INTERNATIONAL ASSOCIATION OF ATHLETICS FEDERATIONS

THE MEASUREMENT OF ROAD RACE COURSES

Second edition, 2004

Acknowledgements

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

The IAAF would like to take this opportunity to thank the Association of International Marathons and Road 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 and this edition updates many aspects, including changes in IAAF Rules. The latest edition of the book was written by Dave Cundy (IAAF Area Measurement Administrator) and Hugh Jones (AIMS' General Secretary and an "A" Measurer) and IAAF owes them a great debt of gratitude.

Measurement procedures outlined in this booklet are those prescribed by IAAF/AIMS for the measurement of IAAF/AIMS races. The IAAF will only recognise times on courses measured by this system for world records, qualifying times for Championships, etc.

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IAAF President's Message

Road racing is one of the most exciting and dynamic branches of our sport, and its steady growth over the years means that, for many people, it is their first point of contact with athletics, either as participants or spectators. Furthermore, the fact that the IAAF began to recognise official World Records in road race events since 1 January 2004, means that the measurement of road courses even more important.

I am pleased to welcome this edition of The Measurement of Road Race Courses since it replaces the first and only version that was published in 1989, and since then the sport has developed dramatically and there have been many changes to IAAF Rules as well as changes in the actual techniques of measurement, thanks to new technologies.

On behalf of the IAAF, I would like to thank AIMS, the Association of International Marathons and Road Races, for its valued work in developing the system of measurement throughout the world and for working, together with the International Measurement Administrators, to draw up a list of road race measurers who are skilled and proficient.

Lamine Diack
IAAF President

Extracts from the IAAF Competition Rules 2004-2005

Rule 240
Road Races

"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 no on soft ground such as grass verges or the like. The start and finish may be within an athletic arena.

Note(i): It is recommended that, for road races staged over standard distances, the start and finish points, measured along a straight line between them, should not be further apart than 50% of the race distance."

"3. The start and finish of a race shall be denoted by a white line at least 5cm wide. In events on roads the course shall be measured along the shortest possible route that a competitor could follow within the section of the road permitted for use in the race.

……….. where possible……….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". " …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 an IAAF/AIMS approved course measurer.

Note (i): For measurement, the "Calibrated Bicycle Method" is recommended.

Note (ii): To prevent a course from being found to be short on future re-measurement, it is recommended that a "short course prevention factor" is 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 decrease in elevation between the start and finish should not exceed one in a thousand, i.e. 1m per km."

This 'decrease in elevation' is commonly called 'drop'.

As course measurers are often asked to advise on course design, it is useful for all measurers to have an understanding of the implications of 'separation' and 'drop' (see Appendix 4).

Rule 260.8
World Records

The IAAF now recognises World Records in road races for the following distances: 10km; 15km; 20km; Half Marathon; 25km; 30km; Marathon; 100km; Road Relay (Marathon distance only). IAAF Rule 260 states that the following criteria with regard to the course must be complied with in order for a World Road Record to be ratified:

"a) The course must be measured by an "A" or "B" IAAF/AIMS approved measurer.

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

c) The decrease in elevation between the start and finish shall not exceed an average of one in a thousand, i.e. 1m per 1km.

d) Either the course measurer who certified the course or another "A" or "B" measurer in possession of the complete measurement data and maps must validate that the course measured was the course run by riding in the lead vehicle.

e) The course must be verified on site (i.e. within two weeks before, on the day of the race or as soon as practical after the race), preferably by a different "A" or "B" measurer from the one that did the original measurement.

f) Road World Records set at intermediate distances within a race must comply with the condition set under Rule 260 and be timed according to IAAF Rules. The intermediate distances must have been measured and marked during the course measurement.

g) For the Road Relay, the race should be run in stages of 5km, 10km, 5km, 10km, 5km, 7.195km.

Measurement procedures - how it is done

A calibrated bicycle fitted with a Jones/Oerth counter is the only approved method of measuring road race courses. The Jones/Oerth counter, which is mounted at the hub of the bicycle's front wheel, is named after its inventor Alan Jones and its current manufacturer Paul Oerth.
The Jones/Oerth counter does not measure distance directly. It measures the revolutions and part-revolutions of the bicycle (front) wheel. Depending on the internal gearing of the counter it may record 20 counts per revolution for the older counters or 260/11 counts (23.63636… counts) for the newer counters. Because the circumference of bicycle wheels normally used in measurement is about 2.1m this means that each count represents approximately 9 to 11cm on the ground.

The counters are available in five- or six-digit configurations. They may be purchased from:

Paul Oerth
2455 Union Street, #412
San Francisco, CA 94123, USA
Phone: +1 415 346 4165
Fax: +1 415 346 0621
Email: POerth@aol.com

The cost of the counters is: USA: $70 for the five-digit model and $80 for the six-digit model. Other countries: $75 and $85 plus postage (air mail). Visa, Mastercard and American Express cards are accepted. Payment in advance is required.

They are also available (with user-friendly modifications) from:

Laurent Lacroix
131 Sunnyside Blvd
Winnipeg
Manitoba R3J 3M1
Canada
Phone: + 1 204 832 2301
Fax:
Email: llacroix@mb.sympatico.ca

The cost is U$110 for a five-digit model and U$ 120 for a six-digit counter.

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 explanation appears in the appendices and is 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 best performance is involved a short course can be extremely embarrassing to the race organiser and to the measurer. So 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, although a length of 500m is recommended. A shorter calibration course near to, or on, the race course is better than a longer one distant from it.

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). If vehicles often park on the street you may need to measure far enough from the edge of the road to avoid them (say 2.5m). 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 to consider riding 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. In general 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.) that 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 584.75m. 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 3 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 that you will probably use only once convenience is more important than durability. Lay out a whole number of tape lengths - say 10 lengths of a 30m 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 20C, 50N) printed on the blade of the tape.

Your steel tape should be at least 30m in length. You will also need masking tape 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 masking 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 masking 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 masking tape. Do not lose count. This is the most common source of error.


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It is recommended that you use a spring balance to apply the correct tension. However if a spring balance 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 may be 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, say, one metre, from those used earlier. This will require new pieces of masking 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 5cm on a 500m 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.

You may then adjust the corrected length of the course to obtain a desired even distance, such as 500m.

Before driving in the nails to mark the endpoints, your measurements should be adjusted for temperature, although this will have minimal impact on the whole 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 Jones/Oerth counter for every kilometre ridden on the bike. This figure is called the ***working constant.***

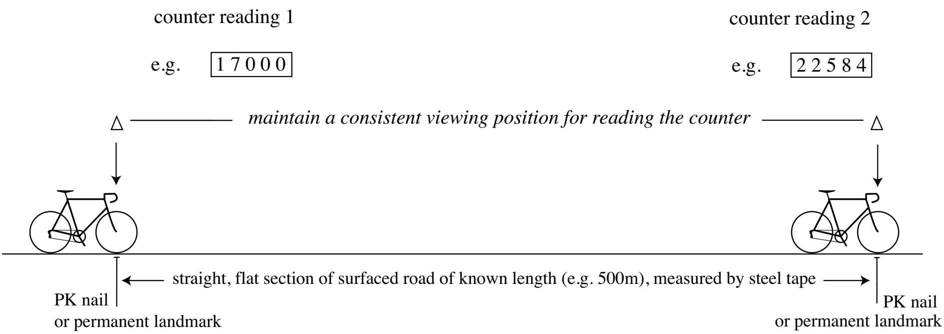
To calibrate the bicycle, follow these nine points:

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).

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 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. 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.

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.

Look at your Jones/Oerth counter. Rotate the wheel until the counter 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, 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).

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

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.

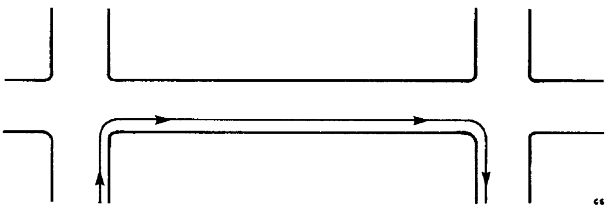
Riding the shortest possible route

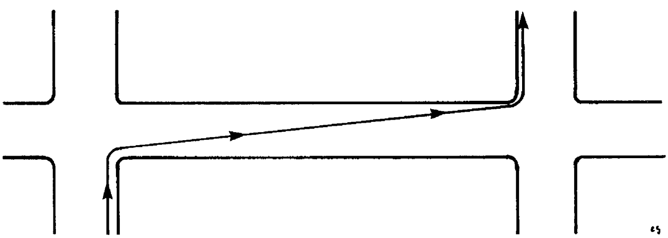
The road race course is defined by the shortest possible route that a runner could take without being disqualified. Any particular runner is most unlikely to follow the shortest possible route, just as a track runner cannot always hold the inside kerb for the length of the race, but must move out in 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.

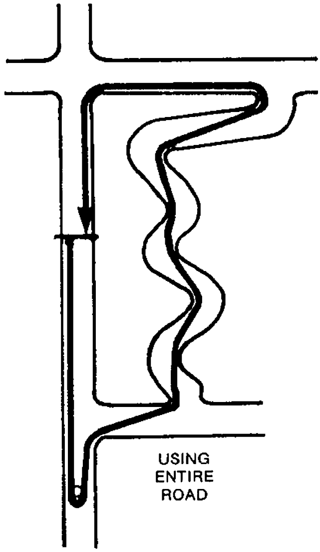
Measuring the SPR means hugging the inside edges of bends. The path you should attempt to measure officially lies 30cm from the kerb or other solid boundaries to the running surface. Attempt to maintain this distance on bends and at corners. On stretches between bends the SPR takes the shortest possible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

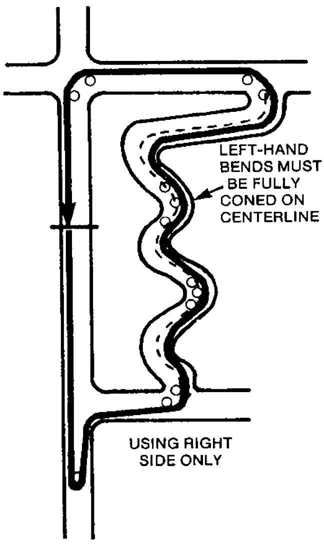




Turns



Winding roads – use of full width of road



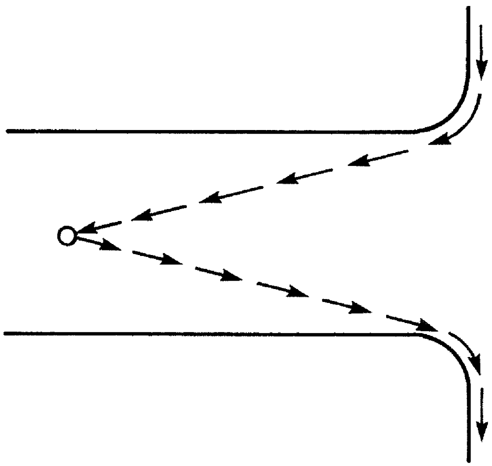
Winding roads – use of half of the road only (runners may not cross the centre line)

Lap courses

The previous 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 (eg. 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. See Appendix 2 – TURNAROUND POINTS - for a full explanation.

