# USATF / Road Running Technical Council

# Course Measurement and Certification Procedures Manual

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This manual 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 manual:

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# INTRODUCTION

Certification of road race courses in the United States is done under the auspices of the USATF Road Running Technical Council (RRTC). Courses certified by USATF are also recognized as certified by the Road Runners Club of America. For a mark to be eligible for record consideration by USATF, it must be achieved on a USATF-certified course. If an entry fee is charged for a road race, runners have a right to a properly measured course. USATF 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 thirty years of experience in measuring road courses accurately. These procedures are now used by IAAF and AIMS as well as USATF. Much of the pioneering work in the United States was done by Ted Corbitt, who started the certification program in 1964 after extensively researching methods of measurement. The program was initially run through the RRCA but later transferred to the AAU, which was then the US governing body for track & field, long distance running and race walking—the role now played by USATF. Corbitt served as the nation's chief course certifier until 1984.

Credit is also due to Ken Young, who oversaw the establishment of official US road running records, adopted in 1983. At the same time, he helped upgrade course certification with more rigorous standards to support the needs of record keeping, including a system of “Verification” measurements (see below) which put real “teeth” in the program. Young also served as Editor of the first edition of this manual, published in 1985.

The new certification procedures adopted in the early 1980s included important changes in measuring philosophy. Previously, the object was simply to produce "accurate" courses. We still try to make courses as accurate as practical; however, to meet the needs of record keeping, we've added a new emphasis: Now we try to make extra sure that courses are **not short.** Specifically, we try to make sure that the **shortest possible route (SPR)** through the available roads is **at least** the stated race distance. This is intended to guarantee that every possible path a runner can take through the course is at least the stated distance.

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. Please note that automobile odometers, aerial survey maps, and electronic distance meters (EDM) are **not suitable for measuring road courses for certification.** An EDM may be used for measuring a "calibration course" (the course used for calibrating the bicycle), although steel tape is also entirely adequate for that purpose.

Historically, several kinds of bicycle wheel revolution counters have been used in the calibrated bicycle method. Currently, the standard counter used for this purpose is the **Jones Counter,** a remarkably simple and reliable mechanical device invented by Alan Jones in 1971 and later enhanced by Paul Oerth and by Tom and Pete Riegel. The latest version is called the “**Jones Counter model JR**” and is available at www.jonescounter.com .  More information about this and other acceptable counter

systems can also be found on the USATF website at
http://www.usatf.org/events/courses/certification/tools.asp .

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 that 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 re-measured by USATF (this is called a “Verification” re-measurement). 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 record will not be accepted, and 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 task you have chosen to perform next, such as laying out a calibration course. Refer to the appendices as needed for clarification of points in the main text. If you are unsure of any aspect of the process, please contact your regional certifier **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 displays “counts” proportional to the number of wheel revolutions. The original Jones Counters were designed so 20 counts = one revolution. Later models had different gear ratios, including 30 counts/revolution and 23.63636… (= 260/11) counts/revolution, which is also the ratio of the latest “JR” model Jones Counter. In all versions, a “count” represents approximately 7 to 10 centimeters (3 to 4 inches) on the ground. The “JR” model counter is available at www.jonescounter.com . Additional information about acceptable counters can be found on the USATF website at http://www.usatf.org/events/courses/certification/tools.asp

2. **Bicycle.** A good "ten-speed" (or higher-speed) bike 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 instructions on 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 50 newton (5 kilograms-force or 11 pounds-force) 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 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. **Nails & Hammer.** Used for making permanent course marks.

10. **Spray Paint.** For temporary course markings and to supplement permanent course marks.

11. **Masking Tape.** Masking tape is used for temporary marks while laying out the calibration course.

12. **Bike Tools.** In the case of a flat front tire, you must recalibrate before resuming measurement.

13. **Safety Equipment.** A safety vest and helmet should be worn. Adorn your bicycle with reflective strips and reflectors in the front and rear, as well as wheel reflectors.

# 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 that is reasonably level and relatively free of traffic and at least 300 meters in length. 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 runners 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 (and any subsequent) measurement to check the distance between those **same** marks. In particular, during the second measurement, simply record counts at the points already marked during the first measurement. **Do not** make new marks on the road during the second measurement. If you measure on different days, calibrate both before and after measuring on each day.

4. **Recalibrate the bicycle.** Ride the bicycle over the calibration course at least four times immediately after the course measurement(s). After recalibrating, determine your **constant for the day,** which is the **larger** of the pre-measurement (working) constant, or post-measurement (finish) constant. (Note: Measurements calculated using the *average* of the working and finish constants will also be accepted; however, use of the **larger** constant is strongly preferred.)

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 applications and supporting documentation to your regional USATF/RRTC certifier** (see Appendix F for the application forms). 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 any areas where the certification will require erection of barriers that restrict runners to a path longer than the shortest path available using the whole roadway (but note: for simplicity and to minimize the chance of having your course found short, it always best to lay out courses **without** any "restrictions" of this sort). In drawing the map, it is also highly desirable to include a line which displays the actual path measured through the course.

   **Note:** Maps of all certified courses are now **posted online at the USATF website** (at www.usatf.org/events/courses/search/ ). Measurers should be aware that their maps will be posted on the Internet for all the world to see. Runners who are thinking of running a race may view its map at this site. And race directors who are thinking of hiring a particular measurer may view maps that the measurer has produced, as evidence of the quality of this measurer's work.

# LAYING OUT A 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, paved,** reasonably level, and lightly traveled stretch of road, and must be **at least 300 meters** in length. Accuracy is also generally best if you can minimize the time required to transport your bike between the calibration course and race course. Therefore, you should consider laying out a calibration course close to the race course to be measured, especially when you must travel a long distance to reach the race course site.

**Method of Measurement:** The standard method of measuring a calibration course is to use a steel tape. Any steel tape, either surveyor's style or construction style, may be used, but to be confident of accuracy, get a tape made by one of the better-known manufacturers of surveying or construction equipment. Nylon-clad steel tapes are okay, but fiberglass tapes are definitely **not** acceptable. Electronic Distance Meters (EDM) can achieve greater accuracy than steel tapes, although that extra accuracy is **not really needed** for calibration courses used in the bicycle method.

**Siting your Calibration Course:** Choose a location that will be safe and convenient for calibrating a bicycle. Every time you measure a race course, you'll need to ride the calibration course at least eight times (four before and four after), and you'll want to ride it in **both directions.** Calibration courses are usually measured along the edge of a straight road—the same distance from the edge as you would ride your bike. (But on a street where vehicles may park, you may wish to measure far enough from the edge to avoid any parked vehicles.)

The marks defining the endpoints of your calibration course must be in the roadway where your bike wheel can touch them—not off to the side somewhere. In general, endpoints should be marked by nails driven into the road. Urban areas, however, often have numerous permanent objects in the street (sewers, manholes, etc.) that may serve as one or both endpoints of a calibration course.

Your calibration course will be most resistant to getting obliterated when the road is resurfaced if **both** endpoints are permanent objects such as sewers or manholes, etc. In this case, you'll have an odd-distance calibration course such as 324.54 meters—which is perfectly acceptable. You can also make your calibration course an even distance, where both endpoints are close to permanent landmarks, and where you've precisely located both endpoints relative to such landmarks.

When laying out an on-site calibration course that you will probably use only once, survivability of the calibration course is unimportant, and convenience is paramount. So just lay out a whole number of tape lengths; for example, 10 lengths of a 30-meter tape or 12 lengths of a 25-meter tape (laid out distance = 300 meters), or 10 lengths of a 100-foot tape (laid out distance = 1000 feet = 304.8 meters).

**Certifying your Calibration Course:** You are not *required* to submit a map for every calibration course you measure. However, when you lay out a calibration course that you think you'll want to use again in the future, or one that you think other measurers would like to use, you may draw a map for it, and you will be issued a certificate that will simplify future use of the calibration course.

*Whether or not* you want such a certificate, you must submit an **"Application for Certification of Calibration Course"** form, along with all your measurement data (including the **"Steel Taping Data Sheet"** if course is measured by steel tape), whenever you lay out a new calibration course.

If you don't submit a map with your application for calibration course certification, then this calibration course, if approved, will be considered certified for only that one measuring occasion. If you want to re-use the calibration course on a later occasion, you must resubmit all the paperwork for the calibration course.

If you do submit a map for the calibration course, and are issued a certificate for it, then whenever you (or others) want to re-use this course, you need only submit a copy of the certificate/map.

If you draw a calibration course map, it must describe the endpoint positions as precisely as possible. Ideally, the endpoints should be permanent objects in the street (such as sewers or manholes), or should be referenced to such objects so precisely that you could relocate your endpoints to an accuracy of one centimeter in case the road is resurfaced and your markings obliterated. If you can't describe the positions that precisely, then the certification will be considered to expire when the road is resurfaced.

# Measuring Your Calibration Course With a Steel Tape

**Equipment Needed for Taping:** A steel tape, preferably at least 25 meters in length; masking tape and ballpoint pen for marking tape lengths on the road; a thermometer for checking pavement temperature; possibly a spring balance for checking tape tension; Notebook and copies of the **"Steel Taping Data Sheet"** for recording data. You can tape a calibration course with just two people, but it might go more smoothly with a third person (for example, to watch for traffic and take notes).

**Requirements:** You must tape the course at least **twice.** (Normally, the second measurement will be done in the reverse direction from the first.) Use a new set of intermediate taping points (new pieces of masking tape) for the second measurement. But treat the second measurement as a check of the distance between the **same** endpoints you measured between the first time. Thus, the second measurement should result in a **number** indicating the distance between your original endpoints (not in a new set of endpoints).

Your final result will be based on the average of both measurements, corrected for temperature (see below). If desired, you may then adjust the course to obtain a desired even distance (such as 1 km).

## Basic Taping Technique:

For each tape length, the Lead and Rear tapepersons first shake out the tape until it lies straight and flat on the road. The Rear tapeperson sights ahead to keep the Lead tapeperson properly aligned **or** the Lead tapeperson uses a ruler to maintain constant distance from the road edge or other desired (straight) line.

Intermediate taping points are marked with ballpoint pen on masking tape. *After* stretching the tape to its *approximate* position, the Lead tapeperson sticks a piece of masking tape on the road, covering the position where the mark will be made. The Lead tapeperson then starts pulling on the tape with proper force (see below). When the Rear tapeperson has his endpoint firmly positioned over the mark (with the tape under tension), he shouts **"mark."** At this signal, the Lead tapeperson draws a fine line on the masking tape to mark the exact endpoint.

Long steel tapes are always designed so that the tape may be easily detached from the reel. You'll find that taping is easiest if you do this, and don't carry the reel along with you!

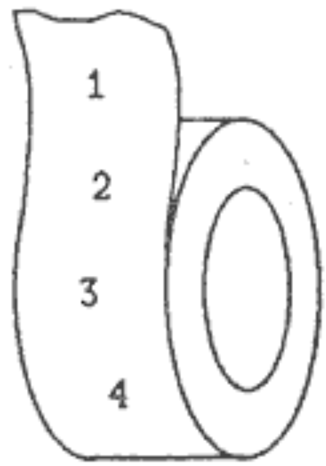
Don't panic if you see that a car is about to ride over your tape. If the Lead and Rear tapepersons hold the tape **flat** and firmly against the road, it will probably come out okay. (But a *twisted* tape will likely get broken.)

When walking from one taping position to the next, only the **Lead** tapeperson holds onto the tape, which is allowed to drag freely on the road. (If Lead and Rear tapepersons attempt to hold both ends off the ground, it may drag at a spot in the middle, resulting in one extremely worn area!)

## Counting the Tape Lengths:

Miscounting the tape lengths in a calibration course is a disaster; the "10 km" race course you lay with it might really be 9 km or 11 km! Fortunately, it's easy to guard against such counting errors.

One handy trick is to **pre-number** your pieces of masking tape **before** you tear them off the roll as in the following diagram:




As pieces of masking tape are used, the Lead tapeperson adds more numbers to the roll, so it always has at least two or three numbered segments that haven't been used yet. (Be sure to write the numbers so they won't be confused with the fine lines that will denote actual tape endpoints.)

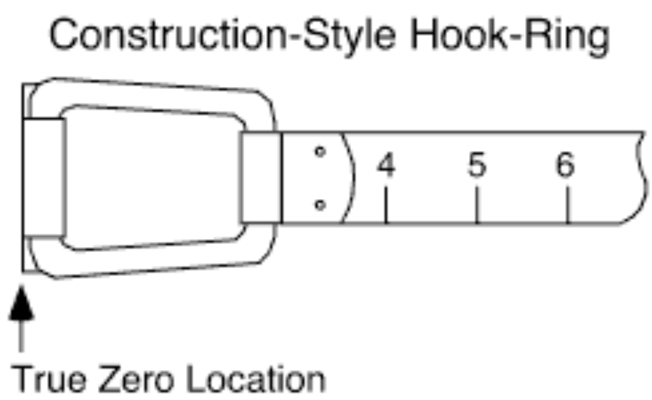
After the taping, walk or jog the course to check the tape count. It is also helpful to do a **bike check** as follows: Ride a bike equipped with Jones Counter over the whole calibration course, and also over any one tape length. The number of counts recorded on the whole course, divided by the number of counts recorded in a single tape length, should come out very close to the number of tape lengths you laid out.

Such a bike check may not be necessary if you will be measuring with a bike that you've previously calibrated on a calibration course that you know to be accurate. Then, if you miscount tape lengths while laying out a new calibration course, you'll see that your riding constant is "way off" as soon as you start calibrating on the new course.

