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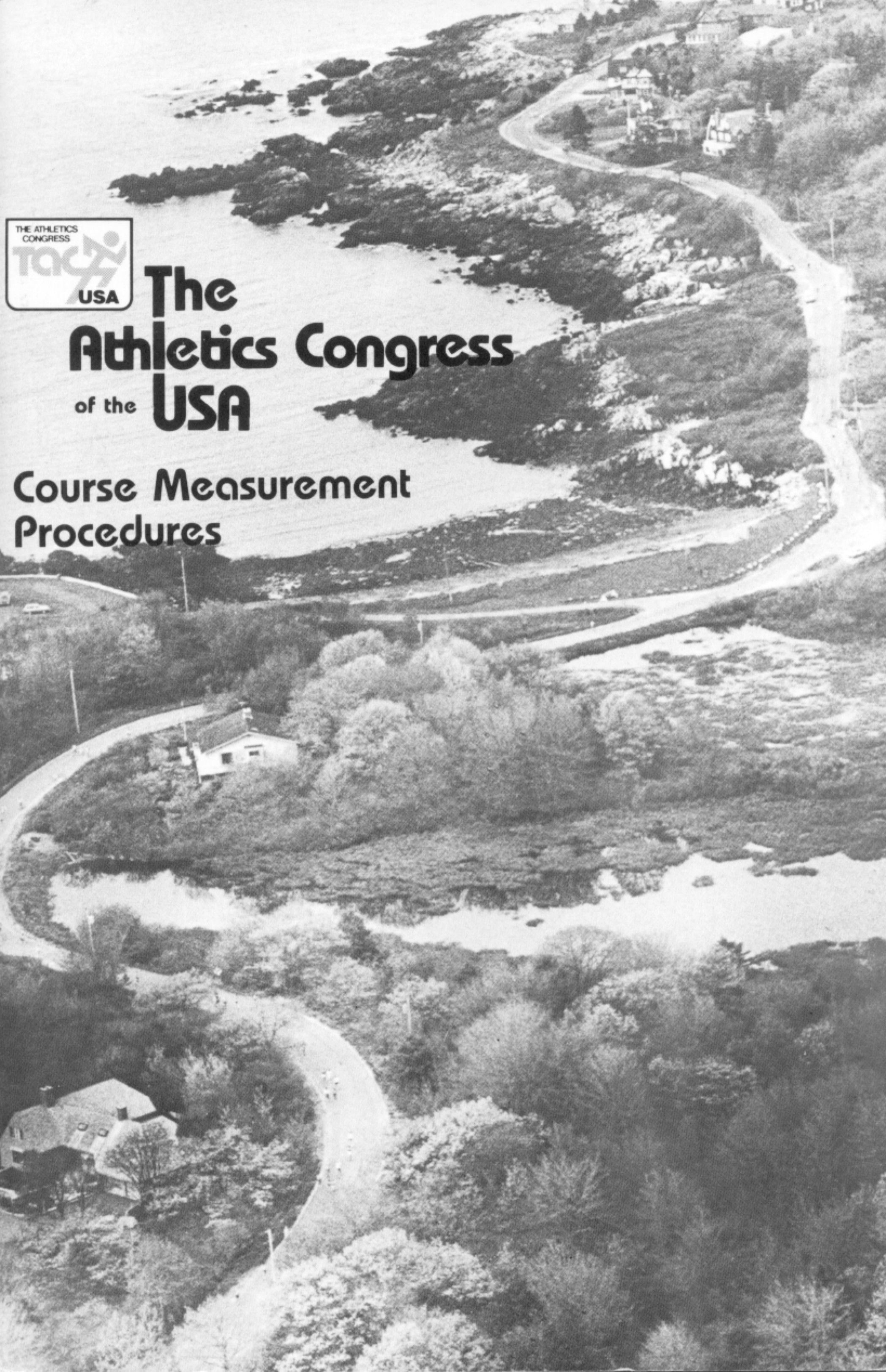
Course Measurement Procedures



Cover: This stretch of the Maine Coast Marathon offers fantastic scenery for runners and a tough challenge for a course certifier. Photo by Fred Field, *Journal Tribune.*

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TAC USA

ROAD RACE COURSE MEASUREMENT AND CERTIFICATION PROCEDURES

PREPARED BY
TAC ROAD RUNNING TECHNICAL COMMITTEE

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This booklet is intended as a guide to those persons interested in measuring and certifying road running courses. The following persons have contributed directly to the preparation of this booklet:

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ROAD RACE COURSE MEASUREMENT AND CERTIFICATION PROCEDURES

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INTRODUCTION

Certification of road race courses in the United States is done under the auspices of the **TAC Road Running Technical Committee (RRTC).** Courses certified by the RRTC are also recognized as certified by the Road Runners Clubs of America. For a mark to be eligible for record consideration by TAC, it must be achieved on a RRTC-certified course. If an entry fee is charged for a road race, runners have a right to a properly measured course. RRTC-certification is an assurance to the runner that times will be based on a properly measured distance.

The rules and guidelines set forth in this booklet represent more than twenty years of experience in measuring road courses accurately. Much of the pioneering work in this country was done by Ted Corbitt and he, more than any other person, deserves the credit for the excellent certification program we have. The IAAF has adopted guidelines for course measurement which are modeled after those in use in the United States.

Although there are many ways to measure a course, experience has shown that the **calibrated bicycle method** is superior to all others because of the speed and accuracy with which it can be performed. The **calibrated surveyor's wheel** is no longer considered a suitably accurate method for measuring road courses. Please note that automobile odometers, aerial survey maps, and electronic distance meters (EDM) are **not suitable for measuring road courses for certification.** An EDM is an excellent device for measuring the course used for calibrating the bicycle, which must be **straight and level.**

There are several different types of revolution counters available for use on a bicycle. The most commonly used (and recommended) counter is the Jones Counter. The procedures using other counters are similar but often require counting spokes to obtain similar accuracy. In this booklet, we will assume you are using a Jones Counter.

The basic method of measurement is to compare the number of revolutions of the bicycle wheel needed to cover the course with the number of revolutions needed to cover a standard calibration course. Once you understand the method, it is simple and direct, but there are many important details which need to be done correctly in order to have an acceptable measurement.

In all probability, your course will not be checked. It is up to **you** to be sure it is right. Follow the instructions carefully and you will obtain a reliable measurement. If an open record is set on your course, it will be remeasured by a member of the RRTC. For a mark to be accepted as an official record, the course length must be **at least the stated distance.** If your course is found to be short of its advertised length, the certification will be withdrawn. Follow the instructions carefully and do your best.

This booklet is organized in "stand-alone" sections. Read the statement of requirements to obtain an overall picture of the procedures. Then study the particular section(s) you need for the particular task you have chosen to perform next, such as laying out a calibration course. Refer to the examples in Appendix C as needed for clarification of points in the text. If you are unsure of any aspect of the process, please contact your regional representative **before** attempting the desired task. It will save both of you a lot of time.

EQUIPMENT NEEDED

1. **Jones Course Measuring Device.** The Jones Counter is attached to the front wheel of the bicycle and counts revolutions of the wheel (20 counts = one revolution; one count is **very roughly** ten centimeters or four inches). Available from: New York RRC, PO Box 881 FDR Station, New York, NY 10150, attention Bill Noel. Price is $20.00 postpaid.
2. **Bicycle.** A good "ten-speed" with high pressure tires is best but any bicycle you are comfortable riding is OK. Refer to the section on "Use of the Calibrated Bicycle" for how to attach the Jones Counter to your bicycle.
3.* **Steel Tape.** A 30 meter/100 foot steel tape is best but a 15 meter/50 foot tape is OK. The steel tape is used to lay out the calibration course and to make adjustments to the course.
4.* **Spring Scale.** A spring scale, capable of a ten pound pull, is needed for the steel tape to be under proper tension. The spring scale need not be a precision instrument; the inexpensive variety sold at sporting goods stores for use by fishermen is OK.
5.* **Thermometer.** Use a small alcohol thermometer to take temperature readings so that steel tape measurements can be corrected for temperature.
6. **Notebook and Pencils.** A small notebook easy to use while cycling and several pencils or pens are needed to record data and to sketch the more complicated sections of the course.
7. **Pocket Calculator.** A small pocket calculator is useful in determining the counts needed for specific splits and for metric/English conversions. Use a calculator that carries at least 8 significant digits. **Note:** the built-in metric conversions in some inexpensive calculators are not sufficiently accurate; if in doubt, use the exact conversions in Appendix E.
8. **Lumber Crayon or Chalk.** Used for temporary pavement markings.
9.* **Concrete or PK nails.** Used for making permanent course marks.
10. **Hammer.** Needed to pound concrete or PK nails into the pavement.
11.* **Spray Paint.** One or more cans of spray paint are useful for temporary course markings and to supplement permanent course marks.
12. **Masking Tape.** Masking tape is used for temporary marks while laying out the calibration course.
13. **Bike Tools.** In the case of a flat front tire, you must recalibrate before resuming measurement.
14. **Safety Equipment.** A safety vest and helmet should be worn. Adorn your bicycle with reflective strips and reflectors front

and rear as well as wheel reflectors.

* These may be obtained at most hardware stores.

STATEMENT OF REQUIREMENTS

There are seven basic steps involved in measuring a course for certification. These are:

1. **Lay out an accurate calibration course.** The calibration course must be a straight stretch of paved road, level and relatively free of traffic, and at least 800 meters in length. The calibration course must be **certified.** You may wish to check with the nearest regional certifier to determine if there is a suitable calibration course near you.
2. **Calibrate the bicycle.** Ride the bicycle over the calibration course, taking care to ride in as straight a line as possible. At least four calibration rides must be made immediately prior to measuring the race course. The "working constant" is the number of counts/km (or per mile) **times** the short course prevention factor of 1.001.
3. **Measure the course.** Ride the bicycle over the course, following the shortest possible route as it will be available to the runner on race day. At least two measurements over the course are required for certification. Use the first measurement to establish tentative start and finish marks. Use the second measurement to check the distances between those **same** two marks. **Do Not** make new marks on the road during the second measurement. If you measure on different days, calibrate both before and after each set of measurements.
4. **Recalibrate the bicycle.** Ride the bicycle over the calibration course at least four times immediately after the course measurement(s). After recalibrating, find your **constant for the day**, which is the **larger** of the pre-measurement (working) constant, or post-measurement (finish) constant.
5. **Determine the proper measured course length.** Recalculate each measured distance using the appropriate **constant for the day.** If you only measure the course twice, the proper measured length is the smaller value. E.g., you measure between the **same** start and finish points and obtain distances of 10,000 and 9,993.7 meters. The proper measured length is 9,993.7 meters. If you measure three times, the proper measured length is the **smallest** value. If you only measure twice, the two measurements may not differ by more than 0.08% or you must take a third measurement.
6. **Make the final adjustments to the course.** If the **proper measured length** differs from the **desired** (or advertised) **course length**, you will need to adjust either your start, finish, or a turn-around point. These adjustments may be made with a steel tape. Once all the measurements have been completed, the proper set of marks should be made permanent and all others should be erased.

7. **Submit application(s) and supporting documentation to your local or regional RRTC representative.** Carefully record all data taken and prepare a map showing the course layout, details of the start and finish zones and turn-around points, and the exact path that was measured through the course.

CALIBRATION COURSE

Accuracy of the calibration course is vital since any error will be multiplied when it is used for measuring a race course. A calibration course **must** be on a **straight**, level, paved, and lightly travelled stretch of road and should be at least 800 meters (880 yards) in length. You may find it convenient to use a 1000 meter calibration course since most race courses are at metric distances. Note that the calibration course may be any desired distance that is at least 800 meters.

There are only two acceptable methods for measuring a calibration course. You can hire a surveyor to measure it with an Electronic Distance Meter (EDM). You can measure it yourself with a **steel tape.** **Note:** Fiberglass tapes are not acceptable.

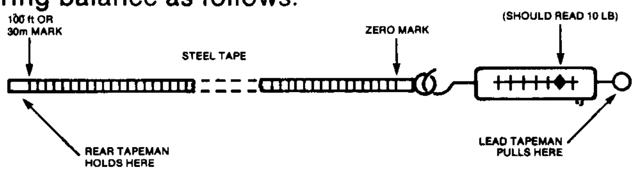
Choose a location that will be convenient for actually calibrating a bicycle. Every time you measure a race course, you'll need to ride your bicycle over the calibration course at least eight times (four prior and four after). Remember you will want to ride the calibration course in **both** directions.

The calibration course should run along the edge of a straight road, the same distance from the road edge as you would ride your bicycle. The marks defining the ends of the calibration course will be in the road-way where you will touch them with your bicycle wheel (not off to the side somewhere).

Characteristics of Steel Tapes

Before using a steel tape, you must be aware of the following:

1. **Type of Graduations.** The tape may be graduated in (a) metric, (b) feet and inches, or (c) feet and decimals of a foot. If the tape is graduated in **feet**, check whether it has 10 or 12 divisions per foot.
2. **Location of True Zero Point.** If the true zero is not on the graduated part of the tape, take a ruler and measure to figure out where the true zero really is. Often it is at the very outer edge of a "hook-ring." **Be careful** to use the true zero point while measuring.
3. **Correct Tension (force) for Stretching Tape.** This is usually 10 pounds-force for tapes up to 100 feet in length, or 20 pounds-force for tapes longer than 100 feet. The manufacturer may specify some other value, e.g., 50 newtons (about 11 pounds) for certain all-metric 30 meter tapes. The tension is applied with a spring balance as follows:



Proper Steel Taping Procedures

The procedure for laying out each tape length is as follows:

1. Lead and Rear tape-persons shake out the tape until it lies straight and flat on the road. Rear tape-person sights ahead to make sure lead tape-person is properly aligned **or** the lead tape-person may use a ruler to maintain a constant distance from the edge of the road-way or from the white "edge line."
2. Lead tape-person affixes a large piece of masking tape to the road-way, covering the position where the mark will eventually be made.
3. With the tape 10 to 15 cm (4 to 6 inches) behind the mark, the Lead tape-person pulls the spring balance to the proper tension as the tape is moved slowly forward.
4. When the end point of the tape is over the last mark (with the tape under tension), the Rear tape-person shouts "**mark**." At this signal, the Lead tape-person (still pulling on the spring balance with the proper tension), marks a fine line on the masking tape using a fine-point pen. This is easier if you have **two** people at the forward end of the tape, one to pull and one to mark.

The pieces of masking tape should be numbered as you go along. Be careful not to confuse these numerals with the actual marks denoting ends of tape lengths.

Laying Out the Calibration Course Using a Steel Tape

If you do not have prior experience with surveying techniques using steel tapes, you **must** measure the calibration course **four** times (use two data sheets and measure on different days). If you do have prior experience, two steel tape measurements **plus** an independent check such as described below is adequate.

The procedure for measuring a calibration course by **steel tape** is as follows:

1. Place a thermometer on the pavement, shaded from the sun. Wait for it to come to equilibrium and then record its temperature.
2. Permanently mark (PK nails or chisel marks) one end of the course. Call this point "A". This should correspond to a permanent object in the road such as the edge of a manhole cover, sewer grate, etc.
3. Starting from point A, use the procedure described above to lay out the desired number of tape lengths. When you reach the end, make a **temporary** mark. Call it point "B".
4. Measure back from point B to point A, using either a different

color pen to make the marks or offset the second set of marks so they don't coincide with the first set. Do not re-use the intermediate marks made during the first measurement. **However,** when you reach the end, measure to the **existing** point A which is already permanently marked. **Do not** make a new point A. You will have two measurements for the distance between points A and B which should not differ by more than a few centimeters (inches).

