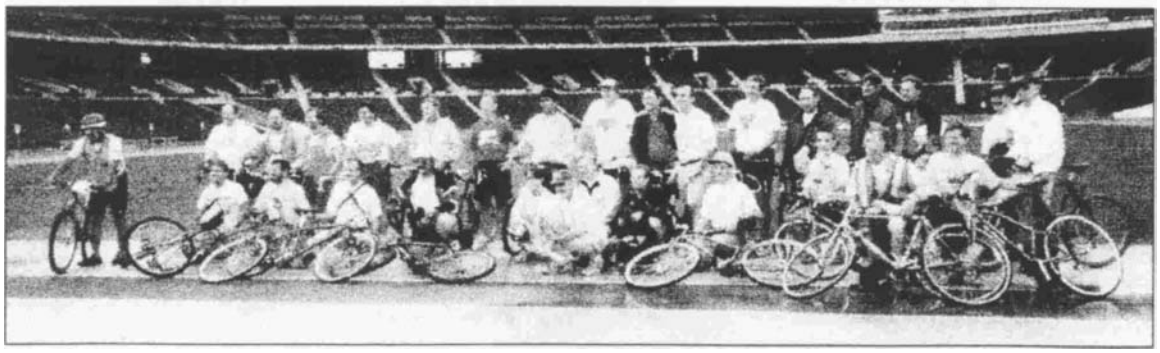
FINAL REPORT OF THE MEASUREMENT
of the
1996 OLYMPIC MARATHON
and
RACE WALKS

July 8, 1996



CONTRIBUTORS TO THIS REPORT

Contributor	From Page	To Page
Bob Baumel	BB1	BB12
Bernie Conway	BC1	
Bob Woods	BW1	
Christian Delerue	CD1	CD10
Dave Cundy	DC1	DC2
Don Shepan	DS1	
Dave Yaeger	DY1	DY 3
Tom McBrayer	ETM1	ETM4
Gerry Rahill	GR1	
Hugh Jones	HJ1	HJ6
Isabelle Marechal	IM1	IM4
John Disley	JD1	
Julia Emmons	JE1	
Jean-Francois Delasalle	JFD1	JFD24
Jean-Marie Grall	JMG1	JMG11
Mike Wickiser	MW1	MW4
Norrie Williamson	NW1	NW3
Pete Riegel	PR1	PR41
Scott Hubbard	SH1	
Wayne Nicoll	WN1	WN13

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To: Olympic Marathon Measuring Team: July 8, 1996

All of the measurers were sent home from Atlanta with a copy of our data, and sent, on June 3, a copy of my preliminary report (included within, pp PR19 to PR30). Many have sent in their own comments on the measurement, and their contributions form the body of this final report. The major result of our work was that recommendations were made regarding adjustments to the course. According to my reading, none of the contributors expressed a strong disagreement with those recommendations.

The final course, as adjusted, would not have been found short by the measurement of any member of the team.

In the various contributions, several questions and proposals were made. I agree with some, I disagree with others. It's not my intention here to try to rebut all of the points with which I disagree. Judge for yourself. I hope that **Measurement News** will be used for future discussion of what we have done. Here are the comments, proposals, and questions:

- The overall quality of the ride was not as we had hoped.
- Riders rode too close to the line when measuring the track. See photo page CD3. The idea of accepting the track surveyor's estimate of lap length was supported. Was the track actually the correct length? We didn't check, in the absence of a curb. The 1.001 Short Course Prevention Factor should not have been applied to the laps taken on the track.
- The calibration course would better have been a single, flat course rather than a divided one with a hill, with one end higher than the other. A dip in the course hindered accurate taping. Pullman Street might have been a better site for the calibration course. The calibration courses were rough.
- A mini-calibration course in the stadium (say the 100 m straight) could have been used for stadium measurements.

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- Should the present IAAF 30 cm curb offset for the ideal line of running be reexamined? A runner who runs closer to the curb may run less than the full distance.

- Solid tires are a better tool for accurate measurement than are pneumatic tires.

- Our failure to adhere strictly to the certified route was regretted.

- It was felt that some riders were measuring the shortest **possible** route rather than the shortest **practicable** route, and this was regretted.

- It might be helpful if we could reconstruct order-of-riding from photos. This might lead to information concerning the effect of one's position in the queue. It was hard to see the proper line at the rear of the queue.

- The interval from 35 to 40 km was too long (Editor's note: this interval included an area on Edgewood which was under construction during the original bicycle measurements. It was measured later with a steel tape).

- There were adaptation problems for some due to having unfamiliar bikes.

- Formal temperature recording should have been done at various stages of the measurement..

- The recommended final adjustment should be checked by an IAAF "A" measurer to see that it is done as recommended (Editor's note: I will check it before the races).

- A supplemental 200 m should be added beforehand to the adjusted turnaround for use in case a lap is missed in the stadium, as happened in Göteborg in the Women's marathon at the last World Championships.

- It would have been desirable had we more female measurers, so that male/female results could be compared.

- A group measurement may be done in Sydney for the 2000 Olympics.

Calculation of the Course Length

The method I employed for calculation of the distance was to use the median measurement of each interval as the accepted one, and add them up. This yielded a length of 42260.7 m. Two other methods were suggested:

The French use a "discounting" method. In this method, the median is established. All values lying more than ± 0.005 from this median are discarded. The median of what is left is taken as accurate. This method yields a course length of 42254m to 42258 m.

Bob Baumel proposes that the minimum ride be taken as a baseline. All values within 0.008 of this value are accepted. All higher values are discarded. The median of what is left is taken as the accurate value. This yields a course length of 42243.2 m.

Larger Constant or Average?

The large calibration variation experienced by some measurers led to support of using the larger constant, rather than the average, for layout. Some favored using the larger constant only, while some support using the larger when calibration change exceeds 0.1 percent, otherwise using the average.

Performance of Measurement Systems

Our US system requires that two measurements be made during layout. If they do not agree within 0.08 percent, they are not acceptable. Our method, using average constant (not recommended but permitted), was seen, in this case, to produce a 91 percent "success" rate (course not measured short). If the recommended larger constant is used, the success rate rose to 99 percent.

The standard IAAF method is for one "expert" to measure the course. No second ride is required. This method, on our ride, produced a success rate of 72 percent.

Race Walks

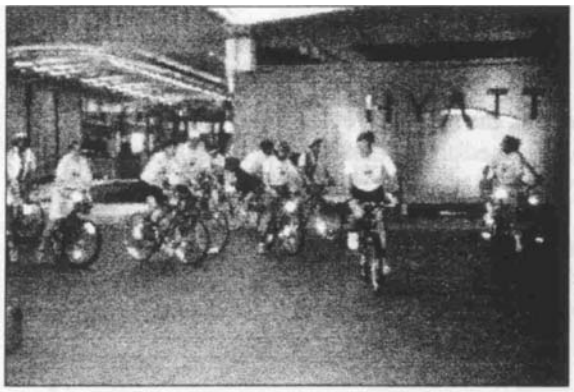
Wayne Nicoll was responsible for measurement of the race walks. Because the final configuration was not established until two days before our group measurement, Wayne did not have time to plan the measurement in detail. Instead, he had to obtain his data at the last minute. You will see his findings as the last section of this report.

I found the individual reports insightful and interesting. There is no doubt that we have enough material to form the basis of some meaningful future research.

My sincere thanks to all of you for your measurement help and contributions to this report.

Best regards,

Pete



Leaving at 5 AM for the course ride

A stop for data-collection

Williamson, Jones, Grall and Delerue take a lap.

After the job is done

On one of the curves on Peachtree Road. At right, enlarged, you see Hugh Jones hugging the curb behind Don Shepan (in the white hat).

The long push up Piedmont

SOME PICTURES FROM THE MEASUREMENT

USA Track & Field

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Notes on Olympic Marathon Measurement – Atlanta, GA – May, 1996

It was a pleasure participating in the measurement of the 1996 Olympic Marathon course. I was especially privileged to have been one of three measurers who took part in both the 1984 Los Angeles measurement (actually performed in April 1983) and this present 1996 Atlanta measurement. Many of my comments will therefore amount to comparison of these two measurements held 13 years apart.

Pete Riegel did a wonderful job in organizing this 1996 measurement. When I arrived in Atlanta before the measurement, Pete was obviously feeling the pressure, and very nervous about how things would turn out. But in the end, it all worked out beautifully: Nobody got hurt, we collected 25 full sets of data for the marathon course, and nearly everybody was happy after the measurement. (Wayne Nicoll also collected lots of data for the racewalk courses, although I did not participate in that process.)

The police escort in Atlanta was fantastic. Before this measurement, the escort in Los Angeles was the best I had seen. However, as I recall, the Los Angeles measurement suffered from numerous breaks (in addition to the breaks for data collection) while waiting for the police to regroup. There were no such breaks in Atlanta. The major difference was that where the Los Angeles police had used cars, the Atlanta police used motorcycles (six of them), allowing the patrolmen to quickly zip through traffic and block successive stretches of road in *real time* as we measured. Consequently, the measurement took place as rapidly as any of us could have hoped, leaving plenty of time for most people to receive a copy of the raw data before leaving Atlanta.

Riding Quality

My biggest surprise (and disappointment) came after returning from Atlanta, when I began calculating the results of the measurement. Unfortunately, our 25 measurements of the marathon spanned a huge range of 90 m — about 0.21% of the course length. This is *much* worse than in Los Angeles, where 13 measurements of a 30.9 km segment of the course spanned a 13 m range, which was only 0.04% of the measured distance. In other words, the range of the Atlanta measurements was about five times as great as that of the Los Angeles measurements!

During the years between Los Angeles and Atlanta, there had been several indications that measuring consistency was declining. For example, during the International measuring seminars in West Jefferson, Ohio in 1990, and in Phoenix, Arizonta in 1994, the ranges of measurements were significantly greater than the 0.1% Short Course Prevention Factor. However, those results could conceivably be attributed to complications such as complexity of the test courses (more curvy than most real road courses, or in the case of West Jefferson, unusual obstacles such as locked gates). Also, as those were training exercises, results may have been skewed by the presence of quite a few inexperienced measurers.

No such factors applied to the present Atlanta measurement. This was *not* an unusually curvy course. And although some inexperienced measurers did participate, the vast majority of the Atlanta measurers must be classified as "experts." In particular, the measurers who obtained the highest and lowest measurements belonged to this "expert" class.

(Also, it's not fair to say that every measurer in Los Angeles was an "expert." For example, Pete Riegel and I had each measured only a handful of courses before Los Angeles!)

The real difference between Los Angeles and Atlanta, in my opinion, was the state of mind of the measurers. The Los Angeles measurement in April 1983 occurred barely six months after Ted Corbitt, the great guiding spirit of course certification, had announced a major change in measuring procedure: Previously, the official measuring line was one metre from road edges. Now, the official measuring line was to hug the inside edges of curves at only 30 cm from curbs (and only 20 cm from uncurbed road edges, although in the interest of simplicity, the 20 cm figure was later dropped from our measuring instructions).

Everybody who was measuring during that 1982–83 period understood that this was a **major** change in procedure. The new clearance of only 30 cm from curbs was non-trivial to achieve; it required great concentration and carefully honed measuring skills. (For myself, I found that I must usually 'scooter' my bike to achieve this clearance around tight corners.)

The new procedures adopted in 1982–83 involved a philosophical change beyond the mere numbers of 1 m vs. 30 cm. Previously, measurers would try to estimate the likely path of a 'prudent' runner. Now, the official measuring line (known as the "Shortest Possible Route" or "SPR") became more of a mathematical abstraction. Due largely to the influence of Ken Young, who operated the National Running Data Center and formulated the initial TAC (now USATF) rules for road-running records, the correct path to measure became the shortest path that a runner can **possibly** run, whether or not a 'prudent' runner would run that tightly.

Everybody who participated in the Los Angeles measurement was fully aware of these changes, and all were imbued with the spirit of riding the tightest possible line. Which is probably why the measurements obtained in Los Angeles were so self-consistent.

For several years after Los Angeles, those measurers who had taken part continued to improve their measuring skills, and found themselves measuring ever more tightly. Thus, whenever they remeasured a course they had measured only a year or two earlier, they would invariably find it short and in need of lengthening. Given this trend of tighter and tighter riding, I wondered how tight a path people might measure in Atlanta! But obviously, that trend couldn't continue indefinitely.

Actually, it seems likely that in later years, many measurers—especially many of those who started measuring around 1985 or later—began to adopt a more relaxed attitude about the path to measure. For example, every measurer knows that the instructions say to measure within 30 cm of the road edge. So everybody dutifully repeats this figure every time they fill out a certification application. Nevertheless, many measurers probably have never figured out what's really involved in measuring 30 cm from the edge. If one were to examine the path they *really* measure, they may be 50 cm or 60 cm or more from the edge!

It is also likely that many measurers reverted to the older philosophy—measuring the

shortest path of a 'prudent' runner—instead of adhering strictly to the shortest **possible** path. This reversion to an older philosophy probably took place especially after Ken Young left the sport at the end of 1986, as Ken had been the leading proponent of a strict SPR interpretation.

In all likelihood, the measurers in Atlanta possessed widely varying attitudes regarding the path to measure. For example, I had participated in Los Angeles and still believed in measuring a strict SPR. Some of the non-US measurers also apparently felt motivated to ride a very tight line (The two lowest measurements were obtained by measurers from Britain and France). But many of the riders (including USATF certifiers) seem to have adopted a more relaxed definition of the SPR. Two of the three highest measurements were obtained by USATF certifiers. The total range among all 25 measurements was about 90 m, and if we consider only the USATF certifiers, the range was still about 80 m.

Possibly, other factors besides varying interpretations of the SPR were responsible for this big range. For example, were some of the measurers 'hypnotized' by the string of cyclists ahead of them, causing them to lose concentration? Or might they have suffered from lack of sleep, due to the early hour (04:30) that we had to get started Sunday morning? Or might some have been intimidated by Pete's instructions intended to maintain measuring speed (to the possible detriment of measuring quality)?

Regarding this latter point, Pete instructed the measurers to ride all corners continuously instead of 'scootering.' Several times before the measurement, I pressed Pete about this scootering prohibition. He admitted that his only concern was to avoid slowing to a crawl. But if a measurer wished to put a foot on a curb for guidance while rounding a corner, and could do this without seriously slowing the pace of the measurement, that was perfectly acceptable. Later after our preliminary tour of the course (see narrative below), Pete admitted further that the number of tight corners on this course was small enough that the effect on overall measuring time would be insignificant even if everybody were allowed to scooter corners as they wished. Unfortunately, few measurers heard Pete say this; most saw only his written prohibition against scootering.

As another possible factor affecting the range of measurements, I wonder whether some measurers chose to honor Jack Grosko's restrictions about exit lanes along the edges of the roads, even though Pete instructed us to ignore those restrictions. (I'll say more about these exit lane restrictions later.)

Still another factor affecting measuring quality was the large range between pre- and post-calibration experienced by many of the measurers (including myself). This increases the uncertainty of some of the measurements, but it didn't have much effect on the overall range because the measurers who obtained the lowest and highest measurements both had rather *small* variations between pre- and post-calibration. (I'll have more comments on calibration ranges later.)

While many factors could conceivably have contributed, I still believe that the dominant reason for the big differences between measurements was that some measurers interpreted the SPR much more loosely than others. This is very unsatisfying, and contrasts sharply with the result from Los Angeles.

Everybody was happy after Los Angeles, because it showed that all the measurers who took part were measuring essentially the same way. Also, because all the measurements agreed

within 0.05%, it helped to justify 0.1% as an adequate Short Course Prevention Factor.

The present Atlanta measurement, considered especially with the results of other group measurements such as West Jefferson and Phoenix, shows that we're **not** all measuring the same any more. If 'experts' can obtain measurements differing by 0.2% or more, this surely seems to imply that 0.1% is no longer an adequate Short Course Prevention Factor.

What choices do we have now? If nothing is done to improve agreement of measurements, then logically, we need a significant increase in the Short Course Prevention Factor. Or maybe we need some other big change in procedure (although I don't know what), similar to the major changes of 1982–83, in order to shake things up and force measurers to acquire a more uniform understanding of the SPR again.

Personal Narrative

I will now recount some of my personal experiences in Atlanta. Later, I will provide some more detailed analysis and commentary on several issues.

My first view of this Atlanta Olympic course came during the USATF Convention in December 1995, when eight of us did a preliminary scouting ride by car. For the measurement itself, I was one of the earlier measurers to arrive in Atlanta (Wednesday afternoon). On Thursday morning, I accompanied Pete Riegel, Jean Francois Delasalle, and Norrie Williamson on another tour of the course.

On this occasion, we scouted possible locations for calibration courses, and chose a length of Washington Street just west of the Olympic Stadium. Although hilly, this stretch of road is straight, lightly-travelled, very close to the race start/finish, and nearly 500 m long. Pete used a walking wheel for a preliminary, rough layout; then we drove nails to mark the endpoints of a pair of calibration courses along the east and west edges of this street (distances to be taped later).

Also at this time Thursday morning, we drove the entire marathon course, paying particular attention to the coning restrictions specified by original course measurer, Jack Grosko. This list of restrictions is many pages long. Most of these restrictions involve exits on the right (or sometimes left) side of the road, where runners could accidentally wander off the course by turning into a shopping center or side-road. In each such case, Grosko's instructions specify blocking off not only the exit itself, but also the *entire exit lane* leading to it.

As we examined the course, the task appeared nearly impossible of ensuring that every measurer honor every one of these restrictions. However, we decided, it would probably make little difference to the measured distance if riders simply ignore the exit-lane restrictions and measure a less restricted SPR. Pete ultimately decided that this is how he would instruct the measurers. (I'll have more comments about these exit-lane restrictions later.)

Saturday, the first day of measuring, began in heavy rain (very reminiscent of Los Angeles). Fortunately, the rain stopped before the actual start of measuring. Unfortunately, the road was still wet during taping of the calibration courses. Thus, masking tape would not stick to the road, forcing most measurers to mark intermediate tape lengths using chalk, which is less precise than the masking tape method.

Because of the limited time available Saturday for in-stadium measurements, Pete decided that we would do only a single pre-calibration ride (southbound on west calibration course) and a single post-calibration (northbound on east calibration course). This was reasonable, given the small percentage of the marathon course comprised by the short stadium segments measured Saturday. However, I have two comments regarding this reduced number of calibration rides:

First, although I did not participate in the racewalk measurements, it appears that many measurements were taken for the racewalk courses using only this low level of calibration effort. I would be very reluctant to accept a determination of the racewalk course length based on this minimal calibration. (I accept it for the marathon course only because it was used for just a small portion, about 1 km, of the whole marathon distance.)

Second, because this is a *hilly* calibration course, it is always necessary to average the results of northbound and southbound rides to eliminate the slope effect. Therefore, all results of the Saturday bicycle measurements *must* be computed using *average* constant. It is not meaningful to make any calculations for these measurements using only a pre-calibration or post-calibration constant alone (as in a "larger constant" calculation), even accounting for the individual measured lengths of the east and west calibration courses.

On the stadium track, the curb that's supposed to mark the inside edge of lane 1 was not present during our Saturday measurements; i.e., the inside edge of lane 1 was marked only by a painted line, just like the other lane lines. Measurers therefore had to judge the correct measuring path, 30 cm from the inner edge of lane 1 (and 20 cm from the inner edge of lane 5 on the portion restricted to lane 5). Their success in accomplishing this is indicated by the results of the lap-length measurement (which Pete wisely chose to ignore in calculating the marathon course length). I'll discuss those results a little later.

Turning to the main course riding on Sunday, I've already expressed my disappointment with the quality of the results. This did not become apparent until we had left Atlanta and calculated the results. During the measurement itself, it did seem to me that some people didn't ride as tightly as they should, but still, I had no idea the range of measurements would be as high as it turned out.

As for myself, although I tired somewhat during the ride, I always tried to maintain concentration, keeping in mind that this was a *measurement* (not a "bike-a-thon" as David Katz facetiously described it). I did 'scooter' most tight corners (in spite of Pete's pronouncement against scootering), although trying to do it reasonably quickly. At two of the corners where I chose *not* to scooter, I felt myself swing wide, and knew that the quality of my ride was reduced a little bit.

After I returned home from Atlanta, with (like all the other participants) a complete set of the raw data in hand, I couldn't hold my curiosity very long. On Monday evening, May 27, I typed all the data into my computer to see how the measurements came out. I will not present those calculations here, because my results were essentially the same as Pete's.

During the following week, from May 28 to about June 2, Pete and I exchanged many communications by email. We compared our calculations (using email attachments to exchange spreadsheet files) and discussed the method of final adjustment. I will provide more detail about these discussions later.

Length of Calibration Courses

A note on steel taping data quality: Standard deviations of the (temperature corrected) measurements for both the East and West calibration courses were about 0.013%. This is worse than the 1994 Phoenix seminar, where the standard deviation for taping the calibration course was about 0.008%. In some ways, conditions in Atlanta were *better* than in Phoenix, where temperature correction had been more ambiguous due to bright sunny conditions, and the calibration course endpoints were ambiguous because they were marked only by pieces of tape (Pete was sure to mark the calibration course with **nails** this time). I think the reason for the worse performance this time was the wet road that prevented masking tape from sticking, forcing most measurers to use chalk. I think this shows that marking fine lines on masking tape **does** make a difference!

Fortunately, we had enough data to still obtain a very accurate determination of the calibration course length. Pete and I disagreed on the best method of figuring this length, although the difference is insignificant. He took simple medians of all the measurements, and then rounded the average of the East & West courses to two decimal places, obtaining 480.71 m. I figured that the errors were essentially random, so an *average* would be more accurate. However, a simple average is non-robust when there are "outliers." One of the tape measurements (by SH & DK) did appear to be an outlier; it is clearly separated from the others if plotted (Maybe they used an out-of-spec tape). The following table shows the simple median, simple average, and average of all measurements except SH,DK:

	Simple Median (m)	Simple Average (m)	Average of all except SH,DK (m)
West course length	480.352	480.368	480.381
East course length	481.062	481.033	481.046
Average East & West	**480.707**	480.701	**480.713**

Using my preferred method (average of all except SH,DK), the West course is 29 mm longer than by Pete's method (simple median); but the East course is 16 mm shorter than by Pete's method. After averaging the East & West courses, the difference between my method and Pete's is only 6 mm, equivalent to only 0.5 m over the full length of a marathon. And *both* my method and Pete's yield the same result of 480.71 m if rounded to 2 decimal places!

Lap Length of Stadium Track

Pete wisely chose to ignore the bicycle measurements of lap length when figuring the 3 laps of the track at the beginning of the marathon (Instead, he accepted the Track Surveyor's measurement as accurate). Nevertheless, the bicycle measurements of lap length are very interesting from a psychological point of view. As noted previously, the track's curb was not in place during these measurements. Thus, in contrast to a normal road measurement where the SPR is basically the shortest path that can *possibly* be measured, here nothing stopped the measurers from riding *shorter* than the correct path (30 cm from the line marking the inner edge of lane 1).

Here are some calculations based on everybody's lap length measurements. The column headed "Lap length with 1.001" is simply copied from Pete's calculation. The next column

"Lap length w/out 1.001" is the first column multiplied by 1.001, to express the result in 'real' metres instead of 'certification' metres (defined as 1.001 m). In the final column, I have backed out the clearance of each rider from the inner boundary of lane 1. In this calculation, I assumed that the track length is exactly 400 m at a clearance of 30 cm. I think Phil Henson said the officially surveyed lap length was actually 400.035 m. If we use that figure instead of 400 m, it would reduce the numbers in my final column by only about 0.5 cm.

	Lap length with 1.001 (m)	Lap length w/out 1.001 (m)	Clearance from lane line (cm)
DK	396.66	397.06	-16.8
WC	398.25	398.65	8.6
DS	398.28	398.68	8.9
DC	398.35	398.75	10.1
HJ	398.40	398.80	10.8
GR	398.49	398.89	12.3
NW	398.52	398.92	12.8
RMF	398.54	398.94	13.2
DY	398.56	398.96	13.4
PR	398.57	398.97	13.6
SH	398.61	399.01	14.2
BG	398.62	399.02	14.3
EP	398.70	399.10	15.7
JFD	398.74	399.14	16.4
IM	398.90	399.30	18.9
CD	399.08	399.48	21.7
BC	399.08	399.48	21.8
AB	399.11	399.51	22.2
LRG	399.12	399.52	22.4
BW	399.21	399.61	23.8
BB	399.25	399.65	24.4
MW	399.26	399.66	24.5
JD	399.26	399.66	24.6
JW	399.39	399.79	26.7
JMG	399.55	399.95	29.2
DL	400.12	400.52	38.3
DL2	400.20	400.60	39.5

It appears that nearly everybody felt most comfortable measuring somewhat closer than 30 cm from the lane line. Jean-Marie Grall gets the prize for coming closest to 30 cm. Only two measurers had clearances greater than 30 cm, and they were still within 40 cm. One measurer had a *negative* clearance of about -17 cm. Assuming that the lane line is 5 cm wide, he probably averaged about 12 cm to the left of the line. If this had been a normal race on the track, then presumably he would have been disqualified for cutting inside his lane!

Tire Size Changes – Range between pre- & post-calibration

Many of the measurers in Atlanta (including myself) experienced large changes between pre- and post-calibration. Also, many of them (including myself) used fat-tired mountain bikes. From this, one might be tempted to conclude that fat mountain-bike tires are not acceptable for measuring, because the calibration changes are too big. But that wouldn't be

a fair conclusion.

Percentagewise, the calibration changes in Atlanta were very similar to those observed in Los Angeles 13 years earlier. We didn't measure the temperature change in Atlanta, but the amount of warming between pre-calibration (at 5:00 am in the dark) and post-calibration (at around 10:00 am) may have been similar to Los Angeles.

In Atlanta, I used a fat-tired mountain bike and obtained a big calibration spread. But Bernie Conway had an even bigger calibration spread, and he had brought his own bike—which surely *didn't* have fat tires. John Disley had a medium-sized calibration spread, but he was using a *solid* tire. (Note that Disley's change was in the opposite direction to everybody else's; his tire compressed, while the others [except Norrie Williamson's] all expanded.)

In my experience, thin-tired bikes with pneumatic tubes can experience just as big calibration changes as fat-tired bikes. My calibration change in Atlanta was nearly identical to what I experienced 13 years earlier in Los Angeles, where I used my own bike with thin (pneumatic) tires. I've also found that calibration changes of fat-tired mountain bikes can be made very acceptable if you pump the tires hard enough (In this case, I probably didn't inflate the tire enough; I filled the tires Friday evening, but then never checked it again before the ride Sunday).

Before going to Atlanta, we knew that large calibration changes were very likely. We knew also that we could have reduced calibration-spread error by use of an additional, intermediate calibration course, perhaps in the Oglethorpe University area. However, Pete was very concerned about accomplishing the measurement in reasonable time. Pete concluded that the extra time (for both measuring this intermediate calibration course, and for the additional calibrating half-way through the marathon measurement) was unacceptable, and this decision must be respected.

Choosing the Official Measured Length

When Pete and I began email correspondence on May 28 regarding the choice of final adjustment, we had rather different ideas. Pete wanted to take simple medians of the measurements of each interval, which leads to a total measured length of 42260.6 m, and implies that the course should be shortened 65.6 m to obtain the marathon length of 42195 m. I felt that the large range of measurements (90 m between lowest and highest) showed that many measurers had poor rides, and therefore, the median is not a good figure. I proposed that in estimating the measured distance, we assign greater weight to those rides with the 'better' (i.e., lower) measurements. I worked out two possible methods of calculating this (to be described below). Both these methods suggested that the original course be shortened only around 50 m, instead of 65 m.

Pete never abandoned his intention of using simple medians. He did later work out "Estimates of Deviation from the Certified Route," which suggested that because of parked cars, construction, and cases where we didn't follow Jack Grosko's coning instructions exactly, the path we measured was about 13 m longer than the official certified route. After accounting for this, Pete's shortening recommendation was reduced from 65.6 m to 52.6 m. Since this was closer to my original recommendation of 50 m, it made me feel better.

From a logical standpoint, however, the "Deviation from Certified Route" estimate is

entirely independent of the estimate of measured course length. If the "Deviation from Certified Route" estimate is taken at face value as the difference between the path we measured and the path that will be available to runners on race day, then this adjustment should be applied *anyway*, independently of our estimate of the distance we measured. Thus, the disagreement between Pete and myself was never resolved on this issue. (But, of course, Pete has the final word on how to adjust the course!)

I proposed two methods of choosing an official measured length which, as opposed to simple median, would come out closer to the 'better' (i.e. lower) measurements. My first proposal was to calculate every measurement of every interval using the ***larger*** constant (i.e., larger of pre- and post-calibration constants)—which is the standard method used for course layouts in the United States—and then pick the median of these larger-constant measurements for each interval. This yields the results:

Interval	Length (m)
Start to Clarke	1539.78*
Clarke to 5 km	3470.62
5 km to 10 km	4997.03
10 km to 15 km	5000.48
15 to 20 km	4999.77
20 to 25 km	4989.56
25 to 30 km	4990.43
30 to 35 km	4994.70
35 to 40 km	5055.56
40 km to Clarke	1546.99
Clarke to Finish	658.24*
Total	42243.15

*Note: Start to Clarke and Clarke to Finish are still calculated using ***average*** constant, because the Saturday in-stadium measurements used only one pre-cal and one post-cal ride, rendering a larger constant calculation meaningless for those measurements.