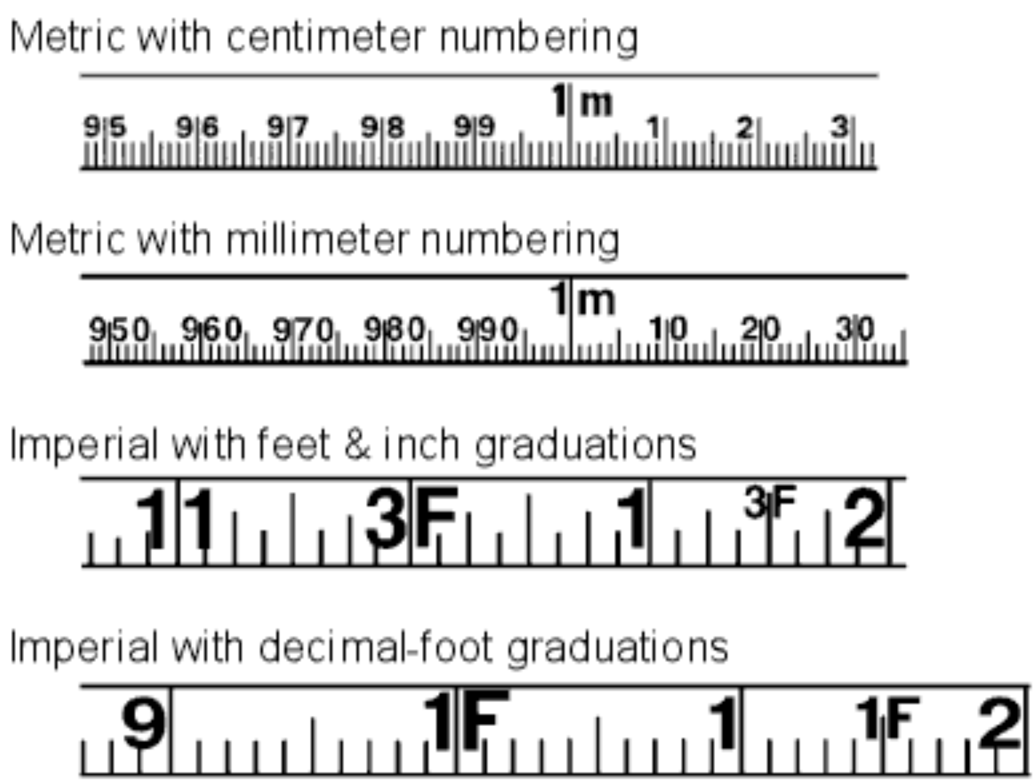
## Know Your Tape's True Zero Point:

Many steel tapes (especially construction-style tapes) don't have their zero point on the graduated portion of the tape. Misjudging the tape's zero point is harder to catch than miscounted tape lengths, but the effect can be insidious. For example, if you misjudge the zero point by 3 cm on a 30-meter tape, your measurements can come out short by about 1 meter per kilometer, entirely canceling our "Short Course Prevention Factor." The runners won't notice anything wrong with their times, but if the course ever needs to be verified, it will be found short.

Before using any tape, examine its markings carefully. If zero is not on the graduated portion of the tape, then take a ruler (or another portion of the same tape) and measure to find out where the true zero is. On construction-style tapes, it's usually at the outer edge of a "hook-ring" as in the following diagram.




While examining your tape, make sure you also understand all its other markings. Is it a metric or Imperial tape? Metric tapes are often graduated to the millimeter, but you must check whether the numbering between meter marks denotes centimeters or millimeters. Imperial tapes may be graduated in either feet & inches or decimal divisions of a foot. The following diagram shows some common styles of tape graduations:




Note: Drawings of tape graduations taken from [Lufkin's online catalog.]

## Correcting for Temperature:

Steel tapes are manufactured to be accurate at 20 °C (68 °F), but the tape expands when heated and contracts when cooled.

To correct your taped distance for temperature, set out a thermometer **on the pavement** and **shaded from the sun.** Read the thermometer before you start taping, and after you finish taping. Find the average temperature, and work out the correction to your raw taped distance by using the formula on the "Steel Taping Data Sheet," or by interpolating in the table below.

While it's a good idea to work out the temperature correction whenever you tape a calibration course, you are **required** to do so only when it's **cooler** than 20 °C (68 °F) since, in this case, the true measured distance is *shorter* than your raw laid-out distance. But note: If you are a *certifier* doing a *Verification* measurement, you should always do the temperature correction, regardless of whether it's warmer or cooler than 20 °C.

The following tables show the temperature correction for a number of temperatures cooler than 20 °C, and for several course lengths. (You may interpolate or extrapolate in the table for other temperatures and course lengths.) Remember: at temperatures *cooler* than 20 °C, the true measured length is *shorter* than your raw taped distance (so you'd need to *lengthen* your course if you want to obtain a desired exact distance). At temperatures warmer than 20 °C, the corrections are in the opposite direction.

## I. Corrections in centimeters

| | Calibration Course Length | | | |
|---|---|---|---|---|
| Temp | 300 m | 500 m | 800 m | 1000 m |
| 20 °C | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 °C | 1.7 | 2.9 | 4.6 | 5.8 |
| 10 °C | 3.5 | 5.8 | 9.3 | 11.6 |
| 5 °C | 5.2 | 8.7 | 13.9 | 17.4 |
| 0 °C | 7.0 | 11.6 | 18.6 | 23.2 |
| –5 °C | 8.7 | 14.5 | 23.2 | 29.0 |

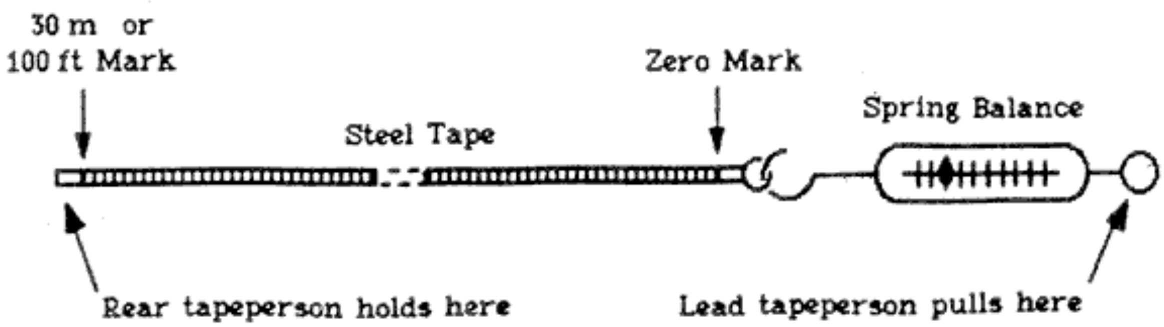
## II. Corrections in inches

| | Calibration Course Length | | | |
|---|---|---|---|---|
| | | 500 m | 1/2 mi | 1000 m |
| Temp | 1000' | 1640.42' | 2640' | 3280.84' |
| 68 °F | 0.0 | 0.0 | 0.0 | 0.0 |
| 60 °F | 0.6 | 1.0 | 1.6 | 2.0 |
| 50 °F | 1.4 | 2.3 | 3.7 | 4.6 |
| 40 °F | 2.2 | 3.6 | 5.7 | 7.1 |
| 30 °F | 2.9 | 4.8 | 7.8 | 9.6 |
| 20 °F | 3.7 | 6.1 | 9.8 | 12.2 |

## How Hard to Stretch the Tape:

Just as steel tapes are manufactured to be most accurate at a particular temperature, they are also most accurate when stretched with a specified amount of force. But while you may not have much control over the temperature at which you do the measurement, you **can** adjust the force you apply to the tape to match the correct force for your tape. (Unfortunately, the proper force varies from tape to tape.)

You can find out how hard you are stretching the tape by using a **spring balance** as in the following diagram:




You needn't actually use a spring balance this way while taping your calibration course; it is enough to do a few trials beforehand to get a feel for the correct tension. With a little experience, it will be easy to judge the proper force, and you'll be able to dispense with the spring balance entirely. Note: It is acceptable to answer question 17 on the "Application for Certification of Calibration Course" by saying you estimated the tension "by feel."

Also, since the errors due to slight variations in applied force tend to be very small, the spring balance you use for checking tape tension needn't be a precision instrument. The type sold in sporting goods stores for weighing fish is quite adequate!

The correct force for stretching a particular tape is sometimes embossed on its blade near the zero end. For example, if you find the markings "20 °C, 70 N" it means that the tape was designed to be accurate at a temperature of 20 °C and tension of 70 newtons (approximately 7 kilograms-force or 16 pounds-force). If you can't find any markings of this sort, use a value from the following table. The first entry in this table (for metric tapes) seems to be emerging as an international standard, so is generally a safe choice if you're not sure which one to pick.

### Standard Tension for Various Steel Tapes

| | |
|---|---|
| Std. Metric tapes (30 m, 50 m, etc.): | 50 N ≈ 5.0 kgf ≈ 11 lbf |
| Traditional U.S. 100 ft tapes: | 45 N ≈ 4.5 kgf ≈ 10 lbf |
| Heavy-gauge steel U.S. 200 ft tapes: | 90 N ≈ 9.0 kgf ≈ 20 lbf |

N = newton, the modernized metric (SI) unit of force.
kgf = kilogram-force, an older (obsolete) metric unit of force.
lbf = pound-force, the unit of force in the Imperial system.

One mistake people sometimes make is to pull with less force when using a smaller portion of the tape. For example, if a 50 m tape requires a tension of 50 N, they might apply a force of only 25 N when measuring a 25 m distance because only half of the tape is used. ***That is a fallacy!*** The correct tension is independent of the length of tape used. If a tape requires a tension of 50 N, you must pull with a force of 50 N, regardless of how much or how little of the tape you are using.

# CALIBRATING THE BICYCLE

The pre-measurement calibration is the initial step that must be performed in the measurement of a road course. The post-measurement calibration guards 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.

2. Warm the tires by riding the bicycle for several minutes immediately prior to the calibration rides. This will reduce the variance in counts for the pre-measurement calibration and ensure 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 the above procedure for a total of **four** rides, 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.

8. The spread among your calibration rides shouldn’t exceed 2 or 3 counts for riding <u>each direction</u> of the calibration course. If your variation is greater, do more rides until your counts stabilize.

9. Add the results of each ride and divide by the number of rides. This gives the “average pre-measurement count.”

10. 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).

11. 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 ensure 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.**

12. The post-measurement calibration must be performed as soon after the course measurement as possible. Repeat steps 3 through 11. **Four** post-measurement calibration rides are required.

13. Determine the average post-measurement count by adding all the post-measurement counts and dividing by the number of rides.

14. 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.

15. 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 accepted, 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 as long as 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!

When a course is measured by **more than one cyclist**, every cyclist who rides the race course must do **his or her own pre-measurement and post-measurement calibration rides**. A separate copy of the Bicycle Calibration Data Sheet must be completed for each rider, calculating individual riding constants for each rider. This procedure must be followed even when cyclists share the same bicycle, because riding constants will vary for different cyclists, depending on riders' weights and riding styles.

# THE SHORTEST POSSIBLE ROUTE

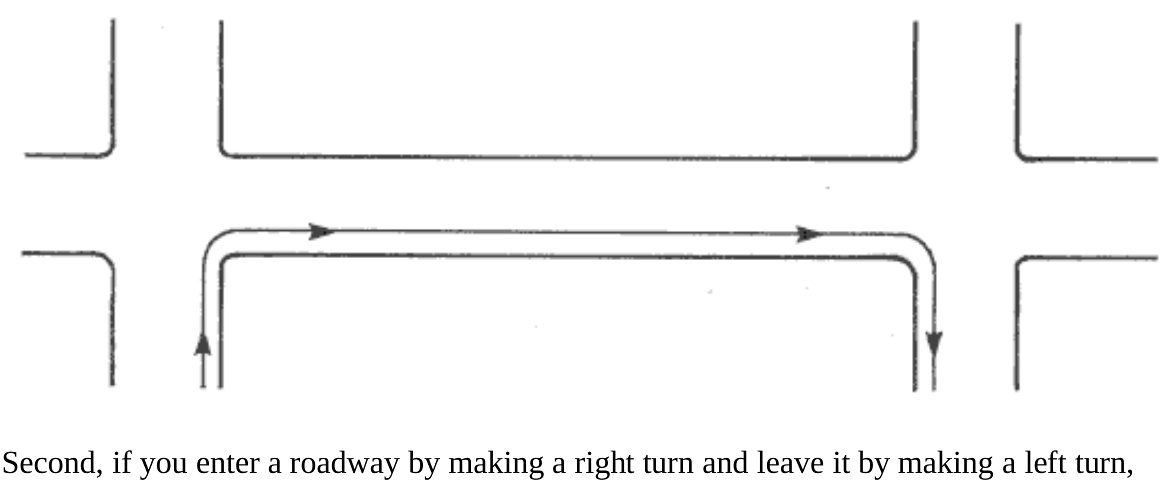
A race course is defined by the shortest possible route that a runner could take and not be disqualified. A given runner might not follow the shortest possible route, just as a runner on a track may be forced to run further to pass another runner. The actual path of any given runner is irrelevant. The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

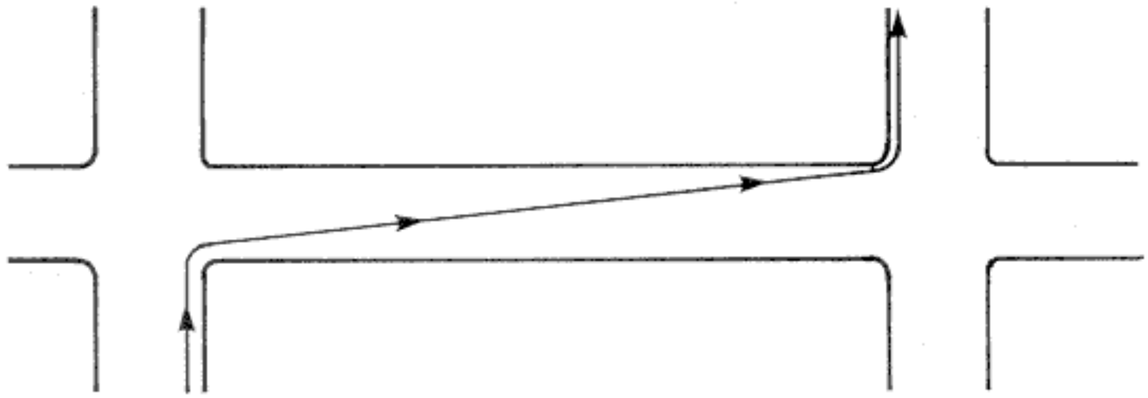
Because it is difficult to follow the shortest possible route perfectly, an extra length factor of 0.1%, called the **short course prevention factor,** is incorporated into the calibration procedure. Use of the factor ensures that your course will **not** be short, even if you make small errors in following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