5. Read the thermometer again.
6. Do the calculations described on the "Steel Taping Data Sheet" to determine the temperature corrected value of the average measured distance between points A and B. If the two taped measurements differ by more than 20 cm per kilometer (6⅜ inches in a half mile), you must remeasure until you achieve an agreement with these tolerances.
7. If the temperature is above 20° C (68° F), you do not need to make a temperature correction although it is recommended. **However,** if the average temperature is **less** than this, failure to correct for temperature may result in a short race course and the temperature correction must be applied.
8. **Optional.** If you wish, you may now adjust **point B** in order to obtain a desired even course distance (such as one kilometer).
9. Permanently mark the corrected end-point.
10. Check that you correctly counted the number of tape lengths. Ride your bicycle with the Jones Counter over the entire length of the calibration course and record total counts. Do the same for any one tape length. If you measured 27 tape lengths, the count of the total course should be about 27 times the count for one length. This guards against miscounting the taped intervals (a common source of error).

Once the calibration course is established, it must be precisely **documented** so you won't lose it if the road is repaved. Point A should already be at a permanent object that will survive repaving. Make careful tape measurements to determine the distance between (the corrected permanent) point B and other (near-by) permanent objects. Draw detailed diagrams describing the **exact** positions of both endpoints.

See example of calibration course layout in Appendix C.

Performing the Calibration

The pre-measurement calibration is the initial step that must be performed in the measurement of a road course. The post-measurement calibration assures against systematic sources of error such as a slow leak. At least **four** pre-measurement and **four** post-measurement calibration rides are required.

1. The bicycle tires should be inflated hard, to the pressure indicated on the side of the tire. Do this a few days prior to the anticipated measurement.
2. Warm the tires by riding the bicycle for several minutes immediately prior to the calibration rides. This will reduce the variability in counts for the pre-measurement calibration and insure a better measurement.
3. At one end point of the calibration course, slowly roll the front wheel forward, just through the next count. Lock the front brake and place the front wheel axle directly over the line. Record the count.
4. 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 actual race course measurement. A calibration ride should be one **non-stop** ride.
5. Stop the bicycle **just** before reaching the end of the calibration course and roll it slowly forward until the axle of the front wheel is directly over the line. Lock the front brake and record the count.
6. With the front wheel brake locked, turn the bicycle around and place the front wheel axle directly over the line for the next ride. Repeat steps 4 and 5.
7. Repeat this procedure **four** times, recording start and finish counts each time. Alternate directions on the calibration course. This will give you two rides in one direction and two rides in the opposite direction. The calibration rides must not have a range of more than 0.07%. If they do, make at least two more calibration rides.
8. Add the results of each ride and divide by the number of rides. This gives the "average pre-measurement count."
9. Divide this count by the length of the calibration course in kilometers (or in miles) to obtain the number of counts per kilometer (or per mile).
10. Multiply this by 1.001 to obtain the **working constant**. The "short course prevention factor" of 1.001 is intended to result in a course which is **at least** the stated distance, within the limits of measurement precision. It also helps assure that (very) slight variations in the course layout on race day won't invalidate your measurement. This lengthens the course by one meter per kilometer or 5.28 feet per mile.

Now go measure the race course. When finished, return to the calibration course.

11. The post-measurement calibration must be performed as soon after the measurement as possible. Repeat steps 3 thru 10. **Four** post-measurement calibration rides are required.
12. Determine the average post-measurement count by adding all the post-measurement counts and dividing by the number of rides.
13. Determine the **finish constant** by dividing the average post-measurement count by the length of the calibration course in kilometers (or in miles) and multiply this by 1.001.
14. The **constant for the day** is **either** the working constant **or** the finish constant, whichever is larger. Although measurements using the average of the working and finish constants will be acepted, it is strongly recommended to use the **larger** constant.

Remember: Each day's measurement **must** be preceded and followed by calibration runs. You may measure as much as you want in a day, just so calibration closely precedes and follows measuring (within a few hours). This is done to minimize error due to changes in tire pressure from thermal expansion and slow leakage. Frequent recalibration "protects" the previous measurement. A smart measurer will recalibrate frequently—you never know when a flat tire is coming!

THE SHORTEST POSSIBLE ROUTE

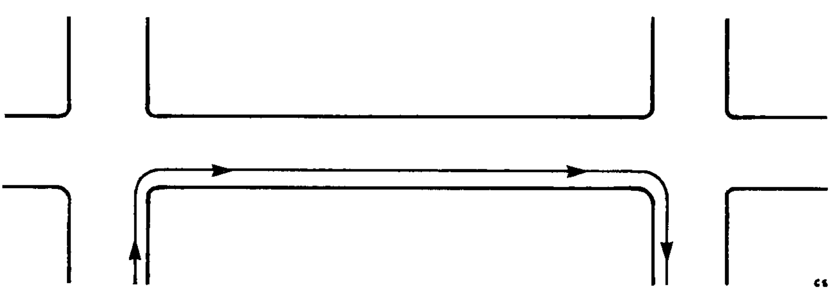
The race course is defined by the shortest possible route a runner could take and not be disqualified. A given runner may not follow the shortest possible route, just as a runner on a track may be forced to run further to pass another runner. The actual path of any given runner is irrelevant. The shortest possible route is a reasonably well-defined and unambiguous route and insures that all runners will run **at least** the stated race distance.

You might envision the shortest possible route as a string, stretched tightly along the course so that it comes within 30 cm (one foot) of all corners, straight through S-turns, and diagonally between corners when crossing a street. You should measure the course following the same route as that hypothetical string.

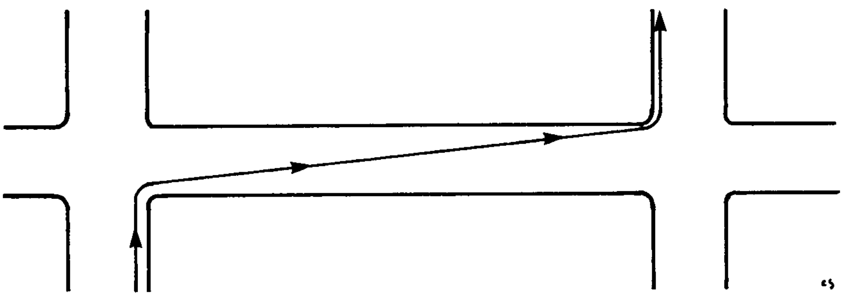
Because it is difficult to follow the shortest possible route perfectly, an extra length factor of 0.1%, called the **short course prevention** factor, is incorporated into the calibration procedure. Use of the factor assures that your course will **not** be short, even if you make small errors in following the shortest possible route.

When making a turn, measure prudently close to the curb or edge of the roadway. Thirty centimeters (one foot) from the edge of the roadway is a good quide. Often man-holes, storm drains, broken pavement, and other hazards render this impractical. In such cases, attempt to measure the shortest route that a runner may be expected to take. You may wish to walk the bicycle through such sections if they are relatively short.

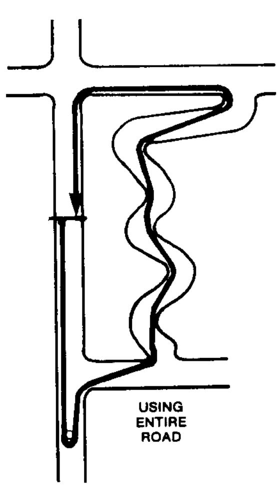
There are three basic situations encountered in following the shortest possible route. First, if you enter a roadway by making a right turn and also leave it by making another right turn, follow a path prudently close to the curb around both turns and in-between.

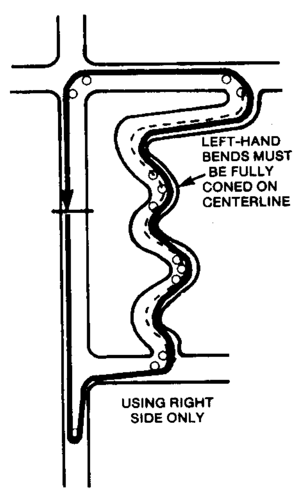


Second, if you enter a roadway by making a right turn and leave it by making a left turn, move in as straight a line as possible, diagonally from where you entered on the right to the most extreme left position allowed to the runner just before making the second turn. Again, make the second turn as prudently close to the curb as you can. In the case of heavy traffic, you may wish to employ the "offset maneuver" described in Appendix A (Supplementary Tips).

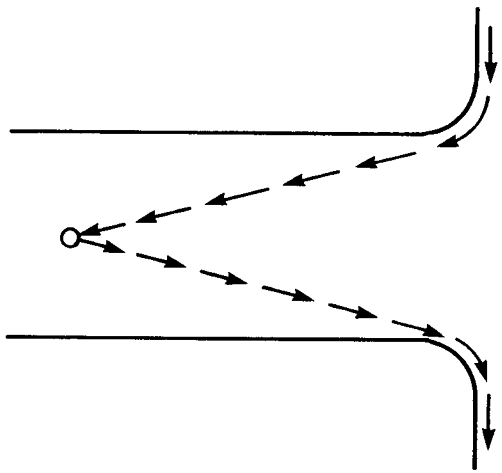


Third, when measuring on a winding roadway, **do not** follow the side of the road. Unless portions of the roadway will be closed to runners by cones and/or barricades **and** will be monitored, measure the straightest and shortest path possible, moving from one side of the road to the other as necessary to follow the shortest possible route. This may be an unsafe practice on highly travelled roads. You may need to measure with a police escort or measure during periods when traffic is light.





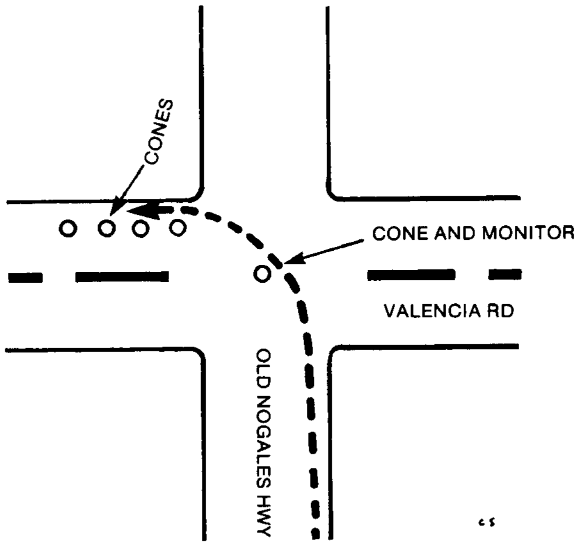
When measuring a turn-around point, cycle up to the position of the turn, freeze the front wheel, record the count, reverse the bicycle, and proceed back the other direction. **Do not** cycle "wide" around the turn.



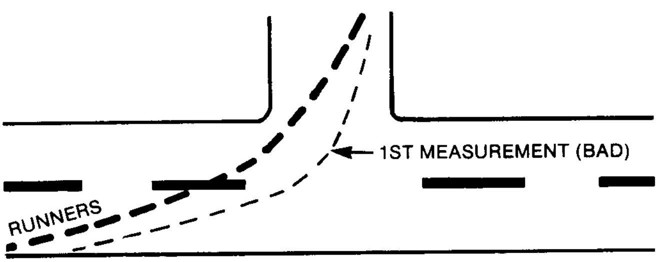
The course must be measured as it will be when the race is run. In particular, detouring around cars or other obstacles which may not be present the day of the race will make the course short. (See Supplementary Tips)

If your course is laid out to restrict the runners to a route which is longer than the shortest possible route (on pavement), traffic barricades or intensive coning is required. Course monitors are nice but often are absent, mis-positioned, or simply ignored by the runners. Instruct course monitors to disqualify on the spot, any runners they observe cutting the course as defined by the barricades and cones.

The locations of barriers must be marked on the road, and their exact locations put on the map. You should be prepared to document every such marker that you put in place. If this seems like too much trouble, you should assume that runners will short-cut all they can and **measure that way,** even if the runners are instructed to run a longer route.

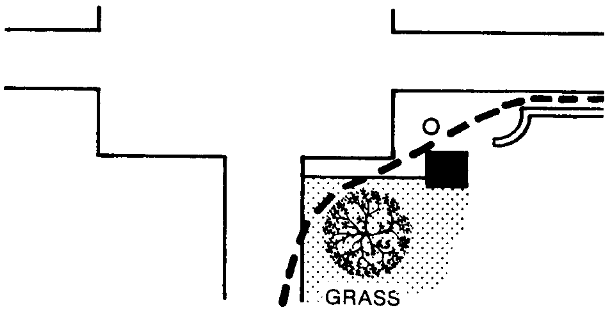


Frequently, unmonitored runners do not stay on the paved roadway. Runners may jump curbs. For example, in the Heart of San Diego Marathon and 10 km:



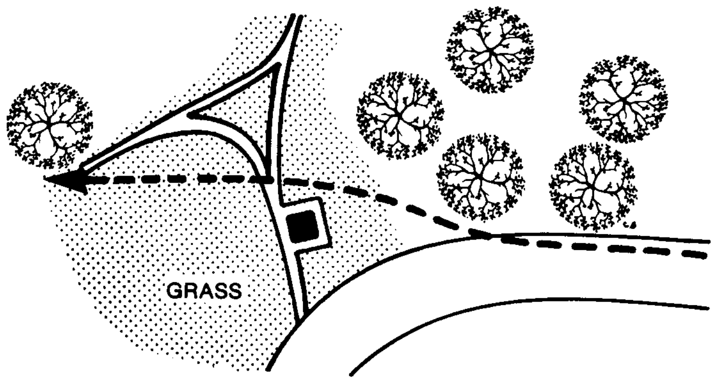
The course was originally measured to avoid the center island however, runners were observed to cross the center island, a difference of almost 15 yards. Subsequently, the course was remeasured along the shortest possible route, as though the center island did not exist.

Runners may go "cross-country" over grass and dirt and around trees and other obstacles. For example, part of the Balboa 8 mile is measured recognizing this:



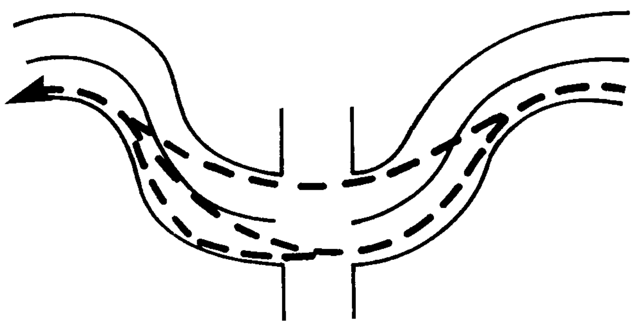
In this case, the measured running route is across the grass, around a tree and onto the sidewalk, following the shortest possible (legal) route around the turn.

Another example of this is the Balboa Park 10 km which cuts across a grassy area:



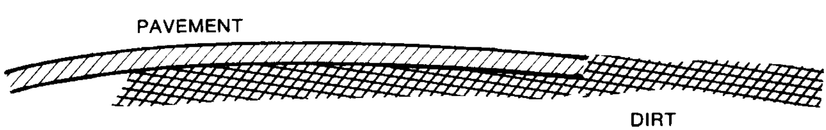
The measured running route is the shortest route across the grass. It is marked with coat hangers formed into loops, stuck in the grass and marked with torn bedsheets.

Another difficult turn is on the 1981 Mission Bay Marathon course. This is a moderately busy street. Runners take various routes as shown:

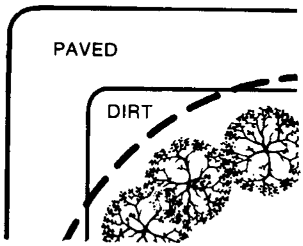


In this case, the shortest route is dangerous for the runners and is not recommended. About half of the runners keep to the left side. Most of the rest move towards the center line and half of these are confronted with automobile traffic. The course was measured along the middle route. The **best** solution is to cone and monitor a running lane on the left side and measure within the coned lane.

Sometimes the sides of the road are poorly defined. For example, the Fiesta Island 10 km has a paved road with firm dirt shoulders that some runners prefer to run on.



Selecting the exact running/measuring route is a matter of judgement. It is probably best to remain on the pavement but as close to the dirt edge as possible **unless** the dirt route is obviously shorter. In that case, you should measure the shortest route, on the dirt.