By this method, the total measured length was 17.5 m less than by Pete's method.

My second proposed method uses Internationally-standard ***average*** constant (like Pete's calculations), but tries to exploit the notion stated in our *Course Measurement Procedures* manual that measurements should agree within 0.08% (Remember: the total range of our measurements was actually about 0.21%). The book says that if "measurements do not agree to within 0.08%, something is wrong. Fix it!" While the method of 'fixing it' may not be obvious, I chose to interpret this as follows: That if the minimum measurement of an interval is not an obvious outlier, then consider only those measurements within 0.08% of the minimum. Therefore, I chose to calculate the measured length of each interval as *the median of those measurements within 0.08% of the minimum*. This yields the following results for all the intervals (see table at top of next page):

Interval	Length (m)
Start to Clarke	1539.78*
Clarke to 5 km	3471.21
5 km to 10 km	4998.31
10 km to 15 km	5002.42
15 to 20 km	4999.56
20 to 25 km	4990.11
25 to 30 km	4990.64
30 to 35 km	4994.09
35 to 40 km	5054.98
40 km to Clarke	1545.90
Clarke to Finish	658.24*
Total	42245.23

*Note: Start to Clarke and Clarke to Finish are still calculated using medians of ***all*** measurements (same as Pete's calculation), due to the vast difference in psychology between the Saturday in-stadium measurements and Sunday road measurements.

By this method, the total measured length was 15.4 m less than by Pete's method.

Using either of the two methods I suggested, the runners would ultimately have to run between 15 m and 17.5 m farther than they will on the course adjusted according to Pete's calculations. I think that my methods would do a better job of producing a 'standard' course, where a 'standard' course is defined as one laid out by a competent measurer, riding a good tight line, and using the full 0.1% short course prevention factor. The final marathon course in Atlanta will be somewhat shorter than this because, although it includes the full 0.1% factor, it incorporates the results of many measurers who *didn't* ride such a tight line.

The question arises: Will the final course in Atlanta be at least 42195 m? I think we're probably safe, based on two arguments that were both contained in emails sent to me by Pete: First, if we consider the *lowest individual measurement* (42230.7 m by Hugh Jones), and decrease this by 65.6 m (Pete's calculated adjustment), and then multiply by 1.001 to cast the result into 'real' metres, we get 42207.3 m which does exceed 42195 m, although the safety factor is only 12.3 m (considerably less than 0.1%). As a second, still more extreme, calculation, if we take the *lowest measurement of every interval* and add them up, we get 42223.9 m. After applying the same manipulations (subtracting 65.6 m and multiplying by 1.001), we get 42200.5 m, which still exceeds 42195 m, although by only 5.5 m.

(If we perform this same calculation using my own measurement of 42240.9 m, we find that after shortening by 65.6 m, the course has a safety factor of 22.5 m—barely over half the standard 0.1%.)

Thus, I think the distance will be greater than 42195 m, although the safety factor is pretty slim. Because we're shaving it so close, it becomes essential that the (logically independent) 13 m estimate of "Deviations from the Certified Route" be very accurate; i.e., we have to hope that we haven't missed any places where the path available on race day will be shorter than the path we measured.

Coning Restrictions & Deviations from Certified Route

Intuitively, I feel that Pete's 13 m of "Deviations from the Certified Route" come pretty close to the mark, although it's hard to say for sure. I don't remember any other places where we were forced to ride significantly longer than the certified route, although such places could have existed. I do recall that there was a construction area on Piedmont (probably between 10 km and 15 km) which Pete didn't mention explicitly, but maybe it's included in his 3 m of "Parked cars on Piedmont."

The very fact that Pete has included these "Deviation from Certified Route" adjustments marks a significant improvement compared with Los Angeles. I recall that in Los Angeles, there were also many places where parked cars forced us to ride a longer path than would be available on race day. At the time of the measurement, we were assured that adjustments for those cases would be calculated later. However, to the best of my memory (and in spite of 8 months spent wrangling over how to calculate the data), no adjustments were ever made for the vast majority of those cases.

Returning to the present Atlanta course and Pete's "Deviations from Certified Route," one aspect of this adjustment illustrates a lesson that we *haven't* learned so well from Los Angeles. Pete's 13 m adjustment is a *net* result, based on 17 m of *positive* adjustments (where we were forced to ride longer than the path runners will have available), and 4 m of *negative* adjustments (where we rode shorter than Jack Grosko's coning restrictions). I object to the 4 m of negative adjustments, which although small quantitatively, illustrate a lesson we didn't learn from Los Angeles.

The lesson I have in mind is to make course descriptions as *simple* as possible, using *natural road boundaries* to the greatest extent possible, and keeping *required coning arrangements to an absolute minimum*.

The Los Angeles course included only four places where, as we defined the course, precise coning was required. It so happened that in the first of the Marathons in Los Angeles (i.e., the Women's race), those cones *almost* weren't set up. The cones did get set up, but only because several of the measurers were present in a lead vehicle that drove about 10 minutes in front of the race. The cones were still just lying on the side of the road when those measurers arrived on the scene!

That incident implied two lessons: First, that it's a good idea, when possible, to have one or more of the measurers ride in a lead vehicle preceding the race. But secondly, to simplify course descriptions and *avoid* coning as much as possible. The first lesson was learned well by AIMS/IAAF, who tried to make it part of their standard procedure. The second lesson hasn't been learned so well, as evidenced by Jack Grosko's numerous pages of coning restrictions which are still part of the course description for the 1996 Olympic Marathon.

By calculating 4 m of negative adjustments (for cases where the measurers violated Grosko's coning restrictions), Pete Riegel officially acknowledged that all of Grosko's restrictions are still part of the official course description. I wish that Pete had chosen instead to simplify the course description. Since the measurers ignored all of Grosko's exit-lane restrictions (assuming that the measurers followed Pete's instructions), Pete could have presented Julia with a simplified set of instructions in which the exit-lane restrictions were no longer required. In this case, of course, Pete would not have included his 4 m of negative adjustments.

If Pete had simplified the course description in this manner, race officials would probably still want to cone off the actual shopping center driveways, etc., where runners might accidentally wander off the course. But there would no longer be any need to cone the *entire exit lanes* leading to those driveways, and therefore, far fewer cones would be required.

Unfortunately, the official course description still includes all of Grosko's many pages of coning restrictions. I think this sets a poor precedent for future races.

Concluding Remarks

I greatly enjoyed my experience in Atlanta, and am very happy to have participated in my second Olympic Marathon Course Measurement. I think that the Marathon in the 1996 Olympics will be at least 42195 m, although we're shaving the safety factor somewhat closer than I consider appropriate. Unfortunately, the very large range of our measurements (90 m or 0.21%) shows that we've developed a problem in the measuring community that cannot be ignored. I think we'll have to do something about this problem: Either increase the short course prevention factor, or take some action to produce more uniform understanding of the shortest possible route.

Bob Baumel

June 30, 1996

Subj: atlanta
Date: 96-06-17 22:53:21 EDT
From: bernconw@enoreo.on.ca (Bernard Conway)
To: riegelpete@aol.com

Pete

Using the length of the calibration courses as Dave Yaeger and I measured them, including temperature corrections; plus the pre and post calibration rides I made, I calculated the following data.

Start to Ref. (no extra laps)	0.341 26 km
Three laps of track at 400 m/lap	1.200 000 km
Ref to 5 km split	3.471 943 km

***I do not agree with you that we should include the 0.1% spr here. The track is certified as 400 m and should be accepted as such. Therefore my accumulative 5 km splits follow:

Start to 5 km mark	5.013 203 km
start to 10 km mark	10.012 998 km
start to 15 km mark	15.015 562 km
start to 20 km mark	20.017 913 km
start to 25 km mark	25.009 189 km
start to 30 km mark	30.000 678 km
start to 35 km mark	34.995 362 km
start to 40 km mark	40.050 53 km
start to Finish	42.257 997 km

Adjust course by removing a total of 62.997 m from the turnaround using values referred to above.

Start	remains the same (3 full laps of track and then out, counter-clockwise)
5 km	move 13.203 m towards start
10 km	move 12.998 m towards start
15 km	move 15.562 m towards start
20 km	move 17.913 m towards start
Turnaround	move 31.498 5 m towards start/finish
25 km	move 53.808 m towards finish
30 km	move 62.319 m towards finish
35 km	move 67.635 m towards finish
40 km	move 12.467 m towards finish
Finish	remains the same (direct to the finish, counter-clockwise)

Pete, I am also sending you copies of some pictures I took in Atlanta. I enjoyed the opportunity to work with such a fine bunch of individuals. I enjoyed the scenery there and back. I only wish I had had a chance to see some of the sights in Atlanta. I hope we can all meet to measure the next Olympics in Australia.

Bernie Conway

BC 1

Able Management Group
3250 Point Pleasant Road
Buchanan, TN 38222-3659
901-232-8587

Peter S. Riegel, Chair
Road Running Technical Council
3354 Kirkham Road
Columbus, Ohio 43221-1368

Dear Pete,

Just have a few comments about the Olympic Marathon measurement-

The first is that I am glad that we as a group could get together, exchange ideas, compare techniques and perhaps learn a better way; and have a fun time doing it all.

Second, I learned a hard and personal lesson: If one decides to come down from the porch and run with the big dogs, one had better be properly equipped and prepared. I wasn't. That won't happen again.

Third, in reviewing the data on the calibration courses and the in-stadium measurements (the only ones where I was as involved as the other measurers) I was surprised to find so much variation in the numbers, but relieved to see that we were all well within the acceptable tolerance. This realization gives some comfort to being on the "fringes" but assurance as well that I'm doing work that would be proven reliable in a validation.

Finally and perhaps most importantly, being a part of the team in Atlanta has caused me to slow down and pay more attention to detail: to wit, proper tension on the tape on the calibration course and checking and rechecking the counter (I transposed numbers twice that I caught). These are little things that can make a big difference.

I'm looking forward to future group efforts. So, until then --

Good measuring,

Bob Woods

BW 1

MESURAGE DU PARCOURS

Marathon des JEUX OLYMPIQUES 1996

ATLANTA

USA

CD 1

La BASE

WASHINGTON STREET (à proximité du stade)

La cuvette

11 groupes ont mesuré la base avec des températures différentes.

Ecart maximum entre les groupes : 480,442 m - 480,244 m =
0,22 m soit 22 cm

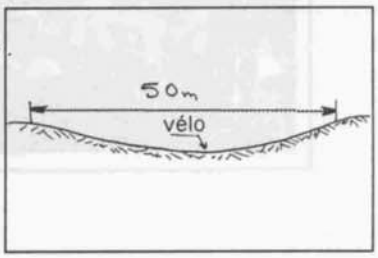
La base au mesurage présentait des inconvénients :

- au début et à la fin de chaque base le sol faisait une cuvette et si l'on tendait le décamétre , le décamétre se levait du sol (donc distance trop courte).

- le sol n'était pas régulier, nombreuses pierres et du sable ainsi que des plaques d'égouts

- le profil vallonné et différent de l'East et du côté West

La difficulté de la BASE a amené des résultats surprenant à l'étalonnage.



En comparant les deux bases à partir du calcul de départ (RIEGEL)
481,03m - 480,35m = 0, 71 m

Ecart idéal entre les deux bases : 0,71 m ou **71 cm**

En analysant les chiffres de l'étalonnage on se rend compte de la difficulté de la base (voir l'étalonnage)

ANALYSE DE LA LONGUEUR

	Moyenne base EAST	Moyenne base WEST
11 groupes	480,37 m	481,03 m
en enlevant les extrêmes (1 et 11)	480,37 m	481,03 m
en gardant les groupes + ou - 0,05%	480,36 m	481, 049 m

CD 2

Translation of preceding page by Pete Riegel:

THE CALIBRATION COURSE

WASHINGTON STREET (close to the stadium)

11 groups measured the calibration courses at different temperatures.

The maximum gap within the groups was 480.442 m - 480.244 m = 0.22 m = 22 cm.

The conditions of the measurement presented some inconveniences:

- At each end of the calibration courses there was a depression in the pavement. If the steel tape was tensioned, it rose off the ground. Therefore the distance was short.

- The pavement was irregular, with numerous stones and sand, and sewer gratings.

- The profiles of the east and west side were different.

The photo "la cuvette" (the depression) shows the dip in the road behind Jean-Francois Delasalle.

The difficulty of the calibration course brought some surprising results to the analysis.

In comparing the two baselines, RIEGEL calculates the difference between the baselines as 481.03 m - 480.35 m = 0.71 m.

The ideal gap between the two baselines: 0.71 m or 71 cm.

In analyzing the numbers of the calculation one realizes the difficulties of the baseline (see the calculations)

ANALYSIS OF THE LENGTH

	Average East Base	Average West Base
11 groups:	480.37 m	481.03 m
after removing the extreme values (1 and 11)	480.37 m	481.03 m
Including groups within ±0.05 %	480.36 m	481.049 m

CD 2a

Le STADE

LA MESURE SUR LE STADE

Les résultats sur le stade donnent des longueurs trop courtes pour 400 mètres de piste. Il est difficile de comparer les distances si le mesureur n'a pas respecté la **distance réglementaire de 30 cm du bord de piste.**

Il y a matière à reflexion et **ne devrait - on pas modifier les régles du mesurage d'une piste à l'IAAF ?**

Exemple :

Source: **THE REFEREE(IAAF 1994)** Traduit de l'anglais par Mr BLANCHET
En général et particuliérement sur les stades récents pour lesquels ne se posent pas de problémes particuliers d'implantation, la forme des virages est semi-circulaire. La portion de ligne droite étant généralement de 80 mètres, dans ce cas, chaque virage mesure 120 mètres ce qui correspond à un rayon de 38,20 mètres, mesuré bien entendu à 30 cm de la lice.

formule de calcul de la longueur de la circonférence
Diamétre x 3,14159

Longueur développée du virage

- à 30cm du bord de la lice: (76,40m x 3,14159) / 2 = 120,008 m
- à 20cm du bord de la lice: (76,20m x 3,14159) / 2 = 119,6948 m
- à 15cm du bord de la lice : (76,10m x 3,14159) / 2 = 119,5373 m
- à 10cm du bord de la lice : (76,00m x 3,14159) / 2 = 119,3805m

Mesurage du Stadium

Si le coureur est à 10cm du bord de piste et effectue un 10000m

il parcourt : (0,61948x2) = 1,2389m en moins par tour

sur un 10000m PISTE : 1,2389 m x 25 tours = 30,974 m

soit 4 à 5 secondes !!!!!

En analysant les chiffres sur la piste aucun mesureur n'arrive à 400 mètres il faut en déduire que

" La distance raisonnable de trajectoire semble être à 15 cm du bord de la lice."

Une évidence le coureur à la corde n'effectuera pas la distance de 400 mètres par tour,
les autres coureurs effectueront d'avantage.

CD 3

Translation of preceding page by Pete Riegel:

THE STADIUM

MEASUREMENT OF THE STADIUM

The results of the stadium measurements yield some lengths that are too short for 400 meters of track. It is difficult to compare the distances if the measurer does not respect the correct 30 cm from the edge of the track.

Is this something on which to reflect - must one not modify the IAAF track measurement method?

Example:

Source: THE REFEREE (IAAF 1994) Translation of the English by Mr BLANCHET
In general and particular, on the recent stadiums for which there are no problems if installation, the turns are semicircular. The straight portions are generally 80 meters. In this case, each turn measures 120 meters, which corresponds to a turn radius of 38.2 meters, measured 30 cm from the line.

The formula for calculation the length of the circumference is:

Diameter x 3.14159

Developed Length of Turn:

- to 30cm of edge of the line: (76.40m x 3.14159)/2= 120.008 m

- to 20cm of edge of the line: (76.20m x 3.14159)/2= 119.6948 m

- to 15cm of edge of the line: (76.10m x 3.14159)/2= 119.5373 m

- to 10cm of edge of the line: (76.00m x 3.14159)/ 2= 119.3805 m

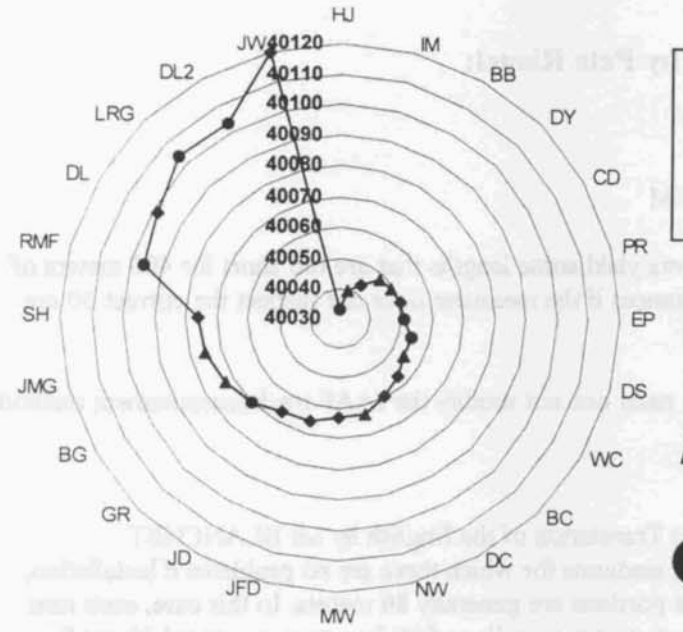
If the runner stays 10 cm from the edge of the track and runs a 10000, he removes (0.61948 x 2) = 1.2389 m per lap.

For a 10000 m course this is 1.2389 m x 25 laps = 30.974 m

This is 4 to 5 seconds!!!!

In analyzing the numbers on the track it is necessary to deduce that the reasonable distance of the trajectory seems to be 15 cm from the edge of the line.

If the runner does not effectively cover the 400 meters each lap, the other runners will have an advantage.



Mesurage MARATHON

ATLANTA 26 mai 1996

zone hors stade

International A

International B

National N

30 km to 35 km	
HJ	4987,30
IM	4992,26
PR	4992,70
BB	4993,23
CD	4993,41
DY	4993,78
DC	4993,97
BC	4994,70
DS	4995,47
WC	4995,63
EP	4995,69
RL	4996,24
[redacted]	
MW	4996,91
GR	4997,47
SH	4997,76
NW	4998,25
JMG	4998,60
JD	4998,68
BG	4999,96
LRG	5001,17
RMF	5001,87
DL2	5001,87
JW	5003,32
DL	5004,83

35km to 40 km	
BB	5053,26
IM	5053,68
DY	5054,95
PR	5055,00
BC	5055,19
CD	5055,56
JD	5056,29
DC	5056,30
EP	5056,82
DS	5057,15
JFD	5057,62
RL	5057,69
[redacted]	
WC	5058,62
SH	5058,98
JMG	5059,11
GR	5059,43
NW	5059,54
BG	5059,82
DL2	5060,74
HJ	5061,23
RMF	5061,82
DL	5061,95
LRG	5062,39
JW	5064,44

40 km to Clarke	
JFD	1545,35
DY	1545,89
JD	1546,01
BG	1546,28
IM	1546,77
DL	1546,79
NW	1546,87
HJ	1546,96
EP	1546,96
CD	1547,19
BB	1547,55
RL	1547,64
[redacted]	
RMF	1547,69
DS	1547,74
JMG	1547,77
MW	1548,07
DC	1548,11
PR	1548,27
LRG	1548,27
BC	1548,33
GR	1549,41
DL2	1549,45
SH	1549,50
JW	1549,89

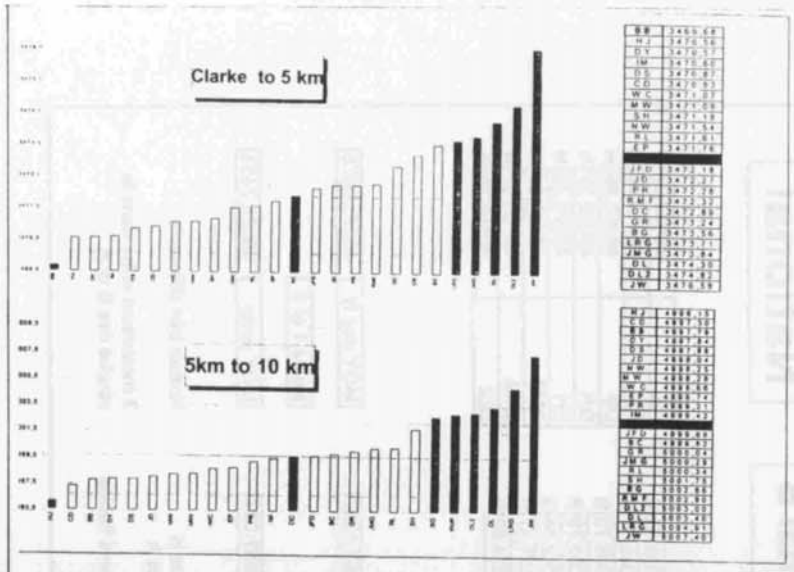
total		
HJ	40033,28	
IM	40039,83	
BB	40042,76	
DY	40048,17	
CD	40048,73	
PR	40050,26	
EP	40050,66	
DS	40053,88	
WC	40053,79	
BC	40056,65	
DC	40059,20	
NW	40062,88	
MW	40062,90	
JFD	40065,49	
JD	40065,81	
GR	40069,27	
BG	40071,87	
JMG	40074,82	
SH	40075,42	
RMF	40095,90	
DL	40098,14	
LRG	40103,33	
DL2	40102,80	
JW	40120,29	
MOY	40066,03	40087,12 maxi
		40044,93 mini

moy bon	40060,6125

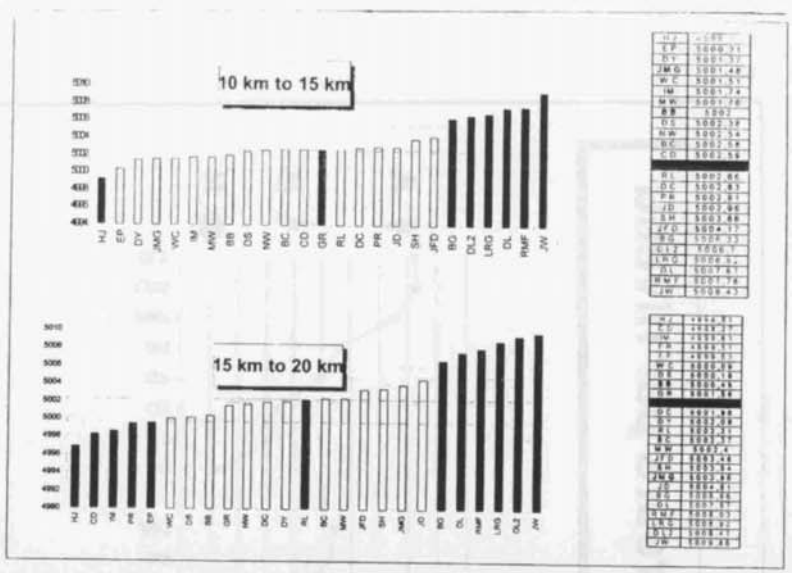
moy survivants	40060,79

CD4

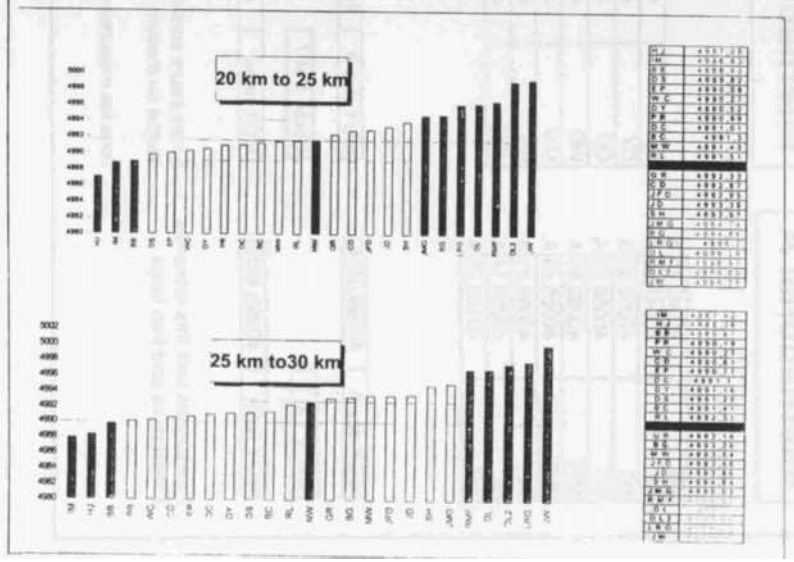
CD 5

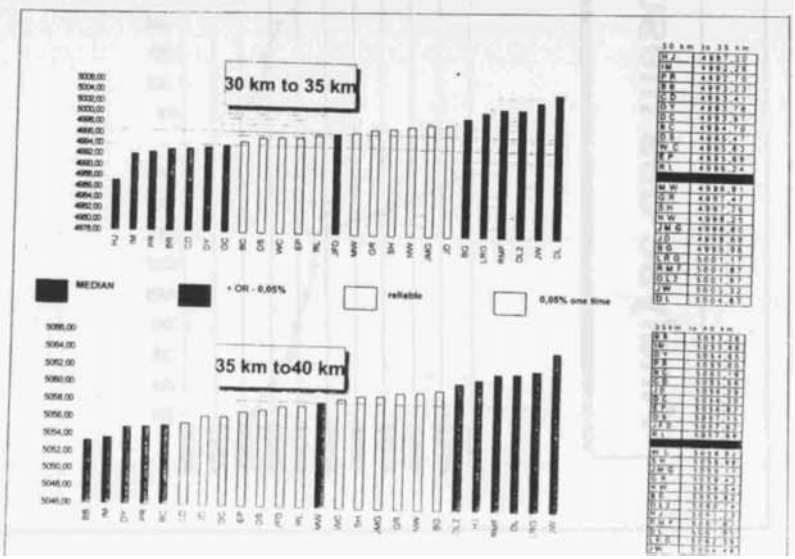

Clarke to 5 km

5km to 10 km

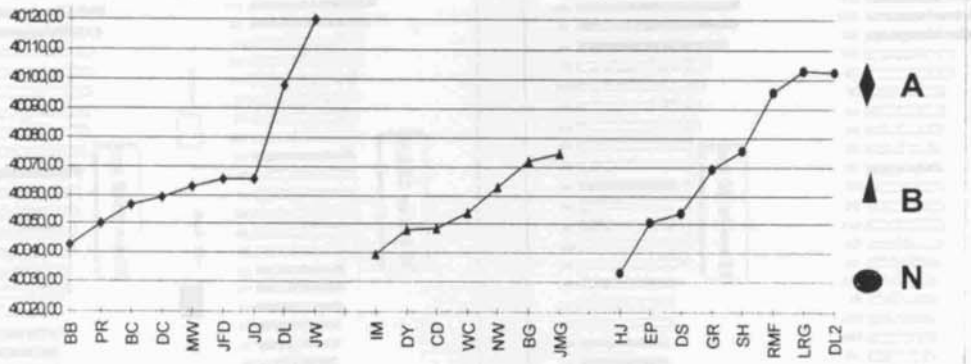

10 km to 15 km

15 km to 20 km


20 km to 25 km
25 km to30 km


30 km to 35 km
MEDIAN
+ OR - 0,05%
reliable
0,05% one time
35 km to40 km

Analyse des mesureurs par niveau



International A

BB	40042,76	A
PR	40049,60	A
BC	40056,65	A
DC	40059,20	A
MW	40062,90	A
JFD	40065,40	A
JD	40065,81	A
DL	40098,14	A
JW	40120,29	A