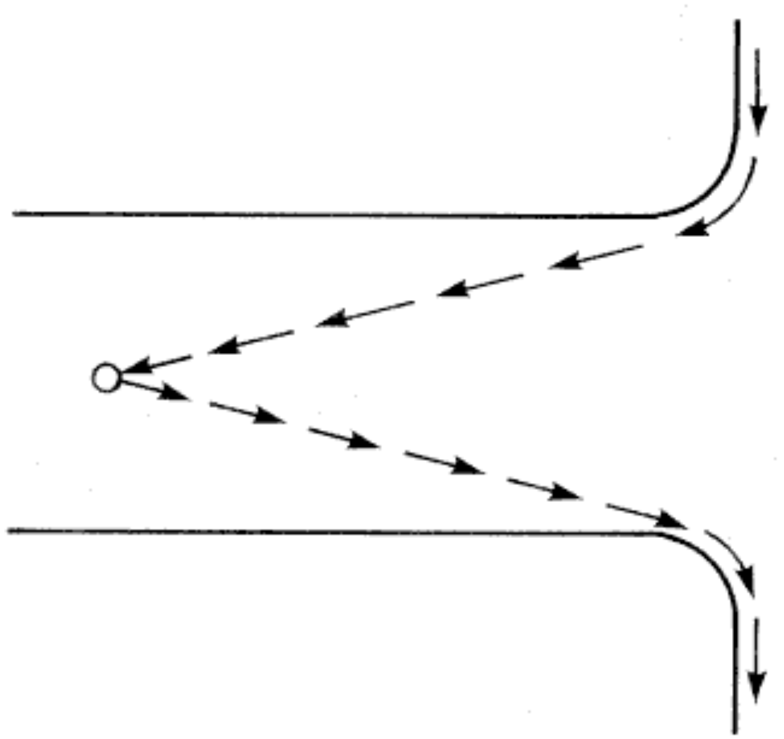


Third, when measuring on a winding roadway, **do not** follow the side of the road. Unless portions of the roadway will be closed to runners by cones and/or barricades **and** will be monitored, measure the straightest and shortest path possible, moving from one side of the road to the other as necessary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

NO RESTRICTIONS —
RUNNERS MAY USE ENTIRE ROAD


RIGHT SIDE ONLY — RUNNERS
MAY NOT CROSS CENTER LINE.
-CONES AND MONITORS REQUIRED

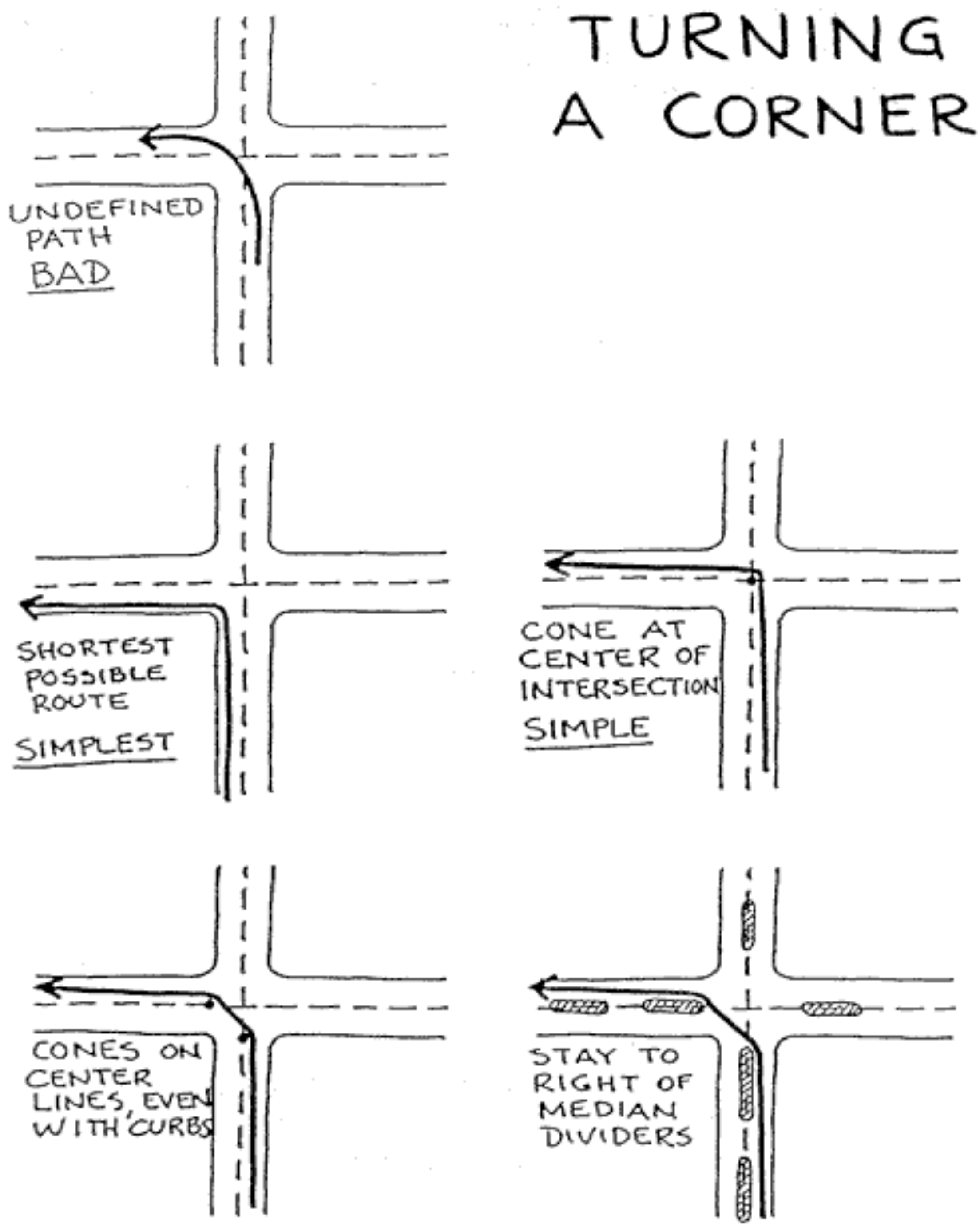
When measuring a turn-around point, cycle up to the position of the turn, freeze the front wheel, record the count, reverse the bicycle, and proceed back in the other direction. **Do not** cycle "wide" around the turn.



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 on 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.

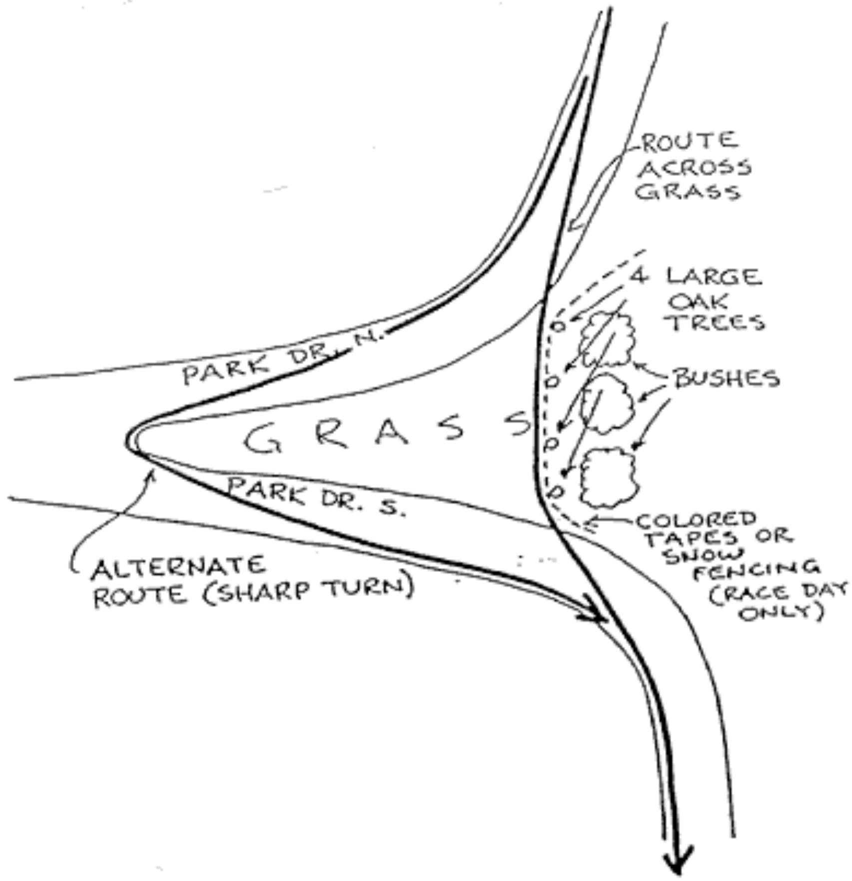
The locations of barriers must be marked on the road, and their exact locations put on the map. You should be prepared to document every such marker that you put in place. If this seems like too much trouble, you should assume that runners will short-cut all they can and **measure that way,** even if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



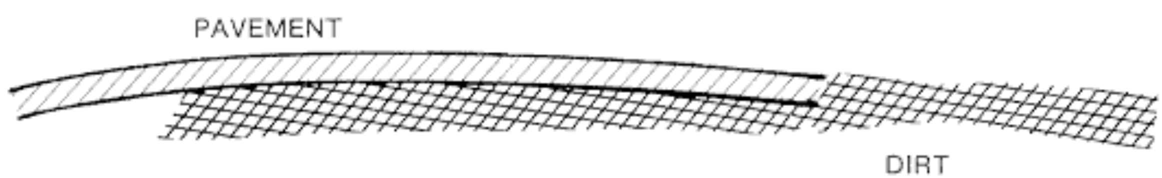

If you restrict the runners to one side of the road, be sure you specify how the corners are to be turned. It makes a difference. There should be no doubt of the exact measured path.

If you cannot enforce the restrictions, it's best to measure the shortest possible route and leave race-day coning as the race director wishes it.

Sometimes the paved route is likely to be ignored by the runners. Plan for this, and measure across the grass in those areas where the runners are likely to shortcut. Be sure the route you choose is bounded by something that is permanent.




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 judgment. 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

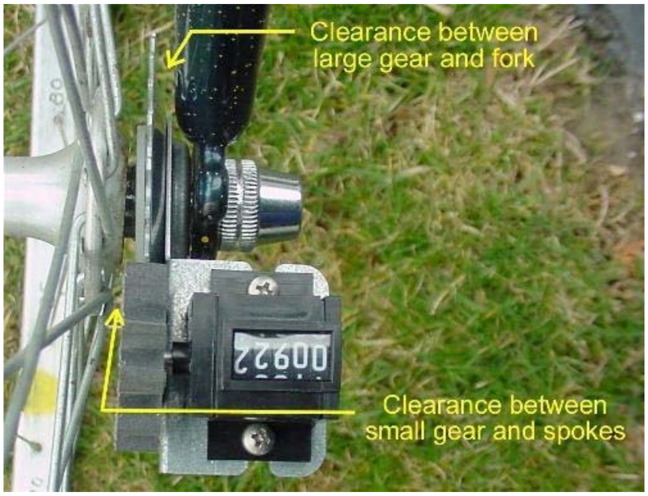
## Mounting the Jones Counter on Your Bicycle

*Note: These mounting instructions apply to the current model of the Jones Counter, known as the "Jones Counter model JR." This information is also available at* www.jonescounter.com .

The JR counter will fit on most bicycles without modification. Remove the wheel from the bicycle and slip the counter over the axle on the LEFT side. Put the wheel back on the bicycle with the counter between the fork and the wheel. Tighten the wheel securing nut or lever.


**Caution: Important – Do not attempt to rotate the wheel or ride the bicycle until you have checked for proper clearance. You may damage the counter.**

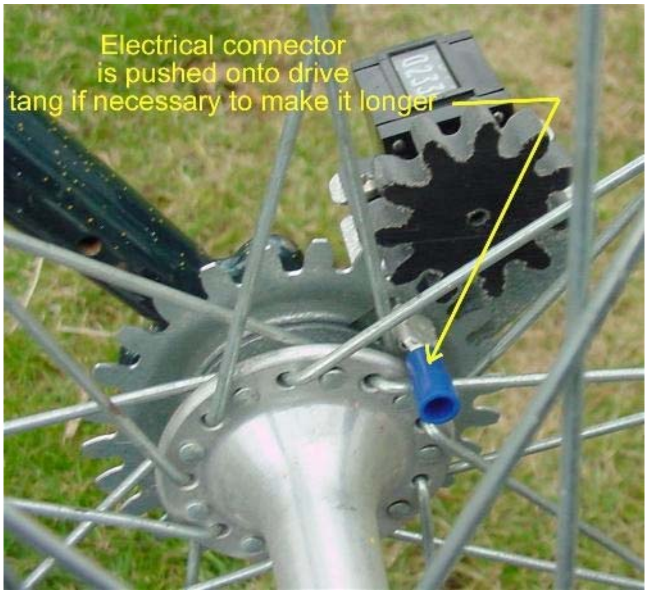
Wiggle the wheel back and forth just a little. If the large counter gear rubs against the fork, the fit is not correct. This can be sometimes be corrected by installing a washer between the outer side of the counter and the inside of the fork. Try this. If free rotation without rubbing cannot be obtained, the counter cannot be used on your bicycle.



If there is interference between the small plastic gear and the spokes, install a washer between the inside of the counter and the adjusting nut on the wheel.

**If you are unable to fit the counter to the bicycle using washers, it may not be possible to use the counter on the bike.**

The counter is driven by a small metal projection (tang) on the inside of the large gear. This should reach between two spokes, which will cause it to rotate. If the tang is not long enough, slip the provided electrical connector over the tang to make it longer. The tang may also be wired to a spoke using the small hole provided on the tang.




Once the counter is properly installed, and no interference is present, you can safely ride the bicycle and obtain proper counter operation.

Again – before attempting to rotate the wheel, check for interference. If you do not do this you may damage 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 in 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 handlebars 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 may significantly alter your riding constant.