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 may 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.

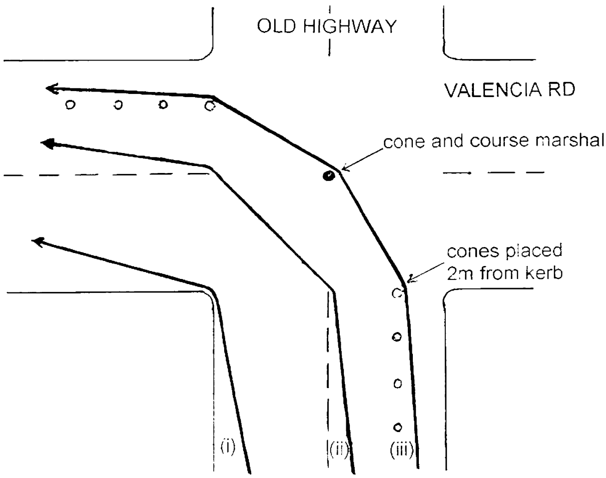
Repeatedly doing this is time consuming. Moving gradually out into the road to avoid a line of parked cars, and gradually back to the kerb after passing them, will add little distance to your measurement on relatively straight sections. For example, moving out 20m before and back 20m after will add about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

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, in such locations, what must be done to prevent short cutting by runners.

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 aim in 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 of the road race course. 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 change 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 (step 8) should be divided by the length of the calibration course in kilometres (step 9) and multiplied by 1.001 (step 10) 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 want 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 Jones/Oerth 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.

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 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 should 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 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 that 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.

See Appendix 3 for an example of a course measurement. It will reinforce all of the lessons from step 2 through to step 7. The example also highlights how to handle a measurement where two or more riders are involved.

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 best performance 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 (e.g. 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.

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. They should be included on the same sheet of paper as the course-length map.

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.

Several copies of the course documentation will have to be prepared. Your map should use black and white only, to allow for easy copying. 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 4 for examples of course maps.

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*** [*w*hat 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 5 for copies of standard forms. 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.

Appendix 1

TEMPERATURE ADJUSTMENT OF THE CALIBRATION COURSE

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 20C. 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 [1 + (average temperature – 20) x 0.0000116]

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.

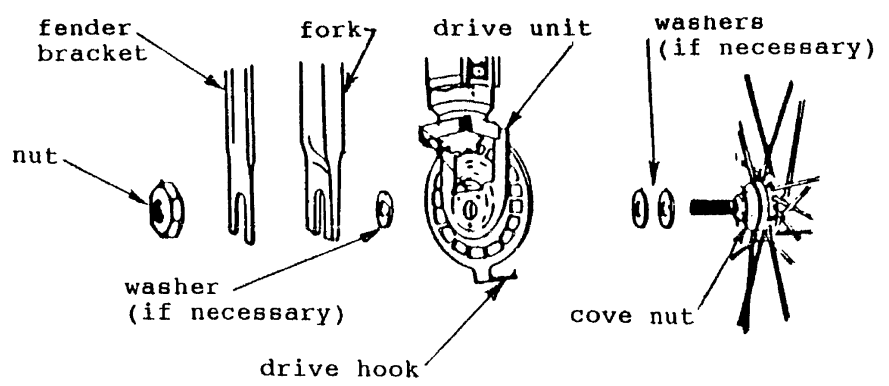
If the average temperature is less than 20°C the correction factor is less than one. The corrected length will be shorter than the measured length.

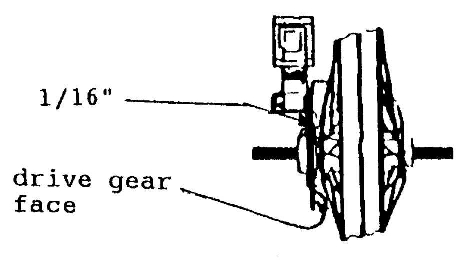
Appendix 2

SUPPLEMENTARY TIPS

Fitting the Jones/Oerth counter to the wheel

The Jones/Oerth counter is mounted on the left 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. If you have a quick-release hub the counter may not fit on the axle and still leave enough threads for the fork to rest on. You may have to remove a spacing washer or adjust the nuts which keep the bearing in place, to move the axle further to the left.





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, you may find that the nuts holding the mudguard stays press against 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.

Reading the Jones/Oerth counter

Electronic odometers are available which are fitted to the front wheel and provide digital readouts that you can attach to the handlebars. These are insufficiently accurate for measurement purposes, but they can alert you to the upcoming kilometre points so that you do not have to strain continuously to read the Jones/Oerth counter. With or without this aid, 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 where you can refer to it easily.

Lock the front wheel with the brake before reading the counter. If you 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.

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 Jones/Oerth 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 Jones/Oerth counter registering that distance.

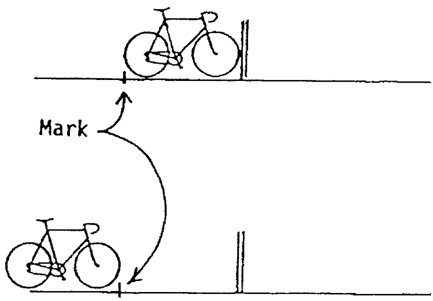
To assist in riding a straight line, locate a distant point in a direct line to where you need to ride and aim for it. If you cannot see which way the road turns over the brow of a hill, look at which way roadside light or telephone poles go and use this as an indicator. Be aware of a natural tendency 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 when you come to a barrier blocking the road (see below).

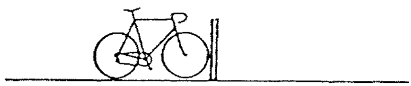
MEASURING AROUND A BARRIER OR GATE

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

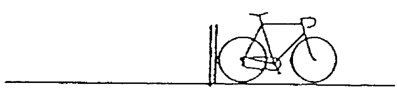
Place the front of the front wheel over the mark.
Unlock the front wheel.



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



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.

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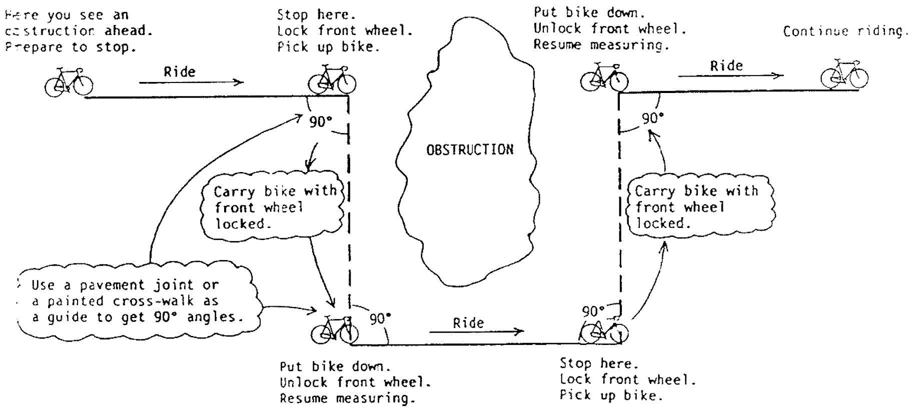
If an obstruction stretches for some distance but does not block the whole road width – the most common example of this is a single awkwardly-parked car – you can do one of two things: measure around it, or perform an "offset manoeuvre". If the obstacle is on a long, straight section of the course, gradually 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.

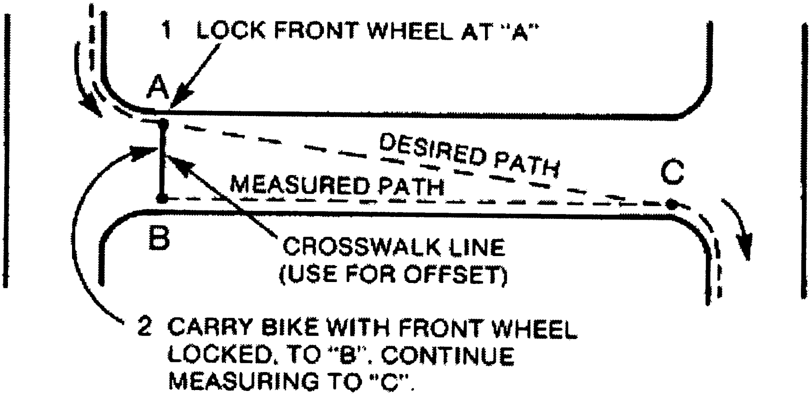
OFFSET MANOEUVRE AROUND AN OBSTACLE



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 blinkers 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 probably be about 100.5m).



HUMAN OBSTACLES

Human obstacles may also present a problem. Pedestrians, runners, skaters 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 courteous, 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. See the 'Example of a Course Measurement' at Appendix 3 for an explanation of how to interpret data when there is more than one rider.

TURNAROUND POINTS

No runner turns instantaneously, spinning on the foot like a ballet dancer. 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 22/7 = 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 it can be removed at the same turnaround by bringing the centre of the turning circle back by half of the distance added (in this case, 3.61m).

Note that when designing walks courses, typically 2km in length, they 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 wherever possible have a 5m turnaround radius (walking path = 5.3m x pi, or 16.65m)

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.

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 big disadvantage in using a solid tyre is that it is sensitive to variations in the road surface. See below: '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). The following precautions can be taken to minimise the variation of the constant:

1. 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'***).

2. Make measurements in stable seasons. Spring and autumn have less daily temperature variation than high summer.

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

4. Measure at a time of day when temperature has stabilised. 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.

5. Avoid alternating wet and dry conditions. Wind-assisted evaporation from a damp tyre will lower its temperature by several degrees.

6. Use a thin tyre. Many such tyres have a smaller temperature coefficient than the fat chunky tyres found on mountain bikes. But temperature coefficient is not just dependent on the thickness of the tyre. Different makes of tyre, even if they have the same dimensions, can vary markedly in their response to temperature.

7. Use a solid tyre. Nearly all solid tyres have lower temperature coefficients than pneumatic tyres (but see below: 'RESPONSE TO SURFACE VARIATION')

8. Make a record of temperature changes at calibration and during the measurement, and use this to help judge the effects on the calibration constant. It is the temperature of the rotating tyre that is of interest, but this is difficult to measure. The air temperature measured with a shaded thermometer is likely to be reasonably representative of the tyre temperature. A shaded thermometer, exposed to the air flow, that can be read while riding is best. Digital aquarium thermometers are cheap and effective. On sunny days, when the surface temperature is much higher than the air temperature, avoid taking the temperature when the bicycle is stationary and in direct sunlight.

   Recording temperatures regularly during a measurement (say every 5km, or every 30 minutes) will help you to identify how the calibration constant may be changing. This is useful information, especially if you cannot re-calibrate during the measurement. Likewise, make a note of when it starts to rain or which sections of the road are wet. This information may help to resolve any doubt about what constant should be used in calculating course length.

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.