MOY des A	40069,0556
éjecte 1 et 9	
MOY reste	40065,4929

7 mesureurs sont très resserrés
2 mesureurs sont trop longs

International B

IM	40039,83	B
DY	40048,17	B
CD	40048,73	B
WC	40053,79	B
NW	40062,88	B
BG	40071,87	B
JMG	40074,82	B

MOY des B	40057,1557
éjecte 1 et 7	
MOY reste	40057,088

5 mesureurs sont dans la courbe de mesure des A

Tous les mesureurs sont fiables

National

HJ	40033,28	N
EP	40050,66	N
DS	40053,88	N
GR	40069,27	N
SH	40075,42	N
RMF	40095,90	N
LRG	40103,33	N
DL2	40102,80	N

MOY des N	40073,0675
éjecte 1 et 8	
MOY reste	40074,7433

Niveau très différents

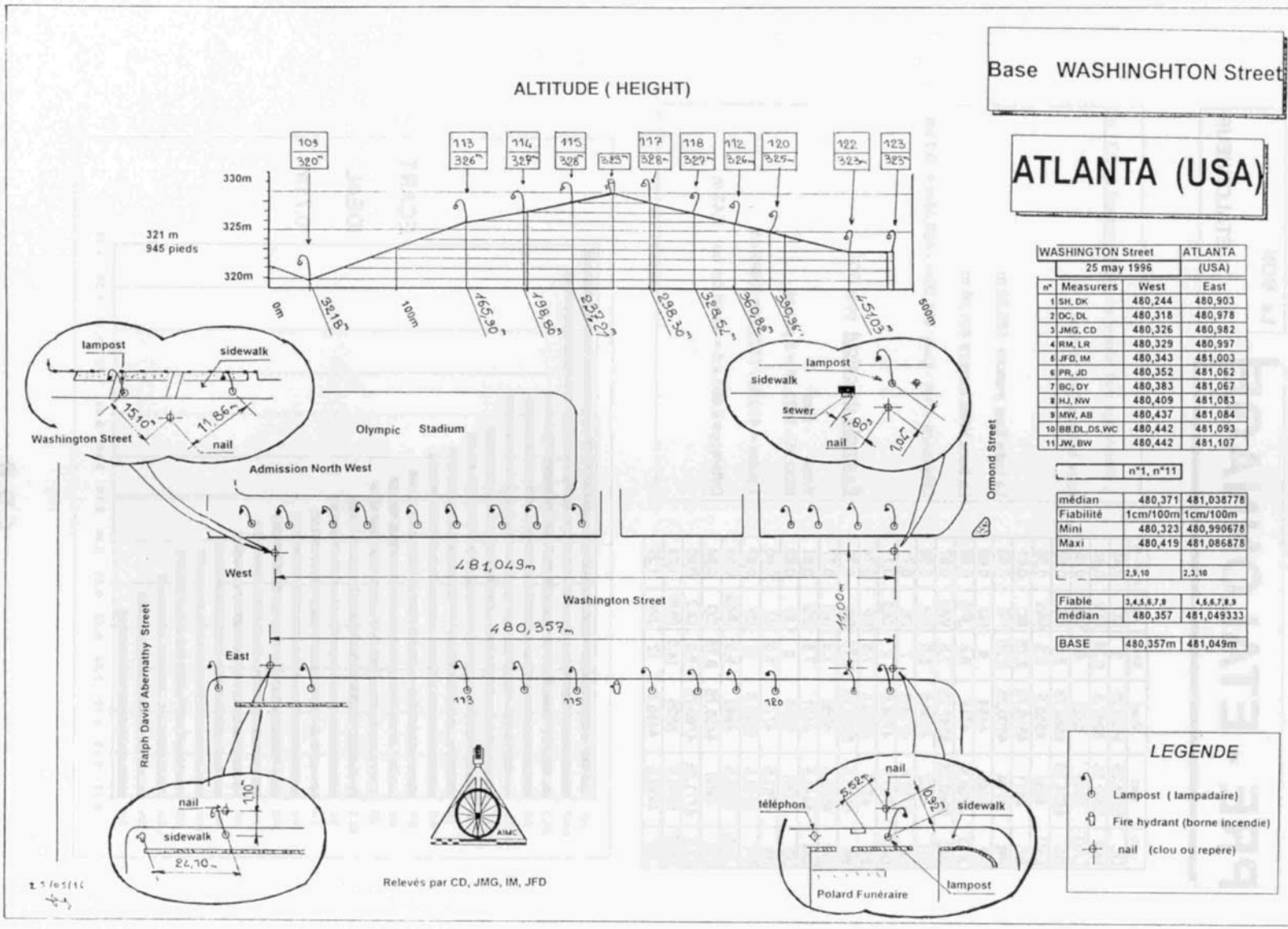
3 mesureurs entre dans la courbe des B et A

CD6

CD 7

Base WASHINGHTON Street

ATLANTA (USA)



WASHINGTON Street		ATLANTA
25 may 1996		(USA)
n° Measurers	West	East
1 SH, DK	480,244	480,903
2 DC, DL	480,318	480,978
3 JMG, CD	480,326	480,982
4 RM, LR	480,329	480,997
5 JFD, IM	480,343	481,003
6 PR, JD	480,352	481,062
7 BC, DY	480,383	481,067
8 HJ, NW	480,409	481,083
9 MW, AB	480,437	481,084
10 BB,DL,DS,WC	480,442	481,093
11 JW, BW	480,442	481,107

	n°1, n°11	
médian	480,371	481,038778
Fiabilité	1cm/100m	1cm/100m
Mini	480,323	480,990678
Maxi	480,419	481,086878
	2,9,10	2,3,10
Fiable	3,4,5,6,7,8	4,5,6,7,8,9
médian	480,357	481,049333
BASE	480,357m	481,049m

LEGENDE

- Lampost (lampadaire)
- Fire hydrant (borne incendie)
- nail (clou ou repère)

PRE - ETALONNAGE

Le BON

ETALONNEUR

nom	East	West	Ecart	nom	# E - W
DC	5525,25	5530,25	5	DC	0,43
NW	5262,25	5267,5	5,25	NW	0,48
LRG	5515	5521	6	LRG	0,52
DS	4584,25	4589,75	5,5	DS	0,58
MW	4551	4556,5	5,5	MW	0,58
BC	4511	4516,75	5,75	BC	0,61
PR	4794	4800,25	6,25	PR	0,63
HJ	4448	4454	6	HJ	0,65
JFD	4708,5	4715	6,5	JFD	0,66
WC	5380,25	5387,75	7,5	WC	0,67
SH	4562	4568,5	6,5	SH	0,68
DL	4727,5	4734,5	7	DL	0,71
DL2	4727,5	4734,5	7	DL2	0,71
EP	4878	4885,5	7,5	EP	0,74
BB	5583,5	5592,25	8,75	BB	0,75
GR	4672,5	4680	7,5	GR	0,77
BG	4443,5	4451	7,5	BG	0,81
JD	5261	5270	9	JD	0,82
IM	4761,5	4770	8,5	IM	0,86
DY	5513,5	5523,5	10	DY	0,87
JMG	4839,5	4849	9,5	JMG	0,94
CD	4450	4458,75	8,75	CD	0,94
DL2	4771,25	4780,75	9,5	DL2	0,96
RMF	5610,5	5625	14,5	RMF	1,24
JW	4473,5	4485,5	12	JW	1,29

L'étalonnage doit donner un <u>écart constant de 0,71 m</u>

entre la base East et West.

La base East mesure 480,35 m

La base West mesure 481,06 m

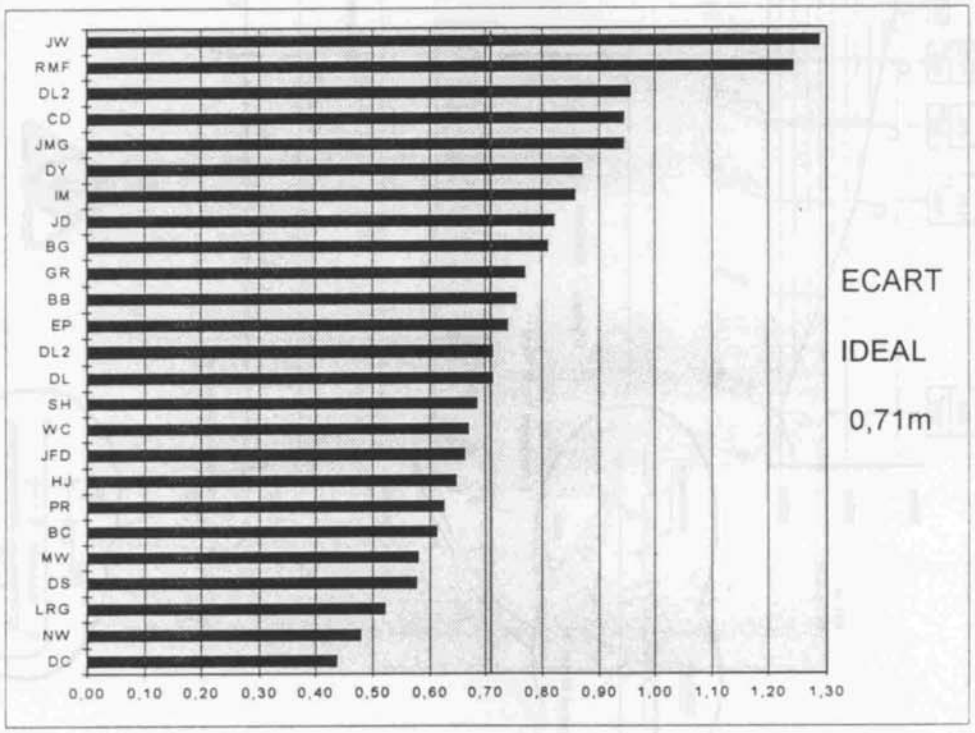
Différence West - East 481,06m - 480,35m = 0,71m

<u>Exemple de calcul</u> pour DC

West - East
5530,25 - 5525,25 = 5 pulses

1 pulse = 480,35 / 5525,25= 8,693 cm

Différence 8,693 x 5 = 43,46 cm ou 0,43 m



CD 8

POST - ETALONNAGE

Le BON

ETALONNEUR

nom	East	West	Ecart	nom	# E - W
PR	4789	4793,25	4,25	PR	0,43
BC	4503,5	4507,5	4	BC	0,43
DC	5518,5	5523,5	5	DC	0,44
NW	5262,25	5267,75	5,5	NW	0,50
SH	4562	4567	5	SH	0,53
JW	4475	4480	5	JW	0,54
HJ	4446	4451	5	HJ	0,54
IM	4755,5	4761	5,5	IM	0,56
WC	5376,75	5383,25	6,5	WC	0,58
DS	4582,5	4588,25	5,75	DS	0,60
DL	4716	4722	6	DL	0,61
BB	5574,75	5582,25	7,5	BB	0,65
RMF	5610	5618	8	RMF	0,68
EP	4871	4878	7	EP	0,69
LRG	5507	5515	8	LRG	0,70
DY	5306,75	5314,5	7,75	DY	0,70
JD	5265,75	5273,5	7,75	JD	0,71
JMG	4835,5	4843	7,5	JMG	0,75
JFD	4701	4708,5	7,5	JFD	0,77
MW	4549	4556,6	7,6	MW	0,80
CD	4451,25	4458,75	7,5	CD	0,81
BG	4437,5	4445	7,5	BG	0,81
GR	4666,5	4675	8,5	GR	0,87
DL2	4667	4677,5	10,5	DL2	1,08
DL2	4667	4677,5	10,5	DL2	1,08

L'étalonnage doit donner un écart constant de 0,71 m

entre la base East et West.

La base East mesure 480,35 m

La base West mesure 481,06 m

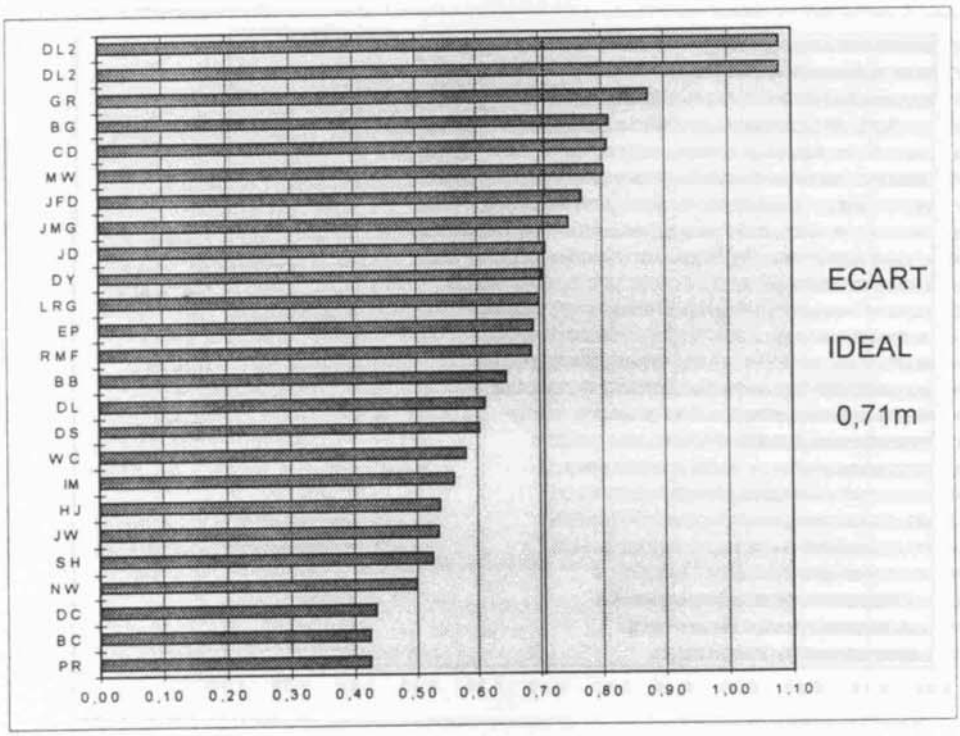
Différence West - East 481,06m - 480,35m = 0,71m

Exemple de calcul pour PR

West - East
4793,25 - 4789 = 4,25 pulses

1 pulse = 480,35 / 4789= 10,030 cm

Différence 10,030 x 4,25 = 42,62 cm ou 0,43 m



CD 9

CONSTANTE du JOUR ETALONNAGE

Le BON

ETALONNEUR

nom	East	West	Ecart		# E - W
DC	5521,825	5526,875	5,05	DC	0,44
NW	5262,25	5267,5	5,25	NW	0,48
BC	4507,25	4512,125	4,875	BC	0,52
PR	4791,5	4796,75	5,25	PR	0,53
DS	4583,375	4589	5,625	DS	0,59
HJ	4447	4452,5	5,5	HJ	0,59
SH	4562	4567,75	5,75	SH	0,61
LRG	5511	5518	7	LRG	0,61
WC	5378,5	5385,5	7	WC	0,63
DL	4721,75	4728,25	6,5	DL	0,66
MW	4550	4556,5	6,5	MW	0,69
BB	5579,125	5587,25	8,125	BB	0,70
EP	4874,5	4881,75	7,25	EP	0,71
JFD	4704,75	4711,75	7	JFD	0,71
JD	5263,375	5271,75	8,375	JD	0,76
IM	4758	4765,75	7,75	IM	0,78
BG	4440,5	4448	7,5	BG	0,81
DY	5310	5319	9	DY	0,81
GR	4669,5	4677,5	8	GR	0,82
JMG	4837,5	4846	8,5	JMG	0,84
CD	4446,875	4455	8,125	CD	0,88
JW	4474,25	4482,75	8,5	JW	0,91
RMF	5610,25	5621,5	11,25	RMF	0,96
DL2	4669,125	4678,875	9,75	DL2	1,00

L'étalonnage doit donner un <u>écart constant de 0,71 m</u>

entre la base East et West.

La base East mesure 480,35 m

La base West mesure 481,06 m

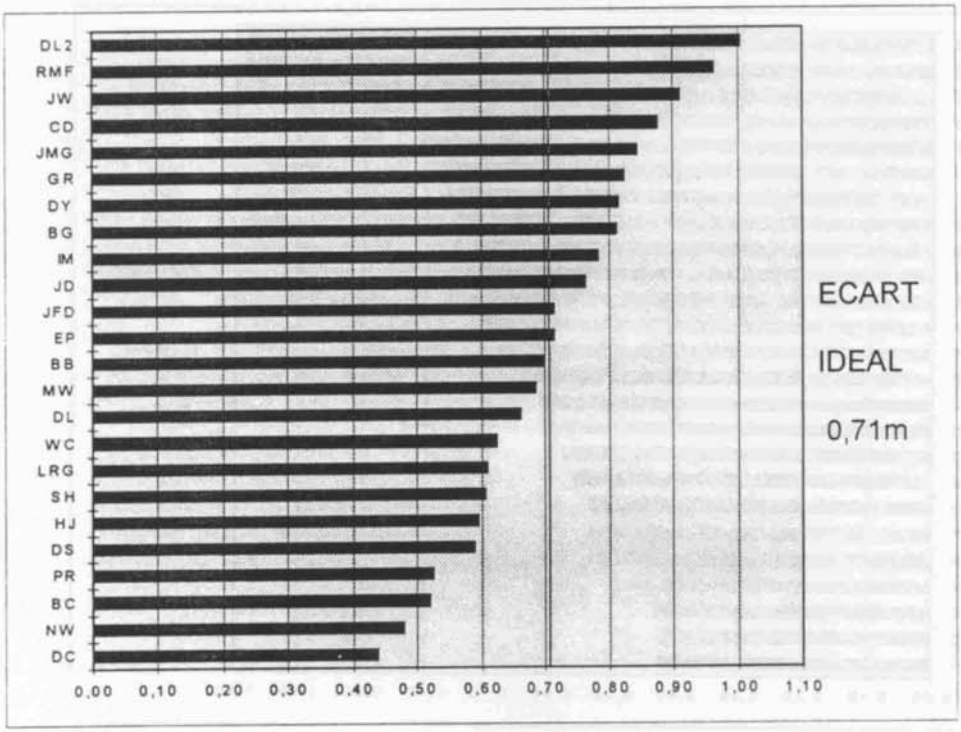
Différence West - East 481,06m - 480,35m = 0,71m

<u>Exemple de calcul</u> pour DC

West - East
5526,875 - 5521,825 = 5,05 pulses

1 pulse = 480,35 / 5521,825= 8,756 cm

Différence 8,756 x 5,05 = 44,2 cm ou 0,44 m



CD 10

CUNDY SPORTS Marketing

Cundy Sports Marketing
P.O. Box 624
CIVIC SQUARE ACT 2608

21 June 1996

Pete Riegel
3354 Kirkham Rd
Columbus, Ohio 43221
USA

Dear Pete

Apologies for my delay in getting back to you following our Olympic measurement exercise in Atlanta. Following the measurement we spent two very enjoyable weeks travelling in the USA. On my return to Australia I stopped off in Sydney to measure the Sydney Marathon course (not the proposed Olympic course but similar). Then on my return to Canberra I received news that my father passed away in his home city of Adelaide so I was immediately on the road again. I'm now back in Canberra and will provide the attached brief report. I haven't, as yet, closely analysed the data that you so kindly forwarded but I look forward to doing that shortly.

Again, we thank you very much for your efforts in organising the measurement. You can be well pleased with the arrangements and no doubt the mountain of data collected is going to be very useful as we strive to improve measuring skills around the world.

As you know I control the course measurement scheme in Australia for Athletics Australia. Other than a seminar in Adelaide in 1986 with Allan Steinfeld, I have not had an opportunity to work with other measurers from around the world. An opportunity to do so was my main incentive for joining you in Atlanta. As I mentioned I was disappointed that I couldn't get any funding assistance from the Sydney Organising Committee of the Olympic Games or Athletics Australia but I am pleased that I invested my own money into keeping up-to-date. The accommodation assistance provided by USAT&F was much appreciated.

Some quick observations on the measurement exercise are in the following report which I trust will be suitable for publishing in your report.

We have enclosed a photograph taken by Fran which you may be able to use in any reports on the measurement. We haven't enclosed any group shots as we assume you have plenty of these.

Thanks once again for your work on this exercise. I hope to be involved in the Sydney measurement in 2000 and look forward to be able to invite international measurers to Australia to assist in that exercise.

Kindest regards

Dave Cundy/Fran Seton

DC1

ATLANTA MARATHON COURSE MEASUREMENT

The following are some brief observations following the measurement exercise for the Atlanta marathon:

- given that I had not had an opportunity to measure with, and meet, my international counterparts since attending an Allan Steinfeld seminar in Adelaide in 1986, I found the experience invaluable.
- it was reassuring that we are using the same techniques in the same way in Australia and arriving at similar results. Following a series of seminars which I have conducted around Australia during the 90s, I'm confident that we have some world class measurers in Australia.
- I found arrangements on the course excellent, thanks to the great assistance of the police.
- I was a bit disappointed that we did not measure the precise course as laid out for the Olympics although I understand the need for Pete's general rules because of the large group and the number of restrictions that will be in place on race day. If I have the opportunity to repeat the exercise in Sydney in 2000, I would limit the size of the group (unless persuaded otherwise).
- for the measurement we used a variety of bikes and tyres. If we undertake another mass measurement of this kind, I think it would be interesting to keep some data on differences between solid tyres, mountain bikes, racing bikes, etc.
- I followed Pete during the measurement and noted that he rode very close to the edge of gutters on some corners where I didn't think it necessarily appropriate. Being a competitive course measurer I often followed but I did think that in some circumstances we were taking the shortest ***possible*** route rather than the shortest ***practicable*** route.
- From my observations about the thorough measurement of the LA Olympic course (where I believe some 13 calibration courses were used along the way), was this measurement a bit rough, or was the LA exercise an overkill and doesn't warrant repeating?

Dave Cundy
SECRETARY
ATHLETICS AUSTRALIA COURSE MEASUREMENT SCHEME
21 June 1996

DC 2

3007 Ronna Drive
Las Cruces, NM 88001
June 25, 1996

Pete Riegel
Chair, RRTC
3354 Kirkham Rd.
Columbus, OH 43221-1368

Dear Pete:

1. Was surprised to learn from the 3 Jun 96 data package that my bicycle was one of the four more precise instruments used by the measurement team.

The bicycle was a 16-speed lightweight racing bike with Mavic CXP10 rims and narrow, high-pressure Michelin 700 X 23C "sew-ups." The tires were aired to 120 psi Friday evening. The bicycle was selected specifically to avoid the high rolling resistance of low-pressure mountain bicycle tires with coarse off-road treads. Since I was accustomed to the semi-arid desert environment of the southwestern US, additional rolling resistance in a highly humid environment was not appealing to me. This bicycle was a good choice. The tire was not susceptible to large temperature effects.

Of the other three bicycles, Mike Wickiser rode a bike with a high-pressure foam-filled front tire; a tire not sensitive to temperature effects according to the manufacturer.
Mike told me that Scott Hubbard only uses a high pressure narrow racing tire in all of his measurements, so Scott's tire had very little variation in pressure due to temperature. Norrie Williamson's bicycle is an unknown because I did not allow sufficient time to correspond with him on the matter. From my own observation, I was surprised by the high number of solid rubber tires used by our international measurers. So, I suspect there is more than an average chance that he was riding on a tire of that design. I hope you might be able to confirm from your own knowledge that this was the case.

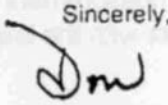
These observations make a strong case for either a narrow high-pressure tire, a foam filled tire or a solid rubber tire when measuring on paved surfaces. This looks like a good starting place for less variation between measurements.

2. As the ninth rider in the column of 28 riders, I became aware early in the ride that I could watch the leaders and then ride a much tighter coarse.

Consequently, it would be interesting to see the summary of results plotted as a function of position in the column. I would not be surprised to see shorter measured lengths associated with higher-numbered positions in the column. Perhaps the position information could be obtained from photographs taken along the route.

The measurement team was an excellent way to validate the course. It was a great opportunity to meet other members of our measurement community. And it certainly was a learning experience and it inspired confidence. Thank you for the opportunity.

Sincerely,



Donald R. Shepan

DS 1

Dave Yaeger
19 Carondale Crescent
Scarborough, Ontario
M1W 2A9

June 25, 1996

Pete Riegel
3354 Kirkham Road
Columbus, OH 43221-1368

Dear Pete:

Thanks for sending a copy of your early report on the group measurement for the Olympic Marathon in Atlanta. This allowed me to correct a couple of minor errors where I couldn't read the data - some of the in stadium data was written outside the boxes on the form and got cut off in the photocopying. After allowing for the differences as noted below my results were virtually the same as the results in your report. That gave me a good feeling.

A copy of my measurement summary is enclosed. The differences between our results are explained as follows.

1) The 3 laps in the stadium have been based on 400 m/lap and without the 1.001 factor. This increases the measured course length by 1.2 m. My understanding is that the 1.001 factor is used to compensate for errors in the measurement and help to ensure that the course is at least the official length. Where the length of a section of the course - in this case the track - has been surveyed with a high level of accuracy using the 1.001 factor appears to be overkill.

2) When calculating the measured length with the pre and post calibration constants, I only adjusted the portion of the course measured outside the stadium on May 26. The in-stadium distances were measured the previous day and would not be affected by the change in calibration constant. This reduces the range between the pre and post cal lengths by approximately 5%

Your rationale for using the median measurement appears to be reasonable. The fact that the average value for the 4 measurers with the least calibration change is the same as the median value is quite comforting.

My regret in the overall measurement was that I did not record the locations or reasons why my measurement did not follow the "official" and shortest route. While your adjustments look reasonable I don't have anything to check them against. Hopefully some other measurers can confirm the adjustments. It seems a shame to use data from 25 measurers to calculate the overall length and then adjust the course based on limited data.

DY 1

I was also initially surprised that distance needed to be added to our measurement as we used an "excluded" right turn lane. Unfortunately this restriction did not come through in the course briefing on Saturday evening. My recollection is that we were warned to stay outside the right turn lanes not because they were excluded from the course but rather because the right turn lane would end and we would need to put a "jog" in our measurement to get back on course. I was therefore surprised on Sunday to find that we used a number of right turn lanes and did not have to jog to get back on course. I felt we were measuring the shortest possible route only to find out later that these lanes will not be available to the runners. I suppose that is what is meant by Note 2 on the Course Map - On Piedmont Road between Piedmont Circle and Peachtree Road, Northbound (Right) Traffic Lanes Only (i.e. traffic lanes and not right turn lanes).

I enjoyed the overall experience. It was great to meet and measure with so many other competent measurers and I feel I will be a better measurer as a result. And some of the things are quite simple such as when taping the calibration course chalk seems to work better than the lumber crayons I have been using, and I now know how to use the pointed end on my steel tape reel to easily hold the tape in the correct location when taping.

I really appreciate the time and effort you and others put into organizing the weekend so it would be such a success. In particular you carried the burden of being "in charge" while the rest of us were along for the "ride".

Cheers,

Dave

DY 2

Olympic Marathon
Atlanta, Georgia

Course Measurement - May 25/26, 1996

Summary of Measurements

Measurer	Length of course based on Average	Pre Cal	Post Cal	Range	Distance from Median
	km	km	km	m	m
HJ	42.2319	42.2206	42.2431	22.5	-29.7
IM	42.2394	42.2100	42.2689	58.9	-22.1
BB	42.2421	42.2085	42.2758	67.2	-19.5
DY	42.2464	42.2168	42.2761	59.3	-15.2
CD	42.2477	42.2168	42.2787	61.9	-13.9
EP	42.2504	42.2207	42.2802	59.5	-11.2
PR	42.2509	42.2248	42.2770	52.2	-10.7
DS	42.2511	42.2440	42.2582	14.2	-10.5
WC	42.2528	42.2380	42.2677	29.8	-8.7
DC	42.2563	42.2318	42.2808	48.9	-5.3
BC	42.2584	42.2212	42.2956	74.4	-3.2
MW	42.2612	42.2568	42.2656	8.8	-0.4
RL	42.2616	42.2500	42.2732	23.3	0.0
NW	42.2617	42.2622	42.2612	1.0	0.1
JFD	42.2640	42.2342	42.2938	59.6	2.4
JD	42.2657	42.2814	42.2500	31.4	4.1
GR	42.2691	42.2466	42.2916	45.0	7.5
JMG	42.2739	42.2532	42.2946	41.4	12.3
SH	42.2743	42.2710	42.2776	6.6	12.7
BG	42.2822	42.2552	42.3093	54.1	20.6
RMF	42.2959	42.2825	42.3093	26.8	34.3
LR	42.3007	42.2753	42.3262	50.9	39.1
DL	42.3015	42.2506	42.3525	101.8	39.9
DL2	42.3049	42.2888	42.3209	32.2	43.3
JW	42.3215	42.3126	42.3305	17.9	59.9
Average	42.2666	42.2469	42.2863	42.0	5.0
Median	42.2616	42.2466	42.2787	45.0	0.0
Maximum	42.3215	42.3126	42.3525	101.8	59.9
Minimum	42.2319	42.2085	42.2431	1.0	-29.7
Range - m	89.6	104.0	109.3	100.9	89.6
SD - m	22.4	26.8	25.9	23.6	22.4

Notes: 3 laps of track based on 400 m/lap without 1.001 factor.
Calibration course length = 480.71 m.
Median of stadium measurements was used for RL.

DY 3

Measure Up

June 1996 Volume 9, No 2

The Battle of Atlanta - Part II

If the 1996 Olympics turn out to be as successful as the marathon validation ride, the IOC, NBC, the organizing committee and the mayor of Atlanta will be a bunch of happy people. Everything worked as planned; it all stayed on schedule and the marathoners will run at least the 42.195 km.

Measurers started arriving in Atlanta on Thursday (May 23) from around the world - France, the UK, Canada, Australia, Mexico - and, by Friday, the US delegation was in. Some of the Americans brought their own bicycles, but 20 rental bikes were provided by a local shop at $25 a day. All were fitted with Jones (or Jones-Oerth) counters.

Since the Olympic stadium was available only for two hours - 7 AM to 9 AM - on Saturday, the first order of business was the track measurement. It was all done on bicycles, not surveying wheels as originally required by track officials. All measurements were related to a single reference point outside the stadium.

The two hours allowed proved to be enough time for measuring, group pictures, and for those physically able, a jog on "the track." Like the kids say, "It's awesome." The balance of Saturday morning was spent taping two 480m calibration courses and measuring two race walk loops.

Sunday morning started early - 4:30 - with a ride to the stadium, four pre-calibration rides and then a short wait for the police escort. Promptly at 6 AM, 28 validators started their SPR (shortest possible route) line across Atlanta. The plan was to take a reading every 5 kilometers and finish up by 10 o'clock. Atlanta is a church-going town and traffic picks up early.

The Atlanta police motorcycle patrol - we had six of them - has had lots of practice and will have even more before the summer is over. They controlled the traffic for almost four hours without the consumption of a single donut! Plenty of bottled water kept everyone hydrated. A few Power Bars came out of pockets and fanny packs. Only three riders had to drop out. One gave up in a battle with a balky derailer; anothers counter decided to be difficult; the third lost to the Atlanta hills. Final readings were taken back at the stadium before 10 o'clock followed by post-calibration rides.

The numbers are still being tabulated but preliminary calculations indicate the course is on the long side and the recommendation by the validation group will probably be to shorten the course as measured.