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

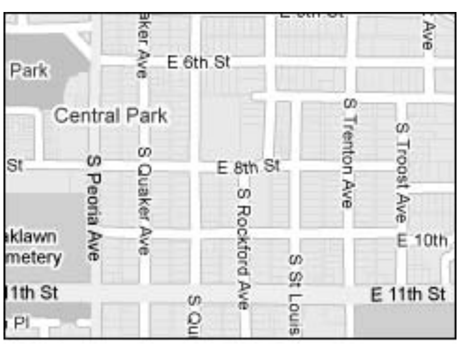
The course map is the most important documentation of your course. Its purpose is to provide, ideally on a single sheet of paper, all the information a race director needs to run the race using the course **as certified.** This documentation is of great value in case a record is set on the course and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

Be aware that after a course is certified, its map is scanned and posted online on the USATF website (at www.usatf.org/events/courses/search/ ). So, your work will be on display for all to see. These online maps may be viewed by runners who wish to run the race, by race directors who are setting up the course on race day, or by race directors who are thinking of hiring a measurer and want to see what kind of work they’ve done.

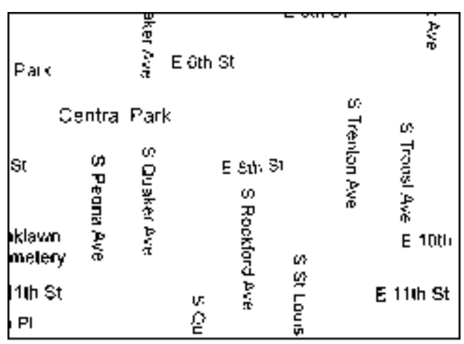
Without good documentation for the course, mistakes could easily be made in laying out the course on race day. By the time of **next** year's race, there may be a new race director who knows nothing about the original course measurement. In addition, all the marks you've painted on the road may have faded into oblivion by the following year!

The map should fit on a single sheet of US Letter size (8.5x11 inch) or A4 paper along with any blow-up or detail maps. The map need not be drawn to scale or 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 colors, as the map will be photocopied in black & white onto the notice of certification. The map **must** indicate the direction of true north.

It is important when creating your map that you make sure all drawings and text are black, and not gray (no pencil). The reason for this is that the map will eventually be scanned for the purpose of posting on the USATF website. This scanning process will be in black and white, which means that gray shades in your map will be converted to either black or white, and the result may not be legible. This is the reason why pictures and images, even grayscale images, are not permitted in maps. The following example shows what can happen when a grayscale image is scanned to black & white:




Original map in grayscale




After scanning to black & white

In short, black or white on your maps, no color, no gray and no pencil.

The map should 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 turn-arounds. 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. (But note: If you did an "offset maneuver" to deal with traffic as explained in Appendix A, do **not** draw it on the map, as this could be very confusing to race directors; instead draw the desired diagonal path that the offset maneuver was intended to approximate.)

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 ensure that the runners cover at least the distance you measured. Your course map must indicate **exactly** where such barriers are to be placed and also show where monitors are to be stationed. 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 nearby 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 case the road is repaved. In complicated cases, it may be necessary to include detailed blow-up maps of some or all of these points.

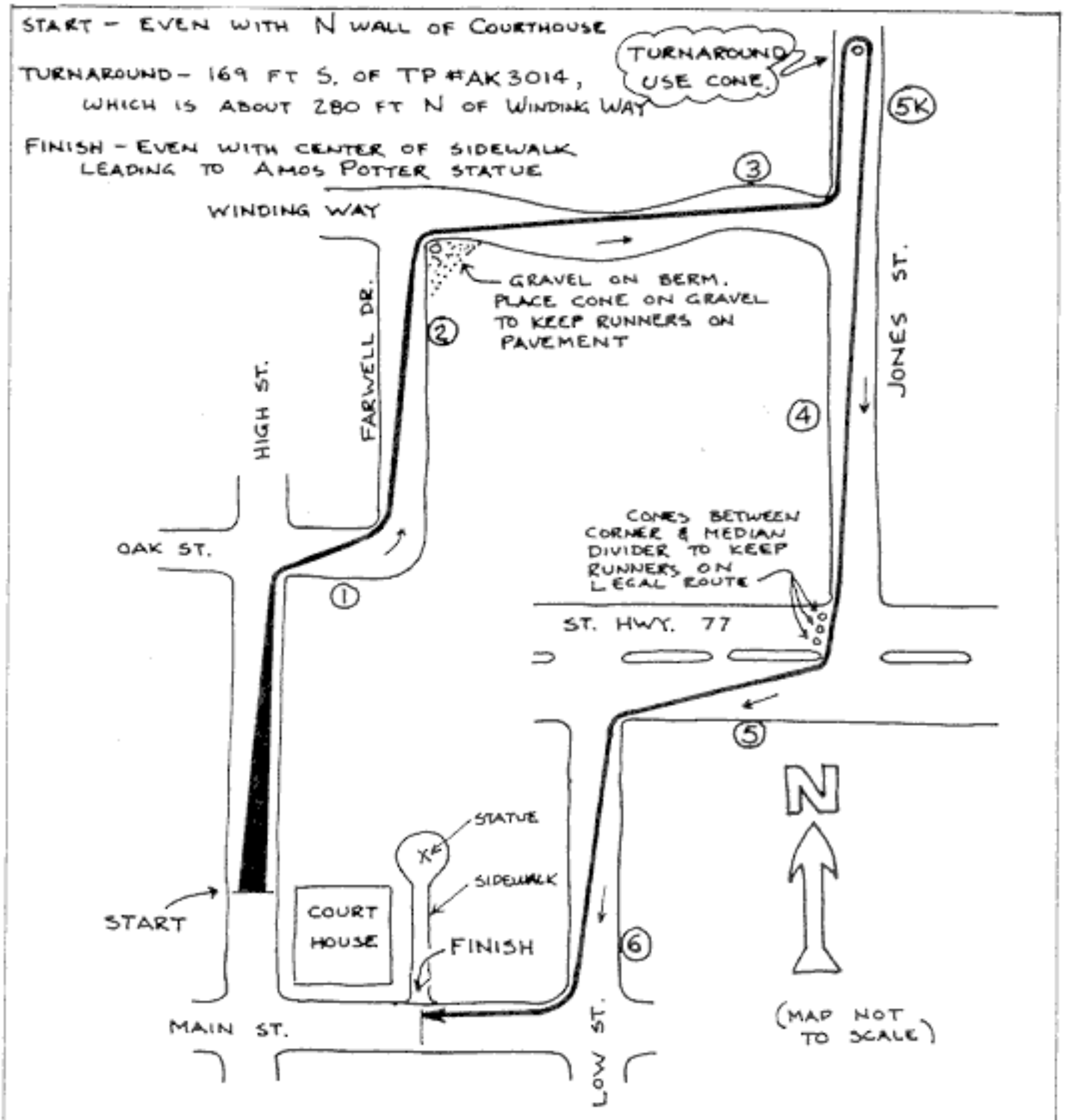
In addition to your start, finish, and turn-around points, you should provide documentation for your intermediate splits so they can be relocated when necessary. It’s best to include all documentation directly on your map, but if this would make the map too cluttered, you may provide your list of split descriptions on a separate sheet.

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

Some important requirements to remember in drawing your map:

1. Maps should not contain Pictures or Photographs.
2. Maps should be done only with Black print on White Paper.
3. Maps should have a margin of 1 cm (3/8") – although if you use A4 paper, increase top & bottom margins to 2 cm so map will have adequate margins when copied to US Letter size paper.

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




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

TURNAROUND "T1" – ON JONES ST, EVEN WITH TELEPHONE POLE # AK 3014 (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 "T2" – 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, that will not be present on race day. One way to deal with this problem is as follows:

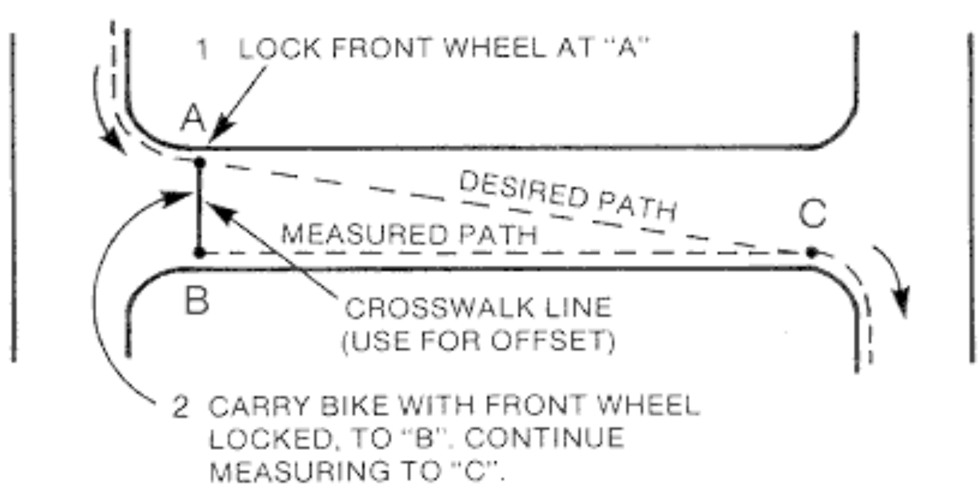
a. stop your bicycle just before the obstacle
b. freeze your front wheel with your hand or the brake
c. very carefully move the bicycle perpendicular to the route being measured until you are clear of the obstacle
d. release the wheel and proceed until past the obstacle
e. reverse the process with the 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 (the "Offset Maneuver")

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 roadway. 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.

## Two-Cyclist Riding Techique

It is often faster and more enjoyable—and possibly also more reliable—to measure with a second cyclist instead of just doing two rides of the course by yourself. Either way, we use the **one set of marks** technique. This means that tentative start, finish, and split marks are only painted on the road during the **first** measurement. In a two-cyclist measurement, only the **lead** rider paints marks on the road. No new marks are ever painted during the second measurement. Therefore, the second cyclist simply stops at the points already marked by the first cyclist, and records counter readings at exactly those marks. To minimize confusion during this process and subsequent data analysis, the second cyclist should **not pre-calculate** any counter readings from his/her working constant before riding.

The two cyclists should strive to make their measurements as **independent** as possible; 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. Ideally, the second cyclist should follow two or three blocks behind the first cyclist; however, this may not be practical in certain situations; e.g., if you have a police escort.

Whenever a course is measured by more than one cyclist, every cyclist who rides the race course must do **his or her own pre-measurement and post-measurement calibration rides**. A separate copy of the Bicycle Calibration Data Sheet must be completed for each rider, calculating individual riding constants for each rider. This procedure must be followed even when cyclists use the same bicycle, because riding constants will vary for different cyclists, depending on riders' weights and riding styles.

## Safety

A course measurer should always wear an orange, reflective, safety vest. A helmet is also an essential piece of safety gear. These will tend to make you look more "official," like a member of a highway crew, **and** will make you much more visible. Since the route that must be measured is often not the logical route for a cyclist, motorists may not be able to easily predict your direction and 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 in 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 that attach to the front wheel and provide digital readouts via a display mounted on the handlebars. Although not sufficiently accurate for certification purposes, such devices can alert you to the upcoming 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 a 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.

## 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 course measurement. **Do not** calibrate before sunset, measure at night, and then recalibrate after dawn.

You will need a good light system for your bicycle and a flashlight to read the Jones Counter. Many Ni-Cad battery-powered light units are available and work very well. You may also attach a flashing strobe light to your bike or person. These units are cheap, lightweight, and provide a greatly increased degree of safety. 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 with a bicycle calibrated on a standard, paved calibration course is acceptable and is, in fact, 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 it 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 can 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.

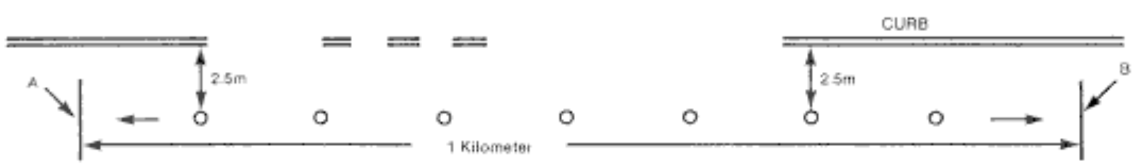
Another way to reduce this effect is to make more frequent re-calibration runs. If you measure over a period of five or more hours, you may wish to do a set of calibration rides mid-way through your measuring. This is feasible only if the calibration course is not too far from the race course. It does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

## Calibration Course

Since you might 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 can be helpful. Another useful feature is to paint dots every 30 m or 100 ft to be used as reference points while calibrating.

If parked cars are a problem, you can 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. During 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, with each loop being from one to ten kilometers (one-half to six miles) in length. 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 on it. Intermediate splits which are integral numbers 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 (for about $12) a small tool called a map measurer which can be pushed along on the map to measure distance.

An approximate 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 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 when 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 likely to be errors. Anticipate them. Check and double check.

# APPENDIX C
# Example of Course Measurement

## Setting Up the Calibration Course

It is 7:15 a.m. 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 300 meter calibration course, which will be convenient for measuring metric race courses (and you are, in fact, planning to measure a 10 kilometer race course). You couldn't find a metric tape in your local hardware store so you are using a 100-foot tape instead. Since 300 meters = 984.25 feet, you will be laying out 9 and a fraction lengths of the 100-foot tape.

[Note: You probably **can** find a metric tape by checking stores that sell to the surveying profession, companies that sell equipment for track meets, educational supply houses, or by visiting any hardware store outside the United States.]

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 50 newtons (5 kilograms-force, or 11 pounds-force), moving the tape slowly forward.

In the meantime, Susan tears off a piece of masking tape (which she has already pre-numbered with numeral "1") from her roll and sticks it 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.

You continue in this manner until you have marked 9 one-hundred-foot sections. At this point, you mark an 84-foot section. The procedure is exactly as before except that Ralph uses the 84-foot mark instead of the 100-foot mark on the tape. You still pull the spring balance with the full force of 50 newtons (**do not** use less force, even though you're using a smaller portion of the tape). The marked point (point "B") is now 984 feet south of point A. It isn't necessary to get exactly 984.25 feet at this step since a final adjustment will be made later. Susan enters 9 tape lengths × 100 feet each, with a "partial" tape length of 84 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 9 full 100-foot tape lengths. However, you measure the last interval to the PK nail at point A. This is found to be 83 feet 11¼ inches. Thus, according to your second measurement, the distance between the permanently marked point A and your temporary point B is ¾ inch short of 984 feet. The second measurement is 983 feet 11¼ inches or 983.94 feet in decimal form.