Conversely, calibrating on a smooth calibration course with a solid tyre and then measuring on roughly-surfaced roads may well yield a short road race course. Solid tyres have a larger constant on rougher surfaces. A thick pneumatic tyre with a very chunky tread could have either a smaller or larger constant depending on the geometry of the tyre and the size of protrusions in the road surface.

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 and this is one reason why they cannot be measured as accurately as road courses. Solid tyres and thin pneumatic tyres give larger variations than thicker pneumatic tyres. If possible, avoid surface variations by locating the calibration course on the actual road race surface. If it is not possible to do this, or if the road race surface itself varies significantly along the route, the measurer would be best advised to avoid solid tyres or very thin pneumatic tyres despite the undoubted advantages these have in respect of temperature stability.

When measuring on off-road surfaces the calibration constant will change. It is acceptable to ignore this only for very short sections. For longer sections, use a tape measure or lay out a calibration course on the off-road surface. Then calibrate the bicycle on it and use the resulting constant to calculate the distance measured.

Remember that off-road surfaces may be as different from each other as they are to a paved surface. You may need a different calibration course for each type of surface. Generally, off-road surfaces and accurate measurement do not fit well together. Off-road surface variations are too great to allow measurement to the same known degree of accuracy that applies for road race courses.

CONCLUSION

When there is little variation in surface texture along the road race course, and in comparison to the calibration course, it may be best to use a solid tyre. If surfaces are uniformly rough this will mean an uncomfortable, jarring ride.

When there is likely to be little temperature variation a normal pneumatic touring tyre may perform best.

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 listed above ('RESPONSE TO TEMPERATURE CHANGE') to minimize, when possible, the effects of temperature variation on the calibration constant.

Multiple calibrations

On a marathon course comprising two laps, a calibration course located near the start and finish will also allow a convenient mid-measurement calibration. A mid-measurement calibration will safeguard your first-half measurement and allow you to use two constants in the calculation of course length: one for the first half, and one for the second half. This will lessen change in the constant between calibrations.

There may be suitable locations along the road race course where calibration courses could be set up. If this is done, they will have different surfaces which will give different calibration constants. See above: 'RESPONSE TO SURFACE VARIATION'. If the calibration surface is not typical of the road race course as a whole then calibrating on it could distort the measurement.

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%

Appendix 3

EXAMPLE OF A COURSE MEASUREMENT

Course survey

Jack and Jill have been engaged to measure a city based marathon course. They arrive in the city on a Saturday morning, with the intention of measuring the marathon course early on Sunday morning when the volume of traffic is low and police assistance is available.

The marathon course is a large loop, with an out-and-back section from approximately the 37 to 40km marks. The start/finish line is fixed so any adjustment to the length will be made at the turnaround point on the out-and-back section. The course director has completed a rough measurement of the course by car.

Around noon on Saturday Jack and Jill survey 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. Jack and Jill make notes as they go, which will help them during their measurement and also when drawing the official measurement map.

Except for the out-and-back section, the runners will have the full use of the road wherever there is no divider. Where there is a divider, runners will run in the right-hand carriageway. Along the out-and-back section the centre line will be coned and runners will go out on the right-hand side of the traffic cones and return on the other side. The turnaround point will be around a single marker.

Where runners turn from the right-hand carriageway on a divided road into the right-hand carriageway of another divided road, the measurement line follows the arc taken by traffic, which is defined by broken white lines. These lines will be coned on race day.

Jack and Jill note that approximately the first 3km of the course are against the traffic flow on a very busy one-way street. They decide that this section must be measured with the flow of traffic. They choose an appropriate starting point (point C) to start Sunday's measurement. They agree to ride from point C back to the start line, and then return to point C to ride to the finish line.

Jack and Jill also note a side street close to the start/finish line which appears suitable for a calibration course. At the completion of the course survey, they inspect this potential calibration course. It is straight, flat and the surface is similar to the marathon course. It has no parked cars and they 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 400m calibration course will fit.

Setting up and measuring the calibration course

Jack and Jill, with help from the course director, decide to measure the calibration course on Saturday afternoon to allow an early start to the bicycle calibration and course measurement on Sunday morning.

They have a 50m steel tape which is marked as accurate at 20C with 50 Newtons of tension. They will need to lay out eight lengths of this tape for the 400m calibration course planned.

The calibration course is in Sunshine Road. There is a numbered light pole just south of the intersection of Sunshine Road with Pleasant Avenue. This will make a good reference point. Jill drives a PK nail into the road, one metre west of the eastern edge of Sunshine Road and in line with the mid-point of light pole #64920. The light pole is located in front of #22 Sunshine Road. This will be the permanent northern endpoint of the calibration course (point A).

Jack lays the thermometer on the roadway, 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 16C. Jill records the start time and temperature.

Jack holds the 50m mark of the tape over the PK nail at point A. Jill takes hold of the 'zero' end and extends the tape southward to its full extension of 50m. Jill uses the zero end because that is the end with a ring to which she attaches a spring balance. Jill and Jack jiggle the tape as needed until it lies straight and flat, and Jill checks that her end is still one metre from the kerb. Then Jill pulls on the spring balance until it reaches 50 Newtons-force, moving the tape slowly forward.

Meanwhile, the course director has stuck a piece of masking tape on the roadway at Jill's end of the tape. When Jill has the tape under steady tension and Jack signals that his end is over the mark, the course director draws a thin black mark on the masking tape alongside the zero mark of the measuring tape. Jill then numbers the piece of masking tape with a '1' to indicate that this is the first tape length. Jack and Jill continue in this manner until they have marked eight 50m sections.

The point marked on the final piece of masking tape (point B) is now provisionally 400m south of point A. Jack and Jill now start measuring back (northward), using a new start point which is exactly one metre north of point B. This creates a new set of taped marks, separate from the previous set of marks. Note that Jack and Jill had to turn the tape around at point B since only the zero end has a ring to which Jill can attach the spring balance.

Jack and Jill lay out only seven full tape lengths of 50m. They measure the eighth tape length to the PK nail at point A. This is 48.95m. This means that according to their second measurement the distance between the permanently marked point A and temporary point B is 5cm shorter than 400m. Jack repeats the temperature reading as before and finds it to be 14C. Jill records this reading, along with the time of the day.

Jack and Jill calculate the average length of the two measurements and determine that the course, without any adjustment for temperature, is 399.975m. It is acceptable practice simply to move point B 2.5cm to the south and determine that the length of the calibration course is 400m.

Jack and Jill are experienced measurers. They decide 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:

(i) Jack and Jill 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 400m course. As the course is 399.975m, Jack and Jill would add 2.5cm to bring the course up to 400m, and then add another 2cm for the temperature adjustment. That is, they would move point B 4.5cm south.

(ii) Jack and Jill can use the Temperature Correction Formula (also shown in Appendix 1).

Corrected average length
= average length [1 + (average temp – 20) x 0.0000116]
= 399.975[1 + (15 – 20) x 0.0000116]
= 399.95m

Using this formula, Jack and Jill would move point B 5cm 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 400m.

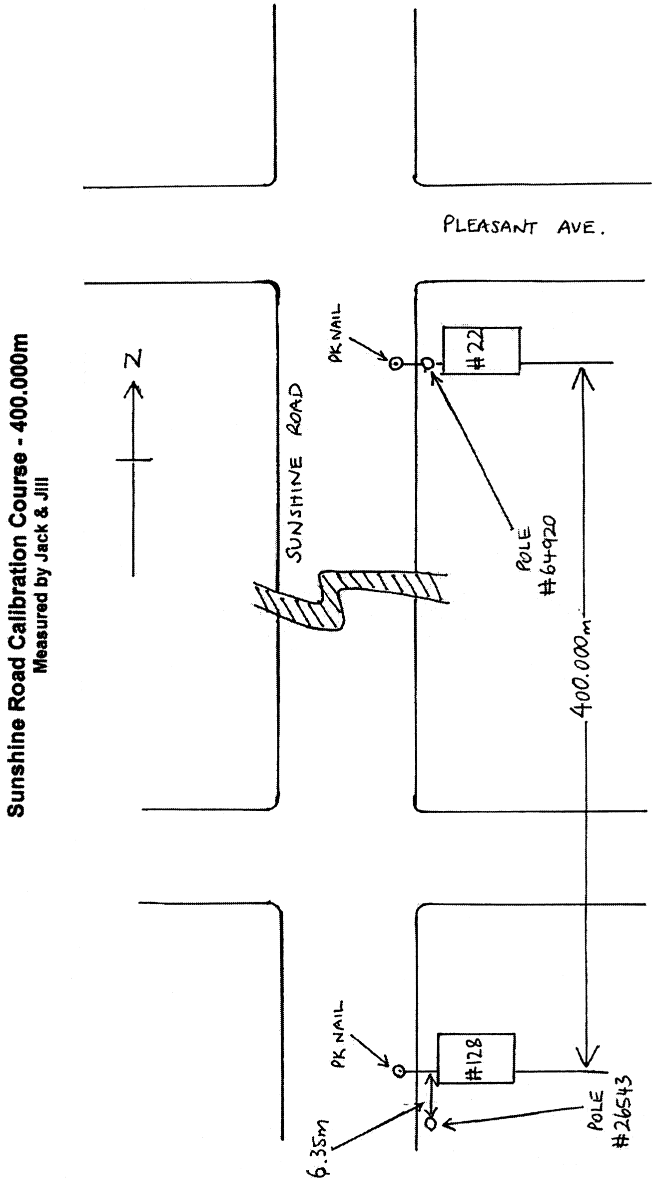
Using the tape measure once more, Jack and Jill find that the corrected point B is 6.35m north of pole number 26543. This light pole is located in front of #128 Sunshine Road. They are now almost finished but, before permanently marking point B, they check to make sure they haven't missed a whole tape length somehow.

Attaching the Jones/Oerth counter to his bicycle, Jack rides it around for a few minutes to warm up the tyres. He places the front axle over the northern endpoint (point A) and records a count of 52546. He then rides southward one 50m tape length and stops with the front axle over the mark. He records a count of 53021. The difference, corresponding to one 50m length, is 475 counts.

Jack now returns to the northern endpoint (point A) and, pointing the bike southward again, notes a counter reading of 53600 with the front axle over the mark. He rides the bicycle over the full calibration course, stopping with the front axle over the corrected southern endpoint. He records a count of 57403. The difference is 3803 counts. Dividing the full course count of 3803 by the 50m count of 475 yields a course length of 8.006 tape lengths. For such a rough check this is in excellent agreement with the intended course length of eight tape lengths.

Finally, Jill puts a PK nail at the corrected endpoint (point B) of the 400m course. They thank the course director and arrange to meet him at 05.00 the following morning to calibrate their bicycles, before moving to point C on the marathon course to meet the police at 06.00. They head back to their 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 5.

At the hotel Jill attaches the Jones/Oerth counter to her bike and both Jack and Jill prepare their equipment for the 05.00 start on Sunday. Jack uses a five digit counter while Jill uses a six digit version.