High Points

➤ The high level of team work and cooperation of all parties: Of the 25 final riders, half were from foreign countries, but they all use the US system. Everyone was talking the "same language."

➤ The list of marathons measured by the group reads like a Who's Who. From New York City to London, Mexico City, Chicago, Dallas White Rock, Toronto, Houston-Tenneco - it goes on. This was another reason for the smooth operation.

➤ Interest is revving up for the Atlanta course. A pair of South Korean runners was seen between the 20/25 km splits accompanied by a coach, trainer, escort, support vehicle, etc. **Anne Marie Lauck** was also out training that morning. She moved to the Atlanta suburb of Marietta from New Jersey about three years ago.

➤ The course was designed by **Julia Emmons**, Executive Director of the Atlanta Track Club, with some input from NBC and the AGOC. It included parts of the Peachtree Road Race, a trip down Auburn Ave and MLK National Park, plus a short side trip to Oglethorp University.

➤ Since the marathon is an international distance and this is the Olympics, every kilometer - all 42 of them - will be marked. If mile splits are added, it will be because NBC (and the American audience) demands them.

➤ Looking forward to 2000, one of the riders was **Dave Cundy** from Australia. Dave will probably be the measurer for the Olympic marathon course in Sydney.

1995 National Stats

The '95 numbers are in. Our course registrar, **Joan Riegel**, reports what we did last year and compares with 1994:

	1995	1994	% change
Total Certified Courses	1134	1050	+8.0
Active measurers	271	292	-7.2
Most active measurer (Glen LaFarlette both years)	44	41	+7.3
Most Active State	112 (California)	98 (Texas)	+14.3
Most active certifier (Tom McBrayer both years)	111	101	+9.9
Certified Courses by State			
California	112	81	+38.3
Texas	104	98	+6.2
Illinois	82	69	+18.8
Florida	74	59	+25.4
Oklahoma	60	56	+7.1
Michigan	58	37	+56.8
Certified Courses by Distance			
5 kilometer	512	488	+4.9%
10 kilometer	188	176	+6.8
8 kilometer	71	62	+14.5
5 mile	45	34	+32.4
Marathon	59	37	+59.5
Measurers Within the States			
Andy Beach, Dallas		32	
Tom McBrayer, Houston		19	
Michael Polansky, Fort Worth		17	
John Ferguson, Austin		8	
Chuck George, New Orleans		7	
Will Lindgren, Lake Jackson		5	

Lots of numbers to digest. What does it all mean? Typical ups and downs, race directors found some new sponsors, or what? One thing for sure, there is still a bunch of runners out there.

SPLITS

✓ The RRTC "How to do It? video on course measurement appears to be having a second life. Since its introduction in 1992, it has been distributed around the world and translated into French (The French measurers have now produced their own video.) Now **Rudolpho Martinez** of the Mexican Athletic Federation has had the video translated into Spanish. And the word continues to spread!

✓ Here's a great idea for your club or association. **Bill Grass**, the Wisconsin certifier, has put together four measuring kits consisting of the procedural manual, a Jones-Oerth counter and the measurement video. Bill's club, The Badgerland Striders, will make these kits available to any potential measurer for a security deposit only. Wisconsin had 11 certified courses in 1995. So that's another way to spread the word.

✓ The measurement seminar held in conjunction with the RRCA national convention (Knoxville, May 8-11) was an overwhelming success by any standard. A total of 30 people were in attendance (That's 10% of all delegates), about half of them with some sort of previous experience. No room for bicycles, so **Pete Riegel**, the seminar leader, demonstrated with a surveyor's wheel on a temporary cal course that had been laid out in front of the hotel. Lots of interest from Road Runner race directors who live in areas without measurers.

✓ The Houston-Tenneco Marathon has a new sponsor and a new name, but not a new course. The current course comes within a block of Methodist Hospital in the Texas Medical Center and that should be close enough. Access to the medical facilities 24 hours a day is vital. Ed Note: The new name will be Methodist Health Care Houston Marathon. Now what will the runners call it?

✓ It's been a long time - over 10 years - but Baton Rouge is about to receive a certified course. Race for the Cure is coming to town and they require certifica-

Measure Up

Volume 9 No. 2

Newsletter — E. T. (Tom) McBrayer
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Typesetting & Editing — Mary Anne McBrayer

ETM 2

tion. Race Director **Ron Terry** is gearing up to measure his event to be held in the fall.

Lost: One Cal Course
If Found, Please Return to Measurer

Is that you? No way! You know exactly where it is. But are you posilutely, absotively sure? Those end points have a way of disappearing from sight what with construction, repaving, weather, etc. The rule is: If you cannot locate the end points, re measure the full distance.

More rules:

- Relate the end points to permanent landmarks with taped distances. Careful with 90° angles.

- If those landmarks are in the street, so much the better. Use expansion joints, storm drain grates, manhole covers, etc. if you can. The cal course length does not have to be an even distance. So use what's available.

- Paint alone won't do it. Use P-K (concrete) nails and shiners (roofing discs) if its an asphalt surface; if concrete you may have to drill holes.

Who's Doing What Across the States

✓ As measurers, these guys make pretty fair runners. **Clent Mericle** (Corpus Christi) turned in a 2:51 at Boston, having qualified at Motorola Austin with a 2:34. **Roger Soler** (San Antonio) was the 7th Texas finisher at 2:38.

✓ **Clent's** club, the Corpus Christi Road Runners, has had about all the success they can handle. Over 1000 teams - 6 runners per team - entered the very popular Beach to Bay Relay Marathon. It's the largest in the US. Traffic gets a bit heavy at those hand-off points along Ocean Drive.

✓ **Roger** will be going back to his home town of Lima, Peru and plans to measure several courses while he's there. The RRTC does have an international division and will assign certification numbers if appropriate. **Contact Pete Riegel at 614-451-5617.**

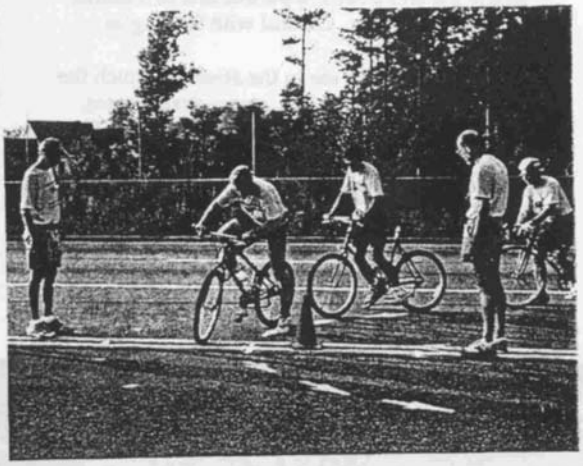
✓ **Chuck George** (New Orleans) was not going solo at the Road Runner convention. He brought three more New Orleans Track Club members with him and everybody was in a attendance at all sessions. The NOTC is "the club" in the New Orleans area, and Chuck serves as full time Director.

They look strong now, but wait 'til they've ridden the course. Twenty-eight measurers from around the world gathered in Atlanta's Olympic Stadium on the weekend of May 25, 1996 to validate one of the toughest Olympic marathon courses ever.

ETM 3

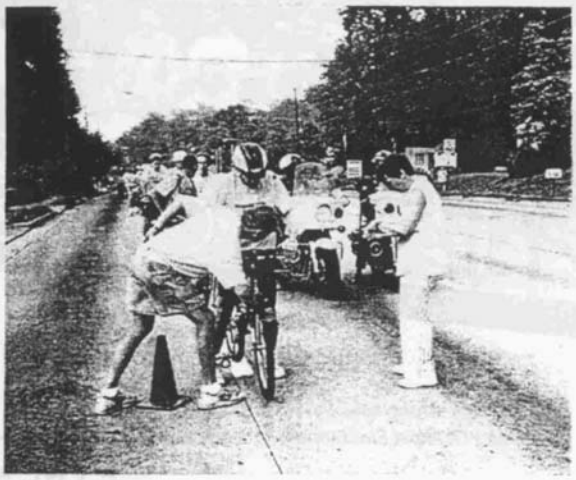
Riders ready and waiting for the signal to "roll out" from the Hyatt Regency at 4:30 AM on Sunday morning.

L to R: Hugh Jones (England), John Disley (England), Norrie Williams (Scotland) discuss Saturday's measurements and plan for Sunday's validation ride.



Pete Riegel "scooters" at the turn-around point on Peachtree Ind. Rd. while Tom McBrayer (left) and Wayne Nichol (right) check out his measurement technique.

Freeze the wheel
Read the counter
Record the count
Repeat the count
Next rider!
Tom and M.A. McBrayer performed this drill 25 times for every 5k split. From start to finish.



ETM 4

6/23/96

Pete—

Being part of the team in Atlanta was enjoyable, educational and exciting for me.

Thanks for including me.

Thanks for sending your report of 6/3... looks good to me!

I'm enclosing some photos of the weekend.

Regards,
Gerry Rahill

GR1

29 May '96

Dear Pete,

My measurements imply the complete ccourse is 42,267.8m I got 2,195.4m for the first day's work (south of Ref. Clarke), and 40,072.4m for Sunday's ride (north of Ref. Clarke).

I found that others' data were consistent with the pattern found in mine: that 0-5km and especially 35-40km were long splits - 35-40km being about 60m too long.
I made my calculations as follows: Constant for Day 1 = (calibrn1 + calibrn2)/0.96139*

* 0.96139 is the combined length of the two calibration courses *as I remember your average.*

Then: $$\frac{3 \times (\text{ref.NE corner1} - \text{ref.NE corner 2}) + (\text{ref.Clarke2} - \text{ref.Start})}{\text{Constant for Day 1}}$$

$$= \textit{distance from Start to ref.Clarke}$$

Similarly: $$\frac{(\text{ref.Finish} - \text{ref.Clarke 1})}{\text{Constant for Day 1}} = \textit{distance from ref.Clarke to finish}$$

Adding both, I got the distance for the first day.

For my Constant for Day 2, I used: $$\frac{\text{total count of 8 calibration rides}^*}{4 \times 0.96139}$$

*Working on the basis that you suggested using the average constant of pre and post-measurement calibrations

On the use of the average constant, I have an observation that is best illustrated by comparing my splits to those of Isabelle Marechal, who rode two places in front of me:

	Ref C* to 5km	5-10km	10-15km	15-20km	20-25km	25-30km	30-35km	35-40km	40km-Ref C
HJ	3474m	5001m	5004m	5001.7	4991.9	4993.2	4998.6	5059.6	1548.4
IM	3474m	5004.3	5006.6	5003.5	4993.7	4992.8	4997.1	5058.6	1547.5
difference	0m	-3.3	-2.6	-1.8	-1.8	0.4	1.5	1.0	0.9

Because the variation between her pre- and post-measurement calibration was greater than mine, using the average constant makes her earlier measurements look longer, and the later measurements shorter. This would have also been the case for me, but to a lesser extent. There is a certain swings and roundabouts syndrome here, within an individual's series (as the above comparison shows). However, this would change into a consistent tendency to under-estimate the overall distance if the sum of shortest splits method is used.

The figures for the first day indicate measured laps of from 397.1m upwards, but as I understand the IAAF specification for a track, the kerb length should be 398.1m, and 400m circuits are obtained by assuming that the running line is offset by 150mm from the kerb. That the kerbs (rails) were not in place on the bends when we measured allowed us to get much closer to the kerb position than a 150mm offset. I think the lowest readings *above 398.1m* were those of Woody Cornwell and Don Shepan at 398.7m and Dave Cundy with 398.75m.

HJ 1

Olympic Marathon Validation: total and 5km split distances by measurer

Measure	lap	start-C	C-5km	5-10km	10-15km	15-20km	20-25km	25-30km	30-35km	35-40km	40km-C	C-end	0-42.2k
AB	399.5m	1,540m										653.4m	
BB	399.6m	1,540.2	3,473.0	5,002.6	5,006.8	5,005.2	4,993.7	4,994.7	4,998.0	5,058.1	1,549.0	658.8m	**42,280.2**
BC	399.5m	1,540.1	3,475.2	5,004.7	5,007.5	5,007.2	4,996.2	4,996.4	4,999.6	5,060.1	1,549.8	659.8m	**42,296.6**
BG	399.0m	1,538.0	3,476.7	5,007.2	5,010.9	5,011.2	4,999.5	4,998.9	5,003.5	5,064.5	1,547.7	658.4m	**42,316.7**
CD	399.5m	1,539.7	3,474.5	5,002.4	5,007.7	5,005.5	4,995.8	4,995.8	4,999.1	5,060.0	1,548.8	658.5m	**42,287.6**
DC	398.8m	1,537.2	3,476.4	5,004.7	5,007.9	5,007.0	4,996.1	4,996.2	5,003.4	5,061.4	1,549.7	658.3m	**42,294.0**
DK	397.1m	1,530.8										656.1m	
DL	400.5m	1,543.4	3,477.5	5,008.3	5,012.6	5,012.5	5,001.2	5,001.9	5,009.7	5,066.9	1,548.3	660.7m	**42,343.0**
DL2	400.6m	1,544.0	3,478.1	5,007.7	5,011.4	5,014.2	5,003.8	5,003.8	5,006.6	5,065.5	1,550.9	660.6m	**42,346.6**
DS	398.7m	1,536.9	3,474.2	5,002.6	5,007.1	5,004.9	4,994.5	4,996.0	5,000.2	5,061.9	1,549.2	658.1m	**42,285.8**
DY	399.1m	1,538.3	3,474.0	5,002.7	5,006.2	5,004.9	4,995.4	4,996.0	4,998.6	5,059.9	1,547.4	658.1m	**42,283.6**
EP	?	?	3,475.2	5,003.6	5,005.2	5,004.4	4,995.0	4,995.7	5,000.6	5,061.8	1,548.5	?	
GR	398.9m	1,543.4	3,476.5	5,004.7	5,007.3	5,006.3	4,997.0	4,997.8	5,002.2	5,064.2	1,550.8	659.2m	**42,304.0**
HJ	398.8m	1,537.3	3,474.0	5,001.0	5,004.0	5,001.7	4,991.9	4,993.2	4,998.6	5,059.6	1,548.4	658.1m	**42,267.8**
IM	399.3m	1,539.3	3,474.0	5,004.3	5,006.6	5,003.5	4,993.7	4,992.8	4,997.1	5,058.6	1,548.3	658.9m	**42,277.0**
JD	399.7m	1,540.6	3,475.7	5,003.0	5,007.9	5,009.5	4,998.3	4,998.6	5,003.6	5,061.3	1,547.5	659.0m	**42,305.0**
JFD	399.1m	1,538.1	3,475.4	5,004.4	5,008.9	5,008.1	4,997.6	4,998.2	5,001.2	5,062.4	1,546.8	658.4m	**42,299.5**
JMG	399.9m	1,540.7	3,477.3	5,005.4	5,006.5	5,009.0	4,999.8	5,000.1	5,003.7	5,064.2	1,549.3	658.9m	**42,314.9**
JW	400.2m	1,542.7	3,479.8	5,012.1	5,014.2	5,014.6	5,004.0	5,004.8	5,008.0	5,069.2	1,551.3	659.8m	**42,360.8**
LRG	399.5m	1,540.0	3,477.9	5,008.9	5,011.8	5,013.8	5,001.0	5,002.9	5,006.0	5,067.3	1,549.8	659.4m	**42,338.9**
MW	399.6m	1,540.3	3,474.5	5,003.2	5,006.8	5,007.4	4,996.4	4,998.5	5,001.9	5,063.1	1,549.6	658.9m	**42,300.6**
NW	398.9m	1,538.2	3,474.9	5,003.1	5,007.3	5,006.5	4,997.3	4,998.7	5,003.0	5,064.3	1,548.3	658.0m	**42,298.0**

HJ 2

Olympic Marathon Validation: total and 5km split distances by measurer

Measure	lap	Start to Ref C	Ref C to 5km	5-10km	10-15km	15-20km	20-25km	25-30km	30-35km	35-40km	40km to Ref C	Ref C to Finish	0-42.2k
PR	399.0m	1,538.2	3,475.7	5,004.1	5,007.8	5,004.4	4,995.9	4,995.1	4,997.6	5,060.0	1,549.8	659.3m	**42,287.7**
RL	?	?	3,475.1	5,005.4	5,007.7	5,007.2	4,996.5	4,997.3	5,001.2	5,062.8	1,549.2	?	
RM	398.9m	1,538.0	3,475.6	5,007.7	5,012.6	5,012.8	5,001.4	5,001.7	5,006.7	5,066.7	1,549.2	659.5m	**42,331.9**
SH	?	?	3,474.5	5,006.8	5,008.9	5,008.6	4,999.1	4,999.9	5,002.8	5,064.1	1,551.1	?	
WC	398.7m	1,537.3	3,474.5	5,003.7	5,006.5	5,005.1	4,995.3	4,995.3	5,000.6	5,063.7	1,549.2	658.5m	**42,289.7**
BW	399.6m	1,541.1										654.8m	

HJ 3

Dear Pete,

These are my corresponding figures for the first page of the *Results of Measurement* section of your report.

They are all raw measurements excluding x 1.001 and are based on a double calibration course of 961.39m *(ie not 961.42m)*

I didn't make any subsitution for in-stadium measurements for Ryan Lamppa as you did, and I couldn't read all the figures on the copy of Ed Prytherch's calibration sheet. Also Scott Hubbard's calibrations seemed to refer to only one calibration course, but I don't know if it was E or W. So I have only 22 out of a possible 25 complete sets of data.

The projected distance is 42,195m x 1.001 = 42,237.2m We ranged from 30.6m-123.6m over this distance.

I don't think there's any point in me trying to repeat the impressive array of operations you performed on the results, Pete, but it looks as if we agree on essentials (some minor discrepancies in the totals must certainly arise from 'pocket calculator thumb', but I can't face checking through them all).

The 65m reduction you initially suggested seemed fair. I understand that you reduced the reduction by 13m due to the cumulative assumptions about extra distance that we covered on the day, as detailed in the report.

The only quibble relates to point 4 of *Why is 42260 a good estimate?* Least calibration change may imply precise equipment, but that source of variation must be far less than from riding different lines on the course. Our calibrations were done so immediately before the start and after the finish, and our only longish pause was at halfway, so use of the average constant would not have 'skewed' the result within our individual series of readings (but would have done so if you had summed the shortest splits)

Hugh Jones, London, 12 June 1996

THE ATLANTA OLYMPIC MARATHON COURSE

From Runner's World (UK), August 1996 issue by Hugh Jones

The day after Liz McColgan won the 1996 Flora London Marathon she was asked if she would be looking over the Olympic course. "No", she said, "I don't think so. It doesn't matter to me where the marathon is. I concentrate on my running, not on what's around me. I just keep my eyes down on that blue line and keep going."

Runners have got used to pancake-flat courses in big city races. New York is as tough a marathon, topographically speaking, as McColgan has run. Everyone knows that the heat and humidity in Atlanta will be a major factor for endurance athletes. But in the marathon, the course itself also threatens hardship.

In 1992 the sharp climb up to Montjuic Stadium in Barcelona was billed as a big challenge - probably because the journalists themselves also had to get up there. In Atlanta there are several sharp climbs, and the total rise and fall is about 400m. That's about twice the climbing required in Boston, and four times as much as in London.

The flattest kilometre on the course is the first; from the 1500m starting line, 1400m is run on the hard, smooth Mondo track before the field squeezes out of the NW gate to the stadium, at the 110m hurdles' start. A gentle ramp leads up to the road surface outside, but the easy stuff ends here.

The walkers will go straight under the highway and do laps of a near-flat course: 1km for the women; 2km for the men. It's the only bit of level ground anywhere near the stadium, and the marathon runners see none of it. They turn right and head up a wide road which curls past the warm-up track, Fulton County baseball ground, and goes up, down, and up again - all in the next kilometre.

They then turn north on to the main stadium approach road from downtown Atlanta - still being prettified when I ran along it - and cross an interstate highway for the first of many times. Each of these bridges is surfaced with concrete, with concrete pavements and a concrete wall. Both marathons start at 7am, when the sun will only be peeping powerlessly over the horizon. These concrete causeways though, including this same one at 40.5km on the way back, will later reflect the heat to debilitating effect. The wire fences looping back off the concrete parapet - suicide savers - also make dropping out more difficult.

The road reaches the second highest point on the course in front of the gold-domed state Capitol. Then it bends away, forming Piedmont Ave. The next 12km is run mostly on this road, just as the following 20km sticks to Peachtree Road and Peachtree Street. At least that makes it easy for David Coleman (1); as it does for me, navigating from memory. But there's a world of difference between these two roads. From the Capitol, Piedmont drops sharply down through the concrete precincts of Georgia State University. It emerges amid parking lots, yet only two blocks from the towering heights of the downtown hotels and office blocks on Peachtree, crowning the highest part of the course at 38km.

Diverting on an eastward loop around the neighbourhood in which Martin Luther King was born, it looks like the main street of small-town USA. Olympic gentrification consists of fancy lamp standards and hard-surface landscaping, as well as giving every fire hydrant in town a lick of shiny silver paint. Past the Ebenezer Baptist Church, the King birth home marks the 5km point. Taking in a couple of sharpish rises, I double back to town over the next kilometre. Two wild tangents swing across the road's full width before turning up Piedmont again, at a concrete junction over the interstate which circles the elevated central area like a moat around a citadel.

The same car-lot aspect gives way to a narrow leafy road for a short while. This is the most picturesque part of the course. Other sections are spoilt by the vast width of the road, or a lack of trees, or the self-concious classiness of the area. Running easily, I could afford to take notice, but even Liz McColgan might see her surroundings here; after the pack has thinned out beyond the elbow-jousting stage, but before anyone has made their move. It's unusual for anyone to make a serious early break in a championship.

Past Piedmont Park and the Botanical Garden, the main features runners will notice are the continued undulations. None of them are long enough or steep enough to inspire fear - just caution. Early exertions on these slopes may drain energy before it's most needed in the final assault. The surroundings lose their greenery and become more typically tacky suburban-American. A median strip appears in the road, and from then on runners keep to the right of it. I'm on the pavement of course- which is more broken than the smooth road surface.

Across Peachtree Creek, I climb up towards an eastward turn onto Peachtree Road, the extended economic and topographical spine of Atlanta. After a sea of low-rise sprawl, the tower blocks sprout again to both sides of the road. The sun will now be in front, and more of a factor now that it's been on the rise for an hour, although the gradients are gentler.

The 20km point lies just outside Brookhaven station on the Atlanta tube(2) system. At 23km it comes back along the other side of the road, the two streams separated by cones. It's an ideal jumping-off point for spectators and coaches, who can catch the race four or five times if the trains aren't too crowded.

From here to the turn, the running line hugs a concrete wall between the road and railway which may offer some shade. I had taken the easier option of starting 40 minutes before 7am, so I can't be sure. Just before the turnaround the huge mock-gothic stone gateway to Oglethorpe University looms on the other side of the road. The whole establishment, named after the founder of Georgia, is done out in sombre Scottish baronial style, topped with an elaborate gantry of bells.

I get plenty of time to notice, as the turnaround here involves successive turns of 180, 90, 180 and 90 degrees. The first is at a point in the road, adjustable as required for any last-minute changes [the course as I ran it will probably be shortened by 65m, and may allow this first turnaround to be eliminated]. The second turn is down a particularly telegenic tree-lined side road which the organisers wanted to showcase. Dodging overhanging branches and watching

out for debris underfoot, I cut through a gap in the grassy median and head back up to Peachtree. This is the psychological homeward turn, the rising sun now at your back, at 22km. Perhaps some runners might start thinking to raise the pace, without a break yet being made.

Even on a hot day at the end of May it was still only 75F at 8.30am. That day's maximum was 92F, and at 7pm, an hour into the earlier-proposed time slot for the men's marathon, it was 88F. Even at an easy jog I felt far more comfortable in the morning.

The sweeping curves along the next section, and later, often push the shortest running line (where the course is measured) into the concrete gutter. Runners won't risk the uneven seam between tarmac and concrete, a camber, and occasional holes into storm drains. Better the extra inches than a lost foot. For all sorts of reasons Atlanta is not going to be a fast course: 2:13 could win it.

At 28km the out-and-back section is completed, and a long drop down to Peachtree Creek starts. Gravity picks up the pace here, and maybe someone will get away. Although the downgrade is consistent, slamming down this stretch could present problems when the ascent begins past Peachtree Creek. It may be the sharpest rise in the course. The Piedmont Hospital has a rehabilitation centre, one of many on the course, right here.

The road levels off at intervals, once even dropping down a little, but I'm climbing for the next 6km - over 350' in all. Coming back into town the buildings shoot up scores of stories again, many of them topped by pyramids - but at this stage it's not only McColgan's eyes that will be down. The break will probably be made around here, the question being which particular rise takes which particular contender's fancy.

Over the top, dead centre of "downtown", the road swoops down to a tight left turn, levels out, and rises again for 400m - with concrete on all sides except heavenward. This could be the last opportunity for anyone without a kick to get away; to win like Rosa Mota did in Seoul or Yegorova in Barcelona.

At 40km I pass behind the Capitol, Martin Luther King and assorted Confederate cannon keeping uneasy company on its slopes. A left and right turn bring me back to join the outward route, on to the last concrete bridge and the small switchback to the stadium gate. From there it's 50m under the stands and 500m on the track. Start and finish marathon runners share with others; it's the bit in between that's our special nightmare - or dream.

Word has got round that the Olympic course demands attention. When running I met three Olympic hopefuls en route: Junko Asari, hoping to go one better for Japan than in Barcelona; Anne-Marie Lauck (nee Letko); and our own Richard Nerurkar. But the one thing McColgan might see that none of us did is that blue line. Let's hope it's all she needs.

Notes: (1) David Coleman, BBC Olympic commentator
(2) 'Tube': Subway/Metro

OLYMPIC MARATHON COURSE 1996

ATLANTA

THE RESULTS OF MEASUREMENT

write by Isabelle MARECHAL (FRANCE)

1996 est l'année des Jeux Olympiques à ATLANTA. Peter RIEGEL, responsable des mesurages de la Fédération Américiane d'Athlétisme et administrateur IAAF pour le continent Américain, est chargé de mener à bien le mesurage du marathon. Il en a profité pour inviter 30 mesureurs internationaux.

Tout d'abord avant de commenter les résultats, je tiens à remercier Peter RIEGEL et son équipe de m'avoir inviter ainsi que 3 autres mesureurs français. Ce séjour m'a apportée une expérience inoubliable et beaucoup de réflexions sur le mesurage.

1) Le marathon avait été mesuré préalablement par un mesureur local d'ATLANTA. Ce fut notre guide lors de la deuxième journée de mesurage.
Le mesurage s'est effectué de la façon suivante :

* 1er jour : mesurage de la partie intérieure du stade
* 2è jour : mesurage de la partie extérieure du stade

Tous les mesureurs étaient impatients de mesurer et prêts à l'aube. En sortant de l'hôtel, je me suis aperçue que le pneu avant de mon VTT était crevé. J'était déçue de rater la première partie du mesurage. Je me disais 'Moi qui n'ai jamais crevée en mesurant, il faut que cela m'arrive le jour du mesurage du marathon des JO'. Ouf, Jean François DELASALLE ayant fini son mesurage rapidement dans le stade m'a prêté son vélo. Cela m'a permis d'effectuer le mesurage in stadium complètement dans un délai très bref (20 minutes) mais de façon correcte. Utilisant la même bicyclette que JFD le même jour au même moment, nous avions des constantes très différentes : 9 818,278 p/km pour JFD et 9 794,331 p/km pour IM. Ceci montre bien l'importance du poids du mesureur qui exerce une pression plus importante sur le pneu avant. JFD a une constante supérieure à IM de presque de 24 pulses/km pour un poids supérieur d'environ de 25 kg. On peut donc considérer qu'un kilogramme de poids fait varier la constante d'étalonnage d'environ un pulse/km.

2) *La plus grande ou la moyenne des constantes* ?
Il est important de savoir que le mesurage s'est effectué avec une différence de température de plus de 4° C entre le début et la fin du mesurage. Ne serait-il pas mieux d'utiliser la plus grande des constantes dans certains cas ?
Veuillez trouver en annexe la comparaison du mesurage entre la plus grande et la moyenne des constantes.
Un regret : Il est dommage que la température n'ait pas été relevé tous les 5 km. Il aurait été intéressant d'étudier la variation de la pression du pneu par rapport à la hausse de la température au cours du mesurage.

3) *La base*
J'ai été surprise d'étalonner sur une base vallonnée. En France, il est recommandé d'étalonner sur une base plate. Les procédures de mesurage IAAF ne mentionne pas le dénivelé. Ici, on peut dire que la base reflète bien le parcours qui est lui-même assez vallonné.

4) *QUESTION :* Comment se fait-il qu'il y ait une grande différence de distance entre les K35 et K40 (environ 50 m) alors que toutes les autres portions sont relativement correctes ?

CONCLUSION

Il est regrettable de ne pas avoir mesuré en compagnie d'autres féminines étrangères. Mais, je pense que l'activité se féminise de plus en plus. Il aurait pu être intéressant de comparer les résultats d'un groupe de féminines avec ceux du groupe des mesureurs masculins.
Après le mesurage, il aurait été fort intéressant d'assister à un débat au sujet de la modification du parcours à faire.
Ce séminaire a permis d'élaborer de multitudes statistiques et d'apporter des réflexions exhaustives sur le mesurage. Je suis sûre que la plupart des mesureurs se sont précipités sur les chiffres afin de les mixer à leur façon.