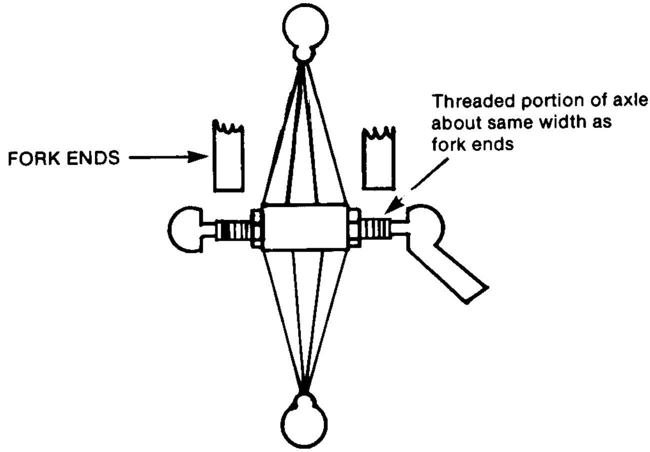
In summary, study is required to determine the shortest route that can actually be run, whether it be in the street, on the sidewalk, or on the grass or dirt.

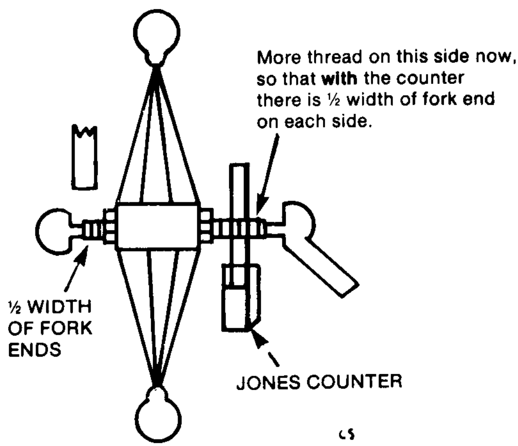
USE OF THE CALIBRATED BICYCLE

Mount the Jones Counter on Your Bicycle

The Jones Counter is mounted on the left side of your front wheel where it can be seen while riding. The counter goes between the hub and the fork. Remove the wheel from the bicycle and then remove any nuts and washers (or the quick release mechanism, if any) from the axle.

If you have a quick release hub, you may have trouble getting the counter on the axle while still leaving enough threads for the fork to rest on. Removing a spacing washer from the axle may help or you may loosen the bearing-keeping nuts and shift the axle to the left as shown.





If, after you place the wheel with the counter back on the bicycle, you find that the whole counter moves with the wheel rather than staying fixed while it registers counts, the counter is binding against the wheel. The solution is to place a washer between the hub and the counter.

Riding Technique

Ride in a relaxed manner, in as straight a line as possible. The basic idea behind the method is that a small amount of "wobble" while riding the course is accounted for when calibrating the bicycle. Ride the calibration course the same way you will ride the race course.

Avoid braking with the front wheel. When you brake, apply the rear wheel brake.

Failure to ride a "straight" line, particularly when diagonally crossing a street, may yield a short course. Rather than watching the ground near the front wheel, aim for a distant point. Locate a point in a direct line to where you need to ride. Then ride toward that point, keeping an eye on that point.

When you encounter potholes or bad bumps, do not swerve to avoid them. Minor ones can be negotiated by slowing down and getting up off the bicycle seat. For a bad bump or hole, stop and carefully walk the bike through it. When you have to get off the bicycle and walk it, e.g., when attempting to reach an exact count or when going through a pothole, you will add roughly 1% to that portion of the course unless you push down on the handle bars to keep some weight pressing down on the front wheel.

Tires should not be checked for pressure at **any** time between calibration and recalibration. This causes a small air loss which will affect the accuracy of the measurement.

Avoid extreme weather conditions. Do not measure on very windy days.

Reading the Counter

Freeze the front wheel before reading the counter. This may be done by hand or by using the front wheel brake.

When reading the counter after backing up, be sure to move the bicycle forward again before taking a reading to avoid a "backlash" effect.

If you go past a count at a kilometer/mile marker, it is best to make a mark where you happen to stop, record the count there, and later adjust the split point by measuring backwards with a tape. Although it is possible to wheel the bicycle backwards, this should be avoided.

Etiquette

When measuring, you may encounter runners, other cyclists, or just people enjoying the out-of-doors. Slow down. Politely explain that you are measuring a race course and have to go in a straight line. They will usually yield to you. Except in extreme cases, avoid moving out of someone's way. If necessary, stop and wait for that person to go around you. Please be courteous at all times. You can minimize such problems by measuring when traffic of all sorts is at a minimum.

If you do a lot of measuring, you may wish to carry fore and aft signs reading **"Official Measuring"** in yellow lettering on a dark background.

COURSE MAPS

The course map is the most important documentation of your course. Its purpose is to provide, ideally on a single sheet of paper, all the information a race director needs to run the race using the course **as certified.** This documentation is of great value in case a record is set on the course and a "validation" measurement is needed.

Without good documentation for the course, mistakes could easily be made in laying out the course on race day. By the time of **next** year's race, there may be a new race director who is totally unfamiliar with the original course measurement. In addition, all the marks you've painted on the road may well have faded into oblivion by the following year!

The map should fit on a single sheet of 8.5x11 paper along with any blow-up or detail maps. The map need not be drawn to scale nor does it have to include every single cross-street or landmark. In fact, the best maps enlarge sections where more detail is needed to show how the course is to be run and shrink sections where less detail is needed. **Do not** use more than one color since the map will be photocopied onto the notice of certification. The map must indicate the direction of true north (toward the top of the page).

A copy machine may be used to reduce or enlarge available maps to serve as a basic layout for your course map. Remember, blue tends to "drop out" whereas reds tend to copy dark for Xerox but the opposite is true for IBM copiers. If you mark over the base map in a color which will copy darker and use a lighter setting on the machine, you can generate a working map which emphasizes the main features of your course. By using the enlarging feature available on some copiers, you can expand sections you wish to detail.

The map must include a line representing the **actual measured path** through the course. Use this line to show how you angled between corners and how you took each turn, including turnarounds. In order to show the measured path, "widen" the streets or roads relative to their length. You may need to further distort the scale to display all relevant detail.

The line representing the measured path indicates the very **shortest** route that runners may be permitted to take during the race. If the race director chooses to restrict the runners' path in such a way that they have to run **farther,** that is OK. But the runners may not be permitted to run any shorter than the measured path or the certification will be invalid.

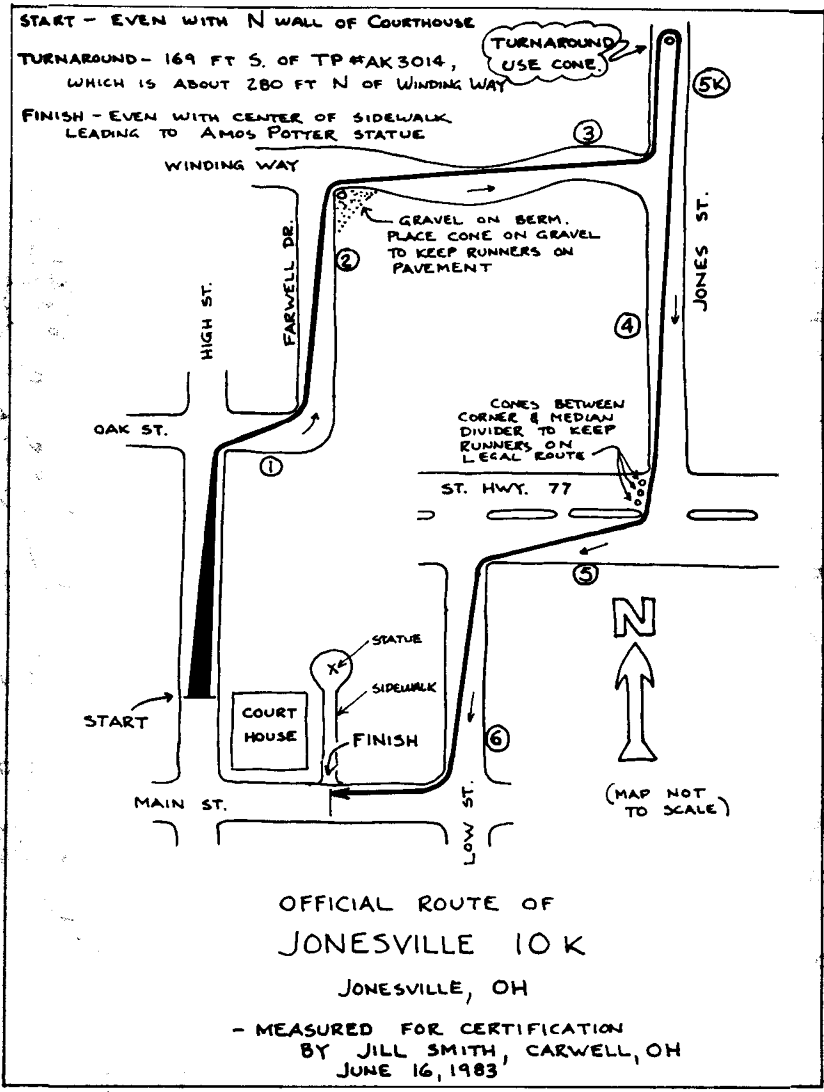
If your measured path was not always the shortest possible route that a runner could run using **any** part of the street or road, then traffic barricades or cones must be set up to insure the runners cover at least the distance that you measured. Your course map must indicate **exactly** where such barriers are to be placed and also show where monitors are to be stationed. Any runner who violates the barriers must be immediately disqualified. If this seems like too much trouble, just measure the shortest route assuming no barricades and you'll be safe.

Your map **must** include descriptions of the **exact** locations of the **start, finish,** and any **turn-around** points. This is done by giving precise tape-measured distances from near-by permanent landmarks. In writing such descriptions, **do not assume** that your painted marks on the road will still be visible. Instead, think of your descriptions as instructions for re-locating the marks without having to remeasure the entire course in the event of repaving the road. In complicated cases, it may be necessary to include detailed blow-up maps of some or all of these points.

In addition to your start, finish, and turn-around points, you should provide documentation for your intermediate splits so they could be relocated if the situation arises. To avoid clutter on your main map, prepare a separate list of split descriptions.

Clearly label all streets and roads used for the course. Indicate kilometer/mile marks with circled numbers. Use arrows to indicate the direction of the race.

Several examples of course maps have been included in Appendix C for your reference.


START – EVEN WITH N WALL OF COURTHOUSE
TURNAROUND – 169 FT S. OF TP #AK 3014, WHICH IS ABOUT 280 FT N OF WINDING WAY
FINISH – EVEN WITH CENTER OF SIDEWALK LEADING TO AMOS POTTER STATUE
TURNAROUND USE CONE.
5K
WINDING WAY
GRAVEL ON BERM. PLACE CONE ON GRAVEL TO KEEP RUNNERS ON PAVEMENT
FARWELL DR.
HIGH ST.
JONES ST.
OAK ST.
CONES BETWEEN CORNER & MEDIAN DIVIDER TO KEEP RUNNERS ON LEGAL ROUTE
ST. HWY. 77
N
STATUE
SIDEWALK
COURT HOUSE
START
FINISH
MAIN ST.
LOW ST.
(MAP NOT TO SCALE)
OFFICIAL ROUTE OF
JONESVILLE 10 K
JONESVILLE, OH
– MEASURED FOR CERTIFICATION BY JILL SMITH, CARWELL, OH
JUNE 16, 1983

LIST OF POINTS AS MEASURED

START – ON HIGH ST, EVEN WITH N SIDE OF COURTHOUSE BLDG, JONESVILLE, OH

TURNARAOUND "T_1" – ON JONES ST, EVEN WITH TELEPHONE POLE # AK3014 (APPROX 280 FT N OF WINDING WAY)

FINISH 10 K – ON MAIN ST, EVEN WITH CENTER OF SIDEWALK LEADING TO STATUE OF AMOS POTTER (E. OF COURTHOUSE)

SPLITS

1 MILE – 17 FT E OF MAILBOX, 237 OAK ST

2 MILE – 35 FT S OF STOP SIGN ON FARWELL AT WINDING WAY

3 MILE – 12 FT W OF TP # AK 3068, ON WINDING WAY APPROX 100 FT W OF JONES ST.

5 K – 182 FT S OF TP # AK 3015
NOTE – 5K IS REACHED AFTER MAKING TURN.

4 MILE – EVEN WITH DRIVEWAY TO UNITED INDUSTRIES, 1714 JONES ST (N. EDGE OF DRIVEWAY)

5 MILE – ON ST. HWY 77, 42 FT E OF STORM DRAIN IN FRONT OF BAKER'S DOZEN SPECIALTY SHOP (4900 E. ST. HWY 77)

6 MILE – ON LOW ST, 6 FT N OF FIRE HYDRANT BY 212 LOW ST.

THESE POINTS ARE IMPORTANT! REPAVING AND WEATHER MAY WIPE OUT YOUR MARKS. WITH THIS INFO THEY CAN BE FOUND AGAIN!

ADJUSTED POINTS – FINAL LOCATIONS.

TURNAROUND "T_2" – ON JONES ST, 169 FT S OF TELEPHONE POLE # AK 3014

– NO OTHER POINTS WERE ADJUSTED.

IMPORTANT!

A LIST LIKE THIS MUST ACCOMPANY YOUR MEASUREMENT DATA.

APPENDIX A

Supplementary Tips

Dealing with Obstacles

When measuring the course, you may encounter an obstacle such as a parked car which will not be present on race day. One way to deal with this problem is as follows:

(a) stop your bicycle just before the obstacle

(b) freeze your front wheel with your hand or the brake

(c) very carefully move the bicycle perpendicular to the route being measured until you are clear of the obstacle

(d) release the wheel and proceed until past the obstacle

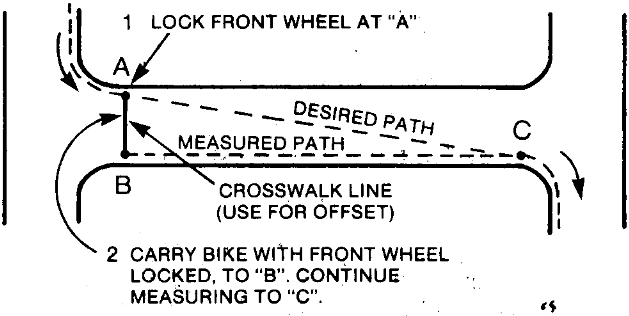
(e) reverse the process with the wheel frozen to return to the shortest possible route

Use this procedure sparingly and report each instance in your application for certification. If you have to do this more than a few times on the course, try again on another day when most of the obstacles are gone.

Dealing with Traffic

It may not be possible to measure some sections of a road course with reasonable safety at any time. The preferred method is to arrange an "escort" which may be an official police escort or simply a large truck equipped with arrows and blinkers used for traffic control.

If the critical section requires a long diagonal run across traffic, you may wish to consider an "offset maneuver." This is performed as follows:



Measure along the (straight) road edge to where a crosswalk or expansion crack lies. Using this as a guide, physically carry the bicycle across the street with the front wheel frozen. Continue the measurement along the opposite side of the road-way. This errs on the side of making the course very slightly longer but it may save your life. When crossing the roadway, **be sure** you cross **perpendicular** to the direction of the roadway.

Freezing the Front Wheel

Many manuevers require or benefit from freezing the front wheel. If you are moving or turning the bicycle, you can freeze the front wheel by applying the front wheel brake. If you need to dismount to mark a split or turn-around point, you may find a **flickstand** useful.

A flickstand is basically a piece of bent wire mounted on a clamp which fastens to the frame of the bicycle, just behind the front wheel. When the bicycle is rolled backwards about three inches against the flickstand, the bent wire locks the front wheel in place, preventing it from turning sideways or rotating. This device is available from most bicycle stores.

Two-Cyclist Riding Techique

When two cyclists measure a race course together, the second cyclist should follow at least two or three blocks behind the first cyclist (this may not be practical with a police escort). The idea is to get two **independent** measurements; i.e., each rider should exercise his/her own judgement as to where the shortest possible route lies. The measurements will not be truly independent if the second cyclist follows directly in the tracks of the first cyclist.

At each mark, the second cyclist just writes down what his/her counter reads at the point marked by the first cyclist. This allows the second cyclist to concentrate more on riding the shortest possible route.