Calibrating the bicycle

Obtaining a Working Constant

Jack and Jill arrive at the calibration course at 04.45. They unload their bicycles and ride around for several minutes to warm up the tyres. Before beginning their calibration rides at the northern end of the calibration course, they note that the temperature is 12°C. They will make four rides - two in each direction. They each set their counter to a convenient starting number and record it.

They start with this recorded count and ride to the other end of the calibration course. There they stop, and record the count again. They lock the wheel with the brake, turn the bike around, and set it down exactly on the mark at which they stopped. They ride back to where they started and record the count again. They repeat this operation until they have made four rides.

Now they are back where they started, and have five recorded numbers. Jack and Jill obtain calibration values as follows:

	Jack	***Jack***	***Jill***	***Jill***
	Recorded count	*Elapsed count*	*Recorded count*	*Elapsed count*
Start count	58700		209400	
End 1st ride	62502	3802	213910	4510
End 2nd ride	66302	3800	218419	4509
End 3rd ride	70103	3801	222930	4511
End 4th ride	73905	3802	227440	4510

Jack and Jill now each calculate the working constant applicable to their bicycle. They will use these working constants to establish a provisional marathon course.

Average counts for 400m =	3801.25	4510
Counts for one kilometre =	9503.125	11275
Counts/km with 1.001 SCPF =	9512.628	11286.275
Working constant =	9512.628	11286.275

Measuring the marathon course

Jack and Jill go to point C of the marathon course, where they meet the police who are to assist with a safe ride. Again they note the temperature which is unchanged at 12°C. They look at their Jones/Oerth counters and rotate their wheels until the counter reaches a number they would like to use as a starting count. They record these counts, place the axle of their front wheel over point C, and then ride along the shortest route to the start line. They stop at the start line and record their counter reading.

	Jack	***Jill***
Point C	77300	231600
Start	(1)06914	266758

Jack and Jill then return to point C, riding on a safe route. At this point, Jack notes that the elapsed counts from point C to the start were 29614. Using the working constant, Jack calculates the number of counts to cover the remainder of the first 5km [(9512.628 x 5) – 29614] = 17949. He adds this to the new point C starting count (37300) to determine the counter reading at the provisional 5km point.

Jack then calculates the number of counts to determine the remaining provisional 5km marks, and the half and full marathon marks. This gives him a list of the rough count for each split point, as in the following table.

Point C	37300
5km	55249
10km	(1)02812
15km	(1)50375
20km	(1)97938
Half	(2)08379
25km	(2)45502
30km	(2)93065
35km	(3)40628
40km	(3)88191
Finish	(4)09072

Although only one measurement is required by the IAAF and AIMS, a second measurement serves as a check against mistakes. The second rider, in this case Jill, should stop at the ***same*** points laid down by the first rider and note his/her counter reading at these points. The second rider does not need to calculate his/her own split points.

Jill notes that her starting count at point C is 302400. Jack and Jill now ride along the course from point C towards the finish, stopping at those points where Jack's counter reading matches each of the successive pre-calculated counts on his list. They turn at a pre-determined turnaround point established by the course director during his rough measurement. They make a mark with a crayon on the road at each place they stop and record a precise description of the location of the mark for later documentation. Jill records her counter reading at each place where they stop.

When they reach the finish line, they note their counter readings and the temperature, which is now 16°C. Jack's counter reading is (4)00621. Jill's readings at each place where they stopped are recorded in the following table.

Point C	231600
Start	266758
Point C	302400
5km	323687
10km	380118
15km	436550
20km	492982
Half marathon	505370
25km	549419
30km	605850
35km	662282
40km	718716
Finish	733447

Re-calibrating the bicycle on the calibration course

Obtaining a Finish Constant

Jack and Jill return to the calibration course to recalibrate their bicycles, and determine the finish constant. The temperature remains at 16°C.

	Jack	***Jack***	***Jill***	***Jill***
	Recorded count	*Elapsed count*	*Recorded count*	*Elapsed count*
Start count	10500		735300	
End 1st ride	14298	3798	739807	4507
End 2nd ride	18097	3799	744313	4506
End 3rd ride	21896	3799	748819	4506
End 4th ride	25696	3800	753326	4507

Average counts for 400m =	3799	4506.5
Counts for one kilometre =	9497.5	11266.25
Counts/km with 1.001 SCPF =	9506.998	11277.516
Finish constant =	9506.998	11277.516

Calculating the Constant for the Day

Use the *average* of the working and finish constants	9509.813 (counts/km)	11281.895

Calculating the length of the marathon course

Jack and Jill now calculate the length of the course as measured. They calculate the length by dividing the number of counts elapsed while riding the whole course by the Constant for the Day. That is:

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

Jack's distance =
[(106914 – 77300) + (400621 – 37300)]/9509.813 = 41.3189km

Jill's distance =
[(266758 – 231600) + (733447 – 302400)]/11281.895 = 41.3232km

The official length of the course prior to adjustment is 41.3189km, since it is the lower figure.

Length of course before final adjustment	=	41318.9m
Desired length of course	=	42195.0m

Final Adjustment : (42195.0 – 41318.9)m = ***Add*** 876.1m to course

Jack and Jill also calculate the distance at each provisional 5km point and the half marathon point, using the Constant for the Day.

Jill (Constant for the Day = 11281.895)

Point	Reading	Cumulative Counts	Cumulative Distance (m)
Point C	231600		
Start	266758	35158	3116.3
Point C	302400		
5km	323687	56445	5003.1
10km	380118	112876	10005.0
15km	436550	169308	15007.0
20km	492982	225740	20009.0
Half	505370	238128	21107.1
25km	549419	282177	25011.4
30km	605850	338608	30013.4
35km	662282	395040	35015.4
40km	718716	451474	40017.5
Finish	733447	466205	41323.2

Jack (Constant for the Day = 9509.813)

Point	Reading	Cumulative Counts	Cumulative Distance (m)
Point C	77300		
Start	(1)06914	29614	3114.0
Point C	37300		
5km	55249	47563	5001.4
10km	(1)02812	95126	10002.9
15km	(1)50375	142689	15004.4
20km	(1)97938	190252	20005.8
Half	(2)08379	200693	21103.7
25km	(2)45502	237816	25007.4
30km	(2)93065	285379	30008.9
35km	(3)40628	332942	35010.3
40km	(3)88191	380505	40011.8
Finish	(4)00621	392935	41318.9

Adjusting the length of the marathon course

The turnaround, half marathon point and each 5km mark must be adjusted. As the turnaround must be adjusted by 876.1m divided by 2 = 438.05m, it will be more convenient to make the adjustment using calibrated bicycles. Adjustment by tape measure would have been the other option.

Jack and Jill also decide that, because of the significant extension to the turnaround which falls between the 37 and 40km marks, they will also adjust the 40km point using their bicycles.

Jack and Jill post-calibrated their bicycles only one hour earlier, so they use their finish constants as working constants for these adjustments. That is, the post-calibration for the course length measurement becomes the pre-calibration for the adjustments.

Using the new working constant, Jack calculates that he must make the following adjustments:

Turnaround:	extend by 438.05m	= 9506.998 x 0.43805 = 4165 counts
40km:	reduce by 876.1m	= 9506.998 x 0.8761 = 8329 counts

Jill makes no calculations as she will simply note her counts at each stopping point, just as she did during the measurement of the course.

Jack and Jill transport their bicycles to the provisional turnaround point. They check their counters and note the readings. Jack adds the additional counts required to extend the course - 31200 + 4165 = 35365. Jill notes that her counter reading at the provisional turn point is 760200.

Jack and Jill ride from this first provisional turnaround point, taking the shortest route along the westbound carriageway, which is the route taken by the runners. When Jack's counter reads 35365, they mark a second provisional turn point. Jill notes her counter reading at this point – 765148. They ride back to the first provisional turn point, using the east bound carriageway. Again, this is the route taken by the runners. Jack and Jill note their counter readings again – Jack = 39547 and Jill = 770080.

Jack and Jill now ride to the 40km mark and Jack rides back along the course for 8329 counts. Jill notes her counter reading at the first provisional 40km mark (959400) and the second provisional mark (969285).

Jack and Jill must now post-calibrate their bicycles so that they can calculate another Constant for the Day. This constant will be used to make the final adjustment to the second provisional turnaround and 40km points. Jack and Jill return to the calibration course to recalibrate their bicycles, and determine a new finish constant. The temperature has risen to 18°C.

	Jack	***Jack***	***Jill***	***Jill***
	Recorded count	*Elapsed count*	*Recorded count*	*Elapsed count*
Start count	47800		981200	
End 1st ride	51597	3797	985706	4506
End 2nd ride	55396	3799	990210	4504
End 3rd ride	59193	3797	994716	4506
End 4th ride	62991	3798	999221	4505

Average counts for 400m = 3797.75 4505.25
Counts for one kilometre = 9494.375 11263.125
Counts/km with 1.001 SCPF = 9503.869 11274.388
Finish constant = 9503.869 11274.388
Working constant = 9506.998 11277.516
Constant for the Day = 9505.434 11275.952

Final calculation of adjustment to turnaround and 40km points

Turnaround point

Jack added (39547 - 31200)/9505.434 = 878.1m
Jill added (770080 - 760200/11275.952 = 876.2m

The correct adjustment was 876.1m. Taking the lowest of the adjusted measurements, the second provisional turnaround point needs to be adjusted by (876.2 – 876.1) = 0.1m. The turnaround point can be shortened by half of 0.1m = 0.05m. Jack and Jill could make this adjustment using their tape measure but, in this case, it is an insignificant adjustment. They confirm the second provisional turnaround as accurate.

40km point

Jack deleted (55429 – 47100)/9505.434 = 876.2m
Jill deleted (969285 – 959400)/11275.952 = 876.6m

The correct adjustment was actually (876.1m + 11.8m) = 887.9m. The 11.8m adjustment is required because the first provisional 40km point was actually measured at 40011.8m. This means the second provisional 40km point can be shortened by (887.9 – 876.2)m = 11.7m.

Adjustments for all splits

At the split points from 5km to 35km, the provisional marks made by Jack and Jill during their measurement must be adjusted. In each case, the lowest measurement at each point is taken as the official measurement.

	Jack	Jill	Shortest	Adjustment
5km	5001.4	5003.1	5001.4	Less 1.4m
10km	10002.9	10005.0	10002.9	Less 2.9m
15km	15004.4	15007.0	15004.4	Less 4.4m
20km	20005.8	20009.0	20005.8	Less 5.8m
Half	21103.7	21107.1	21103.7	Less 6.2m
25km	25007.4	25011.4	25007.4	Less 7.4m
30km	30008.9	30013.4	30008.9	Less 8.9m
35km	35010.3	35015.4	35010.3	Less 10.3m

Jack and Jill adjust these points using their measuring tape and document the location of each point, as follows.