Isabelle MARECHAL (IM)

IM 2

Translation of preceding page by Pete Riegel

1996 is the year of the Olympic Games in Atlanta. Pete Riegel, responsible for measurement in the American Federation and IAAF administrator for the American continent was put in charge of leading the marathon measurement as well. He invited 30 international measurers.

Immediately before commenting on the results I would like to thank Peter Riegel on behalf of myself and the other three French measurers. The trip brought me an unforgettable experience and a lot of reflection on the measurement.

1) The marathon had been measured by a local Atlanta measurer. He was our guide on the second day of measurement.

* 1st day: measurement inside the stadium
* 2nd day: measurement outside the stadium

All the measurers were impatient to begin before dawn. In leaving the hotel, I noticed that my front tire was flat. I was worried that I would miss the first part of the measurement. There was limited time to do the measurement. Jean-Francois Delasalle, having rapidly finished his measurement, had me use his bicycle. It allowed me to do the measurement. The stadium measurement took little time (20 minutes) but was correct. Using the same bicycle of JFD at the same moment, we had very different constants: 9818.278 counts/km for JFD and 9794.331 for IM. This illustrates the importance of the weight of the measurer on the front wheel. JFD has a count greater than IM of almost 24 counts/km for a greater weight of about 25 kg. One can consider that a kilogram of weight varies the calibration constant by about 1 count/km.

2) The larger constant or the average?
It is important to know that the measurement was done with a difference in temperature of 4C between the beginning and the end of measurement. Would it not be better to use the larger constant in some cases? In the annex of this report see the comparison between the average and larger constant.
A regret: It is too bad that temperatures were not recorded at the 5 km points. It would have been interesting to study the variation of tire pressure with temperature ride during measurement.

3) The calibration course:
I was surprised to see an undulating calibration course. In France, it is recommended that a flat course be used. The IAAF procedures do not mention this. Here, one could say that the calibration course reflects the nature of the race course well enough.

4) QUESTION: Why was there a large difference in the K35 to K40 (about 50 m) while all the other portions were relatively correct?

CONCLUSION

I regretted not being able to measure with other female measurers. I think this would have enhanced the exercise. It would have been interesting to compare the results between male and female measurers.
After the measurement it would have been interesting to attend a debate on the topic of the modifications to be made to the course.
This seminar allowed the formulation of many statistics and reflections on measurement. I am sure the various measurers will analyze the numbers in their own way.

Calcul avec la plus grande constante lorsque la variation d'étalonnage est supérieure à 10 pulses/km

Classement selon le calcul classique

	moy cste	T°/Tyre	+ gde cste	Proposition (*)	Diff. entre les 2 mesures
HJ	42 226,83	-5,2	42 215,58	42 226,83	-11,25
IM	42 235,90	-14,6	42 206,50	42 206,50	-29,40
BB	42 239,63	-19,5	42 206,03	42 206,03	-33,60
DY	42 241,87	-16,4	42 212,21	42 212,21	-29,66
CD	42 244,70	-14,3	42 213,80	42 213,80	-30,90
DS	42 245,66	-3,4	42 238,57	42 245,66	-7,09
EP	42 246,29	-15,1	42 216,54	42 216,54	-29,75
PR	42 246,36	-13	42 220,26	42 220,26	-26,10
WC	42 246,97	-8,3	42 232,08	42 246,97	-14,89
DC	42 251,07	-14,1	42 226,61	42 226,61	-24,46
BC	42 255,36	-17,4	42 218,20	42 218,20	-37,16
NW	42 256,99	0,3	42 256,52	42 256,99	-0,47
MW	42 258,69	-2,1	42 254,29	42 258,69	-4,40
JFD	42 259,96	-14,6	42 230,20	42 230,20	-29,76
JD	42 263,26	8,1	42 247,57	42 263,26	-15,69
GR	42 264,26	-10,9	42 241,77	42 241,77	-22,49
SH	42 271,51	-1,6	42 268,22	42 271,51	-3,29
JMG	42 272,26	-10,4	42 251,58	42 251,58	-20,68
BG	42 277,87	-12,5	42 250,81	42 250,81	-27,06
RMF	42 291,27	-7,8	42 277,88	42 291,27	-13,39
LRG	42 297,83	-14,6	42 272,40	42 272,40	-25,43
DL	42 301,60	-25	42 250,74	42 250,74	-50,86
DL2	42 305,19	-7,8	42 289,10	42 305,19	-16,09
JW	42 320,71	-4,2	42 311,76	42 320,71	-8,95

(*) mesurage retenu lorsque la t°/tyre est > à 10 pulses/km

Nouveau classement

	Proposition	moy. cste
BB	42 206,03	42 239,63
IM	42 206,50	42 235,90
DY	42 212,21	42 241,87
CD	42 213,80	42 244,70
EP	42 216,54	42 246,29
BC	42 218,20	42 255,36
PR	42 220,26	42 246,36
DC	42 226,61	42 251,07
HJ	42 226,83	42 226,83
JFD	42 230,20	42 259,96
GR	42 241,77	42 264,26
DS	**42 245,66**	42 245,66
WC	42 246,97	42 246,97
DL	42 250,74	42 301,60
BG	42 250,81	42 277,87
JMG	42 251,58	42 272,26
NW	42 256,99	42 256,99
MW	42 258,69	42 258,69
JD	42 263,26	42 263,26
SH	42 271,51	42 271,51
LRG	42 272,40	42 297,83
RMF	42 291,27	42 291,27
DL2	42 305,19	42 305,19
JW	42 320,71	42 320,71

median	42 245,66
average	42 246,03
+ 0,05 % high	42 266,78
- 0,05 % low	42 224,54

IM 3

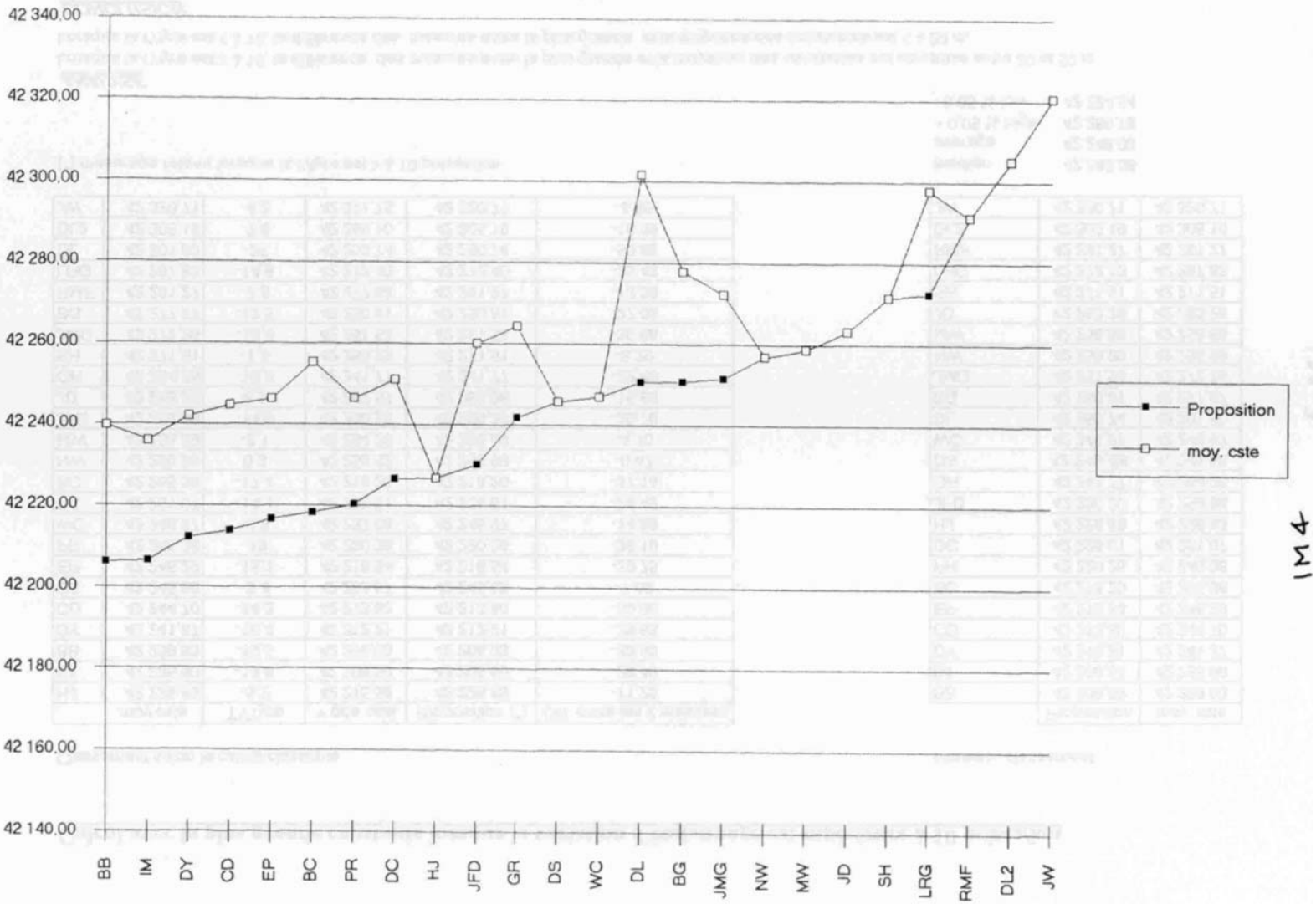
ANALYSE

Lorsque la t°/tyre est > à 10, la différence des mesures entre la plus grande et la moyenne des constantes est comprise entre 20 et 50 m.
Lorsque la t°/tyre est < à 10, la différence des mesures entre la plus grande et la moyenne des constantes est < à 20 m.

CONCLUSION

En fait, lorsque la t°/tyre est < à 10, la marge de sécurité (42 m pour le marathon) n'est pas compromise. Pour les pays utilisant la moyenne des constantes, il serait certainement souhaitable d'utiliser la plus grande des constantes pour une t°/tyre > à 10.

Résultat des calculs faits avec la plus grande constante quand la variation de l'étalonnage est > à 10 pulses/km et en gardant la moyenne des constantes quand elle est < à 10 pulses/km



IM4

P.S.
Having looked at the graphs calibration figures my argument isn't totally sustainable. But I'm sure on the right lines!
J.

John Disley CBE
Hampton House
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HAMPTON
TW12 2DW
Tel: 0181 979 1707
Fax: 0181 941 1867

FAX TO PETE RIEGEL
JUNE 4th 1996

Dear Pete,

I've just got home from Vermont.

Yes, I have no objection to your suggestion to reduce the course as measured by 65m.

The graph of measurements makes interesting examination. As might be expected I think my ride was fair and competent. Positioned near the tail of the riders I was in an ideal position to watch the lines taken by riders in front of me. Naturally, I took particular interest in the line taken by Norrie W., Bob B., and Hugh Jones. It was fascinating to watch how the subsequent riders "polished" the shortest possible route taken by their predecessors.

So having watched this smoothing off process at work and put the final touches to the line myself, I have to ask why did those in front ride shorter than I did?

Again working from the arrogance of knowing I was best, I have to look for a possible reason why I wasn't marginally shorter than Hugh, Norrie and Bob.

I haven't gone through the pre and post calibration rides as yet but I suspect that those big mountain bike tires produced fairly substantial changes from pre to post calibration rides. Your bike which I was riding with its solid polythene tire just changed 3 or 4 counts - actually getting larger. My ride with ~~hardly any~~ change in calibration has to produce a final result which does not have to be compromised by an "average" figure of pre and post rides.

It would have been illuminating to see what differences there were in our rides if we had all used solid wheels. I believe that we would have been more bunched up.

Solid tires significantly reduce the arbitary nature of an average of calibration rides.

Well done - the organisation was superb and the cast a great set of players. Thanks.

JD

JD 1

The Atlanta Committee for the Olympic Games
250 Williams Street, Suite 6000
P.O. Box 1996
Atlanta, GA 30301-1996 USA
Telephone 404-224-1996
Facsimile 404-224-1997

Atlanta 1996

May 25, 1996

Pete Riegel
IAAF Measurement Team
3354 Kirkham Road
Columbus, OH 43221

Dear Pete:

Congratulations on organizing a very successful Olympic Marathon course verification. Your meticulous efforts over many months resulted in a smooth operation which accomplished its task efficiently and effectively.

The sight of 28 yellow-shirt clad riders streaming along the course was stunning. The citizens of Atlanta who saw the procession must have known the task at hand was important, but may not have realized the riders included the most accomplished measurers from around the world.

We look forward to getting your conclusions and making the final adjustments.

Best personal regards,

Julia Emmons
Deputy Competition Manager Athletics/
Marathons and Race Walks

JE 1

MARATHON DES JEUX OLYMPIQUES 1996
MESURAGE DU PARCOURS
ATLANTA - USA

Rapport de **Jean-François DELASALLE (France)**

Plan

ANNEXES (Tableaux)

1. Observations

1.1 / Base d'étalonnage

La base d'étalonnage de Washington Street , située à proximité du stadium olympique, est constituée d'une double base avec deux côtés de longueurs inégales.

Onze groupes de deux à quatre mesureurs ont pratiqué le mesurage de cette double base selon la technique du ruban métallique avec comme résultats médians 480,352 mètres pour la base Ouest et 481,062 mètres pour la base Est.

Les valeurs retenues pour les calculs sont celles de la valeur médiane du groupe de mesureurs, la moyenne de l'ensemble des mesures étant très voisine de cette valeur médiane.

Il est constaté que la concordance entre les onze groupes de mesureurs se rapproche pour la plupart des groupes du coefficient de 0,00020 (0,02 %) habituellement recommandé pour la fiabilité des mesures des bases d'étalonnage.

Les facteurs de correction thermique ont été appliqués selon la température relevée par chacun des groupes. La précision de l'évaluation des températures ne peut être évaluée , dépendant du matériel utilisé et de la façon de tenir compte des zones d'ombre ou d'ensoleillement de la chaussée.

La base d'étalonnage de Washington Street présente comme seul avantage sa proximité du stade facilitant l'ensemble des mesures en groupes .

Par contre elle suscite de multiples critiques :

- l'inégalité de longueur des deux côtés Est et Ouest (rendant plus difficile l'étude des coefficients de fiabilité d'étalonnage de chaque mesureur) .Si cette inégalité de longueurs des deux côtés de la base n'entraîne pas de difficultés techniques particulières à la réalisation des calibrages et des calculs, elle est inadaptée au point de vue pédagogique pour les mesureurs débutants.
- profil particulièrement vallonné avec un profil différent selon le sens d'utilisation des bases Est et Ouest,
- revêtement un peu irrégulier aux extrémités avec présence de cailloux, sable, verre cassé, plaques d'égoût sur la trajectoire idéale d'étalonnage.

1.2 / Mesures in stadium

L'ensemble des mesures in stadium a été réalisé avec un seul pré et un seul post étalonnage sur la base Washington située out stadium.

L'ensemble du parcours mesuré (début et fin de course cumulés) in stadium a une longueur voisine de 2195 mètres jusqu'au point de référence "R-Clarke" situé à la sortie du stade.

Les fractionnements de parcours mesurés dans le stade permettent par ailleurs de différencier l'estimation de la mesure d'un tour de piste complet de 400 mètres ainsi qu'un virage complet entre la ligne d'arrivée et la ligne de départ du 1500 mètres soit 100 mètres.

La comparaison des résultats obtenus sur ces segments de parcours (400 et 100 m splits) montre que la plupart des mesureurs ont probablement utilisé une trajectoire trop proche de la ligne de bordure officielle de la piste avec un résultat personnel égal à la valeur médiane de l'ensemble des mesureurs soit 399,15 m pour le tour de piste (calcul sans safety factor) et 99,71 m pour le virage de 100 m.

Ceci signifie que la plupart des mesureurs , rassemblés en groupe comparatif, ne respectent pas la distance officielle de 30 cm par rapport à la bordure du circuit (lice de la piste en l'occurence) mais se montrent "trop sévères" dans leur mesure .
Un résultat de 399,15 m correspond à un mesureur roulant à 16,5 cm de la lice.

A signaler qu'il était possible de ne mesurer que les zones de jonction du parcours olympique entre le out et le in stadium, en se servant de la distance officielle (sans safety factor) de 400,00 m pour le tour de piste (qui doit être parcouru 3 fois au début de la course).

Il aurait probablement été plus judicieux d'utiliser une mini base in stadium pour mesurer la portion in stadium du parcours avec les bicyclettes , d'autant plus que la base out stadium était très vallonnée et d'un revêtement différent de celui du stade.

J'ai personnellement effectué la comparaison en étalonnant le Jones compteur (une seule fois) sur la distance du 100 m ligne droite de la ligne droite du stade olympique : mon résultat était de 980 pulses / 100 m soit une constante instantanée de 9800 pulses / km
Mon relevé personnel indiquait lors de la mesure du parcours les chiffres suivants :
- pour un tour de piste complet 3915 pulses soit 399,49 m
- pour le virage seul 979 pulses soit 99,90 m

Ces chiffres montrent qu'en fait j'ai roulé sur le tour de piste complet à 22 cm et non pas à 16,5 cm de la bordure de piste . Ce résultat peut être considéré comme presque parfait dans la mesure où la lice n'était pas installée sur le stade lors du mesurage (imposant une mesure à 20 cm de la ligne et non pas à 30 cm comme pour les couloirs extérieurs de la piste selon le règlement IAAF du mesurage des pistes ...)
Avec un peu d'entrainement il serait facile d'améliorer l'imprécision résiduelle.

1.3 / Mesures out stadium

Le circuit out stadium , mesuré par M.Grosko et certifié par M.Cornwell , s'est révélé d'une distance trop longue avec une valeur médiane de **42 257 m** (soit 62 m de plus que la distance officielle du marathon).

Les segments intermédiaires de 5 km en 5 km sont tous concordants à la distance annoncée , à l'exception du segment situé entre le 35ème et 40ème km dont la valeur médiane est de 5 057 mètres , prouvant que l'ensemble de l'erreur de mesurage effectuée par le mesureur local se situe à ce niveau.

L'étude globale de répartition des résultats des 24 mesureurs ayant réalisé l'ensemble du parcours montre que seulement 3 mesureurs ont un résultat excédant 0,1% de la valeur médiane du groupe (donc trop longs) alors qu'aucun mesureur n'est en dessous de 0,1% de cette valeur médiane.
L'analyse des résultats selon la méthode du 0,05% discording système , éliminant toute valeur s'écartant de plus de 0,05% de la valeur médiane d'un groupe, ramène la valeur médiane de la distance officielle du parcours à **42 255 m** et élimine les résultats des 5 mesureurs "les plus longs" ainsi que le résultat du mesureur "le plus court" du groupe , laissant un groupe médian homogène de 18 mesureurs dont la valeur médiane est de 42 251 m et la valeur moyenne **42 254 m** (chiffre représentant probablement la meilleure estimation) .

L'étude comparative des mesures de 3 segments de 10 km (situés entre le 5ème et 15 ème , entre le 15ème et 25ème et entre le 25 ème et 35 ème km du parcours) montre une courbe de répartition des résultats tout à fait similaire à la courbe du résultat global de l'ensemble du parcours , traduisant bien le niveau technique habituel de chacun des mesureurs.

L'étude des variations des constantes d'étalonnage de chaque mesureur , entre le pré et le post étalonnage, montre une différence tout à fait significative entre l'utilisation des pneus solides pleins et les roues à pneus gonflables pneumatiques , beaucoup plus sensibles aux variations de température. La variation moyenne des pneus gonflables varie entre 10 et 20 pulses/km en moins lors du post étalonnage pour une augmentation de température de +4°C entre le pré et le post étalonnage. Pour les pneus solides cette différence n'est estimée qu'à quelques pulses , entre 0 et 5 pulses/km .

L'étude individuelle de l'étalonnage de chaque mesureur selon le côté de la base utilisé (East ou West) montre que la reproductibilité lors de l'étalonnage de l'étalonnage des mesureurs peut être jugée satisfaisante avec en moyenne 0,5 ou 1 pulses de différence entre 2 trajets successifs du même côté de la base.
Par contre la moyenne des variations East/West pour chacun des mesureurs montre que pour 9 d'entre eux une variation de plus de 3 pulses/km est constatée (et de plus de 6 pulses/km pour 4 d'entre eux) témoignant de leur difficulté d'adaptation à la position sur la bicyclette selon le profil du parcours . Ceci doit inciter à choisir des bases d'étalonnage planes , sans côtes ni dénivelé important.

2. Conclusions d'ordre général sur le mesurage

2.1. Il est confirmé que la **détermination des bases** des bases d'étalonnage à l'aide d'un ruban métallique avec facteur de correction thermique ne peut pas être plus précise que dans les limites de 0,02% (facteur 0,00020)

2.2. L'expérimentation de la bicyclette pour les **mesures sur piste** montre que la technique est délicate avec des résultats le plus souvent estimés plus courts et plus sévères qu'en réalité. Le mesurage des distances sur route est il plus "sévère" que celui des géomètres construisant les pistes ?
La règle IAAF de mesurer la piste à 30 cm de la lice ne devrait elle pas être revue en exigeant une mesure à 10 cm de la bordure (cette règle date de l'époque des pistes en cendrée et n'est plus adaptée aux pistes modernes à revêtement synthétique) . Pourquoi ne pas construire les stades modernes avec une mesure à 10 cm des lices cimentées fixes et avec des mesures juste à la limite des lignes de couloirs pour les couloirs extérieurs ?

2.3. **L'étalonnage des compteurs** devrait tenir compte d'une façon plus importante des variations liées à la température pour les pneus gonflables afin de compenser l'avantage fourni par l'utilisation des pneus solides , moins exposés à ces variations.
Je propose de modifier la procédure IAAF/AIMS en utilisant pour les calculs soit :
- la moyenne des constantes lorsque la variation entre le pré et le post étalonnage est inférieure à 10 pulses / km
- la plus grande des constantes lorsque cette variation est supérieure à 10 pulses / km.

2.4. **La distance du parcours** proposé à ATLANTA est de 42 254 mètres selon le 0,05% discording system et de 42 257 mètres selon la valeur médiane brute de l'ensemble du groupe des 24 mesureurs présents.

Mon résultat personnel est de 42 260 mètres .

La valeur proposée par la méthode convenue par Peter RIEGEL , calculée sur la somme des valeurs médianes de chaque segment de parcours , est de **42 260 mètres.**

Cette distance peut donc être la distance officiellement retenue pour le parcours proposé.

JFD 5

3. RECOMMANDATIONS pour la course d' ATLANTA 1996

3.1. Le parcours proposé peut être validé tel que proposé car la distance globale mesurée ne s'avère pas trop courte par rapport à la distance officielle du marathon.
On peut considérer que M.Grosko a inclu un facteur préventif personnel d'environ 50 à 60 mètres et les points intermédiaires qu'il a définis peuvent être considérés comme relativement corrects et ne doivent pas être modifiés puisque l'erreur se situe en fin de parcours entre le 35ème et le 40ème km , à la fin d'une rue en descente , ce qui ne devrait pas altérer de façon visible les temps intermédiaires.

3.2. S'il est décidé de recommander de raccourcir le parcours proposé de 50 mètres ce qui peut être justifié bien que cette course soit déjà certifiée et enregistrée par la fédération américaine , il conviendrait de ravancer le centre du demi cercle servant de point de demi tour d'un peu moins de la moitié de la distance souhaitée , dans le secteur 3 du parcours , en tenant compte du calcul géométrique imposé par le virage à droite situé 70 m après ce demi tour et de la courbe d'environ 200 m précédant ce point de demi tour.

Si cet ajustement modificatif est réalisé , il doit être vérifié avant l'épreuve par un mesureur de grade A de l'IAAF , car seul un mesureur de ce grade est par définition habilité à mesurer un parcours olympique . Ceci est d'autant plus justifié que le mesureur local peut être rendu responsable de l'erreur initiale de mesurage pour le parcours proposé.

Par ailleurs l'avancement du point de demi tour pour obtenir un raccourcissement de 50 mètres nécessitera de recontrôler à la bicyclette calibrée l'ensemble du secteur 3 afin de vérifier que le raccourcissement effectué n'est pas plus important que celui calculé en théorie par les calculs géométriques.

3.3. Le "coning requirement" devra être scrupuleusement respecté le jour de l'épreuve , en particulier au niveau du premier virage à gauche au début du pont de Capitol avenue où la course doit utiliser une seule ligne de circulation , la plus à droite (ne pas respecter cette restriction raccourcirait la course de 8 à 15 mètres selon le virage). De même le respect de la double ligne jaune de séparation de la chaussée , en particulier dans Peach street , devra faire l'objet de beaucoup d'attention afin de ne pas raccourcir le parcours.
Des postes d'eau , rafraichissement et brumisation doivent être installés environ tous les miles en raison de la difficulté du parcours, de la température élevée (> 25°C) et de l'hydrométrie (>80%) rendant les conditions de course dangereuses.

3.4. Le "Stupid Safety Point" : il pourrait être conseillé , à toutes fins utiles , de prévoir un point de demi tour complémentaire préventif des erreurs d'organisation stupides pouvant survenir dans la stade (cf : GOTEBORG woman marathon). Pour cela un point de demi tour complémentaire situé 200 m plus loin que le point officiel prévu permettrait de sauver la distance globale de la course en cas d'oubli d'un tour de piste au début de l'épreuve , en rallongeant en cet endroit de la distance manquante.

JFD 6

MARATHON OF THE 1996 OLYMPIC GAMES
Measurement of the course
Atlanta - USA

- Report **Jean François DELASALLE** (JFD) **FRANCE**

- **Outline :**

1. Observations

    1.1. Calibration Course
    1.2. Mesures in stadium
    1.3. Mesures out stadium

2. General conclusions on the measurement

3. Recommendations for the 1996 Atlanta race

- **Annex (charts)**

1. Washington Street double calibration course
2. Measurement in order of length (split by split and total value)
3. Comparative curve on the total value of the measurement of the course (24 measurers)
4. Study of the median values with the 0,05 % discording system
5. Comparison of the results of the measures in stadium and out stadium
6. Comparative study of the results of the group on 3 roads splits of 10 Km
7. Comparative curves on the 3 10 Km splits
8. Results of the measures done in stadium
9. The Olympic track (400 m and 100 m bend) studied with the calibrate bicycles
10. Variation of the constants of pre and post calibration according to the temperature and the type of tyre
11. Study of the calibration of the group of measurers

1. Observations

1.1. Calibration course

The calibration course of Washington Street, which is situated near the Olympic stadium, consists of a double base line with two sides of unequal lengths.

Eleven groups of two to four measurers did the measurement of this double base line using the technic of the steel tape with median results of 480,352 meters for the West calibration course and 481,062 meters for the East calibration course.

The values that have been kept for the calculations are those of the median value of the group of measurers, the average of all the measures being very close to the median value.

We can notice that between the eleven groups of measurers is close to the coefficient of 0,00020 (0,02 %) for most groups, which is usually recommended for the accuracy of the measures of the calibration courses.

The factors of thermic correction were applied according to the temperature that was registered by each group. The accuracy of the evaluation of the temperatures cannot be evaluated, depending on the equipement being used and on the way you take into account the shaded areas or the sunny areas of the road.

The calibration course of Washington Street has the sole advantage of being situated near the stadium and making it easy for all the measures in groups.

However, it arouses multiple critics:

- the unequal length of both East and West sides making more difficult the study of the coefficients of accuracy of the calibration of each measurer.
If this inequality in length of the two sides of the course does not bring any particular technical difficulty in doing the calibration and the calculations, it is not adequate for beginner measurers if we consider the educational aspect.

- a rather undulating outline with an outline which is different according to which way you use the East and West calibration courses.

- the surface of the road being a little rough at the ends with stones, sand, broken glass and man-holes on the ideal trajectory of the calibration course.

1.2. Measures in stadium

The entire measures in stadium were done with one pre-calibration and one post-calibration only, on the Washington calibration course situated out stadium.

The entire course measured (beginning and end of race combined) in stadium has a length that is close to 2195 meters up to the reference mark "R-Clarke" that is situated just outside the stadium.

The splitting-up of the course measured in the stadium allow us also to differenciate the estimation of the measure of a whole lap of the track of 400 meters as well as a whole bend between the finish line and the departure line of the 1 500 meters , that is to say 100 meters.

The comparison of the results thus obtained on these splits of the course (400 and 100 m splits) shows that most measurers probably use a trajectory that was too close to the official edge of the track with a personnal result equal to the median value of most measurers that is to say 399,15 m for one lap of the track (calculation without the safety factor) and 99,71 m for the 100 m bend.

This means that most measurers, gathered in a comparative group, do not respect the official 30 cm distance from the edge of the course (inside rail of track in that case) but prove to be "too strict" in their measurement.
A result of 399,15 m corresponds to a measurer riding at 16,5 cm from the inside rail.

I would like to point out that it was possible to only measure the junction zones of the Olympic course between out and in stadium, by using the official distance (without the safety factor) of 400,00 m for the whole lap of the track (that has to be run 3 times at the beginning of the race).

It would probably have been better to use a mini-calibration course in stadium in order to measure the part of the course in stadium with the bicycles, the more so that the calibration course out stadium was very undulating and of a different surface than that of the stadium.

I personnaly did a comparison by calibrating the Jones counter (only once) on a 100 m distance straight line of the Olympic stadium : my result was 980 counts/100 m, that is to say an "instant constant" of 9 800 counts / km.