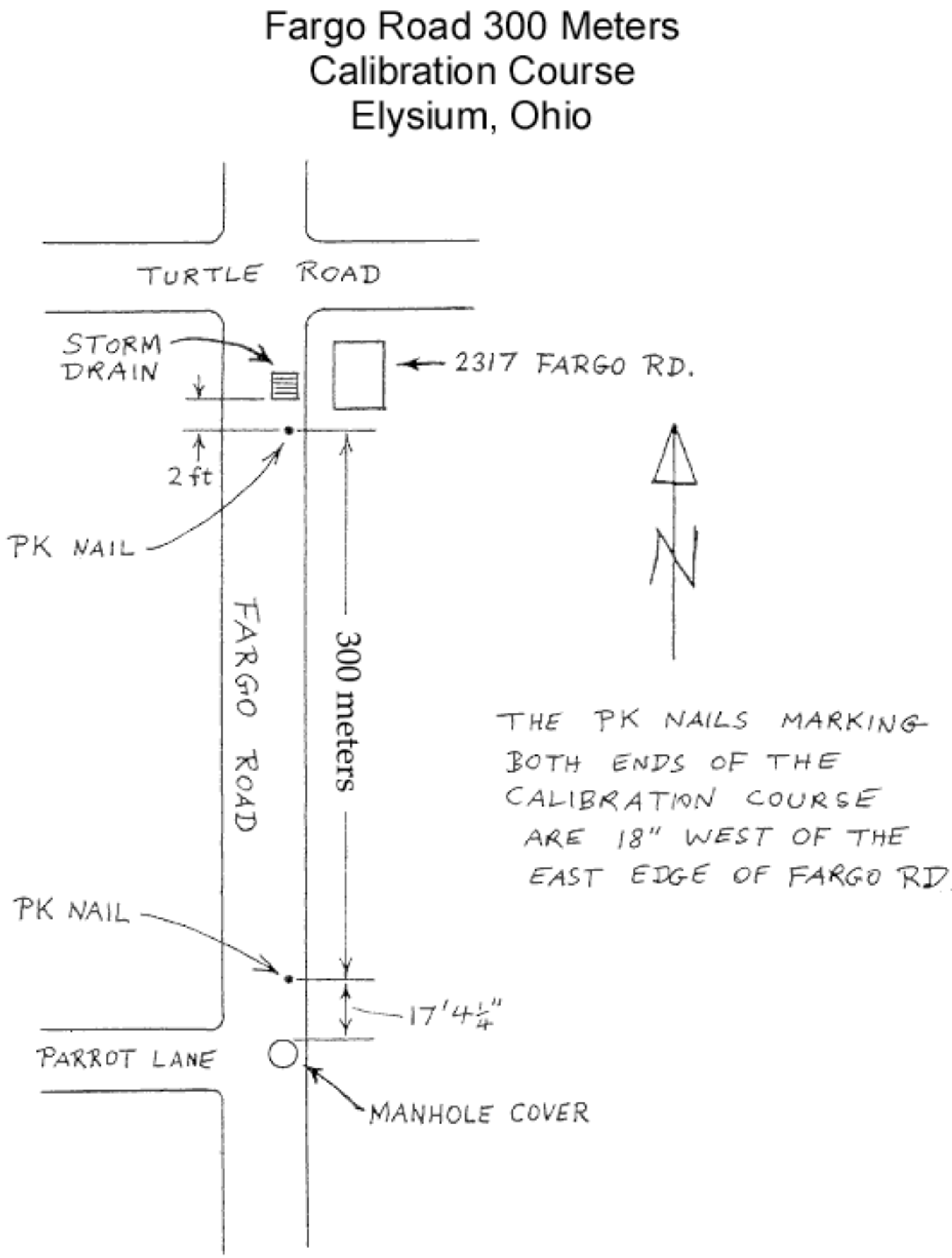
You repeat the temperature reading as before and find it to be 59 °F. Susan records this datum.

You now calculate the temperature-corrected average measured distance between points A and B, as instructed on the Steel Taping Data Sheet. The corrected measurement is 983.89 feet. Since your desired calibration course length is 300 meters or 984.25 feet, you must now lengthen the tentative course by 0.36 feet which is equal to 4¼ inches. You do this by moving point B to a point 4¼ 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 endpoint 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 84 ft interval!), and stop with the front axle over the mark. You record a count of 12833. The difference, corresponding to one tape 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 16036. The difference is 2819 counts. Dividing the full course count of 2819 by the 100 ft count of 287 yields a course length of 9.82 tape lengths which, for such a rough check, is in excellent agreement with the intended course length of 9.8425 tape lengths.

Finally, you put a PK nail at the corrected endpoint (point B) of your 300 meter course. You thank Ralph and Susan and head home to fill out the forms necessary to obtain certification of your new calibration course.



## STEEL TAPING DATA SHEET
## (for measuring a calibration course or track)

Name of Calibration Course Fargo Road 300 Meters

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
(Thermometer shaded from direct sun)

Measurements and Calculations:

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

| 9 | × | 100' | + | 84' | = | 984.00 ft |
|---|---|---|---|---|---|---|
| # 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.

| 9 | × | 100' | + | 83'11¼" | = | 983.94 ft |
|---|---|---|---|---|---|---|
| # tape lengths | | distance per tape length | | partial tape length | | measured distance |

3. Average Raw (uncorrected) Measurement of Course 983.97 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 = ( [Temp(°C) − 20] × .0000116 ) + 1.0000000
Correction factor = ( [Temp(°F) − 68] × .00000645 ) + 1.0000000
Correction factor = ([56 − 68] × .00000645) + 1.0000000
= (−.0000774) + 1.0000000 = 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 | × | 983.97 ft | = | 983.89 ft |
|---|---|---|---|---|
| correction factor | | avg. raw measurement | | corrected measurement |

(Desired length 984.25' − 983.89' = 0.36' = 4¼")

6. If you wish, you may now adjust the course to obtain an even distance, such as 300 meters (not applicable if measuring a track). This is not necessary as you may choose instead to use an odd-distance calibration course whose endpoints are pre-existing permanent objects in the road to guard against hazards such as repaving. If you adjusted the course, explain what you did.
Added 4¼" to south end of course

Final Adjusted Length of Calibration Course 984.25 ft = 300 meters

CONVERSION FACTORS: 1 foot = 0.3048 meters
300 meters = 984.25 feet
1 kilometer = 1000 meters = 3280.84 feet

## APPLICATION FOR CERTIFICATION OF CALIBRATION COURSE

1. Name of Calibration Course Fargo Road 300 Meters
2. Length of Calibration Course 300 meters
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 43807 (Address) john.doe@example.com (E-mail address)

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 direction of north, the name of the road (and relevant cross streets), and the exact locations of start and finish points, including taped distances from nearby permanent landmarks. Enclosed
10. Is this calibration course: STRAIGHT? Yes PAVED? Yes
11. How are the start and finish points marked? Nails & 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 (meters or feet – specify which) 700 ft

**Mark endpoints in a permanent way (concrete or P-K 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 **steel taping data sheet** and complete the following:
16. How much tension (force) was applied to the tape while measuring? 50 newtons = 11 pounds
17. How was this tension maintained? Spring scale
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 2819 (16036 - 13217)

    B. Counts for one tape length 287 (12833 - 12546)

    C. Divide A by B 9.82 <- Close enough to show number of tape lengths is correct

    D. Number of full tape lengths 9.8425

# APPENDIX C
# Example of Course Measurement

## Calibrating the Bicycle

You take your bicycle with tires fully inflated and your pack of equipment out to the calibration course you previously submitted for certification. It is 7:15 a.m. You determine the temperature as before (53 °F) and ride the bicycle around for roughly five minutes to warm up the tires. 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 118914.

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 required, but simplifies the arithmetic and helps ensure accuracy of your average count, even if there are errors in intermediate counter readings.

You now sit down and fill in the first part of the **Bicycle Calibration Data Sheet**. The average pre-measurement count works out to 2822.25 counts on your 300 meter calibration course. To figure the counts in one kilometer (i.e., 1000 meters), you multiply by the ratio 1000/300. Then multiply by the 1.001 **safety factor**. Your resulting **working constant** is 9416.9075 counts per kilometer. You round this upwards to 9417 and will use this value for preliminary course markings.
Since you also intend to mark some mile splits, you multiply the 9416.9075 figure by the conversion factor of 1.609344 (see Appendix E) to obtain a mile constant of 15155.04, which you round to 15155 counts/mile. (It's safest to round constants **upwards**; however the rounding here is minor, and you weren’t planning to certify the mile splits anyway).

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 a.m. You check the temperature and record 63 °F.

You calibrate the bicycle just as you did for the pre-measurement calibration with four rides. Your resulting **finish constant** works out to 9409.40 counts/km, which you round upwards to 9410 counts/km.

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

Length of calibration course 300 meters

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

| Ride | Start Count | Finish Count | Difference |
|---|---|---|---|
| 1. | 116091 | 118914 | 2823 |
| 2. | 118914 | 121734.5 | 2820.5 |
| 3. | 121734.5 | 124557 | 2822.5 |
| 4. | 124557 | 127380 | 2823 |

Pre-measurement Average Count 2822.25

Time of Day 7:15 am

Temperature 53 F

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 = $2822.25 \times \frac{1000 \text{ m}}{300 \text{ m}} \times 1.001 = 9416.9075$ counts/km (use 9417 for layout)

Also 9416.9075 × 1.609344 = 15155.04/mile (use 15155 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 | 345387 | 2820 |
| 2. | 345387 | 348206.5 | 2819.5 |
| 3. | 348206.5 | 351026 | 2819.5 |
| 4. | 351026 | 353847 | 2821 |

Post-measurement Average Count 2820

Time of Day 10:30 am

Temperature 63 F

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

Finish Constant = $2820 \times \frac{1000 \text{ m}}{300 \text{ m}} \times 1.001 = 9409.40$ counts/km (round up to 9410)

CONSTANT FOR THE DAY = **Either** the Working Constant **or** the Finish Constant, whichever is the **larger***.

Constant for the Day = 9417 counts/km

**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 calibration "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**

* You may, if you wish, define your "Constant for the Day" as the *average* of Working and Finish constant instead of the larger. However, if you use the average, you will produce a shorter race course, which will face a greater risk of being found short if it ever needs to be validated. Therefore, use of the **larger** constant is strongly recommended.

# APPENDIX C
# Example of Course Measurement

## 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 have decided to lay out mile splits and splits for one and five kilometers (splits at every multiple of 5 km 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 then 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.

[Note: If these calculations for inserting mile splits into a metric course seem complicated, perhaps you can avoid them by laying out the course entirely with kilometer splits. An increasing number of races are moving to an all-metric format; e.g., see the Tulsa Run example in the next section on examples of course maps.]

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 realize that 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 southwest 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. This time, you've decided to ride from Start to Finish so you can make independent judgments of the shortest possible route. You hold the front axle of the bicycle over the tentative starting line that you marked in the first measurement, and rotate the wheel *forward* until the counter reads an even number of hundreds (248200). You mount and ride the course in the direction the race will be run. This time, you do not need to make any calculations before riding, and you **do not** make any new marks on the road. You simply stop at each of the marks you painted on the road during your first measurement (start, splits, turn-around, finish). 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 (previously fixed) finish line.

Your count at the previously painted finish line 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 that the two measurements differ by 0.0467% which is within the 0.08% maximum allowable tolerance.

You now return to the calibration course and recalibrate the bicycle.

After recalibrating, you find that your post-measurement "finish" constant is smaller than your pre-measurement "working" constant, which means that your "constant for the day" (defined as the larger of the working constant or finish constant) is identical to the working constant. This allows you to avoid recalculating your measurements using the constant for the day. You need only adjust the race course for the difference between the lesser of the two measurement rides and the desired race distance.

The lesser of the two measured distances is 9,995.33 meters, based on ride #2. (Very likely, you did a better job of riding the shortest possible route during your second ride over the course; it is often easier to concentrate on riding the shortest route during the second ride because you don't have to worry about making new marks on the road this time.) 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 4.67 meters.

At this point you must convert back to the Imperial system since you are (unfortunately) using a non-metric tape. You check Appendix E and note the conversion between meters and feet is 0.3048 meters = 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 by which you must lengthen your course 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 ft 8 inches 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 CTS/KM = 15155 CTS/MI

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

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 | Elapsed | | Counts for Measurer #2 Recorded | Elapsed |
|---|---|---|---|---|---|
| FINISH | 154000 | 3240 | FIN | 342326 | 3237 |
| 6 MI | 157240 | 15155 | 6 | 339089 | 15145 |
| 5 MI | 172395 | 15155 | 5 | 323944 | 15139 |
| 4 MI | 187550 | 13535 | 4 | 308805 | 13528 |
| 5 KM | 201085 | 1620 | 5KM | 295277 | 1620 |
| 3 MI | 202705 | 15155 | 3 | 293657 | 15151 |
| 2 MI | 217860 | 15155 | 2 | 278506 | 15149 |
| 1 MI | 233015 | 15155 | 1 | 263357 | 15157 |
| START | 248170 | | START | 248200 | |

| Preliminary Course Length | start-to-finish counts | divide by | working constant | = | measured length |
|---|---|---|---|---|---|
| Measurer #1 | 94170 | / | 9417 | = | 10.000 KM |
| Measurer #2 | 94126 | / | 9417 | = | 9.99533 KM |

| Difference between lengths #1 and #2 | divide by | length #1 | = | Measurement comparison (less than 0.0008?) | (yes or no) |
|---|---|---|---|---|---|
| 0.00467 KM | / | 10.000 KM | = | .000467 | YES |

**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 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 / .3048 m/FT = 15.32 FT

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

ADDED 4.67 m (15.32 FT) BY MOVING TURNAROUND 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 Race Date 23 Nov 82
3. Location of Start ELYSIUM, OH (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. OFFOT (name), 82 JALOUSIE LN, ALTIBOR, OH 44167 (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 10.000 KM
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 – YIELDED SHORTER MEASURED VALUE
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 PLUS 5 KM
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 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 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) | ____ same out/back ____ time(s) |
| ____ figure-8 ____ time(s) | ____ several out/back sections |
| ____ partial loop | X keyhole (out/loop/back) |
| ____ complex of different loops | ____ point-to-point |