Calibrating with Two Cyclists

When two cyclists calibrate their bicycles at the same time on a single calibration course, it can get crowded at the endpoints. If you frequently measure with a partner, you may wish to modify your calibration course as follows to speed the calibration process:

Course Measurement
Data Sheets

NOTE:

The following pages contain the forms required for Course Certification. **DO NOT** write on these forms. **DO NOT** remove these forms from the booklet.

Simply turn the pages and xerox whatever you need.

This way, the next guy along will still have what he needs!

STEEL TAPING DATA SHEET
(for measuring a calibration course)

Name of Calibration Course ____

City and State ____________________________________ Date ______________

Start Time ______________ Finish Time ______________

Pavement Temperature: Start ______ Finish ______ Average _____
(if you do not use a bimetallic thermometer, the thermometer must be shaded)

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, in whichever formula is appropriate (for Celsius or Fahrenheit temperature). Work out answer to at least seven digits beyond the decimal point.

Correction factor	=	1.0000000	+	.0000116	x	[Temp (° C) - 20]
Correction factor	=	1.0000000	+	.00000645	x	[Temp (° F) - 68]
Correction factor	=					

NOTE: For temperatures below 20° C (68° F), factor is less than one
For temperatures above 20° C (68° F), 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 kilometer). This is not necessary as you may choose instead to use an odd-distance course whose end-points are pre-existing permanent objects in the road to guard against hazards such as repaving. If you adjusted the course, explain what you did.

Final Adjusted Length of Calibration Course ______________________________

CONVERSION FACTORS: 1 foot = 0.3048 meters
1 kilometer = 1000 meters = 3280.84 feet

BICYCLE CALIBRATION DATA SHEET

Date of Measurement ____________

Name of Measurer ________________________________

1. Ride the calibration course 4 times, recording data as follows:

Ride	Start Count	Finish Count	Difference

Pre-measurement Average Count ________

Time of Day ________

Temperature ________

Length of Calibration Course ________________________

WORKING CONSTANT = Number of counts in one kilometer or one mile, **calculated from** Pre-measurement average count, and multiplied by **1.001 "safety factor".**

Working Constant =

2. Now, measure the course, including all intermediate distances, using the working constant. Enter data on the **"Course Measurement Data Sheet".**

3. Recalibrate the bicycle by riding the calibration course 4 times, recording data as follows:

Ride	Start Count	Finish Count	Difference

Post-measure Average Count ________

Time of Day ________

Temperature ________

FINISH CONSTANT = Number of counts in one kilometer or one mile, calculated from Postmeasure average count, and multiplied by **1.001 "safety factor"**

Finish Constant =

Constant for the Day = **Either** the Working Constant **or** the Finish Constant, whichever is the **larger**.

CONSTANT FOR THE DAY = ________________________

Remember, each day's measurement must be preceded and followed by a calibration run. You may measure as much as you want in a day, just so calibration precedes and follows it in the same 24 hour period. This is done to minimize error due to changes in tire pressure from thermal expansion and slow leakage. Frequent recalibration "protects" the previous measurement. A smart measurer will recalibrate frequently—you never know when a flat tire is coming!

CONVERSION FACTOR: 1 mile = 1.609344 kilometers

APPLICATION FOR CERTIFICATION OF CALIBRATION COURSE

1. Name of Calibration Course ______________________________

2. Length of Calibration Course ______________________________

3. City and State ______________________________

4. Date(s) Measured ______________________________

5. Method Used to Measure Calibration Course ______________________________

6. How many times did you measure the calibration course? ______________________________

7. Measuring Team Leader: ______________________________ , ______________

   (name) (telephone #)

   ____

   (address)

   Credentials or Experience:

8. List Names and Duties of Team Members:

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

10. Is this calibration course: STRAIGHT? ______________ PAVED? ______________

11. How are the start and finish points marked?

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

13. Approximate altitude of calibration course ______________________________ .
    Mark end points in a permanent way (concrete or PK nails). Paint will fade. The calibration course, once certified, can be used to measure many courses. TAKE CARE OF IT!

14. If the calibration course was measured by **Electronic Distance Meter (EDM)**, describe on a separate sheet the exact procedures used; also include a copy of the original field notes from the measurement.

15. If the calibration course was measured by **steel tape**, fill out a copy of the calibration course data sheet for steel taping and complete the following:

16. How much tension was applied to the tape while measuring? ______________________________

17. How was this tension maintained? ______________________________

18. Was the tape free of any kinks, crimps or splices? ______________________________

19. Bicycle Check. This is a check against miscounting the number of tape lengths. (If you used 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 ______________

COURSE MEASUREMENT DATA SHEET

Name of Course or Race Name ______________________

Name of Measurer #1 ______		Working Constant #1 ______	
Date ______	Start: Time ______	Temperature ______	
	Finish: Time ______	Temperature ______	
Name of Measurer #2 ______		Working Constant #2 ______	
Date ______	Start: Time ______	Temperature ______	
	Finish: Time ______	Temperature ______	

Measurement Data. Use the first measurement ride to lay out the start/finish points and all intermediate split points. Use the second ride to check the location of **those same points. Do not use two sets of marks!**

Measured Point	Counts for Measurer #1		Counts for Measurer #2	
	Recorded	Elapsed	Recorded	Elapsed

Preliminary Course Length	start-to-finish counts	divide by	working constant	=	measured length
Measurer #1	______	/	______	=	______
Measurer #2	______	/	______	=	______

Difference between lengths #1 and #2	divide by	length #1	=	Measurement comparison (less than 0.0008?)	
______	/	______	=	______	(____) [yes or no]

IMPORTANT. Before you leave the course, compare the two measurements. They should agree to within 0.08%. If the two preliminary measurements do not agree to within 0.08%, something is wrong. Fix it! Then go to the calibration course and recalibrate.

If either of the **Constants for the Day** (for measurements #1 and #2) are **not** the same as the **Working Constant**, recalculate the length of the course here.

Final Course Length	start-to-finish counts	divide by	constant for day	=	length of course
Measurer #1	______	/	______	=	______
Measurer #2	______	/	______	=	______

The length of the race course as measured by the calibrated bicycle is the *lesser* of the two lengths calculated above.

Measured course length ______________. Desired course length ______________

Use a steel tape to add or subtract distance as required to bring the **minimum** length to the same value as the desired course length.

How much did you add or subtract, and where (start, finish, turn-around point)?

____

Note: You need not adjust intermediate split points unless certification is desired for those points as well. Did you adjust the intermediate points and, if so, how?

____

APPLICATION FOR CERTIFICATION OF A ROAD COURSE
The Calibrated Bicycle Method (continued)

21. Does your course contain any turn-around (double-back) points? ________ (YES or NO) If YES, attach a detail of the measured path.

22. Does your course include any winding or "S" curved sections? ________ (YES or NO) If YES, show, by attached example, how you chose the route you measured.

23. Are the runners to be restricted to a route longer than the shortest possible route for any portion of the race course? ________ (YES or NO)
If YES, attach a description of how you plan to insure that the runners follow the measured course.

24. Type of course (check one):

_____ one loop _____ time(s)
_____ figure-8 _____ time(s)
_____ partial loop
_____ complex of different loops
_____ same out/back _____ time(s)
_____ several out/back sections
_____ keyhole (out/loop/back)
_____ point-to-point

25. Straight-Line Distance (as the crow flies) between Start and Finish ____________________

26. Altitude of Race Course (above mean sea level):

start ________ finish ________ highest ________ lowest ________

27. Total Climb (summation of all up-hill altitude changes) ____________________ (optional)

---

28. Type of surface (give percentages):

_____ curbed streets
_____ uncurbed streets/roads
_____ concrete sidewalk
_____ concrete/brick streets/roads
_____ paved bike path
_____ unpaved bike path
_____ trail (single file)
_____ graded dirt road
_____ ungraded dirt road
_____ gravel road
_____ undefined paved surface
_____ undefined dirt surface
_____ undefined grass surface
_____ track (curbed or uncurbed)

If your course includes any unpaved sections, please attach a detail of the method(s) used to measure such sections.

29. Is a description of the exact starting and finishing points (and any turn-around points, if any) attached? This description should include diagrams, including street names and taped distances from the start/finish points to near-by prominent landmarks, so that a stranger could find them. ________ (YES or NO)

30. How did you mark the start and finish points (and turn-around points)?

____

31. Did the same person ride the bicycle on both the calibration course and the race course for any given measurement? ________ (YES or NO)

32. Were both the calibration and the race courses DRY during the calibration and measurement rides: ________ (YES or NO)

33. Did you perform both the pre-measurement and post-measurement calibrations and the measurement of the race course on the same day? ________ (YES or NO)

APPLICATION FOR CERTIFICATION OF A ROAD COURSE
The Calibrated Bicycle Method

1. Name this Course will be Known By ____________________

2. Advertised Race Distance ____________________

3. Location of Start ____________________ Finish (if different) ____________________
   city, state city, state

4. Person in Charge of Measurement:

   ____________ ____________________ (___) ___ - ____
   (name) (address) (telephone)

5. Race Director (if course is measured for a specific race):

   ____________ ____________________ (___) ___ - ____
   (name) (address) (telephone)

6. Is this an application for **recertification** of a previously certified course? If so give the reason(s) for recertification.

CALIBRATION OF BICYCLE

7. Did you calibrate the bicycle on a calibration course previously certified by the Road Running Technical Committee?

   ________ (YES or NO)

   If YES, enclose a copy of the letter or certificate, and map, verifying RRTC certification of the calibration course.

   If NO, you must enclose an Application for Certification of Calibration Course.

8. Is your **bicycle calibration data sheet** attached? ________ (YES or NO)

9. Did you include the factor of 1.001 in your calibration constant? ________ (YES or NO)

SUMMARY OF MEASUREMENTS

10. Date(s) of measurements ____________________

11. How many measurements of the course were made? ____________________

12. Name(s) of measurer(s) ____________________

13. Exact length of course ____________________

14. Difference between longest and shortest measurements ____________________

15. Which measurement was used to establish the final race course and WHY?

16. Is your **course measurement data sheet** attached? ________(YES or NO)

COURSE LAYOUT AND MARKING

17. Is your **course map** attached? ________(YES or NO)

NOTE: The course map need not be to scale but must indicate direction of north. It must be in one color and fit on 8.5x11 paper. Descriptions of the **exact** positions on the **start, finish**, and all **turn-arounds** relative to permanent landmarks must be included on the map. Details of any restricted portions where cones and monitors are required must be detailed. Include a line representing the actual measured path.

18. List all intermediate **splits** (attach list describing the position of each relative to permanent landmarks).

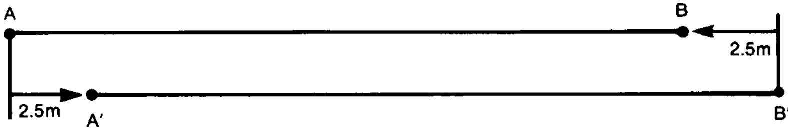
19. How far from the curb (edge of pavement) did you measure on curves? ____________________

20. If your course contains pairs of opposite turns (right-to-left or left-to-right) did you follow the shortest diagonal path?

    ________ (YES or NO)

    If NO, attach a detail of the measured path.

NOTES



In the diagram, points A and B are the endpoints of your original (certified) calibration course. Add points A′ and B′ for a "duplicate" calibration course by offsetting points A′ and B′ by the **same** amount in the **same** direction. The offset should be slightly more than one bicycle length, e.g., 2.5 meters (8 feet). The offset **must** be measured with extreme care using a steel tape. Mark points A′ and B′ with nails and small paint marks which will not be confused with the more prominent paint marks at the primary endpoints A and B.

Now, when two cyclists are calibrating simultaneously, one rides between A and B while the other rides between A′ and B′.

Safety

A course measurer should always wear an orange, reflective, safety vest. A helmet is also advised. These will tend to make you look more "official," like a member of a highway crew **and** it will make you much more visible. Since the route that must be measured is often not the logical route for a cyclist, motorists will not be able to easily predict your direction and try to avoid you.

Even if you cannot arrange an official police escort, a friend following you in a truck with emergency lights flashing can provide considerable protection when measuring with traffic.

When steel-taping or making permanent marks, you may wish to use safety flags or stop signs to add to the protection of the measuring team.

Minimizing Stops to Check the Counter

Electronic devices are available which attach to the front wheel and provide digital readouts you can attach to the handlebars. Although not sufficiently accurate for certification purposes, such devices can alert you to the up-coming location of intermediate split points and measurement end points on your first measurement. Such devices are available in many bicycle stores.

You may also find it convenient to mark (with felt tip pen) all your intermediate stop counts on a sheet of folded 8.5x11 paper and fasten this to the front brake cables with clothes pins for easy reference.

Solid Tires and Avoidance of Flats

A flat (front) tire is a disaster! If you get a flat, **all** measurements made since the last calibration are invalid. You must fix the flat and start over with a new calibration.

Solid tires are one way of avoiding flats. Solid tires require a period of "breaking in" which you should reach after roughly 50 kilometers of riding. Solid tires have two major advantages. First, you eliminate flat tires and the wasted measurements that accompany a flat tire. This allows you to ride the shortest possible route with more confidence since glass fragments are no longer a problem.

Second, the day-to-day and within-day variations in the calibration constant are smaller. Solid tires do not eliminate the need to calibrate before and after measuring but they do reduce differences between the working and finish constants.

Marking the Course

Cheap paint wears off more quickly than more expensive paint. Anything that lasts through the winter is worth it!

Hold spray paint can close to pavement for control but be sure to keep nozzle end higher than the bottom. Shake the can frequently. Clean afterwards by holding can upside down and giving a couple of squirts.

Locating Intermediate Split Points

Many races have signs indicating kilometer or mile points and may have times read to the runners at several points. A "locator" guide describing how to find a painted split point quickly when driving along in a car is often useful. Very little time is available to place signs and drop off timers on race day and such a guide helps assure the runners will get splits at the proper points. Few things are more frustrating to a serious runner than to realize mid-way through the race that the splits are all wrong!

Measuring at Night

For urban race courses on busy streets, the only time that the traffic density is light enough to permit a proper course measurement may be late at night. If you measure at night, you **must** calibrate and recalibrate during the same night under the same conditions as the race course measurement. **Do not** calibrate before sunset, measure at night, and then recalibrate after dawn.

You will need a good generator light system for your bicycle and a flashlight to read the Jones Counter. Use plenty of reflective material such as a vest and reflectors for your bicycle. Wear a helmet. Do not measure alone at night. Have a car behind you with high beams on.

Do not measure at night unless you know exactly where the shortest possible route lies. Visibility may not be good enough to sight distant corners.

Walking the Bicycle

Walking the bicycle removes weight and reduces the counts required to cover a given distance. If this is done while measuring the race course, it will tend to produce a race course that is slightly oversized (which is acceptable). The portions of the course that a bicycle is walked over will be roughly 1% longer than if the bicycle were ridden.

You may find it necessary to walk the bicycle for short distances near intermediate marks, through large potholes or other paving disasters, and occasionally up hills too steep to ride. You might consider measuring down such hills by making temporary marks at the top and bottom and measuring between them in the reverse direction.

You should **never** walk the bicycle over any portion of the calibration course since this will tend to produce short courses.

Measuring on Dirt, Grass, and Sand

Avoid laying out a course over non-paved surfaces. If you must, minimize the distance to be measured over such surfaces. Hard-packed dirt is OK but avoid sand, soft dirt, and deep grass.

The greatest accuracy is obtained by steel-taping all non-paved sections. However, measuring the entire course by a bicycle calibrated on a standard, paved calibration course, is acceptable and, in fact, is the **recommended** procedure since it reduces the chance of error.

The calculations (for start, finish, splits, etc.) can get quite complicated if you piece together a course measured partly by bicycle and partly by steel tape. If you do this, make permanent marks at those points where you change between bicycle and tape measurements.

When you ride the bicycle over non-paved sections, you will tend to get fewer counts than you would riding over the same distance on a paved surface. This will tend to make your course slightly longer. Measuring on firm dirt should not lengthen that part of the course by more than 0.1%; measuring on grass may lengthen that portion by 1% or more; measuring in loose sand may lengthen by more than 3%.

