screen shots or photograph options.

Being widely used and available means that there are also many tutorial videos and help tips for the beginner and the advanced learner.

Google Earth can export routes in kmz and import files in various formats which means that a route can be uploaded from many of the tracker systems.

The screenshots or images can then be independently annotated with additional information such as start, finish, turn points, and km marks. Much of this can also be done directly onto the map and allows these 'layers' to be switched on and off depending on who and what you are wishing to report in the map.

It is also possible to produce a 'fly through' activation of the route which can be useful in race planning.

Some GPS watches / trackers can upload routes, and this can assist and guide the measurer over a newly planned route

Plotaroute

Plotaroute is only one example of the many apps and programmes available.

plotaroute.com is a free worldwide online route planner for all outdoor leisure activities including walking, running and cycling. It provides people with a simple way to accurately plan, measure and share routes, while at the same time offering some unique and advanced features.

The routes can be plotted for both road and off road and a variety of base maps styles are available.

It is possible to annotate the route, and surrounding areas, with directions notes and information, which makes this a great base for map drawing in measurement reports. Additionally the measurer can add photos at key points so that a more detailed explanation and image is available.

Apart from elevation and profiles there are tools that will assist with times for opening and closing roads and other nifty features for race planning.

The finished map can be made private, public, shared using various mechanisms or social media, or shown in image formats.

There is a premium memberships format, which is ad free and comes with additional features and higher plotting speeds.

https://www.plotaroute.com

GPS Camera Programmes:

A more recent addition to our measurement technology are mobile phone apps that add the GPS readings / location to photos which makes finding the location of a specific point a bit easier.

It's important to know that these have limited accuracy but are certainly a great way of getting to the point the photo is taken.

These photos cannot for instance replace the measurements required for locating the end point of a calibration distance but can take you to within a couple of metres making the location much easier.

One example to consider is 'GPS Map Camera Lite' which is a free version that puts Longitude Latitude Elevation Date Time and a physical address on the photo.

This can be augmented with a compass and a grid which gives some feel for the relative distances in the photo.

It is important to stress again that there are many different options and the above are but a few ways to tackle mapping, drawings and reports using latest technology. A simple search in a browser for mapping routes, GPS cameras will give access to some of the more popular and it really is a case of finding one that works best for your style and computing level.

Web sites

AIMS – Association of International Marathon and Distance Races

www.aims-worldrunning.org

The Association of International Marathons and Distance Races (AIMS) website contains details of over 450 international road races in over 80 countries around the world.

The course measurement section of the website also contains the entire World Athletics – AIMS measurement manual, the list of approved measurers, as well as additional advice for race directors regarding course measurement.

United States Track & Field (USATF) Road Running Technical Council

www.usatf.org/resources/course-certification

www.rrtc.net

The Road Running Technical Council is one of the many Committees and Councils of USATF. Its main role is to manage the national road course certification program which includes, certification, measurers, course verification measurements and much more.

The RRTC website host an online portal for measurers to upload their data & maps for certification as it applies to USA road course.

The site also has a comprehensive search engine of all the USA Certified courses/maps & measurers, instructional information, historic documents, drop & separation calculator, and other resources.

Course Measurement Canada

www.acroad.ca

The course measurement website for Canada offers, like that of the US, measurement and certification information, a list of courses, products and publications and an online version of ***Course Measurement Procedures.***

The site also contains a 'Question and Answer' section which offers insight into the difficulties encountered in setting up a national system of course measurement.

Course Measurement United Kingdom

www.coursemeasurement.org.uk

This website contains John Jewell's seminal 1961 report on road race measurement, as well as several theoretical papers using experimental data to examine the sensitivity of bicycle tyres to temperature and surface variation.

Materials used in conducting a seminar for course measurers can also be accessed and downloaded.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