My personal reading showed the following figures during the measurement of the course :
- for a whole lap of track : 3 915 counts , therefore 399,49 m
- for the bend only, 979 counts, therefore 99,90 m.

These figures show that in fact, I rode on the whole lap of the track at 22 cm and not at 16,5 cm, from the inside rail. This result can be considered nearly perfect if we consider that the inside rail had not been fixed on the stadium when we did our measurement (imposing a measurement at 20 cm from the line and not 30 cm as for the outside lanes of the track as is stipulated in the IAAF rules for the measuring tracks...). With a little more experience and training it would be easy to improve the residual imprecision.

1.3. Measures out stadium

The course out stadium, measured by Mr. Grosko and certified by Mr. Cornwell, proved to be too long a distance, with a median value of 42 257 m (that is to say 62 m more than the official distance of the marathon).

The intermediate splits every 5 Km all corroborate the announced distance, except for the segment that is situated between the 35th Km and the 40th Km, the median value of which is 5 057 meters, thus proving that the mistake in the measurement done by the local measurer is to be found there.

The global study of the distribution of the results of the 24 measurers having done the entire course, shows that 3 measurers only have a result above 0,1 % of the median value of the group (therefore too long) when not one measurer is under 0,1 % of this median value.

The analysis of these results with the method of the 0,05 % discording system, getting rid of any value that is more than 0,05 % of the median value of a group, brings back the median value of the official distance of the course to 42 255 meters and suppresses the results of the 5 "longest" measurers, as well as the result of the only "shortest" measurer of the group, leaving a homogeneous median group of 18 measurers, the median value of which is 42 251 meters and the average value 42 254 meters (figure that probably represents the best estimate).

The comparative study of 3 10 Km splits (situated between the 5th and the 15th, between the 15th and the 25th and between the 25th and the 35th Km of the course) shows a curve of repartition of the results quite similar to the curve of the whole result of the entity of the course, giving a good idea of the usual technical level of each of the measurers.

The study of the variations of the calibration constants for each measurer, between pre and post calibration, shows a very significant difference between the use of solid tyres and pneumatic inflatable tyres, which are much more sensitive to temperature variations. The average variation of pneumatic tyres is between 10 and 20 counts/Km less during the post calibration for a 4°C increase in temperature between pre and post calibration. For solid tyres, this difference is estimated only a few counts, between 0 and 5 counts/Km.

The individual study of the calibration of each measurer according to which side of the calibration course was used (East or West) shows that the reproducibility when calibrating the calibration of the measurers, can be thought satisfactory with an average of 0,5 or 1 count difference between 2 successive rides of the same side of the calibration course.
However, the average of the East / West variations for each measurer shows that for 9 of them a variation of more than 3 counts/Km is noticed (and of more than 6 counts /Km for 4 of them) indicating their difficulty in adopting a good position on the bike according to the profile of the course.

This should encourage to choosing flat calibration courses, without any hills or major climbs and descents.

2. CONCLUSIONS

2.1 It has been confirmed that the determination of the basis of the calibration courses with the help of a steel tape and the thermic correction factor cannot be more accurate than in the 0,02 % limits (0,00020 factor).

2.2 The experimentation of the bike for measures on track shows that the technique is tricky with results that are estimated most of the time, shorter and stricter than in reality.
Is the measurement of distances on roads more severe than that of the surveyors building tracks?
Shouldn't the IAAF rule of measuring the track 30 cm from the inside rail be reconsidered and require a measure at 10 cm from the edge : this rule was started at the time of cinders tracks and is not adapted to modern tracks with a synthetic pavement. Why not build the modern stadiums with a measurement at 10 cm from the fix cement inside rails and with measures just at the limit of the lane lines for the outside lanes? Why not ?

2.3 The calibration of the counters should take into account in a more important way, the variations due to the temperature for the pneumatic inflatable tyres in order to compensate the advantage given by the use of solid tyres, less inclined to these variations.
I suggest a modification of the IAAF/AIMS procedure by using in the calculations what follows:
- The average of the constants when the variation between pre and post calibrations is inferior to 10 counts / Km.
- The largest of the constants when this variation is above 10 counts/Km.

2.4 The distance of the course suggested in Atlanta is 42 254 meters according to the 0,05% discording system and 42 257 meters according to the rough median value of the whole group of the 24 measurers that were present .

My own result is 42 260 meters.

The value suggested by the method as chosen by Peter Riegel, which is calculated on the sum of the median values for each split of the course, is 42 260 meters.

This distance can therefore be the distance officially kept for the suggested course.

3. RECOMMANDATIONS FOR THE 1996 ATLANTA RACE

3.1 The suggested course can be validated as put forward since the global distance that has been measured is not too short compared to the official distance of the marathon. We can consider that Mr Grosko included a personal safety factor of around 50 to 60 meters and the intermediate marks that he defined can be considered as relatively correct and must not be modified since the error is at the end of the course between the 35 th and the 40 th kilometer, at the end of a down hill street, which should not modify the intermediate times in a noticeable way.

3.2 If it is decided to recommend to shorten the suggested course by 50 meters, which can be justified although this race has already been certified and registered by the American Federation, it would be proper to bring forward the center of the semi circle used as a turn around point of a little less than half the desired distance, in sector 3 of the course, taking into account the geometrical calculation imposed by the bend towards the right which is situated 70 m after that turn around point and of the curve of about 200 m before this turn around point.

If this modification adjustment is done, it must be checked before the race, by an IAAF A grade measurer, because only a measurer of that grade can be accredited , by definition, to measure an Olympic course. This is all the more justified since the local measurer can be made responsible for the initial error of measurement for the suggested course.

Also, the bringing forward of the turn around point so as to shorten the course of 50 meters will require another checking with the calibrate bicycle of the entire sector 3 so as to check that the shortening done is not more important than that calculated in theory by the geometrical calculations.

3.3 The " coning requirement " will have to be scrupulously respected on the day of the race, specially at the level of the first crossroads when turning left on the bridge of Capitol avenue where the race must use one line of traffic only, the one that is most on the right (not respecting this resctriction would shorten the race of 8 to 15 meters according to the bend). Also, respecting the double yellow partition line of the road, in particular in Peach street, will have to be handled with lots of care so as not to shorten the course .
Water , drinks and spray stations must be settled about every mile because of the difficulty of the course, the high temperature (> 25°C) and the hydrometry (> 80 %) making the race conditions dangerous.

3.4 The " stupid safety point" :

It could be advised, on a point of information, to anticipate a complementary turn around point as a prevention of any stupid organisation mistake that could occur in the stadium (see : Goteborg woman marathon). For that, a complementary safety turn around point situated 200 m further than the official point expected , would allow to save the global distance of the course in case one lap of the track was missed at the beginning of the race, by lengthening with the missing distance at that place.

TABLEAUX ANNEXES

ANNEX (CHARTS)

au rapport de J.F DELASALLE

JFD 13

WASHINGTON STREET - ATLANTA - U.S.A.

CALIBRATION COURSE - BASE D'ETALONNAGE

Base West (AB), côté droit

Measurers	Team	Uncorrected Length	Temperature	FCT	Corrected Length
JW - BW	USA 2	480,44	25	1,0000580	480,468
BB - DL - DS - WC	USA 1	480,42	24	1,0000464	480,442
MW - AB	USA 3	1576'00"	33	1,0001508	480,437
HJ - NW	UK	480,37	27	1,0000812	480,409
BC - DY	CAN	480,35	26	1,0000696	480,383
PR - JD	USA / UK	480,33	24	1,0000464	480,352
JFD - IM	FRA 1	480,31	26	1,0000696	480,343
RM - LR	MEX	480,29	27	1,0000812	480,329
JMG - CD	FRA 2	480,27	30	1,0001160	480,326
DC - DL	AUS	480,29	25	1,0000580	480,318
SH - DK	USA 4	480,205	27	1,0000812	480,244

Average	480,368
Medium	480,352

Base East (CD), côté gauche

Measurers	Team	Uncorrected Length	Temperature	FCT	Corrected Length
JW - BW	USA 2	481,09	23	1,0000348	481,107
HJ - NW	UK	481,06	26	1,0000696	481,093
MW - AB	USA 3	1578'03"	26	1,0000696	481,084
RM - LR	MEX	481,05	26	1,0000696	481,083
BB - DL - DS - WC	USA 1	481,05	23	1,0000348	481,067
BC - DY	CAN	481,034	25	1,0000580	481,062
JFD - IM	FRA 1	480,97	26	1,0000696	481,003
PR - JD	USA / UK	480,98	23	1,0000348	480,997
DC - DL	AUS	480,96	24	1,0000464	480,982
JMG - CD	FRA 2	480,95	25	1,0000580	480,978
SH - DK	USA 4	480,87	26	1,0000696	480,903

Average	481,033
Medium	481,062

Comparaison des 2 bases (Difference between the 2 calibration courses)

Measurers	Team	East	West	East - West (cm)	East + West
JW - BW	USA 2	481,107	480,468	63,9	961,575
MW - AB	USA 3	481,084	480,437	64,7	961,521
BB - DL - DS - WC	USA 1	481,067	480,442	62,5	961,509
HJ - NW	UK	481,093	480,409	68,4	961,502
BC - DY	CAN	481,062	480,383	67,9	961,445
RM - LR	MEX	481,083	480,329	75,4	961,412
PR - JD	USA / UK	480,997	480,352	64,5	961,349
JFD - IM	FRA 1	481,003	480,343	66,0	961,346
JMG - CD	FRA 2	480,978	480,326	65,2	961,304
DC - DL	AUS	480,982	480,318	66,4	961,300
SH - DK	USA 4	480,903	480,244	65,9	961,147

Average	961,401
Medium	961,412

JFD 14

Measurements in order of measured length - Split by split and total course

Réf JFD/GENMED1.XLS

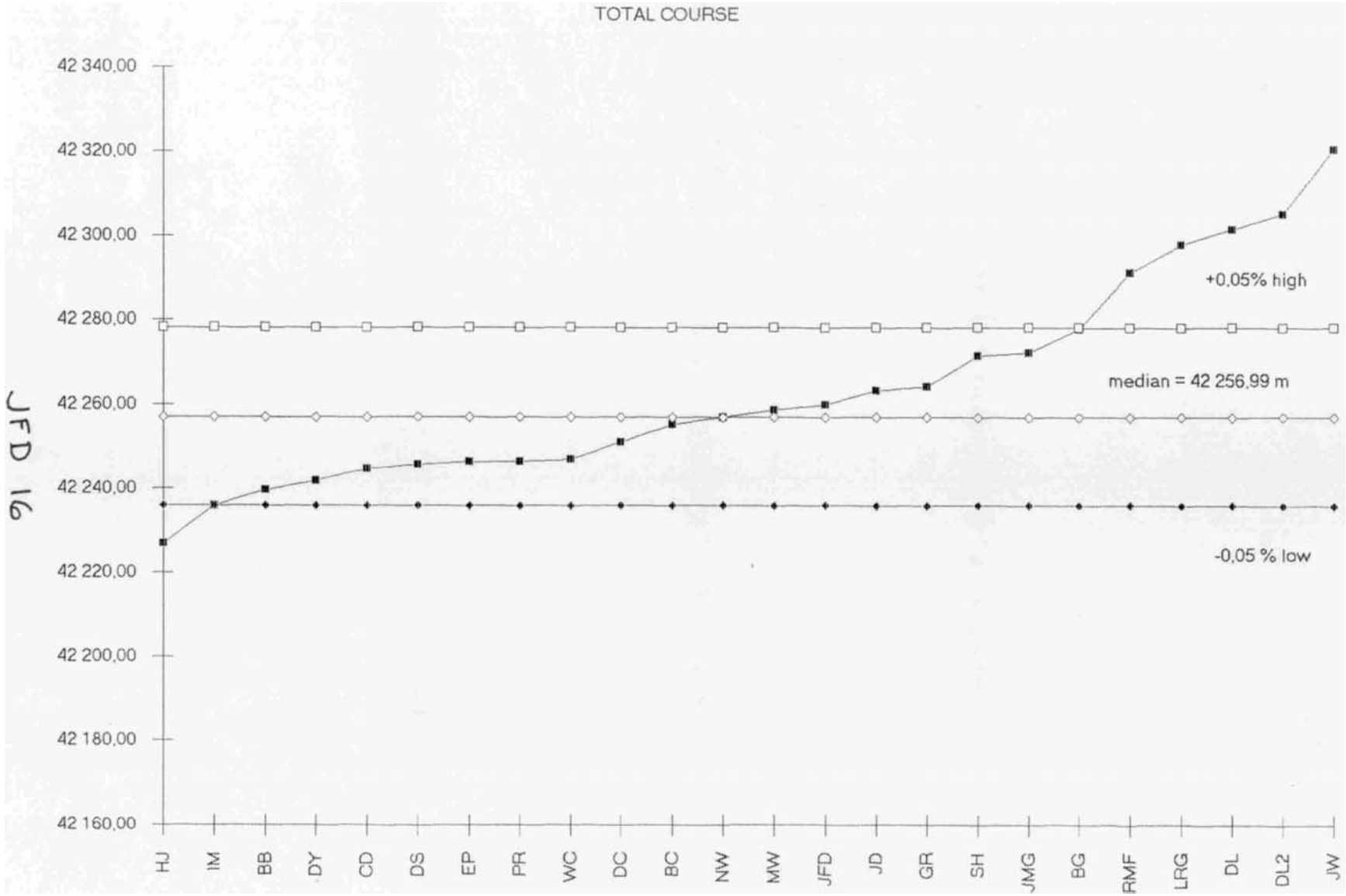
Start to Clarke		Clarke to 5 km		5 km to 10 km		10 km to 15 km		15 km to 20 km		20 km to 25 km	
DS	1 535,40	BB	3 469,68	HJ	4 996,15	HJ	4 999,17	HJ	4 996,91	HJ	4 987,08
WC	1 535,48	HJ	3 470,56	CD	4 997,30	EP	5 000,31	CD	4 998,27	IM	4 988,83
HJ	1 535,67	DY	3 470,57	BB	4 997,79	DY	5 001,37	IM	4 998,61	BB	4 988,93
DC	1 535,67	IM	3 470,60	DY	4 997,84	JMG	5 001,48	PR	4 999,51	DS	4 989,82
DY	1 536,22	DS	3 470,87	DS	4 997,88	WC	5 001,51	EP	4 999,53	EP	4 990,08
GR	1 536,45	CD	3 470,93	JD	4 998,04	IM	5 001,74	WC	5 000,09	WC	4 990,27
RMF	1 536,54	WC	3 471,07	NW	4 998,25	MW	5 001,76	DS	5 000,19	DY	4 990,52
JFD	1 536,62	MW	3 471,09	MW	4 998,28	BB	5 002,00	BB	5 000,45	PR	4 990,99
BG	1 536,64	SH	3 471,19	WC	4 998,66	DS	5 002,38	GR	5 001,58	DC	4 991,01
PR	1 536,65	NW	3 471,54	EP	4 998,74	NW	5 002,54	NW	5 001,71	BC	4 991,30
NW	1 536,75	RL	3 471,61	PR	4 999,21	BC	5 002,58	DC	5 001,96	MW	4 991,43
EP	**1 537,16**	EP	3 471,76	IM	4 999,42	CD	5 002,59	DY	5 002,09	RL	4 991,51
SH	1 537,61	BC	**3 471,93**	DC	**4 999,62**	GR	**5 002,61**	RL	**5 002,21**	NW	**4 991,59**
IM	1 537,83	JFD	3 472,18	JFD	4 999,68	RL	5 002,66	BC	5 002,37	GR	4 992,33
CD	1 538,11	JD	3 472,27	BC	4 999,82	DC	5 002,83	MW	5 002,40	CD	4 992,87
BC	1 538,51	PR	3 472,28	GR	5 000,04	PR	5 002,91	JFD	5 003,46	JFD	4 992,95
LRG	1 538,57	RMF	3 472,32	JMG	5 000,29	JD	5 002,96	SH	5 003,54	JD	4 993,39
BB	1 538,71	DC	3 472,89	RL	5 000,34	SH	5 003,86	JMG	5 003,96	SH	4 993,97
MW	1 538,83	GR	3 473,24	SH	5 001,75	JFD	5 004,17	JD	5 004,51	JMG	4 994,74
JD	1 539,06	BG	3 473,56	BG	5 002,66	BG	5 006,33	BG	5 006,66	BG	4 994,88
JMG	1 539,18	LRG	3 473,71	RMF	5 002,90	DL2	5 006,70	DL	5 007,57	LRG	4 996,20
JW	1 541,23	JMG	3 473,84	DL2	5 003,00	LRG	5 006,92	RMF	5 008,03	DL	4 996,29
DL	1 541,80	DL	3 474,30	DL	5 003,40	DL	5 007,67	LRG	5 008,92	RMF	4 996,57
DL2	1 542,46	DL2	3 474,82	LRG	5 004,91	RMF	5 007,78	DL2	5 009,47	DL2	4 999,09
		JW	3 476,59	JW	5 007,40	JW	5 009,43	JW	5 009,86	JW	4 999,25

Median	1 537,16	3 471,93	4 999,62	5 002,61	5 002,21	4 991,59
Average	1 537,80	3 472,22	5 000,13	5 003,45	5 002,95	4 992,64
+0,05% high	1 537,93	3 473,67	5 002,12	5 005,11	5 004,71	4 994,09
-0,05% low	1 536,39	3 470,19	4 997,12	5 000,11	4 999,71	4 989,09

25 to 30 km		30 km to 35 km		35 km to 40 km		40 km to Clarke		Clarke to Finish		Total Course	
IM	4 987,92	HJ	4 987,30	BB	5 053,26	JFD	1 545,35	NW	657,36	HJ	42 226,83
HJ	4 988,38	IM	4 992,26	IM	5 053,68	DY	1 545,89	HJ	657,42	IM	42 235,90
BB	4 989,87	PR	4 992,70	DY	5 054,95	JD	1 546,01	DS	657,47	BB	42 239,63
PR	4 990,19	BB	4 993,23	PR	5 055,00	BG	1 546,28	DY	657,48	DY	42 241,87
WC	4 990,27	CD	4 993,41	BC	5 055,19	IM	1 546,77	DC	657,61	CD	42 244,70
CD	4 990,61	DY	4 993,78	CD	5 055,56	DL	1 546,79	WC	657,69	DS	42 245,66
EP	4 990,77	DC	4 993,97	JD	5 056,29	NW	1 546,87	BG	657,82	EP	42 246,29
DC	4 991,10	BC	4 994,70	DC	5 056,30	HJ	1 546,96	JFD	657,85	PR	42 246,36
DY	4 991,16	DS	4 995,47	EP	5 056,82	EP	1 546,96	CD	657,86	WC	42 246,97
DS	4 991,29	WC	4 995,63	DS	5 057,15	CD	1 547,19	BB	658,16	DC	42 251,07
BC	4 991,51	EP	4 995,69	JFD	5 057,62	BB	1 547,55	IM	658,24	BC	42 255,36
RL	4 992,31	RL	4 996,24	RL	5 057,69	RL	1 547,64	**JMG**	**658,26**	**NW**	**42 256,99**
NW	**4 992,59**	**JFD**	**4 996,52**	**MW**	**5 058,08**	**WC**	**1 547,67**	MW	658,30	MW	42 258,69
GR	4 993,16	MW	4 996,91	WC	5 058,62	RMF	1 547,69	JD	658,39	JFD	42 259,96
BG	4 993,26	GR	4 997,47	SH	5 058,98	DS	1 547,74	EP	658,47	JD	42 263,26
MW	4 993,54	SH	4 997,76	JMG	5 059,11	JMG	1 547,77	SH	658,54	GR	42 264,26
JFD	4 993,56	NW	4 998,25	GR	5 059,43	MW	1 548,07	GR	658,54	SH	42 271,51
JD	4 993,66	JMG	4 998,60	NW	5 059,54	DC	1 548,11	PR	658,65	JMG	42 272,26
SH	4 994,81	JD	4 998,68	BG	5 059,82	PR	1 548,27	LRG	658,74	BG	42 277,87
JMG	4 995,03	BG	4 999,96	DL2	5 060,74	LRG	1 548,27	RMF	658,83	RMF	42 291,27
RMF	4 996,92	LRG	5 001,17	HJ	5 061,23	BC	1 548,33	BC	659,12	LRG	42 297,83
DL	4 997,00	RMF	5 001,87	RMF	5 061,82	GR	1 549,41	JW	659,19	DL	42 301,60
DL2	4 997,66	DL2	5 001,87	DL	5 061,95	DL2	1 549,45	DL2	659,93	DL2	42 305,19
LRG	4 998,03	JW	5 003,32	LRG	5 062,39	SH	1 549,50	DL	660,00	JW	42 320,71
JW	5 000,11	DL	5 004,83	JW	5 064,44	JW	1 549,89				

Median	4 992,59	4 996,52	5 058,08	1 547,67	658,26	42 256,99
Average	4 992,99	4 996,86	5 058,23	1 547,62	658,33	42 263,42
+0,05% high	4 995,09	4 999,02	5 060,61	1 548,44	658,59	42 278,12
-0,05% low	4 990,09	4 994,02	5 055,55	1 546,90	657,93	42 235,86

JFD 15


TOTAL COURSE
42 340,00
42 320,00
42 300,00
42 280,00
42 260,00
42 240,00
42 220,00
42 200,00
42 180,00
42 160,00
+0,05% high
median = 42 256,99 m
-0,05 % low
HJ
IM
BB
DY
CD
DS
EP
PR
WC
DC
BC
NW
MW
JFD
JD
GR
SH
JMG
BG
RMF
LRG
DL
DL2
JW
JFD 16

Study of corrected median value with 0,05 % discording system

Réf JFD/GENMED2.XLS

Start to Clarke		Clarke to 5 km		5 km to 10 km		10 km to 15 km		15 km to 20 km		20 km to 25 km	
DS	1 535,40	BB	3 469,68	HJ	4 996,15	HJ	4 999,17	HJ	4 996,91	HJ	4 987,08
WC	1 535,48	HJ	3 470,56	CD	4 997,30	EP	5 000,31	CD	4 998,27	IM	4 988,83
HJ	1 535,67	DY	3 470,57	BB	4 997,79	DY	5 001,37	IM	4 998,61	BB	4 988,93
DC	1 535,67	IM	3 470,60	DY	4 997,84	JMG	5 001,48	PR	4 999,51	DS	4 989,82
DY	1 536,22	DS	3 470,87	DS	4 997,88	WC	5 001,51	EP	4 999,53	EP	4 990,08
GR	1 536,45	CD	3 470,93	JD	4 998,04	IM	5 001,74	WC	5 000,09	WC	4 990,27
RMF	1 536,54	WC	3 471,07	NW	4 998,25	MW	5 001,76	DS	5 000,19	DY	4 990,52
JFD	1 536,62	MW	3 471,09	MW	4 998,28	BB	5 002,00	BB	5 000,45	PR	4 990,99
BG	1 536,64	SH	3 471,19	WC	4 998,66	DS	5 002,38	GR	5 001,58	DC	4 991,01
PR	**1 536,65**	NW	3 471,54	EP	**4 998,74**	**NW**	**5 002,54**	NW	5 001,71	BC	4 991,30
NW	1 536,75	RL	**3 471,61**	PR	4 999,21	BC	5 002,58	DC	5 001,96	**MW**	**4 991,43**
EP	1 537,16	EP	3 471,76	IM	4 999,42	CD	5 002,59	**DY**	**5 002,09**	RL	4 991,51
SH	1 537,61	BC	3 471,93	DC	4 999,62	GR	5 002,61	RL	5 002,21	NW	4 991,59
IM	1 537,83	JFD	3 472,18	JFD	4 999,68	RL	5 002,66	BC	5 002,37	GR	4 992,33
CD	1 538,11	JD	3 472,27	BC	4 999,82	DC	5 002,83	MW	5 002,40	CD	4 992,87
BC	1 538,51	PR	3 472,28	GR	5 000,04	PR	5 002,91	JFD	5 003,46	JFD	4 992,95
LRG	1 538,57	RMF	3 472,32	JMG	5 000,29	JD	5 002,96	SH	5 003,54	JD	4 993,39
BB	1 538,71	DC	3 472,89	RL	5 000,34	SH	5 003,86	JMG	5 003,96	SH	4 993,97
MW	1 538,83	GR	3 473,24	SH	5 001,75	JFD	5 004,17	JD	5 004,51	JMG	4 994,74
JD	1 539,06	BG	3 473,56	BG	5 002,66	BG	5 006,33	BG	5 006,66	BG	4 994,88
JMG	1 539,18	LRG	3 473,71	RMF	5 002,90	DL2	5 006,70	DL	5 007,57	LRG	4 996,20
JW	1 541,23	JMG	3 473,84	DL2	5 003,00	LRG	5 006,92	RMF	5 008,03	DL	4 996,29
DL	1 541,80	DL	3 474,30	DL	5 003,40	DL	5 007,67	LRG	5 008,92	RMF	4 996,57
DL2	1 542,46	DL2	3 474,82	LRG	5 004,91	RMF	5 007,78	DL2	5 009,47	DL2	4 999,09
		JW	3 476,59	JW	5 007,40	JW	5 009,43	JW	5 009,86	JW	4 999,25

Surv. median	1 536,65	3 471,61	4 998,74	5 002,54	5 002,09	4 991,43
Average	1 536,92	3 471,71	4 999,05	5 002,47	5 002,00	4 991,60
+0,05% high	1 537,42	3 473,35	5 001,24	5 005,04	5 004,59	4 993,93
-0,05% low	1 535,88	3 469,87	4 996,24	5 000,04	4 999,59	4 988,93

25 to 30 km		30 km to 35 km		35 km to 40 km		40 km to Clarke		Clarke to Finish		Total Course	
IM	4 987,92	HJ	4 987,30	BB	5 053,26	JFD	1 545,35	NW	657,36	HJ	42 226,83
HJ	4 988,38	IM	4 992,26	IM	5 053,68	DY	1 545,89	HJ	657,42	IM	42 235,90
BB	4 989,87	PR	4 992,70	DY	5 054,95	JD	1 546,01	DS	657,47	BB	42 239,63
PR	4 990,19	BB	4 993,23	PR	5 055,00	BG	1 546,28	DY	657,48	DY	42 241,87
WC	4 990,27	CD	4 993,41	BC	5 055,19	IM	1 546,77	DC	657,61	CD	42 244,70
CD	4 990,61	DY	4 993,78	CD	5 055,56	DL	1 546,79	WC	657,69	DS	42 245,66
EP	4 990,77	DC	4 993,97	JD	5 056,29	NW	1 546,87	BG	657,82	EP	42 246,29
DC	4 991,10	BC	4 994,70	DC	5 056,30	HJ	1 546,96	JFD	657,85	PR	42 246,36
DY	4 991,16	DS	4 995,47	EP	5 056,82	EP	1 546,96	CD	657,86	WC	42 246,97
DS	4 991,29	WC	4 995,63	DS	5 057,15	CD	1 547,19	BB	658,16	**DC**	**42 251,07**
BC	4 991,51	EP	4 995,69	JFD	5 057,62	BB	1 547,55	IM	658,24	BC	42 255,36
RL	**4 992,31**	RL	4 996,24	**RL**	**5 057,69**	RL	1 547,64	JMG	658,26	NW	42 256,99
NW	4 992,59	**JFD**	**4 996,52**	MW	5 058,08	WC	1 547,67	**MW**	**658,30**	MW	42 258,69
GR	4 993,16	MW	4 996,91	WC	5 058,62	**RMF**	**1 547,69**	JD	658,39	JFD	42 259,96
BG	4 993,26	GR	4 997,47	SH	5 058,98	DS	1 547,74	EP	658,47	JD	42 263,26
MW	4 993,54	SH	4 997,76	JMG	5 059,11	JMG	1 547,77	SH	658,54	GR	42 264,26
JFD	4 993,56	NW	4 998,25	GR	5 059,43	MW	1 548,07	GR	658,54	SH	42 271,51
JD	4 993,66	JMG	4 998,60	NW	5 059,54	DC	1 548,11	PR	658,65	JMG	42 272,26
SH	4 994,81	JD	4 998,68	BG	5 059,82	PR	1 548,27	LRG	658,74	BG	42 277,87
JMG	4 995,03	BG	4 999,96	DL2	5 060,74	LRG	1 548,27	RMF	658,83	RMF	42 291,27
RMF	4 996,92	LRG	5 001,17	HJ	5 061,23	BC	1 548,33	BC	659,12	LRG	42 297,83
DL	4 997,00	RMF	5 001,87	RMF	5 061,82	GR	1 549,41	JW	659,19	DL	42 301,60
DL2	4 997,66	DL2	5 001,87	DL	5 061,95	DL2	1 549,45	DL2	659,93	DL2	42 305,19
LRG	4 998,03	JW	5 003,32	LRG	5 062,39	SH	1 549,50	DL	660,00	JW	42 320,71
JW	5 000,11	DL	5 004,83	JW	5 064,44	JW	1 549,89				

Surv. median	4 992,31	4 996,52	5 057,69	1 547,69	658,30	**42 255,57**
Average	4 992,28	4 996,83	5 057,93	1 547,73	658,36	**42 256,88**
+0,05% high	4 994,81	4 999,02	5 060,22	1 548,46	658,63	42 276,70
-0,05% low	4 989,81	4 994,02	5 055,16	1 546,92	657,97	42 234,44

Measurement in order of measurement length
(In stadium and out stadium)