25. Straight-Line Distance (as the crow flies) between Start and Finish 69 FT (21 METERS)

26. Altitude of Race Course (above mean sea level):
start 778 FT 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 | ____ graded dirt road |
| 25 uncurbed streets/roads | ____ ungraded dirt road |
| ____ concrete sidewalk | ____ gravel road |
| ____ concrete/brick streets/roads | ____ undefined paved surface |
| 30 paved bike path | ____ undefined dirt surface |
| ____ unpaved bike path | ____ undefined grass surface |
| ____ trail (single file) | ____ track (curbed or uncurbed) |

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

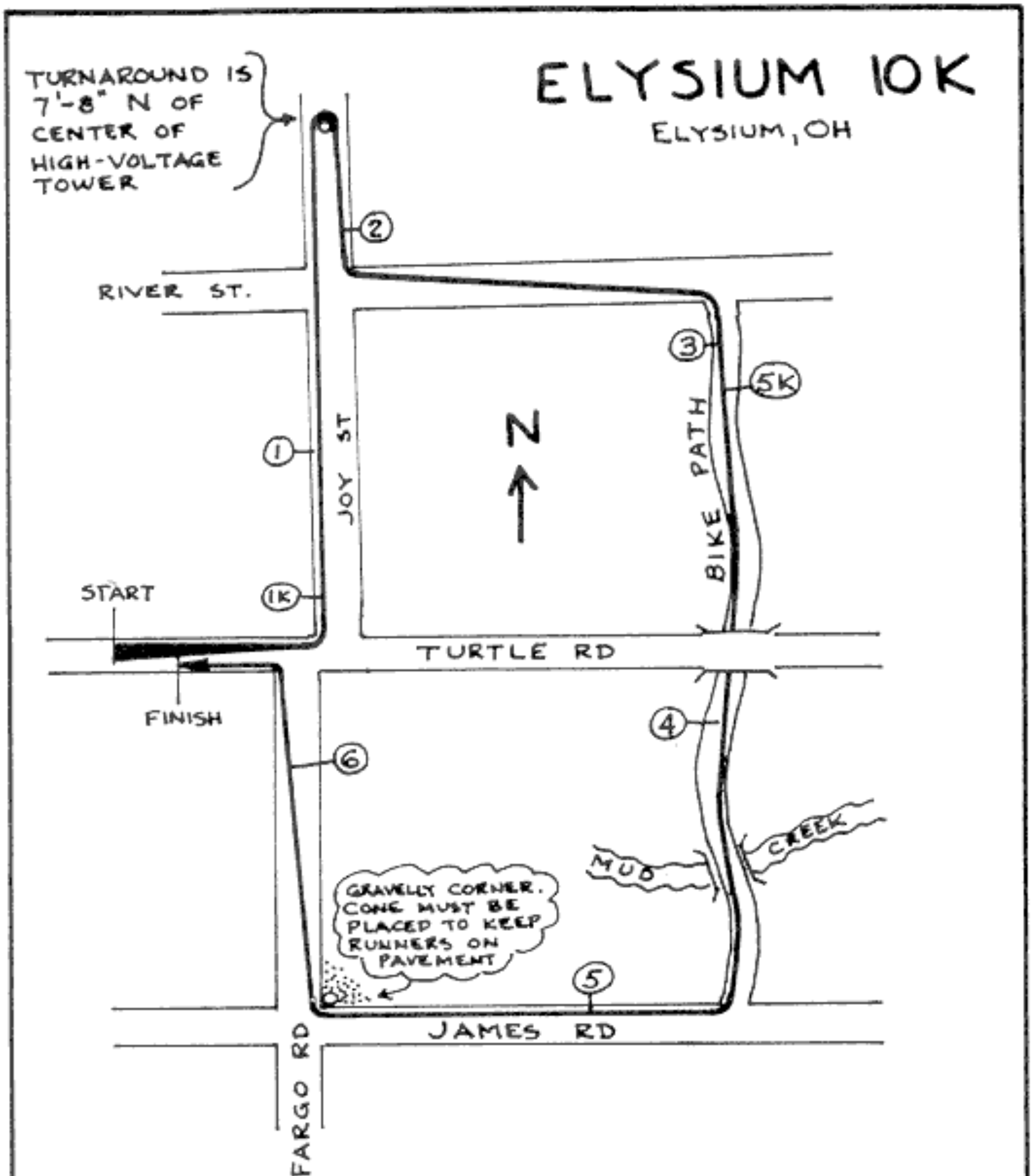
29. Is a description of the exact starting and finishing points (and any turn-around points, if any) attached? This description should include diagrams, including street names and taped distances from the start/finish points to near-by prominent landmarks, so that a stranger could find them. SEE MAP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

30. How did you mark the start and finish points (and turn-around points)?
PAINT, NAILS & WASHERS

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 – 1 FT 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 10K
## LIST OF MEASURED POINTS

| | |
|---|---|
| START: | 1' W OF T.P. #3014-6C IN FRONT OF MERGOR HARDWARE STORE, 2717 TURTLE RD., ELYSIUM, OH. |
| 1km: | 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.

# APPENDIX C
# Example of Course Measurement

## Course Maps

One of the most valuable results of your paperwork 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. (And remember that once the course is certified, your map will be posted online at the USATF website.)

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.

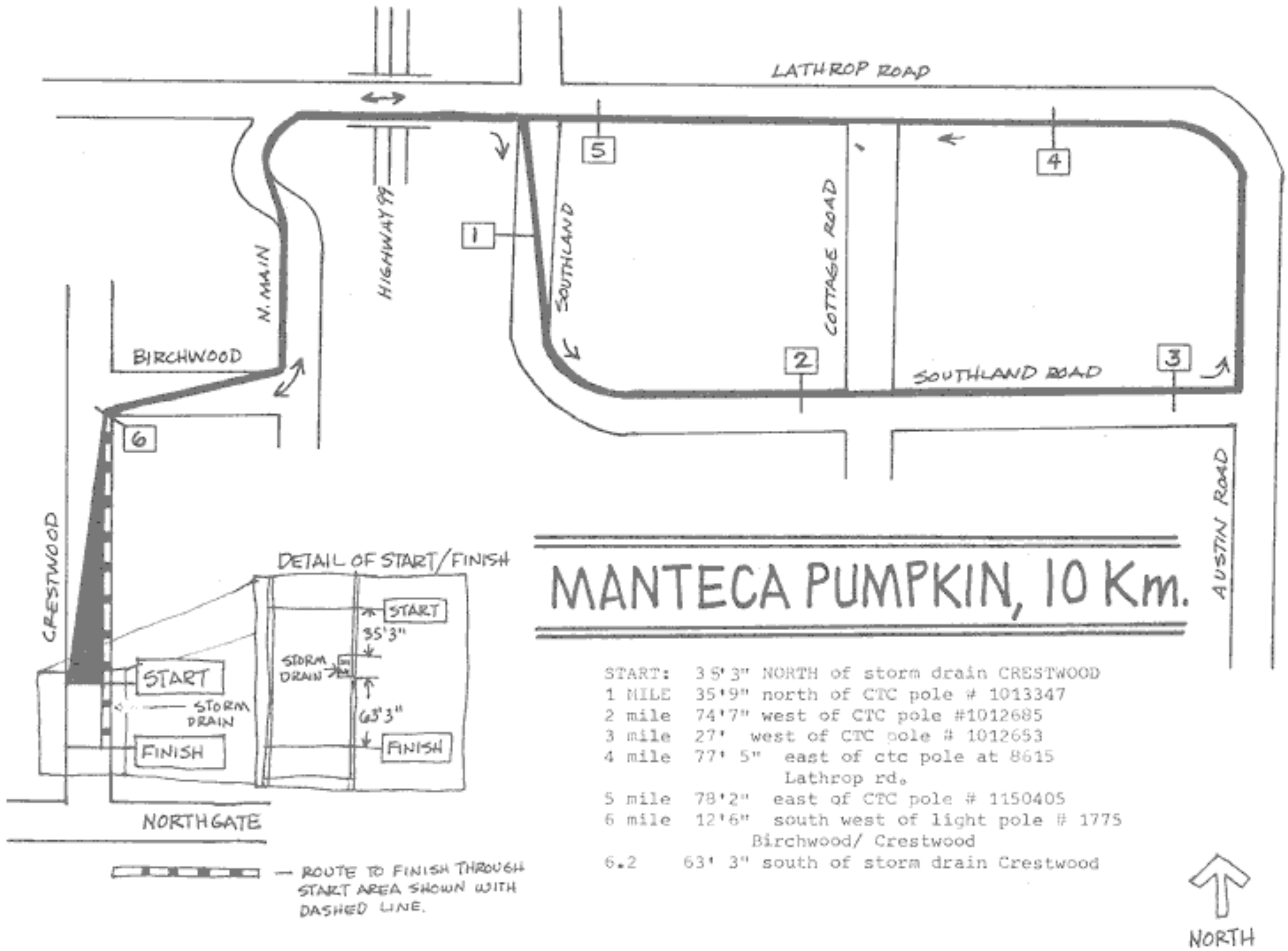
The Manteca Pumpkin 10 km shows a fairly simple keyhole course with only one **S-curve** (encountered twice) and two **diagonals** across traffic. Note the blow-up of the start/finish area. Note also that the runners are kept to the **inside** of the loop and are allowed full use of the roadway on all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

The Reflecting Pool 5 km is a complex course with many turns, some across grass. Note that each and every turn is defined by an object.

The Bay Bridge 10 km shows use of cones to restrict runners to one side of the road. Note that all splits appear on the map. This is desirable if there is room.

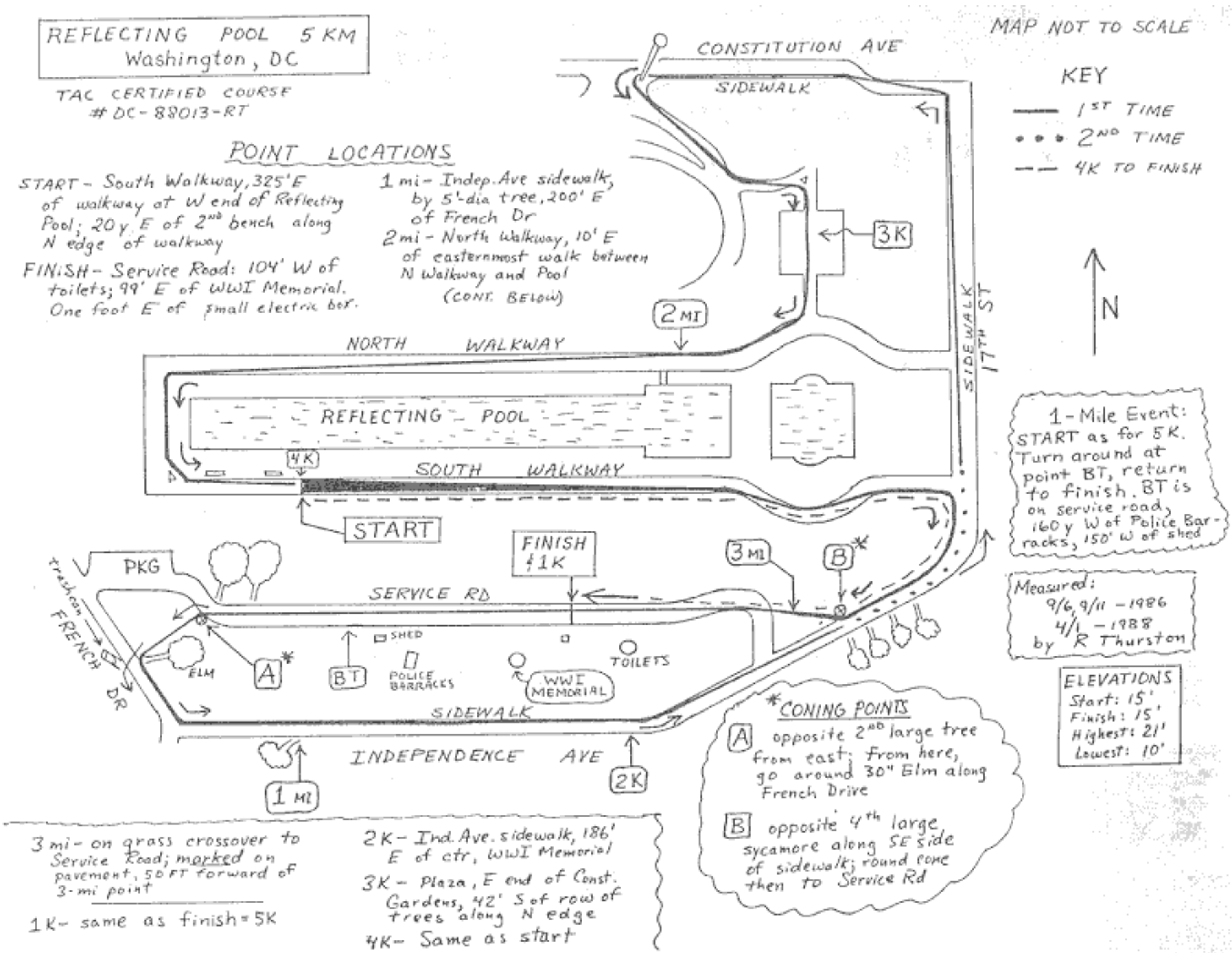
The Kaw City 8 km in Kaw City, OK illustrates proper measurement of a **turn-around** point. The course is classified as an out-and-back since only 20% of the course is a loop and the start and finish are 109 meters apart. Note the detailed description of the location of the turn-around point and metric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

The Tulsa Run 15 km in Tulsa, OK is an example of a metric race conducted in a totally metric format. When the Tulsa Run adopted this all-metric format, they also adjusted (and re-certified) their mostly out-and-back course to place the turn-around at exactly halfway, so the kilometer splits going out and coming back would occur at the same points. The split points aren't shown directly on the map; instead, they are described in a separate list, which the certifier then photocopied onto the back of the certificate. This map also includes a text description of the course route, which is sometimes very helpful.