Measuring dirt roads usually presents little problem **if** the road is well graded. If the non-paved road is not graded (usually two ruts) and is winding, it may be virtually impossible to ride the shortest possible route since the proper route would cross the ruts and intermediate ridge at angles which do not permit safe riding. If such sections are encountered and cannot be avoided, they must be steel-taped.

Minimizing Temperature Effects

In many locales, the daily temperature range may be 20°C (36°F) or more. Such temperature extremes usually create a greater difference between the working and finish (calibration) constants. You may reduce this difference by measuring on days when the temperature variation is small, such as on cloudy days or near dawn when the temperature changes slowly.

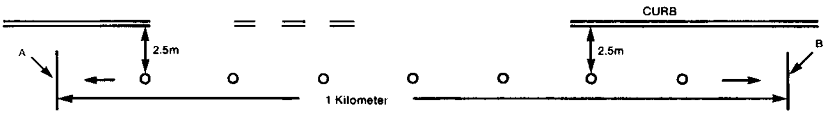
Another way to reduce this effect is more frequent re-calibration runs. If you measure over a period of five or more hours, you may wish to do a set of calibration rides mid-way through your measuring. This is feasible only if the calibration course is not too far from the race course. It does have the additional advantage that it "protects" at least some of your measurements against flats.

Calibration Course

Since you may be calibrating before dawn or after dusk, you may wish to make the paint marks on your calibration course with fluorescent paint for better visibility.

As a warning when approaching the end of the calibration course, an arrow 10 meters or so before the marked endpoints may be helpful. Another useful feature is to paint dots every 100 feet to be used as reference points while calibrating.

If parked cars are a problem, you could establish the calibration course 2.5 meters from the curb.



As a safety measure, you may wish to lay out **two** calibration courses, one on each side of the street so that you are always able to ride legally with traffic. Note that **each** course must be measured and certified separately.

APPENDIX B

Course Layout

If you are measuring an existing race course, consult with the race director to make sure you are measuring the correct course. Find a runner who has run the race to help determine how runners actually run the course.

If you are laying out a new course, find out what restrictions the race director and local authorities may have on where the race may be run. The finish area is especially critical since you will need a traffic-free area with enough room to set up finish chutes, medical and aid stations, results processing areas, and often awards ceremonies. Many courses are laid out from finish to start.

The starting area must be wide enough to accommodate the maximum expected field. Trying to start more than 1000 runners on a two lane road without shoulders creates substantial congestion and delays the back-of-the-pack runners. **Never** lay out a course with a sharp turn within the first hundred meters; the more starting straightaway you have, the better (and safer) the course. Likewise, leave at least a 100 meter straightaway leading into the finish so runners can have a decent finishing sprint.

Avoid crossing traffic where possible. In races, police prefer that runners run with the traffic. This makes it easier, and safer, for the police escort. If you can lay out a course that consists of mostly right turns, you avoid crossing traffic and your measurement job is easier since you will have less traffic to contend with.

When laying out a course for a large race (more than 1000 runners), avoid multiple loop courses and out-and-back courses. Do not lay out a course with three or more loops for large races since monitoring against cheating is nearly impossible. Likewise, a straight out-and-back course requires some type of recording at the turn-around point. This is difficult for large races and should be avoided.

Small races and ultra-marathons are conveniently held on small loop courses, from one to ten kilometers (one-half to six miles) per loop. Certify the loop itself as a **closed loop** course. Once the closed loop is certified, **all** integral multiples of the loop are automatically certified. Thus, you may be able to certify a 100 km course with 10 km of measurement (twice over a 5 km loop).

If the closed loop course can be made an exact standard distance such as 5 km or 5 miles, races of several different lengths may be held. Intermediate splits which are an integral number of loops are also certified and considered valid for record purposes. To set up a closed loop course which is an exact standard distance, refer to the discussion below on laying out a course with fixed start and finish points.

It is important to lay out a reasonably accurate course before doing the actual measurement. One way to do this is to use large-scale maps with a scale of 1 to 5000 (1 cm = 50 meters) or 1 to 6000 (one inch = 500 feet). Such maps may often be obtained at a city or county office. You can buy (about $12) a small tool called a map measurer which can be pushed along on the map to measure distance.

A quick and dirty measurement with your (uncalibrated) bicycle is a good idea since it will give you a rough idea of start and finish points and will familiarize you with riding the shortest possible route. If your chosen course is way off, this is the time to make alterations.

Once you have arrived at a tentative course, consult with the race director and local authorities to determine how much of the roadway will be available to the runners. If the runners are to be restricted to following a longer route while a shorter one is available, it is necessary to include temporary barriers to keep them along the correct path. Instructions such as "stay on the right side" are universally ignored, unless enforcement exists. Note that it is easier to let them run wherever they want on the road and measure the shortest path they can take.

If you measure a restricted route, **it must be coned and monitored** or the certification will be invalid. The restricted route must be marked in such a manner that cones and/or barricades may be properly placed on race day. The positions of barricades and cones must be clearly specified on the course map. Usually, painted lane markings are used as the basis for a restricted route.

If you need to adjust the course, small adjustments can be made by moving the start, finish or turn-around points. If the needed adjustment is large, you may need to reroute the course and make additional bicycle measurements. Making changes in the middle of a course is usually awkward.

If both the start and finish must be at fixed points, you should have a turn-around point somewhere on the course. The position of the turn-around may be varied to get exactly the desired length. Remember when you move a turn-around, the runners will run twice the distance you move the turn.

Mark all important points on the final course carefully and permanently. Determine their locations relative to fixed landmarks so they can be found again in case of repaving or other changes in the road surface. Make sure provisional marks are not confused with final marks. Provisional marks may be obliterated by spraying over them with black spray paint (on asphalt) or simply "block" them out in the original color.

The entire race course should be inspected just before the race by someone who knows the course as it was measured. Be sure the start, finish, and turn-around points are correctly located. Check the positions of course monitors and marshalls as well as the positions of cones and barricades. If there is a lead car, someone who knows the route should be in the lead vehicle. This person should also have a map of the course. In any complicated undertaking involving lots of people, there are bound to be errors. Anticipate them. Check and double check.

APPENDIX C

Example of Course Measurement

Setting Up the Calibration Course

It is 7:15 AM on 7 October 1982 in Elysium, OH. You arrive at your pre-selected site for the calibration course on Fargo Road with your two trusty helpers, Ralph Doe and Susan Marker. This section of Fargo Road is straight and level, recently paved, with no cross-traffic and little traffic of any kind. You have checked your equipment list and everything is accounted for.

You have decided to set up a one kilometer (1000 meter) calibration course since the race course will be 10 kilometers. You couldn't find a metric tape in your local hardware store so you are using a 100 foot tape instead. Since a kilometer is 3280.84 feet, you will be laying out 32 and a fraction lengths of the 100 foot tape.

Locate the start. There is a storm drain just south of the intersection of Fargo Road with Turtle Road. This will make a nice permanent reference. You drive a PK nail into the pavement, 18 inches west of the east edge of Fargo Road and exactly 2.0 feet south of the south edge of the storm drain located in front of 2317 Fargo Road. This will be the permanent northern endpoint of your calibration course (point A).

You lay the thermometer on the pavement, standing so that you shade the thermometer. After three minutes, the temperature seems to have stopped changing. It reads 53°F. Susan records the start time and temperature.

Ralph holds the 100 ft mark of the tape over the PK nail at point A. You grab the "Zero" end and extend the tape (southward) while walking it out to its full extension of 100 feet. You are using the Zero end because that is the end with a ring to which you can attach a spring balance. You and Ralph jiggle the tape as needed until it lies straight and flat, and you check that your end is still 18 inches from the curb. Then you start pulling on the spring balance until it reaches 10 pounds-force, moving the tape slowly forward.

In the meantime, Susan sticks a piece of masking tape on the roadway at your end of the tape. When you have the tape steadily under tension and Ralph signals that his end is over the mark, Susan puts a thin black mark on the masking tape alongside the Zero mark of the measuring tape. Susan then numbers the piece of masking tape with a "1" to indicate this is the first tape length.

You continue in this manner until you have marked 32 one hundred foot sections. At this point, you mark an 80 foot section.

The procedure is exactly as before except that Ralph uses the 80 foot mark instead of the 100 foot mark on the tape. You still pull the spring balance with **ten** pounds-force (not eight!). The marked point (which we'll call "B") is now 3280 feet south of point A. It isn't necessary to get exactly 3280.84 feet at this step since a final adjustment will be made later. Susan enters 32 tape lengths x 100 feet each, with a "partial" tape length of 80 feet.

You now start measuring back (northward) from point B, in 100 foot lengths, using new pieces of masking tape which will each be intermediate to the previous marks. You use a **red** pen this time, to clearly distinguish these marks from the old ones. Note that you had to turn the tape around at point B since only the Zero end has a ring where you can attach the spring balance.

As before, you lay out 32 full 100 foot tape lengths. However, you measure the last interval to the PK nail at point A. This is found to be 79 feet 8¾ inches. Thus, according to your second measurement, the distance between the permanently marked point A and your temporary point B is 3¼ inches short of 3280 feet. The second measurement is 3279 feet 8¾ inches or 3279.73 feet in decimal form.

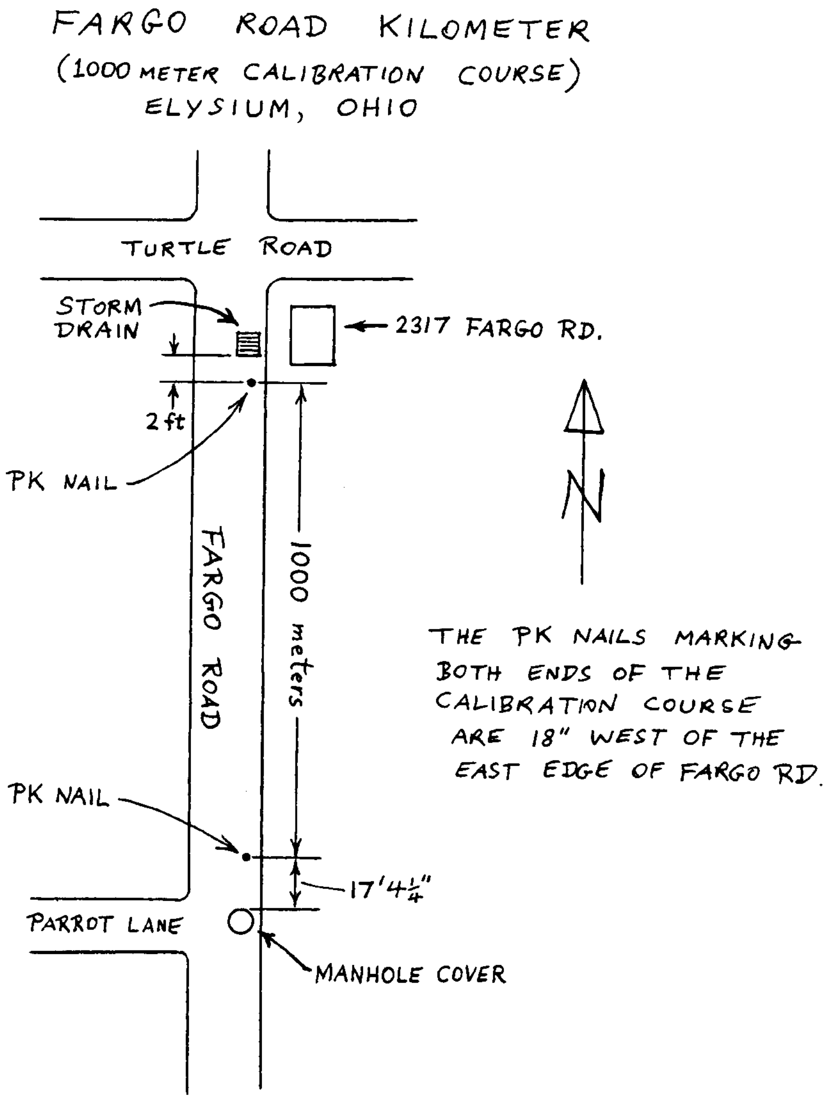
You repeat the temperature reading as before and find it to be 59°F. Susan records this datum.

You now calculate the temperature-corrected average measured distance between points A and B, as instructed in the Steel Taping Data Sheet. The correct measurement is 3279.61 feet. Since your desired calibration course length is one kilometer or 3280.84 feet, you must now lengthen the tentative course by 1.23 feet or 1 ft 2¾ inches. You do this by moving point B to a point 1 ft 2¾ inches further south. Using the tape measure once more, you find that the corrected point B is 17 ft 4¼ inches north of the north edge of the manhole in the center of the intersection of Fargo Road and Parrot Lane.

You are now almost finished. But, before permanently marking point B, you check to make sure you haven't missed a whole tape length somehow. You take your bicycle off of the rack and ride it around for a few minutes to warm up the tires. You place the bicycle's front axle over the north end-point and record a count of 12546. You then ride southward one 100 foot tape length (being careful to use a 100 ft interval rather than the 80 foot interval!), and stop with the front axle over the mark. You record a count of 12833. The difference, corresponding to one foot length, is 287 counts.

You now return to the northern endpoint (point A) and, pointing the bike southward again, note a counter reading of 13217 with the front axle over the mark. You ride the bicycle over the full calibration course, stopping with the front axle over the corrected southern endpoint. You record a count of 22622. The difference is 9405 counts. Dividing the full course count of 9405 by the 100 ft count of 287 yields a course length of 32.77 tape lengths which, for such a rough check, is in excellent agreement with the intended course length of 32.8084 tape lengths.

Finally, you put a PK nail at the corrected endpoint (point B) of your one kilometer course. You thank Ralph and Susan and head home to fill out the forms necessary to obtain certification on your new calibration course.



STEEL TAPING DATA SHEET
(for measuring a calibration course)

Name of Calibration Course FARGO ROAD KILOMETER

City and State ELYSIUM, OHIO Date 7 OCT 1982

Start Time 7:15 AM Finish Time 9:00 AM

Pavement Temperature: Start 53° F Finish 59° F Average 56° F
(if you do not use a bimetallic thermometer, the thermometer must be shaded)

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.

32 × 100' + 80' = 3280.00 ft

# tape lengths	distance per tape length	partial tape length	measured distance
32	100'	80'	3280.00 ft

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.

# tape lengths	distance per tape length	partial tape length	measured distance
32	100'	79' 8 3/4"	3279.73 ft

3. Average Raw (uncorrected) Measurement of Course 3279.865 ft

4. Temperature Correction. Use the average pavement temperature during measurement, in whichever formula is appropriate (for Celsius or Fahrenheit temperature). Work out answer to at least seven digits beyond the decimal point.