Réf JFD/genmed3.xls

In stadium	
DS	2 192,87
HJ	2 193,09
WC	2 193,17
DC	2 193,28
DY	2 193,70
NW	2 194,11
BG	2 194,46
JFD	2 194,47
GR	2 194,99
PR	2 195,30
RMF	2 195,37
EP	**2 195,63**
CD	2 195,97
IM	2 196,07
SH	2 196,15
BB	2 196,87
MW	2 197,13
LRG	2 197,31
JMG	2 197,44
JD	2 197,45
BC	2 197,63
JW	2 200,42
DL	2 201,80
DL2	2 202,39
Average	2 196,13

Out stadium	
HJ	40 033,74
IM	40 039,83
BB	40 042,76
DY	40 048,17
CD	40 048,73
EP	40 050,66
PR	40 051,06
DS	40 052,79
WC	40 053,79
BC	40 057,73
DC	40 057,79
MW	**40 061,56**
NW	40 062,88
JFD	40 065,49
JD	40 065,81
GR	40 069,27
JMG	40 074,82
SH	40 075,36
BG	40 083,41
RMF	40 095,90
DL	40 099,80
LRG	40 100,52
DL2	40 102,80
JW	40 120,29
	40 067,29

Median total course
42 257,19

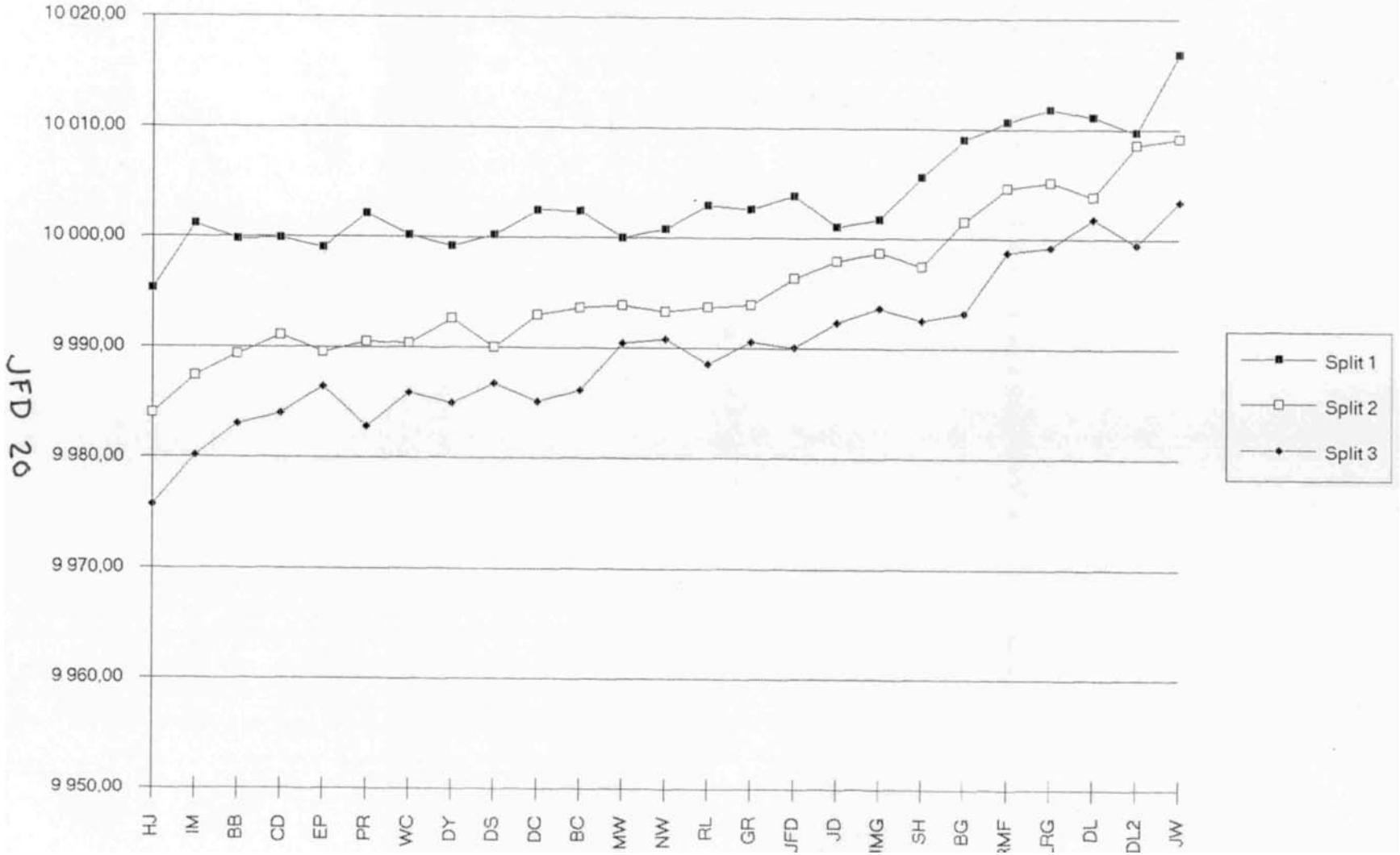
Comparaison des mesures de 3 segments d'environ 10 km
ATLANTA 1996

Réf JDF/GENMED4.XLS

	Split 1	Split 2	Split 3	" 30 km"
HJ	9 995,32	9 983,99	9 975,68	29 954,99
IM	10 001,16	9 987,44	9 980,18	29 968,78
BB	9 999,79	9 989,38	9 983,10	29 972,27
CD	9 999,89	9 991,14	9 984,02	29 975,05
EP	9 999,05	9 989,61	9 986,46	29 975,12
PR	10 002,12	9 990,50	9 982,89	29 975,51
WC	10 000,17	9 990,36	9 985,90	29 976,43
DY	9 999,21	9 992,61	9 984,94	29 976,76
DS	10 000,26	9 990,01	9 986,76	29 977,03
DC	10 002,45	9 992,97	9 985,07	29 980,49
BC	10 002,40	9 993,67	9 986,21	29 982,28
MW	10 000,04	9 993,83	9 990,45	29 984,32
NW	10 000,79	9 993,30	9 990,84	**29 984,93**
RL	10 003,00	9 993,72	9 988,55	29 985,27
GR	10 002,65	9 993,91	9 990,63	29 987,19
JFD	10 003,85	9 996,41	9 990,08	29 990,34
JD	10 001,00	9 997,90	9 992,34	29 991,24
JMG	10 001,77	9 998,70	9 993,63	29 994,10
SH	10 005,61	9 997,51	9 992,57	29 995,69
BG	10 008,99	10 001,54	9 993,22	30 003,75
RMF	10 010,68	10 004,60	9 998,79	30 014,07
LRG	10 011,83	10 005,12	9 999,20	30 016,15
DL	10 011,07	10 003,86	10 001,83	30 016,76
DL2	10 009,70	10 008,56	9 999,53	30 017,79
JW	10 016,83	10 009,11	10 003,43	30 029,37

split 1 = 5 to 15 km
split 2 = 15 to 25 km
split 3 = 25 to 35 km

Comparaison des mesures de 3 segments d'environ 10 km - ATLANTA 1996



In stadium measurement
In order of measured length

Réf JFD/genmed5.xls

	Total In stadium	Start RNEC	RNEC RNEC	RNEC RClarke	RClarke Finish	Piste 400 m	Finish to Start 100 m
DS	2 192,87	158,61	398,28	181,95	657,47	398,28	99,43
HJ	2 193,09	158,69	398,40	181,78	657,42	398,40	99,36
WC	2 193,17	158,65	398,18	182,28	657,69	398,18	99,34
DC	2 193,28	158,63	398,35	181,98	657,61	398,35	99,59
DY	2 193,70	158,65	398,56	181,89	657,48	398,56	99,46
NW	2 194,11	158,80	398,52	182,38	657,36	398,52	99,40
BG	2 194,46	158,63	398,62	182,15	657,82	398,62	99,60
JFD	2 194,47	158,68	398,75	181,70	657,85	398,75	99,71
GR	2 194,99	158,66	398,49	182,32	658,54	398,49	99,57
PR	2 195,30	158,71	398,57	182,22	658,65	398,57	99,47
RMF	**2 195,37**	158,67	398,55	182,24	658,83	398,55	99,49
EP	2 195,63	158,62	398,70	182,43	658,47	398,70	99,68
CD	2 195,97	159,01	399,08	181,86	657,86	399,08	99,77
IM	2 196,07	158,87	398,90	182,25	658,24	398,90	99,55
SH	2 196,15	158,93	398,91	181,95	658,54	398,91	99,65
BB	2 196,87	158,94	399,25	182,01	658,16	399,25	99,75
MW	2 197,13	158,88	399,26	182,18	658,30	399,26	99,84
LRG	2 197,31	158,90	399,12	182,30	658,74	399,12	99,67
JMG	2 197,44	159,07	399,55	181,45	658,26	399,55	99,84
JD	2 197,45	158,92	399,26	182,35	658,39	399,26	99,75
BC	2 197,63	159,04	399,09	182,21	659,12	399,09	99,61
JW	2 200,42	159,31	399,82	182,45	659,19	399,82	99,74
DL	2 201,80	159,24	400,13	182,19	660,00	400,13	99,93
DL2	2 202,39	159,19	400,20	182,68	659,93	400,20	100,04
Average	2 196,13	158,85	398,94	182,13	658,33	398,94	99,64

JFD 21

Measurement of 400 m track with bicycle method
Olympic stadium Atlanta 1996

Réf JFD/genmed6.xls

	With 1.001 safety factor		Without safety factor	
Measurer	Piste 400 m	Finish to 1 500 m start line 100 m	Piste 400 m	Finish to 1 500 m start line 100 m
WC	398,18	99,34	398,58	99,44
DS	398,28	99,43	398,68	99,53
DC	398,35	99,59	398,75	99,69
HJ	398,40	99,36	398,80	99,46
GR	398,49	99,57	398,89	99,67
NW	398,52	99,40	398,92	99,50
RMF	398,55	99,49	398,95	99,59
DY	398,56	99,46	398,96	99,56
PR	398,57	99,47	398,97	99,57
BG	398,62	99,60	399,02	99,70
EP	398,70	99,68	399,10	99,78
JFD	398,75	99,71	**399,15**	99,81
IM	398,90	99,55	399,30	99,65
SH	398,91	99,65	399,31	99,75
CD	399,08	99,77	399,48	99,87
BC	399,09	99,61	399,49	**99,71**
LRG	399,12	99,67	399,52	99,77
BB	399,25	99,75	399,65	99,85
MW	399,26	99,84	399,66	99,94
JD	399,26	99,75	399,66	99,85
JMG	399,55	99,84	399,95	99,94
JW	399,82	99,74	400,22	99,84
DL	400,13	99,93	400,53	100,03
DL2	400,20	100,04	400,60	100,14
Average	398,94	99,64	**399,34**	**99,73**
Median			**399,15**	**99,71**

La valeur médiane du tour de piste est trouvée à 399,15 m.

Ceci signifie que le mesureur a roulé à 0,30 - (0,85/2 *3,141589)= 0,165 m de la bordure de piste au lieu de 0,30 m.

Etude des variations de constantes selon la température et le pneu ATLANTA 1996

Réf JFD/genmed7.xls

Pré étalonnage : 25°C
Post étalonnage : 29°C

Measurer	T°/Tyre	Tyre
DL	-25,0	
BB	-19,5	
BC	-17,4	
DY	-16,4	
EP	-15,1	
JFD	-14,6	
LRG	-14,6	
IM	-14,6	
CD	-14,3	
DC	-14,1	
PR	-13,0	
BG	-12,5	
GR	-10,9	
JMG	-10,4	
WC	-8,3	
DL2	-7,8	
RMF	-7,8	
RL	-6,5	
HJ	-5,2	solid
JW	-4,2	
DS	-3,4	
MW	-2,1	solid
SH	-1,6	
NW	0,3	solid
JD	8,1	solid

T°/Tyre : variation d'étalonnage liée à la température + 4°C (en counts/km)

JFD 23

Etude de l'étalonnage des mesureurs
Influence de la température sur l'étalonnage (+ 4°C)
ATLANTA 1996

Réf JFD/genmed8.xls

Base West : 480,352 m
Base East : 481,062 m

	Variation d'étalonnage en counts							
Measurer	W pré	E pré	W post	E post	Average	DV	T°/Tyre	Tyre
EP	2,0	1,0	2,0	4,0	2,25	**0,51**	-15,1	
DL	3,0	1,0	2,0	0,0	1,50	**1,00**	-25,0	
JFD	1,0	0,0	0,0	1,0	0,50	**1,05**	-14,6	
BB	1,0	0,5	0,5	2,5	1,13	**1,29**	-19,5	
JD	0,0	1,0	1,5	1,0	0,88	**1,31**	8,1	solid
GR	5,0	2,0	8,0	2,0	4,25	**1,76**	-10,9	
BG	1,0	2,0	1,0	0,0	1,00	**1,95**	-12,5	
WC	0,5	0,5	1,5	1,5	1,00	**1,98**	-8,3	
SH	0,0	1,0	0,0	0,0	0,25	**2,07**	-1,6	
MW	2,0	1,0	0,0	1,0	1,00	**2,08**	-2,1	solid
HJ	0,0	0,0	0,0	0,0	0,00	**2,23**	-5,2	solid
DY	1,0	1,0	1,5	1,0	1,13	**2,33**	-16,4	
RL	0,0	0,0	0,0	0,5	0,13	**2,34**	-6,5	
LRG	2,0	0,0	0,0	0,0	0,50	**2,38**	-14,6	
DS	1,0	0,0	1,0	1,0	0,75	**2,39**	-3,4	
JMG	1,0	0,0	1,0	0,0	0,50	**2,81**	-10,4	
IM	0,0	2,0	1,0	1,0	1,00	**3,11**	-14,6	
CD	2,0	1,5	0,5	1,5	1,38	**3,23**	-14,3	
BC	0,0	1,5	1,0	1,0	0,88	**3,72**	-17,4	
PR	0,0	1,5	0,0	0,5	0,50	**4,33**	-13,0	
NW	0,5	1,0	1,5	0,5	0,88	**5,00**	0,3	solid
DL2	2,5	3,5	2,0	1,0	2,25	**6,45**	-7,8	
DC	0,5	0,5	1,0	1,0	0,75	**6,58**	-14,1	
RMF	1,0	2,0	2,0	2,0	1,75	**6,80**	-7,8	
JW	1,0	1,0	2,0	0,0	1,00	**7,29**	-4,2	

DV : moyenne des variations East/West pour le mesureur (en counts/km)
T°/Tyre : variation d'étalonnage liée à la température + 4°C (en counts/km)

JFD 24

FÉDÉRATION FRANÇAISE D'ATHLÉTISME
LIGUE DE BRETAGNE

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14, rue Pierre CORNEILLE
35131 CHARTRES de BRETAGNE
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Tél et Fax: (33) 99 41 10 08 (Dom.)

June 21, 1996

Dear Pete,

Thank you very much for your letter. Now, I send you my report of the measurement for the marathon of the Olympic Games, in French and English.
Your choice will be the best.
There is a mistake in charts:

Course Ride DATA - May 26, 1996 - Counts obtained during the measurement

	Pre-Calibrations - 480.71m avg				Post - Calibrations - 480.71m avg			
	Pre 1	Pre 2	Pre 3	Pre 4	Post 1	Post 2	Post 3	Post 4
JMG	4839	**4849**	**4840**	4849	4836	**4843**	4835	4843

The other results are O.K.

For me it was a great experience to meet other measurers and work with them.
I hope to see you again soon.

Best regards,

Jean-Marie

JMG 1

RAPPORT CONCERNANT LE MESURAGE DU CIRCUIT DU MARATHON DES JEUX OLYMPIQUES 1996 - ATLANTA - USA

Jean-Marie GRALL (France)

PRÉAMBULE

Un groupe de 28 mesureurs, sous la conduite de Monsieur Peter RIEGEL, a effectué une vérification du circuit proposé pour le Marathon des Jeux Olympiques d'ATLANTA (USA) 1996.

Cette vérification a été réalisée en 2 étapes:

- le 25 mai In-Stadium, mesure concernant le départ, 3 tours de piste et l'arrivée,
- le 26 mai Out-Stadium, mesure de "Reference CLARKE" à "Reference CLARKE", partie urbaine uniquement sur route.

Ce circuit, préalablement mesuré par Monsieur Jack GROSKO, est homologué sous le numéro GA 96012 WC du 5/9/96 par Monsieur Woody CORNWELL.

Le texte et les 2 tableaux ci-après donnent les résultats des mesures globales et individuelles avec mes commentaires et conclusions.

Pour l'ensemble des calculs je n'ai pris en compte que les résultats des 24 mesureurs ayant effectué la globalité du mesurage. Pour chaque calcul la valeur minimale et la valeur maximale ont été systématiquement supprimées.

1 - BASE D'ÉTALONNAGE

11 groupes de 2 à 4 mesureurs ont procédé à la mesure des bases d'étalonnage dans la matinée du 25 mai 1996 entre 9h45 et 11h45.

Les valeurs retenues pour les 2 bases, EST et OUEST, situées WASHINGTON Street, sont les moyennes des résultats donnés par ces 11 groupes.

Les valeurs moyennes de 480,35 m pour la base OUEST et de 481,06 m pour la base EST sont correctes.

La valeur moyenne, avec correction thermique, de la base est donc de 480,71 m.

Un plan détaillé de la base d'étalonnage, réalisé par les 4 mesureurs Français, est donné en annexe.

1.1 Remarques

Avec la suppression des mesures min et max, les autres résultats ont un coefficient de fiabilité inférieur à 0,02%.

Pour la base OUEST (au soleil), entre 11h25 et 11h55, il y a des différences de température importantes: 27°C, 30°C, 26°C, 33°C, 27°C, 27°C. Pour cette base un écart de température de 7°C représente 3,9 cm.

Cette double base d'étalonnage n'est pas un modèle type permettant une calibration de précision maximale.

Elle présente les inconvénients suivants:

- dénivelé important (+ 9m) avec pente différente en fonction du sens (cf. plan)
- présence de 2 rues débouchant perpendiculairement à chaque base
- côté OUEST, dans la descente il y a une plaque d'évacuation des eaux pluviales qui est située sur la trajectoire idéale
- le revêtement de la route n'est pas de bonne qualité, présence de cailloux, graviers et de boue autour des repères cloutés (côté ORMOND Street).

1.2 Proposition

La base d'étalonnage aurait pu être située PULLMAN Street, de part et d'autre de la rue, sur le circuit de la marche et plus particulièrement entre les points de repères F et G, avec 2 bases de longueur identique (500m par exemple).

2. MESURES IN-STADIUM

Pour ces mesures, effectuées le 25 mai à partir de 7h 15, 1 seul pré-calibrage et 1 seul post-calibrage ont été pris en compte, ce qui est insuffisant.

L' écart maximum de mesure est très important pour le tour de piste: 1,85 m pour 399,60 m (avec facteur de correction 1001), ce qui donne un coefficient de fiabilité de 0,00463. Au vue de ce résultat il est tout à fait logique de prendre 399,60 X 3 = 1198,80 m pour les 3 tours de piste.
Sans utiliser la valeur 1198,80 m pour les 3 tours de piste, la moyenne des mesures est plus courte de 2,13 m (cf. tableau).

Malgré les recommandations, la majorité des mesureurs, 21 / 24, ont parcouru le tour de piste à moins de 30 cm de la bordure. La moyenne des mesures est de 398,91 m pour le tour et de 99,63 m pour le 100 m entre "Arrivée" et "Départ".
Pour la mesure sur la piste, un étalonnage court (100 m en ligne droite) aurait pu être effectué sur ce revêtement spécial.

Sur la piste, les résultats montrent que les mesures sont sensiblement plus fiables dans la partie demi-virage puis ligne droite (Ref NE Corner - Finish) que dans la partie ligne droite puis demi-virage (Start - Ref NE Corner). Cela malgré une distance plus courte 140,45m contre 158,83m.

La valeur moyenne de la distance in-stadium est de 2198,05 m.
La valeur 2197,94m, retenue par Peter RIEGEL, est tout à fait acceptable.

3. MESURES OUT-STADIUM

Ces mesures ont été effectuées le 26 mai, à partir de 06h 00, du point "Reference CLARKE" à "Reference CLARKE", avec un pointage intermédiaire tous les 5 km.

Le tableau "Results of Measurements" indique les résultats des 24 mesureurs qui ont réalisés la totalité du circuit avec l'analyse de chaque segment de 5 km. En fonction de la valeur moyenne les résultats à + et - 0,05% sont grisés.

Les écarts de mesures sont plus importants à partir du 30ème km, cela s'explique par l'augmentation du trafic, du nombre de véhicules en stationnement et sans doute un peu de fatigue.

Par rapport au mesurage initial de Monsieur Jack GROSKO, les résultats sont comparables jusqu'au 35ème km. Par contre pour la partie 35ème - 40ème km la moyenne des mesureurs est de 5057,88m. Cet écart de 57,88m est assez inexplicable, d'autant que le point de référence du 40ème km est bien positionné puisque la mesure entre le 40ème km et le point "Reference CLARKE" est correcte.

Remarques:

Le mesurage en groupe assez serré, permet d'obtenir un maximum de résultats et d'établir ainsi une valeur de mesure très précise, par contre à l'intérieur du groupe il est plus difficile d'anticiper la trajectoire idéale car il n'y a aucune visibilité à distance éloignée. Dans le groupe le mesureur qui est devant influence celui qui suit.

4. MESURE TOTALE DU CIRCUIT

Pour la totalité du circuit la mesure moyenne est de 42264,72m et la valeur médiane du groupe (22/24) est de 42260,21m. Pour ces résultats la moyenne des médianes est: 42258,55m et la moyenne des moyennes: 42258,60m.
L'application stricte de ce résultat indique qu'il y a 7 mesureurs hors tolérance:
- 2 trop "court" et 5 trop "long" (cf tableau).

En conséquence la longueur du circuit mesuré peut-être estimée à **42258,60m.**

Monsieur Peter RIEGEL propose **42260,60m**, cette valeur très proche est tout à fait acceptable.

Pour cette valeur, 17 mesureurs (maximum du groupe) se situent dans la tolérance de + ou - 0,05%.

Pour la mise en conformité du circuit il faudra tenir compte des obstacles rencontrés et des petites erreurs de trajectoire, cet ensemble étant évalué à 13m.

En conséquence, pour une distance estimée à 42260,60m, la distance réelle, à prendre en considération est de 42247,60m. Le circuit est donc trop long de 52,60m. La mise en conformité pourra se faire au demi-tour, entre le 20 et 25ème km, en raccourcissant le parcours de 26,30m.

Cette modification devra être exécutée et validée par un expert, le segment de 20 à 25km devra être vérifié suite à cette mise en conformité. Le travail terminé il est nécessaire de tracer le demi-tour en respectant parfaitement la valeur du rayon initial.

En fonction des moyennes déterminées pour chaque segment de 5km, les repères devront être positionnés, avec précision, sans oublier de tenir compte, après le 20ème km de la modification apportée au demi-tour.

Les repères de départ et d'arrivée sur le stade sont inchangés.

5. SYNTHÉSE DES RÉSULTATS

5.1 Base d'étalonnage

Malgré un profil trop vallonné et des écarts de température sensibles, les mesures retenues pour les bases d'étalonnage OUEST et EST sont correctes et doivent être utilisées pour l'ensemble des calculs. La longueur moyenne de la base est de **480,71m.**

Sur PULLMAN Street il était possible de créer une base mieux adaptée à ce mesurage.

5.2 Mesure In-Stadium

Ces mesures ont mis en évidence la difficulté de mesurer avec précision une piste d'athlétisme. La majorité des mesureurs a indiqué un résultat plus court que la réalité. La décision de prendre une valeur commune de 1198,60m (coefficient 1001 inclus) pour les 3 tours de piste est sage et réaliste.

5.3 Mesure Out-Stadium

Lors de cette mesure une anomalie a été décelée entre le 35ème et le 40ème km, un écart de plus de 57m a été constatée par rapport à la mesure initiale.

5.4 Mesure totale du circuit

La mesure globale du circuit est estimée à 42260,60m, pour cette valeur 17 mesureurs sur 24 sont dans la tolérance de + ou - 0,05%.

Pour la mise en conformité du circuit il est proposé de rapprocher le point de demi-tour d'une distance de 26,30m. Cette modification faite, après traçage au sol, il sera nécessaire de vérifier la longueur du segment 20 à 25km.

6. CONCLUSION

La mesure du circuit proposé pour le Marathon des Jeux Olympiques d'ATLANTA (USA) a été effectuée les 25 et 26 mai 1996. Les résultats globaux de 24 mesureurs ayant effectués la totalité du parcours indiquent que la distance totale est estimée à 42260,60m et certifiée à 42247,60m.

Si les organisateurs décident de mettre le circuit en conformité par rapport à la distance réelle du marathon , 42195m, nous proposons de déplacer le point de demi-tour en le rapprochant de 26,30m par rapport au Stade Olympique.

Mes sincères remerciements à Monsieur Peter RIEGEL pour l'organisation de ce mesurage qui m'a permis de connaître d'autres experts et de partager avec eux des expériences pour une passion commune.

Fait à Chartres de Bretagne - FRANCE -
Le 18 Juin 1996
Jean-Marie GRALL

REPORT CONCERNING THE MEASUREMENT OF THE 1996 ATLANTA OLYMPIC GAMES' MARATHON

Jean-Marie GRALL (France)

PREAMBLE

A group of 28 measurers, under the direction of Mr. Peter RIEGEL, carried out a verification of the proposed course for the marathon of the Olympic Games in ATLANTA (USA) 1996.

This verification was carried out in 2 stages:

- on May 25th In-Stadium, measurement concerning the start, 3 laps and the finish,
- on May 26th Out-Stadium, measurement from "Reference CLARKE" to "Reference CLARKE", in the city and only on the road.

This course, previously measured by Mr. Jack GROSKO, is registered under the number GA 96012 WC on 5/9/96 by Mr. Woody CORNWELL.

The following text and charts give the results of the overall and individual measurements with my comments and conclusions.

For all the calculations, I only took into account the results of the 24 measurers who carried out all the measurements. For each calculation, the minimum value and the maximum value were systematically eliminated.

1. CALIBRATION COURSE

11 groups of 2 to 4 measurers carried out the measurement of the calibration courses on the morning of May 25th 1996 between 9:25 a.m and 11:45 a.m.

The values retained for the 2 course calibrations, EAST and WEST, located on Washington Street, are the average of the results given by these 11 groups.

The average values of 480.35 meters for the WEST calibration course and 481.06 meters for the EAST calibration course are correct.

The average value, with thermic correction, of the calibration course is 480.71 meters.

A detailed plan of the calibration course made by the 4 French measurers is given in the annex.

1.1 Remarks

With the elimination of the minimum and maximum measurements, the other results have a reliability coefficient inferior to 0,02%.

For the WEST calibration course (in the sun), between 11:25 a.m. and 11:55 a.m., there are important temperature differences: 27°C, 30°C, 26°C, 33°C, 27°C, 27°C. For this calibration course, a difference in temperature of 7°C represents 3.9 centimeters.

This double calibration course is not a standard course which permits a calibration with maximum precision.

It presents the following inconveniences:

- important differences in level (+ 9 meters) with a slope difference in function with the direction (cf. plan),
- the presence of 2 steets emerging perpendicularly at each calibration course,
- on the WEST side, going downhill, there is a man-hole cover which is situated on the ideal trajectory,
- the road covering is not of good quality, the presence of pebbles, gravel and mud around the nailed marks (ORMOND Street side).

1.2 Proposal

The calibration course could have been located on PULLMAN street, on each side of the street, on the walking course and particularly between the reference points F and G, with 2 identical base lengths (500 meters for example).

2. MEASUREMENTS IN-STADIUM

For these measurements, carried out on May 25th beginning at 7:15a.m., only one pre-calibration and 1 post-calibration were taken into account, which is insufficient.

The maximum measurement difference is very significant for the lap: 1.85 meters for 399.60 meters (with a correction factor of 1001), which gives a reliability coefficient of 0.00463. In view of this result it is logical to take 399.60 X 3 = 1198.80 meters for 3 laps.
Without using the value 1198.80 meters for 3 laps, the average of the measurements is shorter by 2.13 meters (cf. chart).

In spite of the recommandations, the majority of the mesurers (21 out of 24) covered the circuit less than 30 centimeters from the edge. The average of the measurement is 398.91 meters for the lap and 99.63 meters for 100 meters between "Finish line" and "Start line".
For the measurement on the track, a short calibration (100 meters on a straight line) could have been made on this special surface.

On the track, the result show that the measurements are significantly more reliable in half-turn/straight line section (Ref. NE Corner - Finish) than in the straight line/half-turn section (Start - Ref. NE Corner). This, in spite of a shorter distance, 140.45 meters, compared to 158.83 meters.

The average value of In-Stadium distance is 2198.05 meters.
The value of 2197.94 meters, held by Peter RIEGEL, is perfectly acceptable.

3. MEASUREMENTS OUT-STADIUM

These measurements were carried out on May 26th beginning at 6:00 a.m., from "Reference CLARKE" point to "Reference CLARKE", with an intermediary pointing every 5 kilometers.

The chart "Results of Measurements" indicates the results of the 24 measurers who carried out the measurement of the whole course with the analysis of each 5 kilometer segment. Depending on the average value the + and - 0.05% results are greyed out.