# MANTECA PUMPKIN, 10 Km.

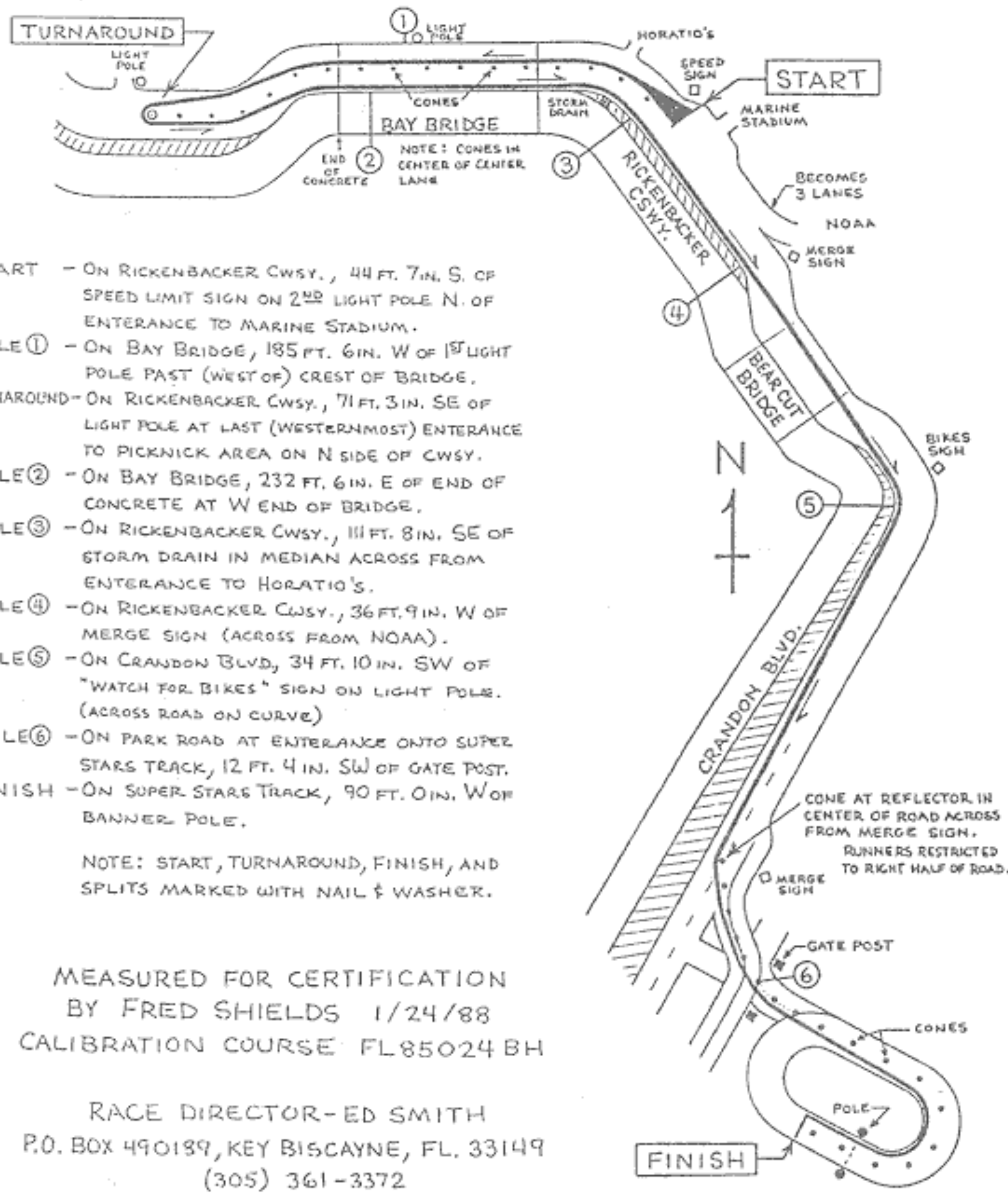
| | | |
|---|---|---|
| START: | 35'3" | NORTH of storm drain CRESTWOOD |
| 1 MILE | 35'9" | north of CTC pole # 1013347 |
| 2 mile | 74'7" | west of CTC pole #1012685 |
| 3 mile | 27' | west of CTC pole # 1012653 |
| 4 mile | 77' 5" | east of ctc pole at 8615 Lathrop rd. |
| 5 mile | 78'2" | east of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


REFLECTING POOL 5 KM
Washington, DC
TAC CERTIFIED COURSE
# DC-88013-RT
POINT LOCATIONS
START - South Walkway, 325' E of walkway at W end of Reflecting Pool; 20 y E of 2nd bench along N edge of walkway
FINISH - Service Road: 104' W of toilets; 99' E of WWI Memorial. One foot E of small electric box.
1 mi - Indep. Ave sidewalk, by 5'-dia tree, 200' E of French Dr
2 mi - North Walkway, 10' E of easternmost walk between N Walkway and Pool
(CONT. BELOW)
MAP NOT TO SCALE
KEY
1ST TIME
2ND TIME
4K TO FINISH
N
CONSTITUTION AVE
SIDEWALK
3K
2 MI
NORTH WALKWAY
REFLECTING POOL
4K
SOUTH WALKWAY
SIDEWALK
17TH ST
START
FINISH
1K
3 MI
B*
PKG
trash can
FRENCH DR
SERVICE RD
SHED
POLICE BARRACKS
ELM
A*
BT
WWI MEMORIAL
TOILETS
SIDEWALK
INDEPENDENCE AVE
1 MI
2K
1-Mile Event: START as for 5K. Turn around at point BT, return to finish. BT is on service road, 160 y W of Police Barracks, 150' W of shed
Measured: 9/6, 9/11 - 1986
4/1 - 1988
by R Thurston
ELEVATIONS
Start: 15'
Finish: 15'
Highest: 21'
Lowest: 10'
*CONING POINTS
A opposite 2nd large tree from east; From here, go around 30" Elm along French Drive
B opposite 4th large sycamore along SE side of sidewalk; round cone then to Service Rd
3 mi - on grass crossover to Service Road; marked on pavement, 50 FT forward of 3-mi point
1K - same as finish = 5K
2K - Ind. Ave. sidewalk, 186' E of ctr, WWI Memorial
3K - Plaza, E end of Const. Gardens, 42' S of row of trees along N edge
4K - Same as start

OFFICIAL ROUTE OF

# BAY BRIDGE RACE

MIAMI, FLORIDA




START – ON RICKENBACKER CWSY., 44 FT. 7 IN. S. OF SPEED LIMIT SIGN ON 2ND LIGHT POLE N. OF ENTERANCE TO MARINE STADIUM.

MILE ① – ON BAY BRIDGE, 185 FT. 6 IN. W OF 1ST LIGHT POLE PAST (WEST OF) CREST OF BRIDGE.

TURNAROUND – ON RICKENBACKER CWSY., 71 FT. 3 IN. SE OF LIGHT POLE AT LAST (WESTERNMOST) ENTERANCE TO PICKNICK AREA ON N SIDE OF CWSY.

MILE ② – ON BAY BRIDGE, 232 FT. 6 IN. E OF END OF CONCRETE AT W END OF BRIDGE.

MILE ③ – ON RICKENBACKER CWSY., 111 FT. 8 IN. SE OF STORM DRAIN IN MEDIAN ACROSS FROM ENTERANCE TO HORATIO'S.

MILE ④ – ON RICKENBACKER CWSY., 36 FT. 9 IN. W OF MERGE SIGN (ACROSS FROM NOAA).

MILE ⑤ – ON CRANDON BLVD, 34 FT. 10 IN. SW OF "WATCH FOR BIKES" SIGN ON LIGHT POLE. (ACROSS ROAD ON CURVE)

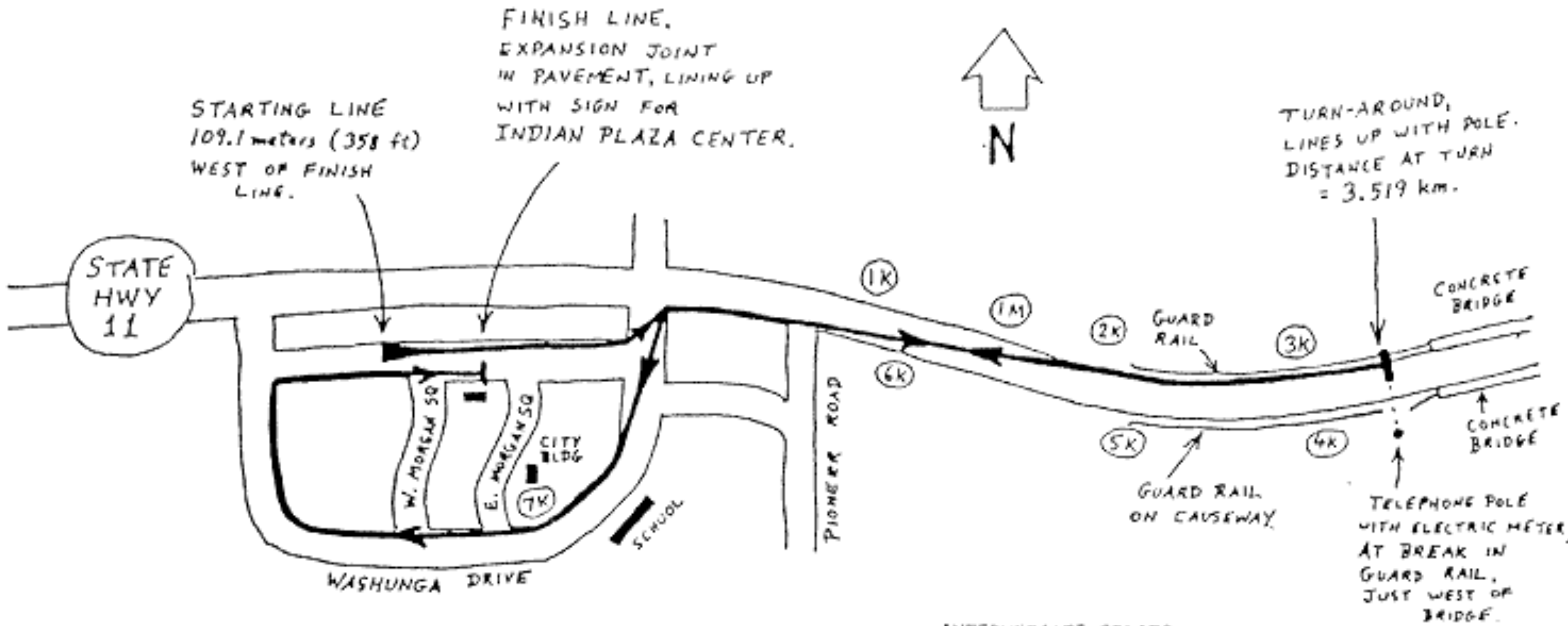
MILE ⑥ – ON PARK ROAD AT ENTERANCE ONTO SUPER STARS TRACK, 12 FT. 4 IN. SW OF GATE POST.

FINISH – ON SUPER STARS TRACK, 90 FT. 0 IN. W OF BANNER POLE.

NOTE: START, TURNAROUND, FINISH, AND SPLITS MARKED WITH NAIL & WASHER.

MEASURED FOR CERTIFICATION
BY FRED SHIELDS 1/24/88
CALIBRATION COURSE FL85024BH

RACE DIRECTOR – ED SMITH
P.O. BOX 490189, KEY BISCAYNE, FL. 33149
(305) 361-3372




# 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.

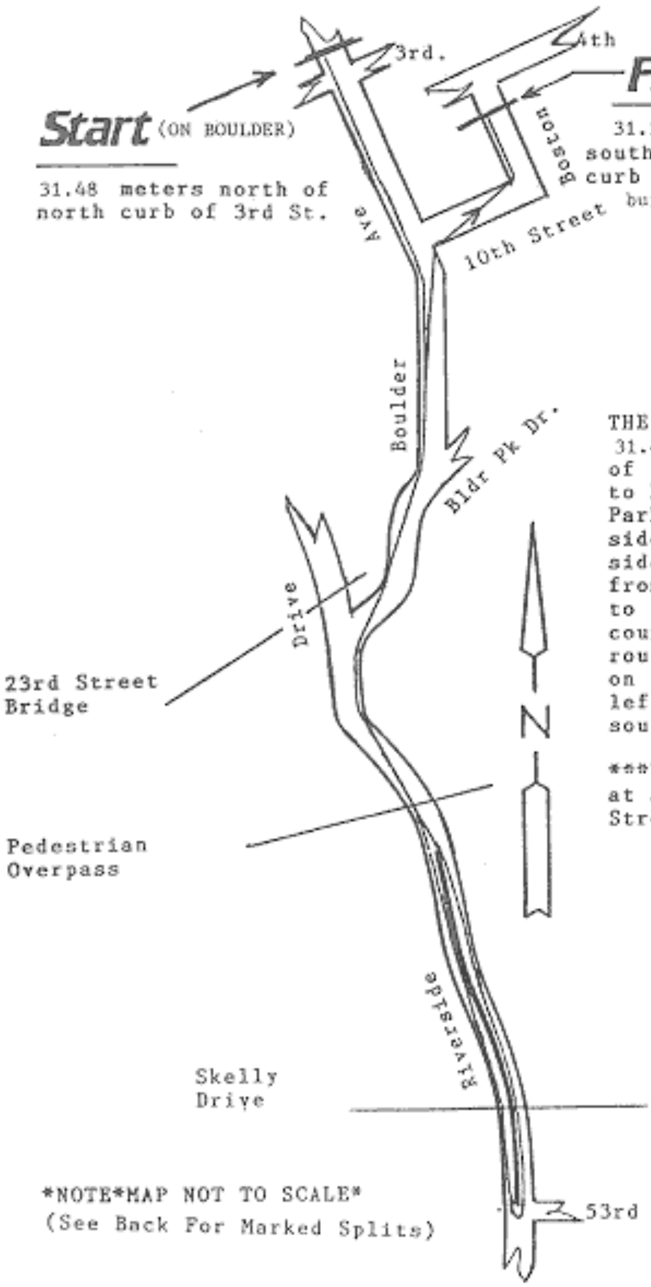
INTERMEDIATE SPLITS

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.




**Finish** (ON BOSTON)

31.18 meters south of south curb of 4th St, (0.3 meters south of 1st building on west side)

# Tulsa Run 15 km
## Tulsa, OK
## OK-94041-BB

THE RACE starts on Boulder Avenue, 31.48 meters north of the north curb of 3rd Street.--- Follow Boulder south to Boulder Park Drive. Follow Boulder Park Drive across 21st Street to Riverside Drive. Continue south on Riverside Drive (keeping right of median from 32nd Street to the turning point ), to 53rd Street. Turn around the median counter-clockwise and follow the same route back to 10th Street. Turn right on 10th Street to Boston Avenue. Turn left on Boston and finish 31.18 meters south of south curb of 4th Street.