Correction factor = 1.0000000 + .0000116 × [Temp (°C) - 20]
Correction factor = 1.0000000 + .00000645 × [Temp (°F) - 68]
Correction factor = 1.0000000 + .00000645 × (56-68)
= 1.0000000 + (-.0000774) = 0.9999226

NOTE: For temperatures below 20° C (68° F), factor is less than one
For temperatures above 20° C (68° F), factor is greater than one

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

0.9999226 × 3279.865 ft = 3279.61 ft

correction factor	avg. raw measurement	corrected measurement
0.9999226	3279.865 ft	3279.61 ft

6. If you wish, you may now adjust the course to obtain an even distance (such as one kilometer). This is not necessary as you may choose instead to use an odd-distance course whose end-points are pre-existing permanent objects in the road to guard against hazards such as repaving. If you adjusted the course, explain what you did. ADDED 1' 2 3/4" by moving Southern endpoint further south (3280.84 - 3279.61) = 1.23'

Final Adjusted Length of Calibration Course 1 KILOMETER

CONVERSION FACTORS: 1 foot = 0.3048 meters
1 kilometer = 1000 meters = 3280.84 feet

APPLICATION FOR CERTIFICATION OF CALIBRATION COURSE

1. Name of Calibration Course FARGO ROAD KILOMETER
2. Length of Calibration Course 1 Kilometer (EXACTLY)
3. City and State ELYSIUM OHIO
4. Date(s) Measured 7 OCT 1982
5. Method Used to Measure Calibration Course Steel Tape
6. How many times did you measure the calibration course? 2
7. Measuring Team Leader: JOHN DOE (name) (614) 123-4567 (telephone #)
   123 Accurate Rd, Perfection OH 43607 (address)

   Credentials or Experience: has helped measure other calibration courses
8. List Names and Duties of Team Members:
   JOHN DOE - lead tapeman RALPH DOE - rear tapeman
   SUSAN MARKER - marked tape lengths and kept notes
9. Submit a **map** of this calibration course, showing the name of the road (and relevant cross streets), and the exact locations of start and finish points, including taped distances from nearby permanent landmarks. ENCLOSED
10. Is this calibration course: STRAIGHT? YES PAVED? YES
11. How are the start and finish points marked? PK Nails and Paint
12. Are the start and finish points located in the road where a bicycle wheel can touch them or elsewhere? in the road
13. Approximate altitude of calibration course 235 meters
   Mark end points in a permanent way (concrete or PK nails). Paint will fade. The calibration course, once certified, can be used to measure many courses. TAKE CARE OF IT!
14. If the calibration course was measured by **Electronic Distance Meter (EDM)**, describe on a separate sheet the exact procedures used; also include a copy of the original field notes from the measurement. N/A
15. If the calibration course was measured by **steel tape**, fill out a copy of the calibration course data sheet for steel taping and complete the following: ENCLOSED
16. How much tension was applied to the tape while measuring? 10 pounds
17. How was this tension maintained? Spring Scale - held by lead tapeman
18. Was the tape free of any kinks, crimps or splices? Yes
19. Bicycle Check. This is a check against miscounting the number of tape lengths. (If you used a gross measurement check other than a bicycle, please explain.)
   A. Counts for full calibration course 22622 - 13217 = 9405
   B. Counts for one tape length 12833 - 12546 = 287
   C. Divide A by B 32.77
   D. Number of full tape lengths 32.8084

   } close enough to show number of tape lengths is correct

Calibrating the Bicycle

You take your trusty bicycle with tires fully inflated and pack of equipment out to the calibration course you previously submitted for certification. It is 7:15 AM. You determine the temperature as before (53°F) and ride the bicycle around for roughly five minutes to warm the tires up. You record the time and temperature.

You position the front axle of the bicycle over the start point on the calibration course. You record the start count as 116091. You ride the calibration course, carrying your equipment. You carefully stop the bicycle with the front axle positioned directly over the end point. You record the finish count as 125499.

You then repeat this procedure three more times, recording the start and finish counts. Each time you reverse direction, you freeze the front wheel with the handbrake before turning the bike around. In this way, your finish count for one ride is your start count for the next ride. This isn't necessary but it makes it slightly easier to calculate your average count.

You now sit down and fill in the first part of the **Bicycle Calibration Data Sheet.** The average pre-measurement count works out to be 9407.25 counts. If you had been using an odd-distance calibration course, you'd have to convert this to one kilometer (or one mile), but in your case, your calibration course is already one kilometer. You multiply your average pre-measurement count by 1.001 to obtain your **working constant** of 9416.6572 counts per kilometer. You raise this to 9417 and will use this value for preliminary course markings. Also, since you will be marking some mile splits, you multiply the 9416.6572 figure by the conversion factor of 1.609344 (see Appendix E) to obtain a mile constant of 15154.64 which is raised to 15155 counts per mile.

You now measure the course (see next section).

After you have completed your two measurements of the race course, you return to the calibration course. It is now 10:30 AM. You check the temperature and record 63°F.

You calibrate the bicycle just as you did for the pre-measurement calibration with four rides. This time the average count is 9399.75. You multiply this by 1.001 to obtain your **finish constant** of 9409.1497 which is raised to 9410 counts per kilometer.

Since the **finish constant** is smaller than the **working constant,** the **constant for the day** is taken to be the **working constant** or 9417 counts per kilometer. If you start your measurements in the early morning, you will generally find your working constant to be larger than your finish constant. This means that the preliminary course marks will not need to be adjusted for the change in the bicycle calibration.

BICYCLE CALIBRATION DATA SHEET

Date of Measurement 16 OCT 1982

Name of Measurer JOHN DOE

1. Ride the calibration course 4 times, recording data as follows:

Ride	Start Count	Finish Count	Difference
1	116091	125499	9408
2	125499	134905	9406
3	134905	144314½	9409.5
4	144314½	153720	9405.5

Pre-measurement Average Count 9407.25

Time of Day 7:15 AM

Temperature 53° F

Length of Calibration Course 1.00000 Kilometers

WORKING CONSTANT = Number of counts in one kilometer or one mile, calculated from Pre-measurement average count, and multiplied by **1.001 "safety factor"**.

Working Constant = 9407.25 X 1.001 = 9416.66 counts / Km
(use 9417 cnts / Km for course layout)
also 9416.66 cnts/km X 1.609344 = 15154.64 cnts/mile
(use 15155 cnts/mile for mile splits)

2. Now, measure the course, including all intermediate distances, using the working constant. Enter data on the **"Course Measurement Data Sheet"**.

3. Recalibrate the bicycle by riding the calibration course 4 times, recording data as follows:

Ride	Start Count	Finish Count	Difference
1	342567	351965½	9398.5
2	351965½	361366	9400.5
3	361366	370765	9399
4	370765	380166	9401

Post-measure Average Count 9399.75

Time of Day 10:30 AM

Temperature 63° F

FINISH CONSTANT = Number of counts in one kilometer or one mile, calculated from Postmeasure average count, and multiplied by **1.001 "safety factor"**

Finish Constant = 9399.75 X 1.001 = 9409.15 cnts/Km

Constant for the Day = **Either** the Working Constant **or** the Finish Constant, whichever is the **larger**.

CONSTANT FOR THE DAY = 9417 counts per Kilometer

Remember, each day's measurement must be preceded and followed by a calibration run. You may measure as much as you want in a day, just so calibration precedes and follows it in the same 24 hour period. This is done to minimize error due to changes in tire pressure from thermal expansion and slow leakage. Frequent recalibration "protects" the previous measurement. A smart measurer will recalibrate frequently—you never know when a flat tire is coming!

CONVERSION FACTOR: 1 mile = 1.609344 kilometers

Measuring the Race Course

The race course has already been defined in terms of the route and desired start and finish points. The course is to be a 10 kilometer course. The start may be adjusted but the finish line is fixed.

You have completed your pre-measurement calibration rides and have determined your working constant to be 9417 counts per kilometer (15155 counts per mile). You wish to lay out mile splits and splits for one and five kilometers (5 km splits are recommended for all metric races and the half and full marathons).

You mark the finish line in the pavement on Turtle Road and note its location as 37 feet west of the "No Parking" sign by the Weed Shoe Store. You place the front axle of the bicycle over the finish line and rotate the wheel forward until you reach an even thousands of counts (154000 counts). This simplifies the arithmetic but is not required. In your notebook, you record the initial count and calculate the count for each intended split, working backwards from the finish to the starting line.

These counter readings are calculated as follows. First you work out the metric splits:

Finish				=	154000 counts
5 km	154000	+	5 x 9417 cnt/km	=	201085 counts
1 km	154000	+	9 x 9417 cnt/km	=	238753 counts
Start	154000	+	10 x 9417 cnt/km	=	248170 counts

Knowing what the count will be at the starting line, you work backwards to figure out what the count will be at each mile split.

Start				=	248170 counts
1 mile	248170	-	15155 cnt/mi	=	233015 counts
2 miles	233015	-	15155 cnt/mi	=	217860 counts
3 miles	217860	-	15155 cnt/mi	=	202705 counts
4 miles	202705	-	15155 cnt/mi	=	187550 counts
5 miles	187550	-	15155 cnt/mi	=	172395 counts
6 miles	172395	-	15155 cnt/mi	=	157240 counts

After computing all these counts, you arrange them in a single list, in the same order as you will come to them in the measurement, from finish to start.

You check the temperature and record the time and temperature. You mount the bicycle and ride, checking the count periodically. You make a sharp right-hand turn onto Fargo Road, staying close to the right-hand curb as you round the corner. Since the next turn will be a left, you sight a straight diagonal that will take you to the curb at the northeast corner of the intersection of Fargo and James Roads. Following this shortest course, you ride until you reach a count of 157240. You dismount and paint a short line and a small "6" on the pavement at the position of the front axle, indicating the tentative six mile mark. You record the mark as located opposite the center of the driveway at 2180 Fargo Road.

You continue the diagonal path to the James Road intersection. At this point, you know that the next turn will also be a left turn. You find the corner to be gravelly and runners could cut here. You note that a cone and monitor must be placed at this corner to keep the runners on the pavement. You measure following a path close to the curb on the north side of James Road. As you reach your count of 172395, you dismount and mark the tentative five mile point.

Your next turn is left onto a winding bike path. You carefully follow the shortest route, crossing from one side of the path to the other as needed to follow the shortest route. You note and mark the four mile, 5 kilometer, and three mile marks.

Your next turn is a left onto River Street. As soon as you can see a straight path for the south-west corner of River Street and the bike path, you head for it. The next turn will be a right, heading north onto Joy Street. You sight the diagonal and ride the shortest route to the northeast corner of Joy and River Streets. You note and mark the two mile mark.

Your tentative turn-around point on Joy Street is adjacent to a high-voltage tower. You head for the middle of the street adjacent to the tower. When you are opposite the tower, you stop and "freeze" the front wheel. You mark the turn-around with a line and a "T." You record the count. You then carefully reverse the direction of the bicycle while holding the front wheel frozen. You now sight for the northwest corner of Joy Street and Turtle Road where you will make a right turn, noting and marking the tentative one mile and one kilometer marks enroute.

You round the last corner and stay to the north side of Turtle Road. When the counter reaches 248170, you have reached your tentative starting line. You mark as before and paint a small "S" on the pavement next to the line. You then locate and record that the tentative starting line is 1.0 feet west of the telephone pole #3014-6C in front of Mergor Hardware Store at 2717 Turtle Road.

Now you are ready for the return measurement. You again hold the front axle of the bicycle over the tentative starting line and rotate the wheel forward until the counter reads an even number of 100's (248200). You mount and ride the course in the direction it will be run. This time, you do not need to make any calculations before riding to figure out where to stop your bicycle. You simply stop at each of the marks you've painted on the road during your first measurement (splits and turn-around point). At each such mark, you record exactly what your counter reads when the front axle is directly over the previously painted mark. You continue in this manner all the way to the finish line.

The final count is 342326. You calculate the start-to-finish counts for measurement #1 as 94170 and for measurement #2 as 94126.

You divide each start-to-finish count by the working constant to obtain the preliminary course length for each measurement. You record these as 10,000 meters and 9,995.33 meters. Their difference is 4.67 meters. You then divide this difference by course length #1 (10,000 m) and note the two measurements differ by 0.0467% which is less than the 0.08% maximum allowable for tolerance.

You are now ready to recalibrate the bicycle.

After performing your post-measurement calibration runs, you find that the finish constant is smaller than the working constant based on the pre-measurement calibration runs. This means that you only need to adjust for the difference between the lesser of the two measurement runs and the desired distance.

The lesser of the two measurements gave you a distance of 9,995.33 meters. This is the "official" measured length of the tentative course. To bring the course up to the full desired distance of ten kilometers, it must be lengthened by another 4.67 meters.

At this point you must convert back to the English system since you are using a non-metric tape. You check Appendix E and note the conversion between meters and feet is 0.3048 meters equals one foot. Dividing the 4.67 meters by 0.3048 meters per foot gives you 15.32 feet or 15 feet 4 inches which is the distance that you need to lengthen your course by to bring it up to the full 10 kilometers.

Rather than adjust the starting line, you opt to adjust the turn-around point. Using your steel tape, you measure 7'8" north from your tentative turn-around point and make a permanent mark, using concrete nails pounded into the pavement. You also mark the turn-around with spray paint and a "T" for turn-around.

Since the difference between the marked intermediate split points and the split points that would result from using the lesser measurement value would not be greater than 5 meters (the overall adjustment was 4.67 meters), you opt to leave the intermediate split point marks where they are and mark them with concrete nails and spray paint.

You return to the start/finish area and make permanent marks for the start and finish lines.

You now return home and have lunch before sitting down to fill in the blanks in the forms for certification. You are satisfied with the morning's work.

COURSE MEASUREMENT DATA SHEET

Name of Course or Race Name ELYSIUM 10K

Name of Measurer #1 JOHN DOE — Working Constant #1 9417 cnt/Km (15155/mile)

Date 16 OCT 1982 Start: Time 7:45 AM — Temperature 53°F

Finish: Time 9:00 AM — Temperature 57°F

Name of Measurer #2 JOHN DOE — Working Constant #2 9417 cnt/Km

Date 16 OCT 1982 Start: Time 9:10 AM — Temperature 57°F

Finish: Time 10:15 AM — Temperature 62°F

Measurement Data. Use the first measurement ride to lay out the start/finish points and all intermediate split points. Use the second ride to check the location of **those same points. Do not use two sets of marks!**

Measured Point	Counts for Measurer #1 Recorded	Counts for Measurer #1 Elapsed			Counts for Measurer #2 Recorded	Counts for Measurer #2 Elapsed	
FINISH	154000	3240		FINISH	342326	3237	
6 mile	157240	15155	47085		339089	15145	47049
5 mile	172.395	15155			323944	15139.5	
4 mile	187550	15155			308.804.5	15147.5	
5 Km	201085	15155		5 Km	295277	15151	
3 mile	202705	15155	47085		293657	15149.5	47077
2 mile	217860	15155			278506	15156.5	
1 mile	233015				263356.5		
START	248170			START	248200		

Preliminary Course Length	start-to-finish counts	divide by	working constant	=	measured length
Measurer #1	94170	/	9417	=	10.00000 Km
Measurer #2	94126	/	9417	=	9.99533 Km

(lesser measurement)

Difference between lengths #1 and #2	divide by	length #1	=	Measurement comparison (less than 0.0008?)	
0.00467 Km	/	10.00 Km	=	0.000467	(YES) (yes or no)

IMPORTANT. Before you leave the course, compare the two measurements. They should agree to within 0.08%. If the two preliminary measurements do not agree to within 0.08%, something is wrong. Fix it! Then go to the calibration course and recalibrate.

If either of the **Constants for the Day** (for measurements #1 and #2) are **not** the same as the **Working Constant**, recalculate the length of the course here.

Final Course Length	start-to-finish counts	divide by	constant for day	=	length of course
Measurer #1		/		=	
Measurer #2		/		=	

(not needed since working constant = constant for the day)

The length of the race course as measured by the calibrated bicycle is the *lesser* of the two lengths calculated above.

Measured course length 9995.33 meters. Desired course length 10,000 meters

Use a steel tape to add or subtract distance as required to bring the **minimum** length to the same value as the desired course length. 4.67 meters ÷ 0.3048 m/ft = 15.32 feet

How much did you add or subtract, and where (start, finish, turn-around point)?

added 4.67 m or 15'4" by moving turn-around 7'8" to north

Note: You need not adjust intermediate split points unless certification is desired for those points as well. Did you adjust the intermediate points and, if so, how?