Start/Finish	Flat Rd, in line with pole #64288 at eastern end of Princess Park.
5km	7.7m before Pole #64032. Outside #59 First Ave.
10km	1.2m after Pole #64111. Outside Rebel Sports store in Prince St.
15km	Poplar St, 16.5m past eastern edge of Spring St.
20km	Cowper Rd, 20.7m before pedestrian crossing.
Half	Opposite letterbox to house #24 Fern St
25km	9.7m after Pole #64776. Outside #136 Lakeview Dr.
30km	Middle of driveway to house #45 Pine Ave.
35km	12.1m past Pole #64321. Outside #77 Sunset Rd.
Turn	27.7m before Pole #64787. Outside #524 Pacific Blvd.
40km	17.4m past ‘No Parking’ sign, outside ‘The Bakery’ in Port Rd.

Jack and Jill have now finished their on-course adjustments. They retire to their hotel to complete the appropriate forms and draw the course map.

Appendix 4

EXAMPLES OF COURSE MAPS

One of the most valuable results of your documentation will be your course map. It should document exactly how the course is laid out and where the crucial start, finish, and turn-around points are located.

The following course maps show various ways in which they may be drawn.

1) ***real,-*** *BERLIN-MARATHON* – This map indicates the roads by a single unbroken line. This style of map may only be used when runners have full use of the roads or carriageways everywhere along the course, and unrestricted turns. This is noted on the map.

The precise start and finish lines are also highlighted with specific references to fixed objects.

Also included on this map is a course profile which indicates the course elevation. The elevation at the start and finish is important information, allowing an observer of the map to clearly see whether this marathon meets the 'drop' guidelines in Note 4 to Rule 240.3 in *The IAAF Competition Rules*.

Although not specifically noted on the map, it can be clearly seen that the course also meets the 50 per cent separation rule outlined in the Note of Rule 240.2.

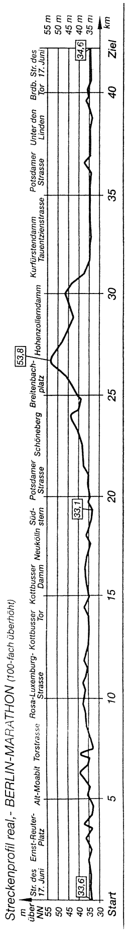
Observing these rules is not mandatory (unless the race director is aiming for a Road World Record on his course or the race is used as a qualification race for Championships). The 1m/km drop and 50% separation criteria are designed to limit the 'assistance' to the athlete which may arise from gravity (topography) and wind (orientation).

2) Flora London Marathon – This map indicates the measurement line on the full length of the course. This style of map allows the measurer to indicate those areas where participants do not have use of the full width of the road.

This map also documents the measured length of various sections of the course which makes future partial adjustments of the course possible.

3) Bermuda 10K – This map also indicates the measurement line on the full length of the course. The start and finish points are accurately referenced to permanent landmarks, as are each of the mile points. Road restrictions are listed separately. The elevations at the start and finish, as well as the highest and lowest points on the course, are listed.

4) Gold Coast Marathon – This map also indicates the measurement line on the full length of the course. The start, finish and turnaround points are accurately referenced to permanent landmarks. Key intersection and turns are enlarged to show clearly the line available to participants.



FINISH DETAIL

(Soviet War Memorial)

Entire width of roads are available to runners, or half-width if divided

SCC running

real,- 30. BERLIN MARATHON

28. September 2003

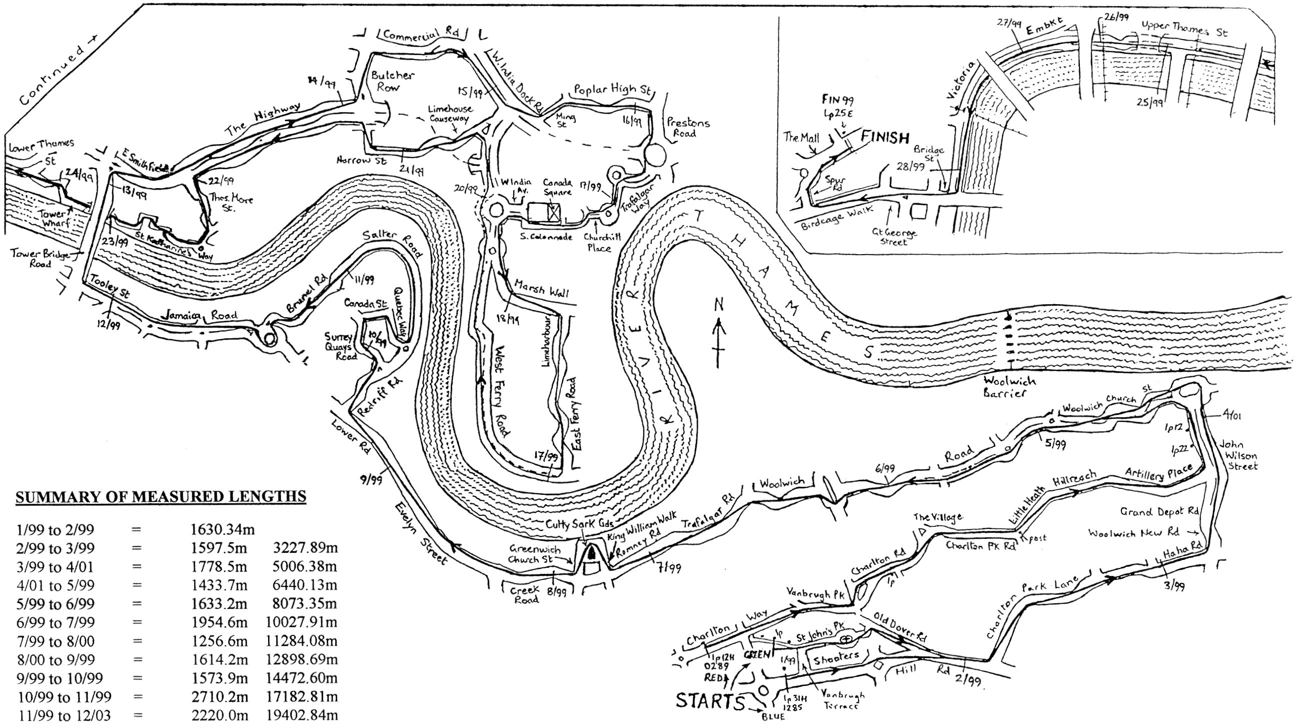
1-42 km

N

- Streckenplan -

- course map -

- itinéraire -



SUMMARY OF MEASURED LENGTHS

1/99 to 2/99	=	1630.34m	
2/99 to 3/99	=	1597.5m	3227.89m
3/99 to 4/01	=	1778.5m	5006.38m
4/01 to 5/99	=	1433.7m	6440.13m
5/99 to 6/99	=	1633.2m	8073.35m
6/99 to 7/99	=	1954.6m	10027.91m
7/99 to 8/00	=	1256.6m	11284.08m
8/00 to 9/99	=	1614.2m	12898.69m
9/99 to 10/99	=	1573.9m	14472.60m
10/99 to 11/99	=	2710.2m	17182.81m
11/99 to 12/03	=	2220.0m	19402.84m
12/03 to 13/99	=	1009.2m	20412.01m
13/99 to 14/99	=	2188.4m	22600.38m
14/99 to 15/99	=	1425.1m	24025.45m
15/99 to 16/99	=	1007.7m	25033.13m
16/99 to 17/99	=	848.5m	25881.66m
17/99 to 18/99	=	1487.0m	27368.65m
18/99 to 19/99	=	2208.9m	29577.58m
19/99 to 20/99	=	2611.6m	32189.19m
20/99 to 21/99	=	958.8m	33148.00m
21/99 to 22/99	=	2379.1m	35527.07m
22/99 to 23/99	=	958.4m	36485.46m

23/99 to 24/99	=	383.0m	36868.46m
24/99 to 25/99	=	1062.0m	37930.44m
25/99 to 26/99	=	676.4m	38606.87m
26/99 to 27/99	=	859.4m	39466.23m
27/99 to 28/99	=	1184.2m	40650.45m
28/99 to FIN99	=	1545.0m	42195.41m

FINISH POSITION 1m BEFORE FIN99

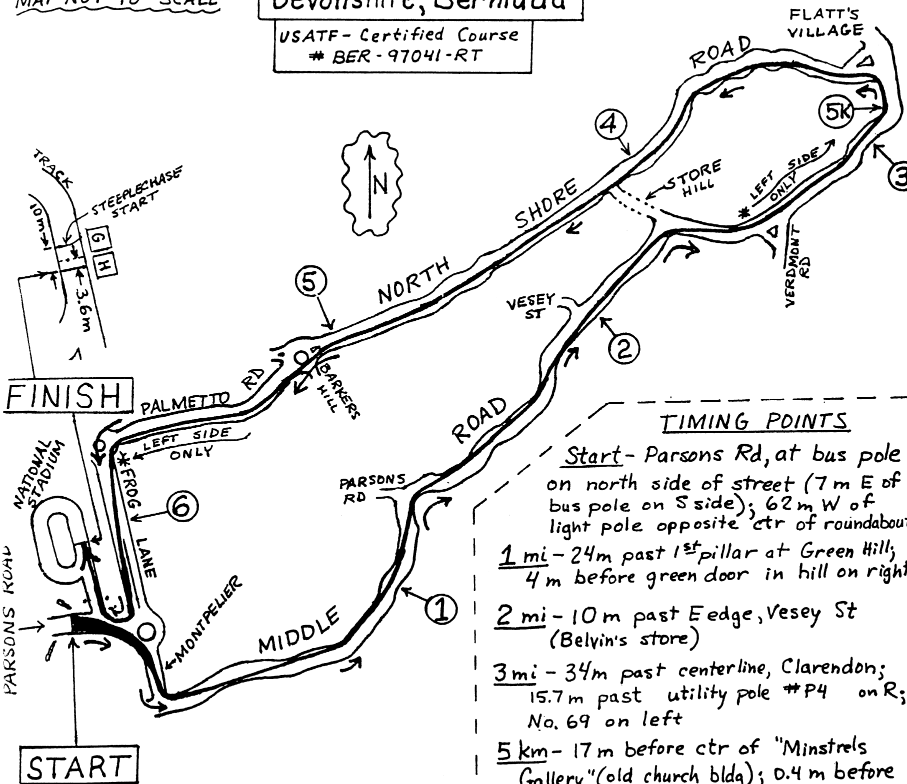
COURSE FROM REF 1/99 TO FIXED (2003) FINISH = 42194.41m

STARTLINE POSITION IS 0.59m WEST OF REF 1/99 (lp31H1285)

FLORA LONDON MARATHON
13 APRIL 2003

BERMUDA 10K
Devonshire, Bermuda

USATF-Certified Course
BER-97041-RT



TIMING POINTS

Start - Parsons Rd, at bus pole on north side of street (7 m E of bus pole on S side); 62 m W of light pole opposite ctr of roundabout

1 mi - 24m past 1st pillar at Green Hill; 4 m before green door in hill on right

2 mi - 10 m past E edge, Vesey St (Belvin's store)

3 mi - 34m past centerline, Clarendon; 15.7 m past utility pole #P4 on R; No. 69 on left

5 km - 17 m before ctr of "Minstrels Gallery" (old church bldg); 0.4 m before utility pole #P404 on right