***Runners must keep right of median at all times from a point near 32nd Street to 53rd Street***

ELEVATIONS:

| | | |
|---|---|---|
| Start | - 221 | meters |
| Finish | - 226 | meters |
| High | - 226 | meters |
| Low | - 191 | meters |

**Turn** Break in median at 53rd Street just south of Skelly Drive.
= 7.5 km split!

#455 08 94 Glen & Coneil

## Tulsa Run Splits

1/14 km – 2 meters south of north curb of 12th Street.

2/13 km – 1 meter south of 2nd seam south of 18th, &/or Council Oak Trail.

3/12 km – 14 meters south of south curb of 26th Place.(measure along west side of Riverside)

4/11 km – 14 meters south of sewer grate at 1st street light south of 31st, or 19 meters south of cross-walk.

5/10 km – 7 meters south of north end of median at 37th Street.

6/9 km – 3 meters south of 1st street light in median north of 43rd Place.

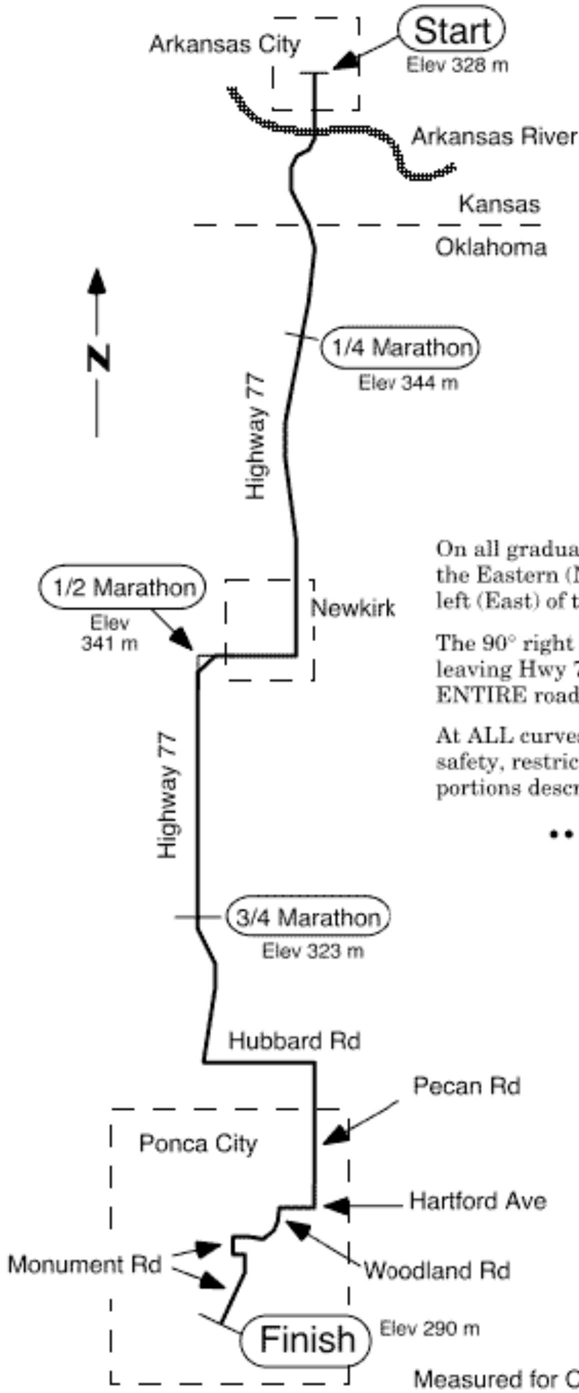
7/8 km – 8 meters north of 1st sewer grate north of 50th Street.

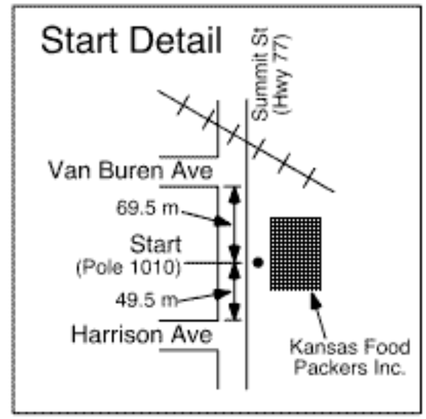
The Cherokee Strip Marathon, a point-to-point course from Arkansas City, KS to Ponca City, OK, illustrates a **single-line map.** (This also happens to be a *computer-drawn* map, which is becoming more common as suitable graphics software has become widely available.) Sometimes, especially for long courses such as marathons, it isn't practical to draw a line depicting the measured path through the entire course. In such cases, it is acceptable to draw the road as a single line, as long as the actual measured/certified path is clearly described. For this particular course, the measured/certified path was chosen as a well-defined path that can be easily described, although it's probably not safe for runners to run this path (unless the course could be closed to traffic, which isn't likely in a small rural race). Therefore, the map also advises that, in the interest of safety, the race director may restrict runners to any desired sub-region of the allowed road portions—which would force runners to run **longer** than the measured distance. It is always acceptable for race directors to impose additional restrictions of this sort. However, care must be taken to make sure that runners never run *shorter* than the measured distance.

Still more complicated course maps could be shown, but they would just be comprised of more of the same kinds of features. 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 longer the course map will take to draw (and there is also a greater risk of something going wrong on race day). The more turns you have, the slower the course will be for the runners. Start with something simple.

# Cherokee Strip Celebration Marathon & Relay

(OK-93028-BB)



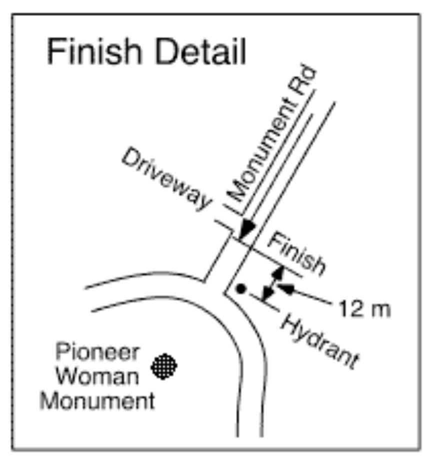

**Restrictions:**

On all gradual curves on Highway 77, runners must remain within the Eastern (Northbound) shoulder or lanes; i.e., they must keep left (East) of the median or center-line.

The 90° right turn in Newkirk, and all turns in Ponca City after leaving Hwy 77, were measured as if runners are free to use the ENTIRE roadway.

At ALL curves and turns, race director may, in the interest of safety, restrict runners to any desired sub-region of the road portions described above.

•• See Splits on Back of Certificate ••




Measured for Certification by Bob Baumel 31 May & 13 June 1993

# 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.

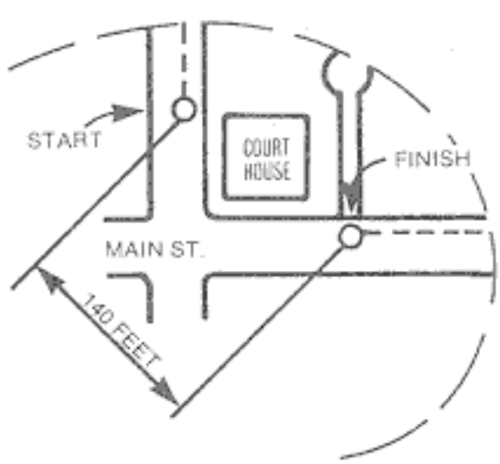
A **loop** course follows a path that eventually closes on itself with the runners headed in the **same** direction as they were at the start of the loop. This circular motion can be repeated indefinitely without the need for the runner to reverse his/her direction of running.

An **out-and-back** course follows a path **out** to a turn-around point where the runners are required to reverse direction and come **back** on the same roadway. When the out-and-back section is completed, the runners are 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 and finish points is greater than 50% of the overall race distance **or** any course whose net decline averages more than 1.0 meter per kilometer (i.e., where the finish elevation lies below the start elevation by more than 1/1000 of the race distance).

## Straight-Line Distance Between Start and Finish

The **straight-line distance between start and finish** is the distance "as the crow flies" (see diagram below). This may be taken from a map drawn to scale by measuring with a ruler and converting to kilometers (or miles) using the map scale. Or it can be determined with just a few mouse clicks by using some of the newer online mapping tools.



The rules on eligibility for USATF and IAAF records make a distinction between courses with start-to-finish separation less than or greater than 50% of the race distance (such as 2.5 km for a 5 km race). If it appears that your course is close to this threshold, try to determine its separation more accurately. Your course can be certified either way; however, if the separation exceeds 50%, official records cannot be set on the course.

## Altitude of the Race Course

Elevations of points on race courses have traditionally been obtained from topographic ("section" or "quadrangle") maps produced by the U.S. Geological Survey (USGS). Unfortunately, these maps are getting increasingly out-of-date. USGS officially completed their series of 7.5-minute quadrangles in 1992 and has now replaced them with an online topographic map called the "National Map," available at http://nationalmap.gov/ . For information about this and other helpful online mapping tools, see our Certification Tools page at www.usatf.org/events/courses/certification/tools.asp .

Finding elevations from traditional topographic maps requires interpreting (and interpolating between) contour lines. Some of the newer online tools allow determining the elevation of a point simply by clicking on it.

Classic topographic maps show locations of prominent natural and man-made features. Some of the newer online tools supplement this information by providing satellite imagery. This can be very useful, as it may allow you to zoom in and make sure you've located your course's start and finish points correctly. Note: you'll probably find more available imagery if your course is in a major urban area than if it's in a rural area.

The Application for Certification of a Road Course asks for four elevations: start, finish, highest and lowest. Of these, the start and finish elevations are most important. To find the high and low elevations, you'll need to trace over your course route, as shown on the map, and check elevations at many points along the course.

**Note:** We are most interested in the **difference** in elevation between the Start and Finish; therefore, it is more important to determine this difference accurately than to get all of the individual elevations above sea level just right. Eligibility for records depends on whether the course has a net **drop** in elevation exceeding 1/1000 of the race distance (such as 10 meters for a 10 km race). If it appears that your course is close to this threshold, try to determine its drop more accurately. Your course can be certified either way, and will also be eligible for USATF "best" times either way; however, it must not drop more than 1 m/km in order to be eligible for official USATF "records."

## 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-Imperial Conversions

It should be kept in mind that the metric system is the fundamental measurement system of the United States. Since 1893, all U.S. Customary units (also often referred to as “Imperial” or “English” units—see additional info below) have been defined in terms of metric units. The easiest such definition to remember is that of the inch:

one inch = **2.54** centimeters *exactly**

*Throughout this appendix, all conversion values in **boldface** are *exact.*

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

| | | | |
|---|---|---|---|
| one foot | = 12 × 2.54 cm | = 30.48 cm | = **0.3048** meters |
| one yard | = 3 × 30.48 cm | = 91.44 cm | = **0.9144** meters |
| one mile | = 5280 × 0.3048 m | = 1609.344 m | = **1.609344** km |

## Doing Conversions in the Working Constant

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/km or counts/mile.
b. **Multiply** constant in counts/km by **1.609344** to obtain the constant in counts/mile, or:
c. **Divide** the constant in counts/mile by **1.609344** to obtain the constant in counts/km.

## 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 much easier to do the conversion **once** in your measuring constant, as described above, than to do repeated conversions for each split. The table does show, for example, that 10 km 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 |

**The marathon is **defined** as **42.195 km** *exactly*.

## Conversions for Steel Taping

| | | |
|---|---|---|
| 1 foot | = | **0.3048** meters |
| 300 meters | = | 984.25 feet |
| 1 kilometer | = | 3280.84 feet |
| degrees Celsius (°C) | = | [degrees Fahrenheit (°F) **– 32**] ÷ **1.8** |
| 1 pound-force | = | 4.448 newtons |

## More about U.S. Customary, "Imperial" and "English" Units

There is no really good name for the 'system' (such as it is) of non-metric units still used in the United States. They aren't necessarily customary, or used in England, and differ in significant ways from the British Imperial System. In some contexts, they're referred to simply as "inch-pound" units. The Imperial System is a reasonably well-defined set of units, established by the U.K. in 1824, sharing the same basic units of length and mass as U.S. customary units, but with significantly different sizes for some units such as the gallon, bushel, fluid ounce, and hundredweight.

Of perhaps greater interest to course measurers, two sets of sizes for the non-metric length units (inch, foot, mile, etc.) can still be found in the U.S. The definition quoted above (that 1 inch = **2.54** cm exactly) is the modern definition of the inch, as standardized in 1959 by all English-speaking countries. However, when U.S. customary units were first defined in terms of metric units in 1893, the inch was defined as the fraction 1 / 39.37 of a meter, equivalent to about 2.54000508… centimeters, or about 2 parts per million longer than the modern 2.54 cm definition. Moreover, versions of the foot and mile based on the 1893 U.S. definitions have persisted under the names "U.S. survey foot" and "U.S. survey mile." Thus, a U.S. survey mile is about 1.609347 km, or about 3 mm longer than a standard mile of exactly **1.609344** km.

Fortunately, the differences between these values are so small (about 8 cm in a marathon) that they are insignificant compared with all the other uncertainties in measuring a race course. We recommend that all length conversions be performed using factors based on the modern definition, 1 inch = **2.54** cm exactly.

# APPENDIX F
# Application Forms

The application forms needed for USATF course certification are all provided in a single file named “appforms.pdf” which you can download in Adobe PDF format. The forms contained in this file are as follows:

- Steel Taping Data Sheet
- Application for Certification of Calibration Course
- Bicycle Calibration Data Sheet
- Course Measurement Data Sheet
- Application for Certification of a Road Course

Download **appforms.pdf** file
(URL: http://www.usatf.org/events/courses/certification/forms/appforms.pdf )

Note: You'll probably have to include a **processing fee** when sending the completed application forms to your regional certifier. The exact amounts of these fees vary from state to state. Therefore, check with your certifier **before** sending in the application forms.

View current list of USATF/RRTC certifiers
(URL: http://www.usatf.org/events/courses/certification/certifiers.asp )