No

APPLICATION FOR CERTIFICATION OF A ROAD COURSE
The Calibrated Bicycle Method

1. Name this Course will be Known By ELYSIUM 10K
2. Advertised Race Distance 10 Kilometers
3. Location of Start ELYSIUM OHIO (city, state) Finish (if different) Same (city, state)
4. Person in Charge of Measurement:
   JOHN DOE (name), 123 Accurate Rd, Perfection OH 43807 (address) (614) 123-4567 (telephone)
5. Race Director (if course is measured for a specific race):
   M. Offut (name), 82 Jalousie Blvd, Altibor OH (address) (614) 555-6602 (telephone)
6. Is this an application for **recertification** of a previously certified course? If so give the reason(s) for recertification. NO

CALIBRATION OF BICYCLE

7. Did you calibrate the bicycle on a calibration course previously certified by the Road Running Technical Committee? NO (YES or NO)
   If YES, enclose a copy of the letter or certificate, and map, verifying RRTC certification of the calibration course.
   If NO, you must enclose an Application for Certification of Calibration Course. ENCLOSED
8. Is your **bicycle calibration data sheet** attached? YES (YES or NO)
9. Did you include the factor of 1.001 in your calibration constant? YES (YES or NO)

SUMMARY OF MEASUREMENTS

10. Date(s) of measurements 16 OCT 1982
11. How many measurements of the course were made? 2
12. Name(s) of measurer(s) JOHN DOE
13. Exact length of course 10.00000 Kilometers
14. Difference between longest and shortest measurements 4.67 meters
15. Which measurement was used to establish the final race course and WHY?
    2nd Ride - indicated the tentative course to be shorter
16. Is your **course measurement data sheet** attached? YES (YES or NO)

COURSE LAYOUT AND MARKING

17. Is your **course map** attached? YES (YES or NO)

NOTE: The course map need not be to scale but must indicate direction of north. It must be in one color and fit on 8.5x11 paper. Descriptions of the **exact** positions on the **start, finish**, and all **turn-arounds** relative to permanent landmarks must be included on the map. Details of any restricted portions where cones and monitors are required must be detailed. Include a line representing the actual measured path.

18. List all intermediate **splits** (attach list describing the position of each relative to permanent landmarks). Every mile, 1 km, 5 km (see attached)
19. How far from the curb (edge of pavement) did you measure on curves? 30 cm (1 foot)
20. If your course contains pairs of opposite turns (right-to-left or left-to-right) did you follow the shortest diagonal path? YES (YES or NO)
    If NO, attach a detail of the measured path.

APPLICATION FOR CERTIFICATION OF A ROAD COURSE
The Calibrated Bicycle Method (continued)

21. Does your course contain any turn-around (double-back) points? YES (YES or NO) If YES, attach a detail of the measured path. see Course Map

22. Does your course include any winding or "S" curved sections? YES (YES or NO) If YES, show, by attached example, how you chose the route you measured. See Course Map

23. Are the runners to be restricted to a route longer than the shortest possible route for any portion of the race course? NO (YES or NO)
If YES, attach a description of how you plan to insure that the runners follow the measured course.

24. Type of course (check one):

- ____ one loop ____ time(s)
- ____ figure-8 ____ time(s)
- ____ partial loop
- ____ complex of different loops
- ____ same out/back ____ time(s)
- ____ several out/back sections
- ✓ keyhole (out/loop/back)
- ____ point-to-point

25. Straight-Line Distance (as the crow flies) between Start and Finish 21 meters

26. Altitude of Race Course (above mean sea level):
start 778' finish 778' highest 787' lowest 738'

27. Total Climb (summation of all up-hill altitude changes) ____________ (optional)

28. Type of surface (give percentages):

- 45 curbed streets
- 25 uncurbed streets/roads
- ____ concrete sidewalk
- ____ concrete/brick streets/roads
- 30 paved bike path
- ____ unpaved bike path
- ____ trail (single file)
- ____ graded dirt road
- ____ ungraded dirt road
- ____ gravel road
- ____ undefined paved surface
- ____ undefined dirt surface
- ____ undefined grass surface
- ____ track (curbed or uncurbed)

If your course includes any unpaved sections, please attach a detail of the method(s) used to measure such sections.

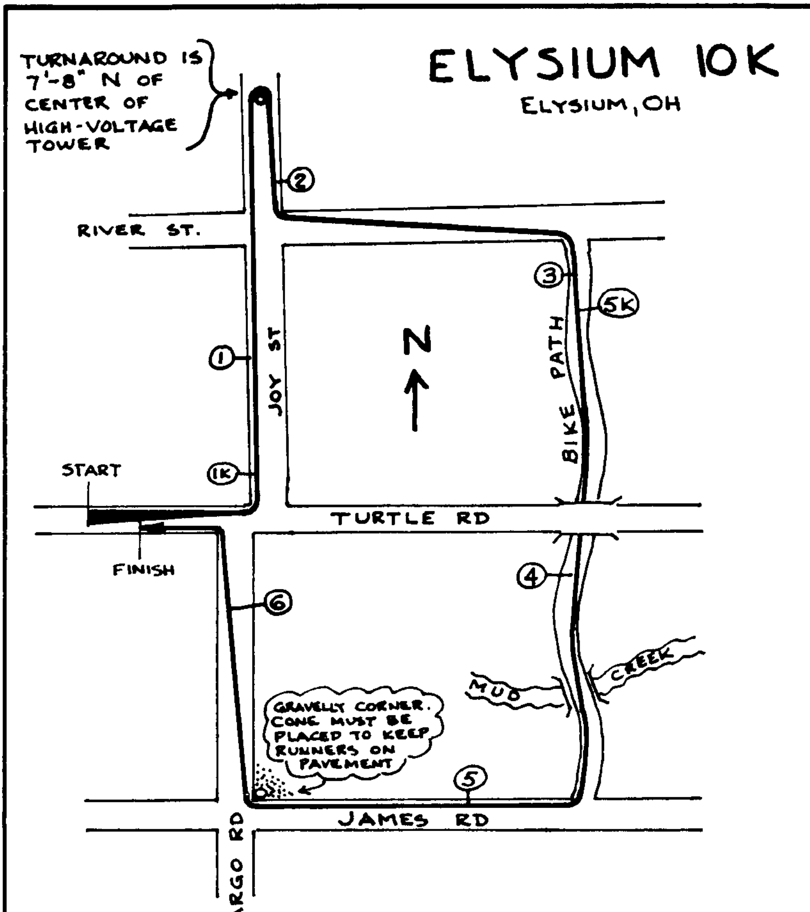
29. Is a description of the exact starting and finishing points (and any turn-around points, if any) attached? This description should include diagrams, including street names and taped distances from the start/finish points to near-by prominent landmarks, so that a stranger could find them. (See Course Map) YES (YES or NO)

30. How did you mark the start and finish points (and turn-around points)?
Paint and Concrete Nails

31. Did the same person ride the bicycle on both the calibration course and the race course for any given measurement? YES (YES or NO)

32. Were both the calibration and the race courses DRY during the calibration and measurement rides: YES (YES or NO)

33. Did you perform both the pre-measurement and post-measurement calibrations and the measurement of the race course on the same day? YES (YES or NO)



START - 16' 4" W OF TP #3014-6C IN FRONT OF MERGOR HARDWARE, 2717 TURTLE RD.

FINISH - 37 FT W OF "NO PARKING" SIGN IN FRONT OF WEED SHOE STORE, 2953 TURTLE RD.

MEASURED BY JOHN DOE, PERFECTION, OH
16 OCTOBER 1982

ELYSIUM 10 K

LIST OF MEASURED POINTS

START :	1 ft W. OF T.P. #3014-6C IN FRONT OF MERGOR HARDWARE STORE, 2717 TURTLE RD, ELYSIUM, OH.
1 km :	43 ft. N OF LIGHT POLE AT NW CORNER TURTLE & JOY.
1 mile :	8 ft N OF "JOY CAFE" SIGN ON JOY ST.
Turn-around*	7'8" N OF CENTER OF HIGH-VOLTAGE TOWER
2 mile :	4 ft N OF "BURIED CABLE" SIGN ON JOY ST.
3 mile :	17 ft S OF DRINKING FOUNTAIN ON BIKE PATH
5 km :	23 ft S OF S. EDGE OF PUBLIC RESTROOMS ON BIKE PATH.
4 mile :	68 ft N OF "NO DOGS ALLOWED" SIGN ON BIKE PATH.
5 mile :	3 ft W OF T.P. # 3004-8B ON JAMES RD.
6 mile :	CENTER OF DRIVEWAY, 2180 FARGO RD.
FINISH :	37 ft W OF "NO PARKING" SIGN IN FRONT OF WEED SHOE STORE, 2953 TURTLE RD, ELYSIUM, OH.

* Turn-around description includes final course adjustment.

Course Maps

One of the most valuable results of your paper work will be your course map. Not only should it demonstrate to the certifier the manner in which you measured your course, but it should document **exactly** how the course is laid out and where the crucial start, finish and turn-around points are located.

The following examples of course maps demonstrate there are many ways to draw maps. However, they **all** clearly show how the course is to be run and where crucial points are located. Note in particular that each map shows how the shortest possible route was followed. This assures the regional certifier that the measurer was aware of and followed the shortest possible route in the measuring.

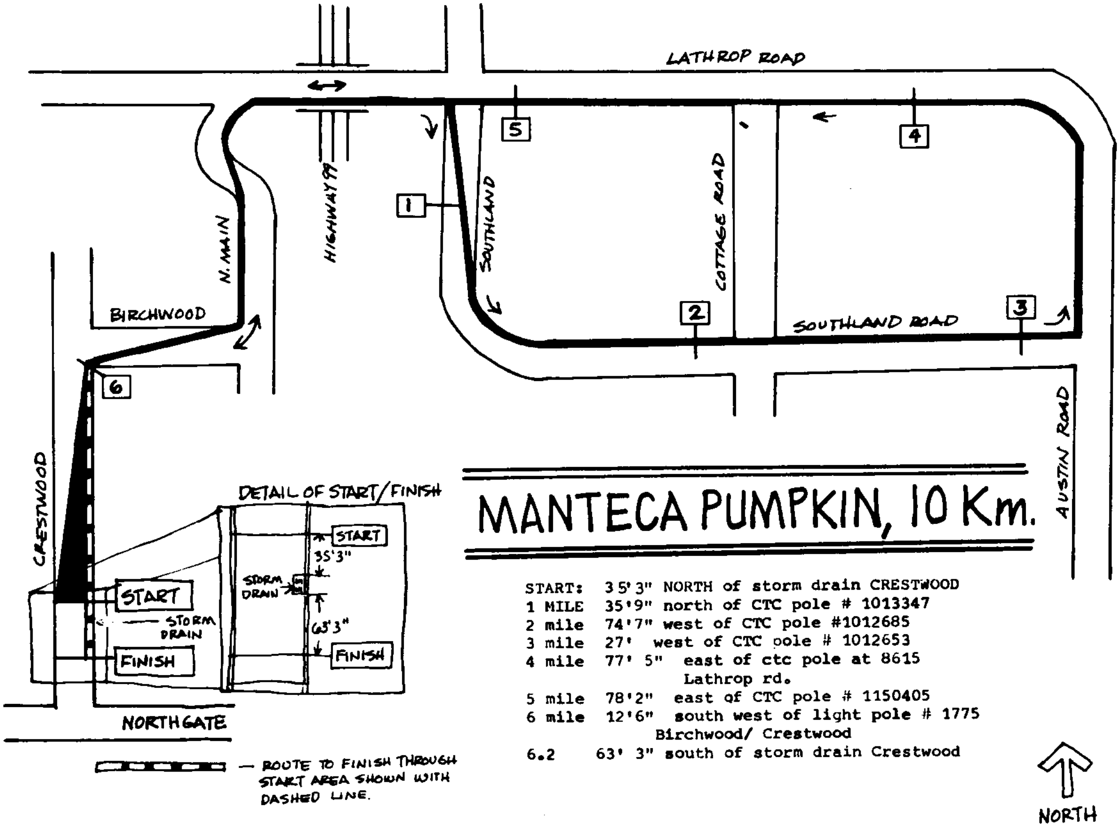
The Manteca Pumpkin 10 km shows a fairly simple keyhole course with only one **S-curve** (measured twice) and two **diagonals** across traffic. Note the blow-up of the start/finish area. Note also that the runners are kept to the **inside** of the loop and are allowed full use of the roadway on all portions of this course. The lack of a 5 km split is a deficiency.

The DC Hometown Run (15 km) in Washington, DC, is a single loop course which is more complex. Note several sections where the **runners are restricted** to a portion of the roadway which should be coned and monitored during the race. Names of streets the course follows are given as well as major cross-streets. Note that 5 and 10 km splits are given. The following page provides detailed blow-ups for locating all split points.

The Woodland Park 10 km in San Marcos, CA, illustrates another nice feature, the **course profile**. Not only is this a nice feature for a race flyer but it makes it quite easy to calculate the total climb or total gain in elevation. Again, the map provides a **minimum** of extraneous detail.

The Kaw City 8 km in Kaw City, OK, illustrates proper measurement of a **turn-around** point. The course is classified as an out-and-back since only 20% of the course is a loop and the start and finish are 109 meters apart. Note the detailed description of the location of the turn-around point and metric splits.

Still more complicated course maps could be shown but these would be comprised of the same kind of features, just more of them. Remember the best course is the simplest course, i.e., the one that requires the least monitoring and is easy for the runners to follow. The more complicated the course, the more monitors you need and the course map will take longer to draw. The more turns you have, the slower the course will be for the runners. Start with something simple.

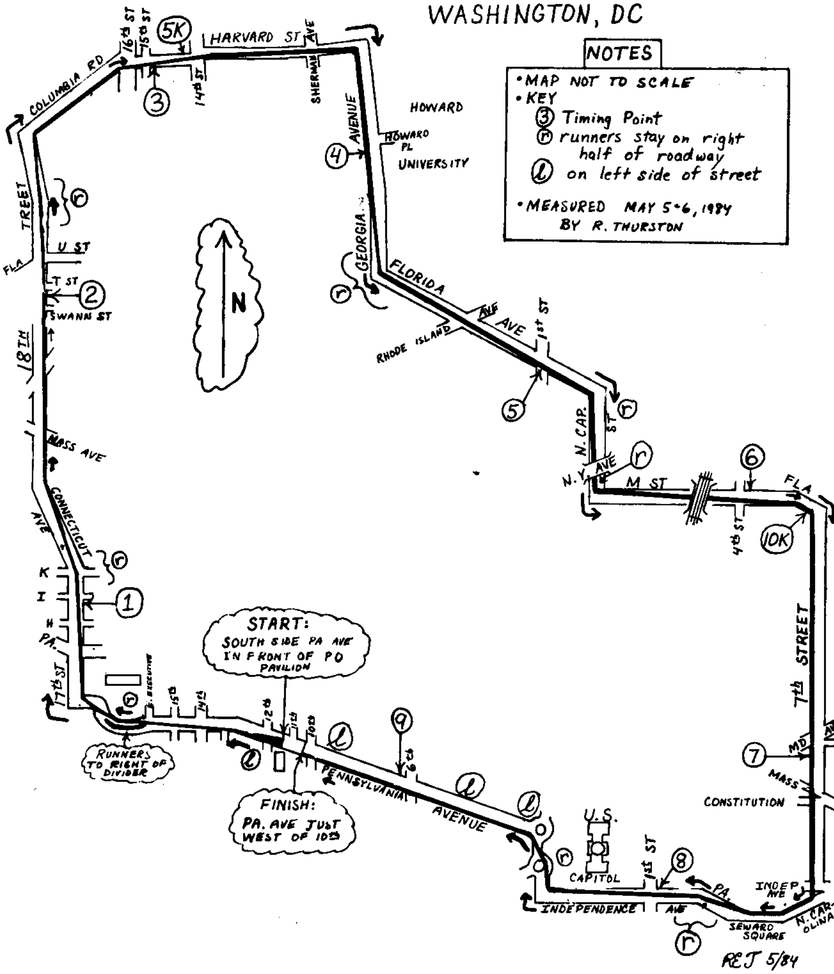


MANTECA PUMPKIN, 10 Km.