4 mi - 1.5m past U.P. #W23 on R; 1.5 m past steps to olive house on left

5 mi - 24 m before nose of divider island before Palmetto/Barkers Hill roundabout

6 mi - 7.4 m before 1st pillar at GATE 2 (brick sidewalk begins at 1st pillar)

Finish - On track, 10 m before start of steeplechase; 3.6m before point even with aisle between sections G, H

RFT

ROAD RESTRICTIONS

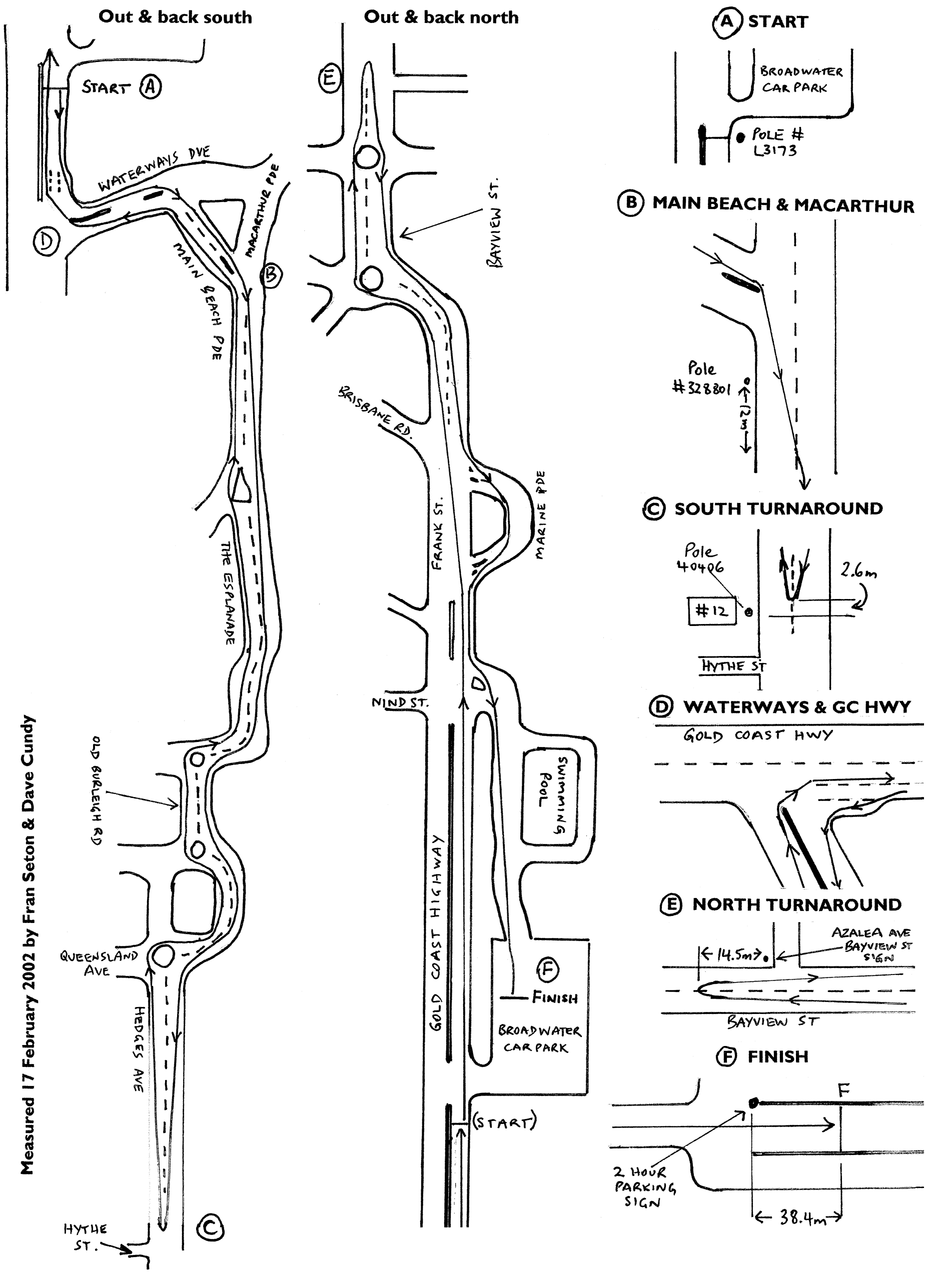
1. Start to Verdmont Rd (1st "leg" of Verdmont): no restriction
2. Verdmont (1st "leg") to Frog Lane: left side only
3. Frog Lane to finish: no restriction (direct runners to R side of median)

Elevations

St, Fin: 37m High: 47m Low: 1.8m

Measured, 13 & 15 December, 1997 by R Thurston

Australia's Gold Coast Marathon



Measured 17 February 2002 by Fran Seton & Dave Cundy

Appendix 5

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.

APPLICATION FOR CERTIFICATION OF A ROAD COURSE

Name of event: ____

Advertised race distance: ________________ Race date: ______________

Race director: ____

Address: ____

Phone: ____________ Fax: ____________ Email: ____________________

Name of measurement team leader: ______________________________

Address: ____

Phone: ____________ Fax: ____________ Email: ____________________

Location of start: ____

Location of finish: ____

Type of terrain (please tick): Flat Undulating Hilly

Type of course (please tick): Loop Out & back Point to point Other

Altitude (in metres above sea level): Start _________ Finish __________

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

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?

____

____

____

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?

____

____

____

OVERVIEW OF THE MEASUREMENT PROCEDURE

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

DETAIL OF THE CALIBRATION COURSE

1. Name of event: ______________________________
2 City/town: ______________________________
3 Location of calibration course: ______________________________
4 Length of calibration course: ______________________________
5 Date(s) measured: ______________________________
6 Method used to measure calibration course: ______________
7 How many times did you measure the calibration course? ________
8 Measurement team leader: ______________________________
9 Address of team leader: ______________________________
10 Phone contact of team leader: ______________________________
11 Email address of team leader: ______________________________
12 List names and duties of team members: ______________

____

13 Is the calibration course: STRAIGHT? ________ PAVED? ________
14 How are the start and finish points marked? ______________
15. Are the start and finish points located in the road where a bicycle wheel can touch them, or elsewhere?

____

16. 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 ______________________

17. 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.

STEEL TAPING DATA SHEET
For measuring a calibration course

Name of calibration course: ____________________

City/town and State: ____________________

Date: ____________________

Start time: ____________ Finish time: ____________

Pavement 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 pavement 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 =
   NOTE: For temperatures below 20C, factor is less than one
   For temperatures above 20C, 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 one kilometre. 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____________

BICYCLE CALIBRATION DATA SHEET

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 =

COURSE MEASUREMENT DATA SHEET

Name of event: ____

Name of measurer: ____

Date of measurement: ____

Start time: ____________ Temperature: ____________

Finish time: ____________ Temperature: ____________

Constant for the Day: ____________ counts/km

MEASUREMENT DATA

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

Desired length of course: ____________

Length of course as measured: ____________

Note any adjustments made to the course after measurement: ____________

____

____

Appendix 6

MEASURING EQUIPMENT

Bicycle – 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.

Jones/Oerth counter - available from: Paul Oerth, 2455 Union Street, #412, San Francisco, CA 94123, USA. Email: Poerth@aol.com and Laurent Lacroix, 131 Sunnyside Blvd, Winnipeg, Manitoba R3J 3M1, Canada. E-mail: llacroix@mb.sympatico.ca

Steel tape – either 30m, 50m or 100m versions are available. The tape is needed for measuring calibration courses and final adjustment of course length, as well as measuring distances from permanent landmarks to points the measurer wishes to define. A steel tape may be coated with nylon to protect the figures and gradations. It will indicate temperature and tension specifications on the blade, near to the zero point.

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.

Spring balance – needed to ensure that the steel tape is under the correct tension when laying out calibration courses. Once the 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 small pocket calculator is essential for determining the counts needed for specific splits. Make sure that your calculator will keep adding the last number keyed in (e.g. the working constant) every time you press the '=' sign. Avoid solar powered calculators as measurement is often done in the early morning, when it may still be dark.

Notebook, pens, pencils etc. – a small notebook will fit into a pocket in bad weather. More than one pencil or pen is essential. Some outdoor equipment shops sell paper which can be written on even when wet.

Crayon or chalk – useful for making temporary marks on the road.

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 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 are 'PK' nails (Parker-Kalon Nails, of Campbellsville, Kentucky 42718, USA) or 'Magnails' (made by ChrisNik Inc. in Cincinnati, Ohio, USA).

Masking tape – 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.

Torch – if measuring at night, it will be extremely difficult to read the Jones/Oerth counter without a torch.

Bike tools – as many as will keep you on the road and riding safely. Consider: spanner (needed to fix the Jones/Oerth counter to the wheel), pump and adapters, tyre levers, spare inner tube, Allen keys, pliers and steel wire.

Safety equipment – a reflective vest or jacket is essential. In some countries a cycle helmet is required by law, and is in any case highly advisable. Front and rear bike lights will be required for night riding. A reflective hazard warning triangle will be useful when laying out calibration courses.

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 a chocolate bar or two and some juice.

Bum bag – will allow quick access to equipment used while measuring which may not fit into your pockets.

Appendix 7

THE IAAF/AIMS MEASUREMENT SYSTEM

INTERNATIONAL MEASUREMENT ADMINISTRATORS

The IAAF and AIMS recognise four 'International Measurement Administrators', each responsible for the administration of measurement matters in one of the following geographical areas. The current Administrators are:

- Jean-François Delasalle - French- & Spanish-speaking Europe and Africa: Telephone: +33 3 2248 5190; Fax: +33 3 2248 5191; E-mail: chrchspic@club-internet.fr
- John I. Disley - English-speaking Europe and Africa: Telephone: + 44 208 979 1707; Fax: +44 208 941 1867; E-mail: johnapdisley@aol.om
- Dave Cundy - Asia & Oceania: Telephone: + 61 2 4342 7611; Fax: + 61 2 4342 7648; E-mail: cundysm@ozemail.com.au
- Bernie Conway - The Americas: Telephone: + 1 519 641 6889; Fax: + 1 519 633 4887; E-mail: measurer@rogers.com

The measurement administrators:

- may appoint measurers for road race courses within their areas, particularly those races in the IAAF and AIMS Calendars
- should be closely involved in course measurement seminars held in their areas
- recommend re-grading of course measurers as detailed below.

The AIMS Technical Director may also appoint measurers for AIMS member races. Currently, the AIMS Technical Director is:

> Gordon Rogers: Telephone: + 1 604 733 6224; Fax: + 1 604 733 6221; E-mail: gordonrogers@attglobal.net

GRADES OF MEASURERS

IAAF and AIMS recognise three grades of course measurers as competent to measure the following types of courses:

C local courses, including National Championship courses, but no races in the AIMS/IAAF calendars

B as above, plus Area Championship races and races in the AIMS/IAAF calendars

A as above, plus World Championships, Cup and Olympic Games' courses (run under IAAF Rule 1.1(a), (b) and (c))

APPOINTMENT OF MEASURERS

IAAF Member Federations or IAAF/AIMS competition organisers wishing to have courses measured by any other than a local 'C' measurer – and this is necessary if the race is to be included in the AIMS/IAAF calendars – should contact the appropriate International Measurement Administrator, who will appoint a course measurer (see Appendix 8). However, you may wish to contact the IAAF or the AIMS Technical Chairman (Gordon Rogers) who will refer any requests received to the appropriate International Measurement Administrator. The measurement reports must be sent to the International Measurement Administrator, the IAAF and the AIMS Technical Chairman.