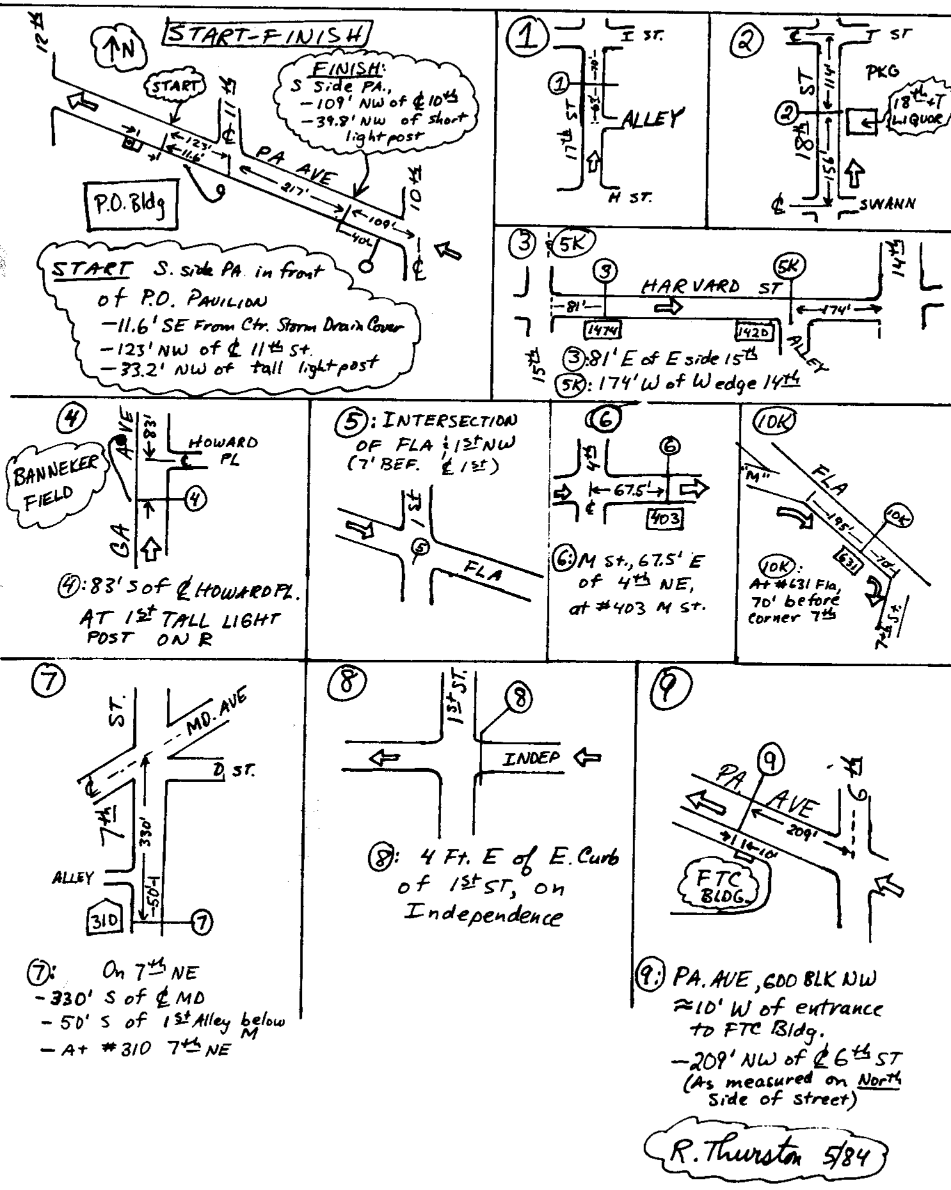
START: 3 5' 3" NORTH of storm drain CRESTWOOD
1 MILE 35'9" north of CTC pole # 1013347
2 mile 74'7" west of CTC pole #1012685
3 mile 27' west of CTC pole # 1012653
4 mile 77' 5" east of ctc pole at 8615 Lathrop rd.
5 mile 78'2" east of CTC pole # 1150405
6 mile 12'6" south west of light pole # 1775 Birchwood/ Crestwood
6.2 63' 3" south of storm drain Crestwood

DC HOMETOWN RUN

WASHINGTON, DC

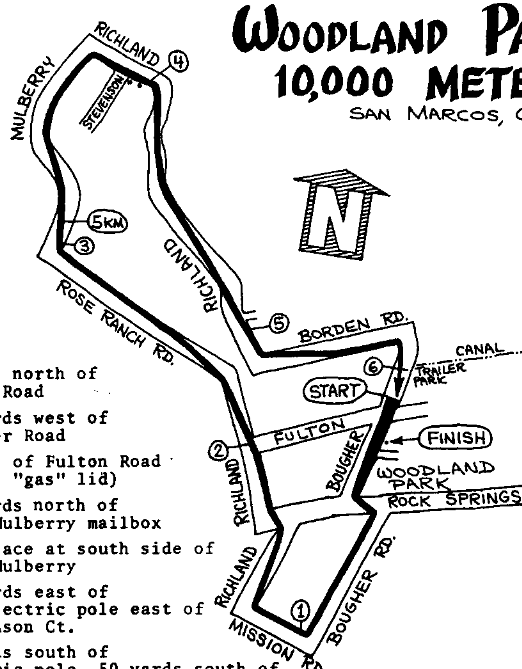


HOMETOWN RUN: TIMING POINTS



WOODLAND PARK 10,000 METERS

SAN MARCOS, CA



START - 9 yards north of Fulton Road

1 MILE - 30 yards west of Bougher Road

2 MILE - Middle of Fulton Road (metal "gas" lid)

3 MILE - 31 yards north of 1090 Mulberry mailbox

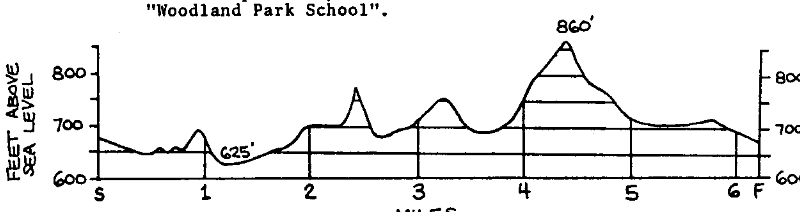
5 Km - Fireplace at south side of 1168 Mulberry

4 MILE - 27 yards east of 2nd electric pole east of Stevenson Ct.

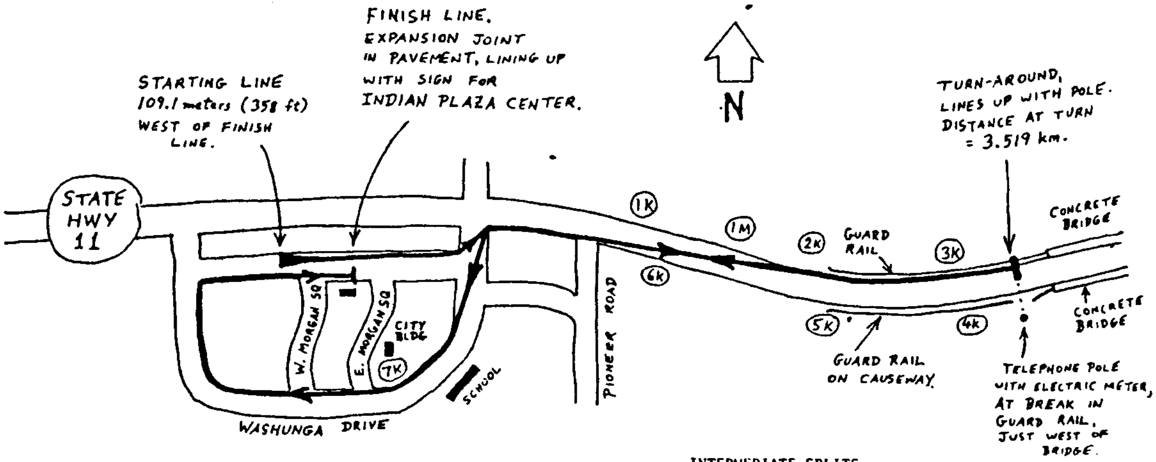
5 MILE - 7 yards south of electric pole, 50 yards south of "Casa Loma" (about 200 yards north of Borden Road).

6 MILE - 10 yards south of the center of a flood channel (canal) at the north side of a trailer park.

FINISH - Electric pole 50 yards north of entrance to "Woodland Park School".



TOTAL GAIN IN ELEVATION = 450 FEET/10KM = 73 FEET/MILE



KAW CITY 8 km
KAW CITY, OKLAHOMA

COURSE MEASURED ASSUMING RUNNERS ARE FREE TO USE ANY PART OF THE ROADWAY, INCLUDING THE (PAVED) SHOULDERS ON HIGHWAY 11.

MEASURED BY BOB + MARCIA BAUMEL
MARCH 17, 1984

INTERMEDIATE SPLITS

1 km: 15 meters West of the "Pioneer Park Recreation Area" sign on the East side of Pioneer Road.
1 mile: 28 meters East of center of Mahann's Drive.
2 km: 30 meters East of curve sign, with green sign on back, showing the numbers 36, 28, 12.80 (arranged vertically).
3 km: Alongside "Watch for Ice on Bridge" sign.
4 km: 32 meters East of sign used as reference for 3 km mark.
5 km: 62 meters East of sign used as reference for 2 km mark.
6 km: 15 meters East of sign used as reference for 1 km mark.
7 km: 17 meters West of West driveway of City Building.

Note: Reference distances for intermediate splits are approximate -- estimated by pacing.

The Starting Line, in addition to being 109.1 meters West of the Finish Line, is also 16.15 meters West of the West end of curbing on the West side of W. Morgan Square.

The turn-around is marked by a PK nail on North side of road.

APPENDIX D

Filling Out the Forms

This section is intended to clarify certain portions of the "Application for Certification of a Road Course."

Type of Course

Courses rarely fit the simple categories exactly. Attempt to determine the **basic** structure of the course with the following points in mind.

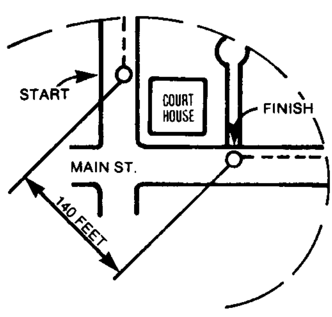
A **loop** course follows a path that eventually closes on itself with the runner headed in the **same** direction as he/she was at the start of the loop. This circular motion can be repeated indefinitely without the need for the runner to reverse his/her direction of running.

An **out-and-back** course follows a path **out** to a turn-around point where the runner is required to reverse direction and come **back** on the same roadway. When the out-and-back section is completed, the runner is headed in the **opposite** direction to that followed at the start of the out-and-back section.

A **point-to-point** course is defined as any course whose straight-line distance between the start point and the finish point is greater than 10% of the overall race distance **or** any course whose net decline averages more than 2 meters per kilometer (10.6 feet per mile).

Straight-Line Distance Between Start and Finish

The **straight-line distance between start and finish** is usually taken from a map drawn to scale. This is the distance "as the crow flies." Locate the start and finish points. Place a ruler edge so that it touches both the start and finish points. Read off the distance on the ruler. Convert this to kilometers (or miles) using the map scale.



Altitude of the Race Course

The **altitude of the race course** may be obtained from section (quadrangle) maps available from the U.S. Geological Survey. If your library does not possess a set, check the major blueprint stores in your area. These often carry a full set of maps for your state. Hiking stores often carry a selection of USGS maps. Prices usually run between $1.50 and $4.00 each.

The USGS maps show locations of prominant natural and man-made features. The locations of cities, towns, and major roads are of primary interest. The background of the map consists of contour lines, indicating elevation above mean sea level. Depending on the roughness of the terrain, the contour interval may range from 10 feet up to 80 feet.

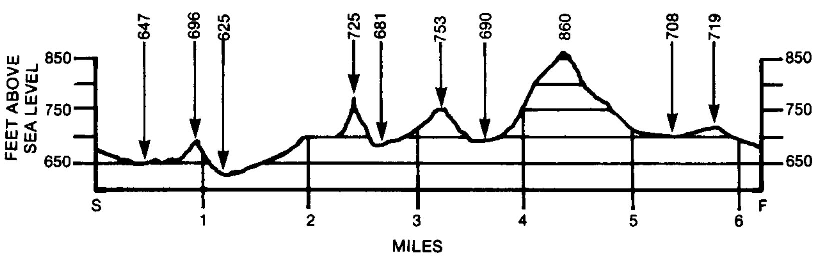
If possible, copy the pertinent sections of the USGS map so that you can mark the race course on it. Locate the start and finish points and estimate the elevation if either is between contour lines. Unless you are trying to determine elevation at a "saddle point," a linear interpolation between given contours is usually quite good. This will give you the elevation or altitude of the start and finish points.

Next, trace over the race course to find the highest and lowest points. These two elevations complete the altitude section. A good magnifying glass is very helpful in reading elevations.

Total Climb

The section on **total climb** is **optional**! If you have a hilly course which you consider to be rather difficult, you may wish to prepare a "course profile" to impress your runners. A course profile simply plots the elevation for each point along the course (see example below). Depending on your patience and eyesight, a fairly detailed profile can be obtained (see Appendix C, Woodland Park 10km example).

Once such a course profile has been prepared, mark each section of uphill that does not contain any downhill portions. You may have several such sections depending on the "hilliness" of your course. Determine the low and high points for each section and calculate the elevation rise for each. Add all of the elevation rises for the entire course to obtain the total climb.



In this example, there are five major uphill stretches. Only the first section is complicated by "rolling;" the total climb for each of the other four sections is simply the difference between the low (begin) and high (end) point elevations. In the first section, the net climb from begin to end points is 49 feet. The "downs" within the up section total 17 feet. This gives a total climb for that section of 66 feet. For the course, the total climb is then 421 feet.

TYPE OF SURFACE

The various classifications are, for the most part, self-explanatory. The "undefined" surfaces are those which do not offer a preferred direction of travel, such as a large parking lot or an open field.

Defining a course in such areas presents certain problems. Often these areas are traversed between prominent landmarks which provide guidance for measuring the course as well as laying it out on race day. If the route is straight, only the entry and exit points need to be defined. If the route is curved or uses several landmarks, such as light poles in a parking lot, the route must be coned and monitored.

APPENDIX E

Metric-English Conversions

It should be kept in mind that the metric system is the fundamental measurement system of the United States. All customary "English" units are defined in terms of metric units. The easiest such definition to remember is that of the inch:

one inch = 2.54 centimeters **exactly**

From this, one can derive the equivalents of other units of length, e.g.,

one foot = 12 x 2.54 cm = 30.48 cm = 0.3048 meters

one yard = 3 x 30.48 cm = 91.44 cm = 0.9144 meters

one mile = 5280 x 0.3048 meters = 1.609344 kilometers

If both mile and kilometer distances must be marked when laying out a race course, the conversion is most easily done in the **working constant**:

(a) Determine the working constant in counts/mile or counts/kilometer.
(b) Divide the constant in counts per mile by 1.609344 to obtain the constant in counts per kilometer.
(c) Multiply the constant in counts per kilometer by 1.609344 to obtain the constant in counts per mile.

CONVERSION TABLE FOR STANDARD DISTANCES

The following table shows how kilometer and mile distances are related but is not intended for routine measuring. It is easier to do the conversion **once** in your measuring constant, as above, than do repeated conversions for each split. The table does show, for example, that 10 kilometers is not exactly 6.2 miles. Courses measured to exactly 6.2 miles **will not** be certified as 10 kilometers!

1 km =	0.62137119	miles	1 mile =	1.609344	km*
5 km =	3.1068560	miles	5 miles =	8.04672	km
8 km =	4.9709695	miles	10 miles =	16.09344	km
10 km =	6.2137119	miles	20 miles =	32.18688	km
12 km =	7.4564543	miles	30 miles =	48.28032	km
15 km =	9.3205679	miles	40 miles =	64.37376	km
20 km =	12.427424	miles	50 miles =	80.4672	km
25 km =	15.534280	miles	100 miles =	160.9344	km
30 km =	18.641136	miles			
50 km =	31.068560	miles			
60 km =	37.282272	miles			
100 km =	62.137119	miles			
150 km =	93.205679	miles			
200 km =	124.27424	miles			

half marathon	=	21.0975 km**	=	13.10938 miles
marathon	=	42.195 km**	=	26.21876 miles

* English to metric conversions are **exact.**
** The marathon is **defined** as 42.195 km **exactly.**

CONVERSIONS FOR STEEL-TAPING

1 foot	=	0.3048 meters (**exact**)
1 kilometer	=	3280.84 feet (accurate to within 1/30th of a millimeter)
degrees Celsius (° *C*)	=	[degrees Fahrenheit (° F) – 32] divided by 1.8
1 pound force	=	4.448 newtons