GRADING OF MEASURERS

Grading of measurers is at the discretion of the International Measurement Administrator, who will make recommendations for the approval of the IAAF/AIMS. The basic guidelines for grading measurers are as follows:

C measurers are C graded on successful completion of a bona fide course measurement seminar which was managed by an A grade measurer

B 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 by IAAF/AIMS

A 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 AIMS/IAAF joint calendar. 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 by IAAF/AIMS.

Inactive or inefficient measurers may be downgraded by the International Measurement Administrator or, if they have retired, could be named as Measurer Emeritus in agreement with IAAF/AIMS.

COURSE MEASUREMENT CRITERIA

Courses of all AIMS member events or those races who wish to obtain an IAAF Permit must be measured by an accredited A or B IAAF/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.

Appendix 8

GUIDELINES FOR RACE DIRECTORS SEEKING IAAF/AIMS MEASUREMENT OF COURSES

For the attention of the Race Director:

Before seeking a measurement you should have a confirmed route for your course (negotiated with the police and civil authorities as necessary) which you believe to be approximately the correct length. It is best to scale the race distance from large-scale maps, if available. Measurement by a car odometer will most likely be short by 5% or more. You should consider what section of each road will be open for use by the runners on the day of the race. If it is not the entire road width then you must clearly state any restrictions. Include the exact route to be taken at turns. If this cannot be described as "the shortest possible route" you should indicate the precautions that will be taken to prevent corner-cutting.

Even with your attention to these details the measurer may need to adjust your course to obtain the correct distance. To allow for this you should consider in advance where extra distance may be added (or subtracted): at the start, finish, or at any other point along the course.

To arrange for your course measurement (after settling the above points) contact either the International Measurement Administrator for your area (see Appendix 7) or:

For AIMS races:	AIMS Technical Director (currently Gordon Rogers) PO Box 2931 Vancouver British Columbia V6H 1EI Canada
For IAAF races:	IAAF (Sue Richardson) 17 rue Princesse Florestine BP 359 – MC 98007 Monte Carlo Tel: +377 93 10 88 88 Fax: +377 93 15 95 15

They will refer your enquiry to the International Measurement Administrator responsible for your area.

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. The measurers are listed as 'A' or 'B'. 'A' measurers are required for Olympic or World Championship measurements but all those listed will be competent to measure your course.

You should fix a date with the measurer and undertake to provide travel, accommodation and subsistence costs, and a minimum daily allowance for those days spent on the measurement and travelling (US$75 per day at time of printing).

see checklist below, item 1

Courses are measured using a "Jones counter" mounted on the front wheel of a bicycle. For international measurements it is often impossible for measurers to bring their own bicycles – and you will have to provide one. It is best to use a standard road bike (not a racing bike or a mountain bike) with a typical tyre size of 28-630 or 32-622 [*note:* the first figure refers to the width of the tyre (in mm), the second to the diameter of the wheel]. You may also need to provide other items, such as spray paint and a hammer to use for making road markings, as these are prohibited on aircraft.

see checklist below, item 2

Several copies of a detailed map of the course are also essential, along with directions concerning the road width available on race day and a specification of the exact path to be followed at road junctions if this cannot be described as the "shortest possible route" (SPR).

see checklist below, item 3

The measurer will ride the bike along the SPR to obtain a measurement. This will involve taking a direct line from one corner to the next – often cutting diagonally across the road to do so. 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. You should also consider the best time of the day or night at which the measurement can be made, so that there is less traffic on the road. If no police protection can be provided then you should arrange for a vehicle to drive with the measurers, "shielding" them from other traffic. A vital precaution is to allow plenty of time for the measurement, so that the ride is not rushed and risks are not taken.

see checklist below, item 4

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 400-500m 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).

see checklist below, item 5

The measurer will complete a single ride of the course and based upon his/her calculations will certify that the course is not less than the advertised distance "from start to finish". If you wish to have exact splits (kilometres, miles) or any other points marked which may require a second ride over the course then the costs for this extra ride must be agreed upon beforehand.

After the measurement the measurer will send one copy of his/her report to the 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 IAAF/AIMS Certificate of Accuracy. ***The certification remains valid for five years, or until any change is made to the course.***

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.**

Appendix 9

SOURCES OF FURTHER INFORMATION

Web sites

www.aims-association.org

The Association of International Marathons (AIMS) website contains details of over 170 international road races in 65 countries around the world. These details include the course measurement status of each member, and in some instances a copy of the most recent measurement report (accessed through the race directory).

The course measurement section of the website also contains advice for race directors seeking measurement of their courses and an explanation of the IAAF/AIMS course measurement system.

This IAAF measurement handbook, ***Measurement of Road Race Courses***, is available in an online version.

www.rrtc.net

The website of the Road Running Technical Council of USA Track & Field. The RRTC is charged with responsibilities for finish line procedures and measurement of courses in the United States.

Measurement and certification information is available as it applies in the US. Forms required in filing a measurement for course certification may be downloaded. A number of publications and products (including course measurement software) is available either for purchase or freely downloadable.

Course lists can be viewed and downloaded. There is an online version of the US course measurement manual, ***Course Measurement Procedures*** (see "Publications" below) and the six time annual publication ***Measurement News***. There are also a number of articles of historical interest posted.

www.coursemeasurement.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.

www.coursemeasurement.org.uk

This website contains John Jewell's seminal 1961report 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.

www.seaa.org.uk/coursemeasure/index.htm

A website recording measurement activity in the South of England. The site contains course lists, a list of measurers and a Q&A section, and links to other regions of Great Britain, where available.

Email list

MNForum@aol.com

Contributions from any source, relating to course measurement, are collated and circulated to subscribers to the "Measurement News Forum". Subscription is made simply by sending a "subscribe" message to the above address.

Publications

Measurement News

Published in the US six times each year since 1983, Measurement News was, before MNForum (see above), the only means of exchange between measurers. It continues to offer material of interest to both US measurers and those in other countries, concentrating on substantive matters less easily tackled by exchanges on MNForum.

Course Measurement Procedures (TAC USA)

This is the measurement manual for the United States which explains from first principles how anyone can measure a course and document the measurement so that it may be certified and registered with the USATF Road Running Technical Council.

Appendix 10 - Glossary of terms

FRENCH	***ENGLISH***	***SPANISH***
BICYCLETTE	BIKE	BICICLETA
BICYCLETTE CALIBREE	CALIBRATED BICYCLE	BICICLETA CALIBRADA
ROULER EN BICYCLETTE	TO RIDE	CONDUCIR
COMPTEUR JONES	JONES COUNTER	CONTADOR JONES
ETALONNER	TO CALIBRATE	CALIBRAR
ETALONNAGE	CALIBRATION	CALIBRADO
BASE D'ETALONNAGE	CALIBRATION COURSE	RECORRIDO DE CALIBRADO
CONSTANTE D'ETALONNAGE	CONSTANT	CONSTANTE DE CALIBRADO
PULSES, UNITES C.J.	COUNTS	PASOS , NUMEROS
PARCOURS, CIRCUIT	CIRCUIT,COURSE	CIRCUITO
COURSE,COMPETITION	RACE	CARRERA
LIGNE DIRECTE DU COUREUR	SHORTEST POSSIBLE ROUTE	LINEA IDEAL DE CARRERA
TRAJECTOIRE	TRAJECTORY	TRAYECTORIA
LIGNE DE DEPART	START LINE	SALIDA
LIGNE D'ARRIVEE	FINISH LINE	META
MESURER UN PARCOURS	TO LAY OUT A COURSE	MEDIR UN CIRCUITO
CONTROLER UN CIRCUIT	TO CHECK A COURSE	CONTROLAR UN CIRCUITO
GUIDER SUR LE CIRCUIT	TO LAY THE COURSE	CONDUCIR SOBRE EL CIRCUITO
CARREFOUR	INTERSECTION	CRUCE
ROND POINT, GIRATOIRE	ROUNDABOUT	PLAZA
VIRAGE	CURVE	CURVA , GIRO
ILOT DIRECTIONNEL	MEDIAN STRIP, CENTRAL RESERVATION	ISLETA
PANNEAU INDICATEUR	ROAD SIGN	SENAL INDICADORA
FEU TRICOLORE	TRAFFIC LIGHT	SEMAFORO
PASSAGE PIETON	PEDESTRIAN CROSSING	PASO DE PEATONES
PARKING	CAR PARK	APARCAMIENTO
REVERBERE	LAMP POST, LIGHT POLE	REFLECTANTE
POTEAU TELEGRAPHIQUE	TELEGRAPH POLE	POSTE TELEGRAFICO
BORNE D'INCENDIE	FIRE HYDRANT	BOCA DE INCENDIO
TROTTOIR	PAVEMENT, SIDEWALK	ACERA
BORDURE DU TROTTOIR	KERB, CURB	BORDILLO
CANIVEAU	GUTTER	CUNETA

ITALIAN	***PORTUGUESE***	***GERMAN***
BICICLETTA	BICICLETA	FAHRRAD
BICICLETTA CALIBRATA	BICICLETA CALIBRADA	GEEICHTES FAHRRAD
PEDALARE		FAHREN
CONTATORE JONES	CONTADOR JONES	JONES-ZÄHLER
CALIBRARE	CALIBRAR	EICHEN
CALIBRATURA	CALIBRAGEM	EICHUNG
PERCORSO DI CALIBRATURA	CURSO DE CALIBRAGEM	VERGLEICHSSTRECKE
COSTANTE DI CALIBRATURA	CONSTANTE	VERGLEICHSKONSTANTE
GIRI	CONTAGEM	ZÄHLER
CIRCUITO	PERCURSO , CIRCUITO	STRECKE
CORSA	COMPETICAO , CORRIDA	WETTKAMPF
LINEA IDEALE DI CORSA	PERCURSO MAIS CURTO	KÜRZESTE MÖGLICHE STRECKE
TRAIETTORIA	TRAJECTORIA	IDEALLINIE
PARTENZA	LINHA DE PARTIDA	STARTLINIE
ARRIVO	LINHA DE CHEGADA/META	ZIELLINIE
MISURARE UN PERCORSO	MEDIR UM PERCURSO	EINE STRECKE ENTWERFEN
VERIFICARE UN PERCORSO	CONTROLAR UM PERCURSO	EINE STRECKE PRÜFEN
CONDURRE SUL CIRCUITO	PERCORRER O CIRCUITO	STRECKE ABFAHREN
INTERSEZIONE	CRUZAMENTO	KREUZUNG
ROTONDA	PONTO DE VIRAGEM	KREISVERKEHR
CURVA	CURVA	KURVE
ISOLA PEDONALE	SEPARADOR	GRÜNSTREIFEN
CARTELLO INDICATORE	SINAL INDICADOR	STRASSENSCHILD
SEMAFORO	SEMAFOROS	AMPEL
PASSAGGIO PEDONALE	PASSAGEM DE PEOES	FUSSGÄNGERWEG
PARCHEGGIO	PARQUE DE ESTACIONAMENTO	PARKPLATZ
LAMPIONE	POSTE DE ILUMINACAO	STRASSENLATERNE
PALO TELEGRAFICO	POSTE TELEGRAFICO	TELEGRAFENMAST
IDRANTE	BOMBA DE INCENDIO	WASSERHYDRANT
MARCIAPIEDE	PASSEIO	FUSSWEG
BORDO DEL MARCIAPIEDE	REBORDO DO PASSEIO	BORDSTEIN
CANALE DI SCOLO	SARGETA	GULLI

FRENCH	***ENGLISH***	***SPANISH***
REVETEMENT DE LA CHAUSSEE	ROADWAY, PAVEMENT	PAVIMENTO
PAVE OU BITUME	PAVED OR TARMAC	ASFALTADO
PISTE CYCLABLE	CYCLE LANE	CARRETERA TRANSITABLE
CHEMIN EN TERRE BATTUE	PATHWAY	CAMINO DE TIERRA BATIDA
CHEMIN DE TERRE	TRACK , SMALL ROAD	CAMINO DE TIERRA
SENTIER	PATH	SENDERO
SENTIER DE MONTAGNE	TRAIL	SENDERO DE MONTANA
BARRIERES	BARRIERS	VALLAS
FRENCH	ENGLISH	SPANISH
CONES	CONES	CONO
CORDE	STRING	CUERDA
RUBAN	TAPE	CINTA
ELASTIQUE	ELASTIC TAPE	ELASTICO
RUBAN METALLIQUE	STEEL TAPE	CINTA METALICA
MESUREUR	MEASURER	MEDIDOR
MESURE, MESURAGE	MEASUREMENT	MEDICION
GEOMETRE	SURVEYOR	AGRIMENSOR
DIRECTEUR DE COURSE	RACE DIRECTOR	DIRECTOR DE CARRERA
JUGE ARBITRE	REFEREE	JUEZ ARBITRO
CHEF DE JURY	CHEEF OFFICIAL	DIRECTOR DE REUNION
CHRONOMETREUR	TIME KEEPER	CRONOMETRADOR
CONTROLE ANTI DOPING	DRUG TEST,DOPING CONTROL	CONTROL ANTIDOPAJE
RECORD DU PARCOURS	COURSE RECORD	RECORD DEL CIRCUITO
RECORD PERSONNEL	PERSONAL BEST (PB)	RECORD DE LA PRUEBA
DOSSARD	NUMBER BIB	DORSAL
EPINGLES DE NOURRICE	SAFETY PINS	IMPERDIBLES
PLAN , CARTE	MAP	MAPA , PLANO
DOSSIERS , CLASSER	FILES , TO FILE	DOSIER , CLASIFICADOR
CALCULS	FIGURES	CALCULOS , NUMEROS
FACTEUR PREVENTIF D'ERREUR	SHORT COURSE PREVENTION F.	FACTOR PREVENCION DE ERROR
FACTEUR PREVENTIF 1.001	SAFETY FACTOR 1.001	FACTOR DE PREVENCION 1.001
THERMOMETRE	THERMOMETER	TERMOMETRO
CHAUD , FROID	HOT , COLD	CALOR , FRIO
TEMPERATURE	TEMPERATURE	TEMPERATURA

ITALIAN	***PORTUGUESE***	***GERMAN***
PAVIMENTAZIONE	REVESTIMENTO DA ESTRADA	ASPHALT
ASFALTO	PAVIMENTO OU BETUME	ASPHALTIERT
PISTA CICLABILE	CAMINHO DE BICICLETAS	SEITENSTRASSE
SENTIERO IN TERRA BATTUTA	CAMINHO EM TERRA BATIDA	PISTE
VIA SECONDARIA	CAMINHO DE TERRA	WEG
SENTIERO	TRAJECTO	PFAD
SENTIERO DI MONTAGNA	CAMINHO DE MONTANHA	WEG
BARRIERE	BARREIRAS	BARRIERE
ITALIAN	PORTUGUESE	GERMAN
CONI	CONES	HÜTCHEN
CORDE	CORDA	FADEN
NASTRO	FITA	BAND
NASTRO ELASTICO	FITA ELASTICA	BANDMASS
NASTRO METALLICO	FITA METALICA	STAHLBANDMASS
MISURATORE	MEDIDOR	VERMESSER
MISURAZIONE	MEDIDA	VERMESSUNG
GEOMETRA	GEOMETRO	BEOBACHTER
DIRETTORE DI CORSA	DIRECTOR DA CORRIDA	VERANSTALTUNGSLEITER
GIUDICE ARBITRO	JUIZ ARBITRO	KAMPFRICHTER
DIRETTORE DI RIUNIONE	CHEFE DO JURI	OBERKAMPFRICHTER
CRONOMETRISTA	CRONOMETRISTA	ZEITNEHMER
CONTROLLO ANTI-DOPING	CONTROLO ANTI DOPING	DOPING-TEST
RECORD DEL CIRCUITO	RECORDE DO PERCURSO	STRECKENREKORD
RECORD PERSONALE	RECORDE PESSOAL	PERSOENLICHE BESTLEISTUNG
PETTORALE	DORSAL	STARTNUMMER
SPILLE DA BALIA	ALFINETES	SICHERHEITSNADELN
MAPPA	MAPA / CARTA	KARTE
DOSSIER	ARQUIVO , ARQUIVAR	UNTERLAGEN, ABLEGEN
CIFRE, CALCOLI	CALCULOS	ANGABEN, ZAHLEN
FATTORE DI PREVENZIONE DI ERRORE	FACTOR DE ERRO PREVENTIVO	KURZE STRECKE VERHINDERUNGS FAKTOR
FATTORE DI PREVENZIONE 1.001	FACTOR PRECENTIVO 1.001	SICHERHEITSFAKTOR 1.001
TERMOMETRO	TERMOMETRO	THERMOMETER
CALDO, FREDDO	QUENTE , FRIO	WARM, KALT
TEMPERATURA	TEMPERATURA	TEMPERATUR

FRENCH	***ENGLISH***	***SPANISH***
MORCEAU DE CRAIE	PIECE OF CHALK	TROZO DE TIZA
CRAYON	PENCIL	LAPIZ
CALCULETTE	POCKET CALCULATOR	CALCULADORA
ODOMETRE	ODOMETER	PODOMETRO
ALTIMETRE	ALTIMETER	ALTIMETRICO
MARTEAU , CLOU	HAMMER , NAIL	MARTILLO , CLAVO
CLEF	KEY	LLAVE
CLEF A MOLETTE	SHIFTER,SHIFTING SPANNER	LLAVE DE ESTRELLA
ECROU , RONDELLE	NUT , WASHER	TUERCA , ARANDELA
ROUE , PNEU	WHEEL , TYRE	RUEDA , NEUMATICO
PNEU PLEIN	SOLID TYRE	NEUMATICO HINCHADO
PNEU GONFLABLE	PNEUMATIC TYRE	NEUMATICO HINCHABLE
CHAMBRE A AIR	TUBE	TUBULAR , CAMARA DE AIRE
RAYON	SPOKE	RADIO
PEDALE	PEDAL	PEDAL
FRENCH	ENGLISH	SPANISH
CHAINE	CHAIN	CADENA
DERAILLEUR	GEAR CHANGE	CAMBIO
POMPE	PUMP	BOMBIN
BEQUILLE	BIKE STAND	SOPORTE
PORTE BAGAGE	LUGGAGE RACK	PORTAEQUIPAJE
SELLE	SEAT , SADDLE	SILLIN
CADRE	BIKE FRAME	CUADRO
GUIDON	HANDLEBAR	MANILLAR
FREINS	BRAKES	FRENOS
FOURCHE	FORK	HORQUILLA
PORTE BIDON	BOTTLE HOLDER	PORTABIDON
BOMBE DE PEINTURE	SPRAY PAINT	BOTE DE PINTURA
CREVER	TO GET A PUNCTURE	PINCHAR
CREVAISON	PUNCTURE	PINCHAZO
METTRE EN CONFORMITE	TO ADJUST, TO CORRECT	
COEF.DE FIABILITE D'ETALONNAGE	CALIBRATION PRECISION COEFFICIENT	
COEF. DE FIABILITE DE MESURAGE	MEASUREMENT PRECISION COEFFICIENT	

ITALIAN	***PORTUGUESE***	***GERMAN***
PEZZO DI GESSO	PEDAZO DE GIZ	STÜCK KREIDE
MATITA	LAPIS	KUGELSCHREIBER
CALCOLATRICE PORTATILE	CALCULADORA	TASCHENRECHNER
CONTACHILOMETRI	ODOMETRO	ENTFERNUNGSMESSER
ALTIMETRO	ALTOMETRO	HÖHENMESSER
MARTELLO, CHIODO	MARTELO , PREGO	HAMMER, NÄGEL
CHIAVE	CHAVE	SCHLÜSSEL
CHIAVE INGLESE VARIABILE	CHAVE FRANCESCA	SCHALTER, SCHALTHEBEL
BULLONE, RONDELLA	PORCA , ANILHA	MUTTER, UNTERLEGSCHEIBE
RUOTA, PNEUMATICO	RODA , PNEU	RAD, REIFEN
PNEUMATICO PIENO	PNEU CHEIO	VOLLGUMMIREIFEN
PNEUMATICO GONFIABILE	PNEU INSUFLAVEL	SCHLAUCHREIFEN
CAMERA D'ARIA	CAMARA DE AR	SCHLAUCH
RAGGIO	RAIO	SPEICHE
PEDALE	PEDAL	PEDAL
ITALIAN	PORTUGUESE	GERMAN
CATENA	CADEIA	KETTE
CAMBIO	MUDANCAS	GANG WECHSELN
POMPA	BOMBA	PUMPE
CAVALLETTO	PARQUE DE BICICLETAS	STÄNDER
PORTA BAGAGLI	PORTA BAGAGENS	GEPÄCKTRÄGER
SELLINO	SELIM	SITZ, SATTEL
TELAIO	QUADRO DA BICICLETA	FAHRRADRAHMEN
MANUBRIO	GUIADOR	LENKER
FRENI	TRAVOES	BREMSE
FORCELLA	FORQUETA	GABEL
PORTA BIDONE	PORTA BIDONS	FLASCHENHALTER
VERNICE SPRAY	SPRAY DE PINTURA	SPRÜHFARBE
FORARE	TER UM FURO	PLATTEN KRIEGEN
FORATURA	FURO	LOCH
PORTARE UN PERCORSO A CONFORMITA'		
COEFFICIENTE DI PRECISIONE DELLA CALIBRATURA		
COEFFICIENTE DI PRECISIONE DELLA MISURAZIONE		

NOTES

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