The differences in measurements are more important starting at kilometer 30, this is due to the increase in trafic, the number of parked vehicles and probably to tiredness.

In comparison with the Mr. Jack GROSKO's original measurement, the results are comparable up to kilometer 35. But for the section from kilometer 35 to 40, the measurer's average is 5057.88 meters. This difference of 57.88 meters is quite inexplicable, even more so since the reference point for kilometer 40 is correctly positionned (since the measure between the 40th kilometer and the "Reference CLARKE" point is correct).

Remarks

Measuring in a tight group allows us to obtain a maximum of results and thus to establish a very precise measuring value, but inside the group it is more difficult to anticipate the ideal trajectory since there is no long distance visibility ahead. Within the group, the measurer ahead influences the one following him.

4. TOTAL MEASUREMENTS OF THE COURSE

For the whole course, the average measure is 42264.72 meters and the median value of the group (22 out of 24) is 42260.21 meters. For these results the medians' average is 42258.55 meters and the averages' average is 42258.60 meters.
The strict application of this result indicates that 7 measurers are beyond tolerance:
- 2 are too "short" and 5 are too "long" (Cf. chart).

Therefore the lenghth of the full-course can be estimated to be **42258.60 meters**.
Mr. Peter RIEGEL suggests **42260.60 meters**, this very close value is perfectly acceptable.
For this value, 17 measurers (maximum of the group) are in the + or - 0.05% tolerance.
For the adjustement, one will have to take into account the obstacles encountered and the minor mistakes in trajectory, this alltogether is evaluated to be 13 meters.

Therefore, for a distance which is estimated to be 42260.60 meters, the real distance to be taken into consideration is 42247.60 meters. The course is too long by 52.60 meters. The adjustment can be done at the turnaround, between the 20th and the 25th kilometer, by shortening the course by 26.30 meters.

This modification will have to be carried out and validated by an expert, the section from 20 to 25 will have to be checked up after this adjustment. Once this is done, it is necessary to draw the turnaround respecting the value of the original radius.

Depending on the averages determined for each 5 kilometers section, the marks will have to be positionned precisely without forgetting to take into account the modification on the turnaround after kilometer 20.

The start and finish marks in the stadium remain unchanged.

5. SYNTHESIS OF THE RESULTS

5.1 Calibration course

Despite a slopy profile and significant differences in temperature, the measurements selected for the WEST and EAST calibration courses are correct and must be used for all calculations. The average length of the course is **480.71 meters**.

On PULLMAN Street, it was possible to create a calibration course more adapted to this measurement.

5.2 Measurements In-Stadium

These measurements have shown the difficulty of measuring precisely an athletics track. The majority of the measurers have indicated a result shorter than reality. The decision to choose a common value of 1198.60 meters (including 1001 coefficient) for the 3 laps is wise and realistic.

5.3 Measurements Out-Stadium

During this measurement an anomaly has been found between kilometer 35 and 40, a difference of 57 meters with the original measurement has been established.

5.4 Global measurement of the course

The global measurement of the course is estimated to be 42260.60 meters, for this value 17 measurers out of 24 are in the + or - 0.05% tolerance.

For the adjustement of the course, it is suggested to draw the turnaround point nearer by 26.30 meters. Once this modification is done, after drawing it on the road, it is necessary to check the length of the segment from kilometer 20 to 25.

6. CONCLUSION

The measurement suggested for the Atlanta Olympics' marathon was carried out on May 25th and 26th 1996. The global results of the 24 measurers who carried out the measurement of the whole course show that the total distance is estimated to be 42260.60 meters and certified at 42247.60 meters.

If the organizers decide to have the course adjusted to the real distance of a marathon, 42195 meters, we suggest to move the turnaround point by drawing it closer to the Olympic stadium by 26.30 meters.

My sincere thanks to Mr. Peter RIEGEL for the organization of this measurement which gave me the opportunity to get to know other experts and to share with them experiences of a common passion.

Chartres de Bretagne - FRANCE
June 18th 1996
Jean-Marie GRALL

Results of Measurements

Start to Clarke		Clarke to 5 km		5 km to 10 km		10 km to 15 km		15 km to 20 km		20 km to 25 km	
JFD	1539,18	BB	3469,70	HJ	4996,18	HJ	4999,20	HJ	4996,94	HJ	4987,12
HJ	1539,27	HJ	3470,58	CD	4997,33	EP	5000,35	IM	4998,65	IM	4988,86
JMG	1539,32	DY	3470,59	BB	4997,82	DY	5001,40	FR	4999,54	BB	4988,96
DY	1539,34	IM	3470,62	DY	4997,87	JMG	5001,51	EP	4999,54	DS	4989,85
DS	1539,36	DS	3470,90	DS	4997,91	WC	5001,55	WC	5000,12	EP	4990,11
DC	1539,41	CD	3470,95	JD	4998,07	IM	5001,77	DS	5000,22	WC	4990,30
SH	1539,43	WC	3471,09	NW	4998,28	MW	5001,79	CD	5000,46	DY	4990,55
BG	1539,58	MW	3471,11	MW	4998,31	BB	5002,03	BB	5000,48	CD	4990,76
CD	1539,67	SH	3471,21	WC	4998,69	DS	5002,42	GR	5001,61	FR	4991,02
RMF	1539,70	NW	3471,56	EP	4998,77	NW	5002,57	NW	5001,75	DC	4991,04
FR	1539,73	EP	3471,78	FR	4999,24	BC	5002,62	DC	5002,00	BC	4991,33
BB	1539,76	BC	3471,95	IM	4999,45	CD	5002,62	DY	5002,12	MW	4991,46
GR	1539,78	JFD	3472,20	DC	4999,65	GR	5002,64	BC	5002,40	NW	4991,82
WC	1539,79	JD	3472,29	JFD	4999,71	DC	5002,87	MW	5002,43	GR	4992,37
EP	1539,84	FR	3472,30	BC	4999,85	FR	5002,94	JFD	5003,49	JFD	4992,98
MW	1539,86	RMF	3472,34	GR	5000,07	JD	5002,99	SH	5003,57	JD	4993,42
IM	1539,91	DC	3472,91	JMG	5000,32	SH	5003,89	JMG	5003,99	SH	4994,00
NW	1539,98	GR	3473,26	SH	5001,79	JFD	5004,20	JD	5004,54	JMG	4994,77
LRG	1540,00	BG	3473,58	BG	5002,69	BG	5006,36	BG	5006,69	BG	4994,91
BC	1540,05	JMG	3473,86	RMF	5002,93	DL2	5006,73	DL	5007,60	LRG	4996,24
JD	1540,07	DL	3474,32	DL2	5003,03	LRG	5006,95	RMF	5008,06	DL	4996,32
DL	1540,23	LRG	3474,60	DL	5003,44	DL	5007,70	LRG	5008,95	RMF	4996,60
JW	1540,56	DL2	3474,84	LRG	5004,07	RMF	5007,81	DL2	5009,50	DL2	4999,13
DL2	1540,67	JW	3476,61	JW	5007,43	JW	5009,47	JW	5009,90	JW	4999,28
Median	1539,78		3472,07		4999,55		5002,63		5002,26		4991,54
Average	1539,76		3472,22		4999,97		5003,44		5003,08		4992,57
H +0,05%	1540,53		3473,96		5002,47		5005,94		5005,58		4995,07
L -0,05%	1538,99		3470,48		4997,47		5000,94		5000,58		4990,07
25 km to 30 km		30 km to 35 km		35 km to 40 km		40 km to Clarke		Clarke to Finish		Total Course	
IM	4987,96	IM	4992,29	HJ	5052,62	JFD	1545,36	NW	657,37	HJ	42230,67
HJ	4988,41	FR	4992,73	BB	5053,30	DY	1545,90	HJ	657,42	IM	42238,24
BB	4989,90	BB	4993,26	IM	5053,71	JD	1546,02	DS	657,47	BB	42240,92
FR	4990,22	DY	4993,81	CD	5054,95	BG	1546,29	DY	657,48	DY	42245,22
WC	4990,30	DC	4994,00	DY	5054,98	IM	1546,78	DC	657,61	CD	42246,50
CD	4990,64	CD	4994,09	FR	5055,03	DL	1546,80	WC	657,82	EP	42249,22
EP	4990,80	BC	4994,74	BC	5055,22	NW	1546,88	BG	657,82	FR	42249,68
DC	4991,13	DS	4995,50	JD	5056,32	HJ	1546,97	JFD	657,86	DS	42249,87
DY	4991,19	WC	4995,66	DC	5056,33	EP	1546,97	CD	657,86	WC	42251,64
DS	4991,32	EP	4995,72	EP	5056,85	CD	1547,20	SH	658,06	DC	42255,06
BC	4991,54	HJ	4995,97	DS	5057,18	BB	1547,56	BB	658,16	BC	42257,15
NW	4992,62	JFD	4996,55	JFD	5057,65	WC	1547,67	IM	658,24	MW	42259,96
GR	4993,19	MW	4996,94	MW	5058,11	RMF	1547,70	JMG	658,27	NW	42260,47
MW	4993,57	GR	4997,50	WC	5058,65	DS	1547,75	MW	658,30	JFD	42262,78
JFD	4993,59	SH	4997,79	SH	5059,01	JMG	1547,78	JD	658,39	JD	42264,50
JD	4993,69	NW	4998,28	JMG	5059,14	MW	1548,08	EP	658,48	GR	42267,84
BG	4994,37	JMG	4998,63	GR	5059,46	DC	1548,12	GR	658,55	JMG	42272,65
SH	4994,84	JD	4998,71	NW	5059,57	FR	1548,28	FR	658,65	SH	42273,10
JMG	4995,06	BG	4998,91	BG	5059,85	LRG	1548,28	LRG	658,74	BG	42281,03
RMF	4996,95	LRG	5001,20	DL2	5060,77	BC	1548,34	RMF	658,84	RMF	42294,68
DL	4997,03	DL2	5001,90	RMF	5061,85	GR	1549,12	BC	659,12	LRG	42299,51
DL2	4997,69	RMF	5001,91	DL	5061,98	DL2	1549,45	JW	659,20	DL	42300,28
LRG	4998,06	JW	5003,35	LRG	5062,42	SH	1549,51	DL2	659,94	DL2	42303,64
JW	5000,14	DL	5004,86	JW	5064,48	JW	1549,90	DL	660,01	JW	42320,30
Median	4992,90		4996,74		5057,88		1547,68		658,25		**42260,21**
Average	4993,01		4997,14		5057,83		1547,61		658,29		**42264,72**
H +0,05%	4995,51		4999,64		5060,36		1548,38		658,62		**42285,85**
L -0,05%	4990,51		4994,64		5055,30		1546,84		657,96		**42243,59**
All calculation without value min and max											

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In-Stadium Measurements

Name	Ref Clarke - Ref Ne Com.	Name	Ref Ne Corn Finish	Name	Finish - Start	Name	Start Ref NeCo	Name	Rf Ne Cor Ref Clarke	Name	1 Lap	Name	Start to Ref Clarke	Name	Ref Clarke - Finish	Name	Total In Stadium	Name	Total In Stadium (1)*	Name	Difference
DY	517,03	DC	140,14	HJ	99,36	DS	158,61	JMG	181,45	WC	398,26	DS	1535,41	NW	657,37	HJ	2193,10	HJ	2196,69	HJ	3,59
NW	517,04	WC	140,22	WC	99,36	EP	158,62	JFD	181,70	DS	398,28	DC	1535,68	HJ	657,42	DY	2193,71	DY	2196,83	DY	3,11
HJ	517,07	SH	140,22	NW	99,40	BG	158,63	HJ	181,78	DC	398,35	HJ	1535,68	DS	657,47	DS	2192,88	DS	2196,83	DS	3,96
DS	517,23	DS	140,24	DS	99,43	DC	158,63	SH	181,82	HJ	398,40	WC	1535,77	DY	657,48	DC	2193,29	DC	2197,03	DC	3,74
BG	517,43	GR	140,26	DY	99,46	DY	158,65	CD	181,86	GR	398,49	DY	1536,23	DC	657,61	JFD	2194,49	JFD	2197,05	JFD	2,55
DC	517,48	CD	140,30	FR	99,47	GR	158,66	DY	181,89	NW	398,53	GR	1536,46	WC	657,82	NW	2194,13	NW	2197,35	NW	3,22
JFD	517,51	NW	140,32	RMF	99,49	RMF	158,67	DS	181,95	RMF	398,55	SH	1536,48	BG	657,82	BG	2194,47	BG	2197,41	BG	2,93
CD	517,56	JFD	140,35	IM	99,55	WC	158,68	DC	181,99	DY	398,56	RMF	1536,55	JFD	657,86	SH	2194,54	SH	2197,49	SH	2,95
WC	517,60	HJ	140,35	GR	99,57	JFD	158,68	BB	182,01	FR	398,57	JFD	1536,63	CD	657,86	CD	2195,98	CD	2197,53	CD	1,55
BB	517,60	BG	140,39	SH	99,58	HJ	158,69	BG	182,15	SH	398,62	BG	1536,65	SH	658,06	JMG	2197,46	JMG	2197,59	JMG	0,13
JMG	517,62	RMF	140,39	DC	99,59	FR	158,71	MW	182,18	BG	398,62	FR	1536,66	BB	658,16	WC	2193,59	WC	2197,61	WC	4,02
IM	517,75	FR	140,40	BG	99,60	NW	158,80	DL	182,19	EP	398,71	NW	1536,76	IM	658,24	BB	2196,88	BB	2197,92	BB	1,04
MW	517,76	EP	140,41	BC	99,61	SH	158,82	BC	182,22	JFD	398,75	EP	1537,17	JMG	658,27	MW	2197,14	MW	2198,16	MW	1,02
JD	517,79	BC	140,44	LRG	99,67	IM	158,87	FR	182,23	IM	398,91	IM	1537,84	MW	658,30	IM	2196,08	IM	2198,16	IM	2,08
SH	517,83	DY	140,45	EP	99,68	MW	158,88	RMF	182,24	CD	399,08	CD	1538,12	JD	658,39	EP	2195,65	EP	2198,32	EP	2,68
EP	518,06	IM	140,49	JFD	99,71	LRG	158,90	IM	182,25	BC	399,09	BC	1538,52	EP	658,48	FR	2195,31	FR	2198,39	FR	3,08
LRG	518,19	MW	140,54	JW	99,74	JD	158,92	LRG	182,30	LRG	399,13	LRG	1538,58	GR	658,55	GR	2195,01	GR	2198,43	GR	3,42
FR	518,26	LRG	140,55	JD	99,75	BB	158,95	WC	182,32	BB	399,25	BB	1538,72	FR	658,65	JD	2197,46	JD	2198,47	JD	1,01
GR	518,29	BB	140,56	BB	99,75	CD	159,01	GR	182,32	MW	399,26	MW	1538,84	LRG	658,74	RMF	2195,38	RMF	2198,54	RMF	3,16
JW	518,42	JD	140,60	CD	99,77	BC	159,04	JD	182,35	JD	399,26	JD	1539,07	RMF	658,84	LRG	2197,32	LRG	2198,75	LRG	1,42
RMF	518,44	JMG	140,65	JMG	99,84	JMG	159,07	NW	182,38	JMG	399,56	JMG	1539,19	BC	659,12	BC	2197,64	BC	2199,18	BC	1,53
BC	518,69	JW	140,77	MW	99,84	DL2	159,19	EP	182,43	JW	399,83	JW	1541,23	JW	659,20	JW	2200,43	JW	2199,76	JW	-0,67
DL2	518,96	DL	140,96	DL	99,93	DL	159,24	JW	182,45	DL	400,13	DL	1541,81	DL2	659,94	DL	2201,82	DL	2200,24	DL	-1,58
DL	519,05	DL2	140,98	DL2	100,04	JW	159,31	DL2	182,68	DL2	400,20	DL2	1542,47	DL	660,01	DL2	2202,41	DL2	2200,61	DL2	-1,80
Médian	517,75		140,40		99,60		158,81		182,21		398,73		1536,96		658,25		2195,82		2198,04		1,03
Average	517,85		140,45		99,63		158,83		182,14		398,91		1537,67		658,29		2195,94		2198,05		2,13
H +0,05%	518,11		140,52		99,68		158,91		182,23		399,11		1538,44		658,62		2197,03		2199,15		
L -0,05%	517,59		140,38		99,58		158,75		182,05		398,71		1536,90		657,96		2194,84		2196,96		
All calculation without value min and max																					
(1)* Total with 3 laps = 1198,80 (includes 1001)																					

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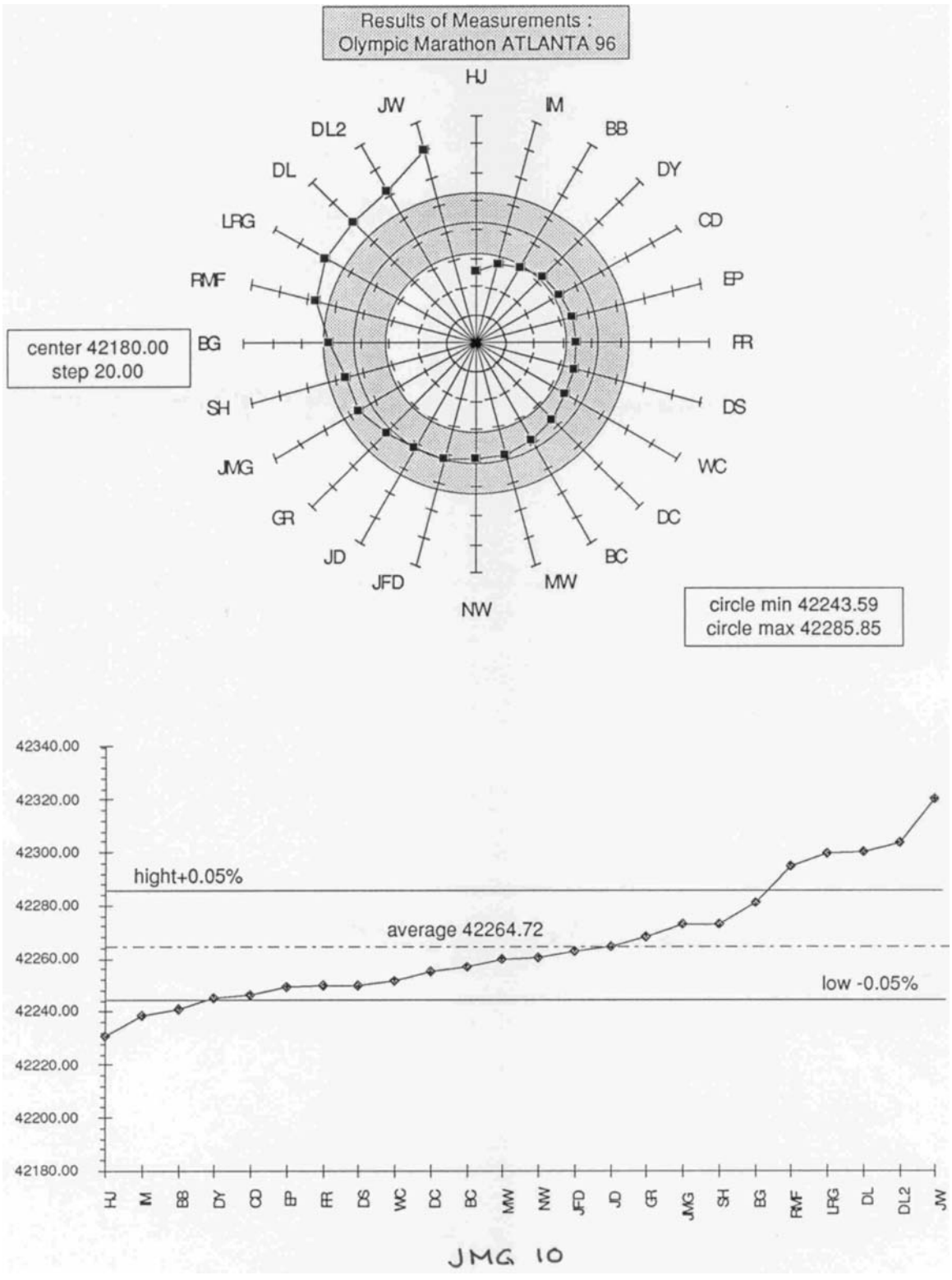
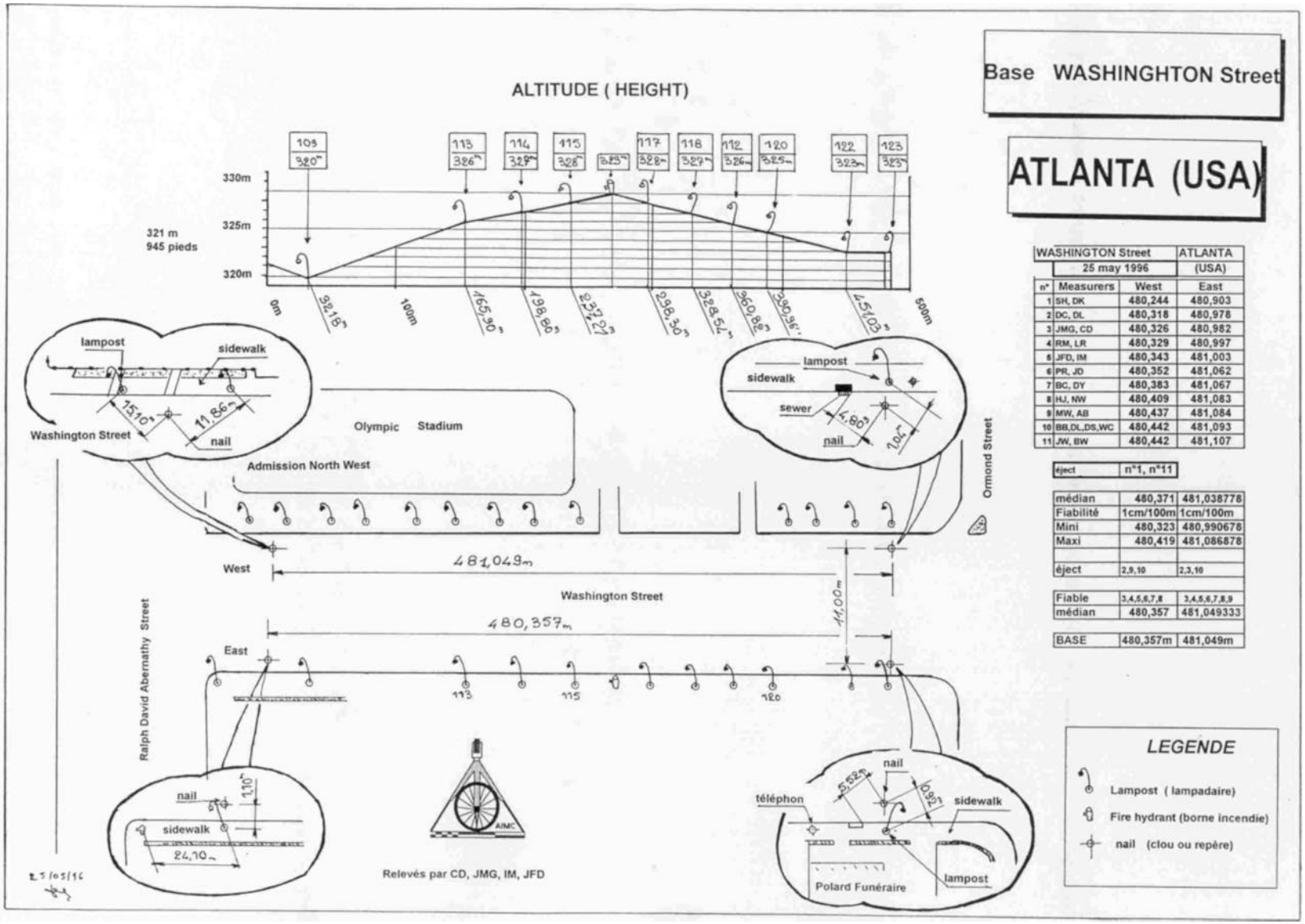

Results of Measurements :
Olympic Marathon ATLANTA 96
HJ
IM
BB
DY
CD
EP
FR
DS
WC
DC
BC
MW
NW
JFD
JD
GR
JMG
SH
BG
RMF
LRG
DL
DL2
JW
center 42180.00
step 20.00
circle min 42243.59
circle max 42285.85
42340.00
42320.00
42300.00
42280.00
42260.00
42240.00
42220.00
42200.00
42180.00
hight+0.05%
average 42264.72
low -0.05%
HJ IM BB DY CD EP FR DS WC DC BC MW NW JFD JD GR JMG SH BG RMF LRG DL DL2 JW

JMG 10



WASHINGTON Street 25 may 1996			ATLANTA (USA)
n°	Measurers	West	East
1	SH, DK	480,244	480,903
2	DC, DL	480,318	480,978
3	JMG, CD	480,326	480,982
4	RM, LR	480,329	480,997
5	JFD, IM	480,343	481,003
6	PR, JD	480,352	481,062
7	BC, DY	480,383	481,067
8	HJ, NW	480,409	481,083
9	MW, AB	480,437	481,084
10	BB,DL,DS,WC	480,442	481,093
11	JW, BW	480,442	481,107

éject	n°1, n°11	
médian	480,371	481,038778
Fiabilité	1cm/100m	1cm/100m
Mini	480,323	480,990678
Maxi	480,419	481,086878
éject	2,9,10	2,3,10
Fiable	3,4,5,6,7,8	3,4,5,6,7,8,9
médian	480,357	481,049333
BASE	480,357m	481,049m

JMG II

Olympic Marathon and Race Walk Measurement
May 24,25,and 26, 1996
Atlanta, Georgia

The following narrative is for inclusion in the official report of the Measurement Proceedings compiled by Peter Riegel.

Measurement activities for the group began Friday evening with the arrival of rented bicycles. The bikes were a bit unique in that they were "softride" suspension equipped. This odd looking beam type suspension provided for a great deal of adjustment and the same bike could be adjusted to fit nearly any size rider. A few of us had brought our own bikes and they were assembled and stores along with the others overnight in an empty meeting room at the hotel.

Saturday morning the entire group travelled to the Olympic stadium. Most of us rode bikes while a support group drove there in Pete Riegel's car. Arriving at the stadium we were issued temporary passes for access to the stadium and track. All data for the days marathon measurement was taken on a sheet provided for that purpose and turned in to Ryan Lamppa. A single pre-calibration ride was done followed by measurement inside the stadium and out to a reference point just outside the stadium. This provided data for the Start and Finish segments of the Marathon. The majority of the group was then instructed to post-calibrate and steel tape the calibration courses on each side of Washington St.. Several of the group were pressed into service measuring the Race Walk courses for the Men's and Women's events. The data for this was taken on a form provided by Wayne Nicoll. This was done after a standard four ride pre and post calibration. All data was collected by Wayne for the purpose of checking his measurement of the two race walk courses.

Not allowing anyone to get away without steel taping each of the calibration courses, Pete Riegel instructed all of the group to get into teams and check the calibration courses. This provided eleven sets of data for each of the calibration courses. Completing this task we were free to return to the hotel and enjoy a few hours of leisure prior to a 5:00 pm. meeting with Julia Emmons, Jack Grosko, and Pete Riegel for instructions on the following days measurement of the major portion of the Marathon.

The Saturday pm. meeting proved to be enjoyable and informative. Julia Emmons greeted us all and passed out Olympic pins for all team members. T shirts from J.F. Delasalle and the McBrayers were quickly picked up by eager members of the group. Much discussion took place and from this all members of the measurement team received clarification of the plan for next day's measurement. Jack Grosko discussed the course to be measured and gave a general idea of the restrictions on the route. Pete Riegel explained the problems of twenty eight measurers all riding simultaneously over the course. He also set out some general rules for the following morning's measurement. At this time it was made clear that in the shortest distance would not be used and that the group would have to stay together as much as possible. Pete also explained that the median measurement would be that which determined the official distance. This was, in my opinion probably the best choice as it tends to throw out those measurements that come up short due to the competitive urge whenever two or more measurers work together. It also disregards those measurements on the other end of the spectrum.

Sunday morning's measurement began with a mass bike ride to the stadium and pre-calibration before 6:00 am.. We were met there by Julia Emmons with a truck from the Atlanta Track Club which provided SAG support and water for a break just after the turn around. For the measurement a group of five Atlanta motorcycle policemen provided traffic control . They covered all portions of the roadway as the entire group covered the Marathon route like a giant yellow catapillar in our "Official Measurement Uniform" T shirts. At times it seemed as though there were a lot more than only five officers. They leap frogged along the route and at no time was traffic allowed to interfere with the measurement group. Accomplishing this degree of protection was no minor task and the officers are to be commended for their efforts.

During the actual measurement, all data was taken by Tom and Mary Anne McBrayer. This worked well and provided a check for transposed numbers. During the measurement it was my intent to ride the route as would be available to runners for the race. Over much of the course the concrete curbing was significantly lower than the road surface also there were many areas where the concrete curbs slanted steeply into storm drains. I felt these areas were hazardous enough that in my opinion they were not a part of the course available to competitors, much the same as running off the road surface into rough shoulder areas of road way. For these areas it was my attempt to measure a path of 30 cm. or less to the edge of the asphalt surface.

Completing the measurement we post calibrated bikes. There was then time for discussing the day's work, group photos were taken using everyones camera and a last look around this site for Olympic competition.

OBSERVATIONS

My position in the measurement group was in the tail of the group. For this reason I was afforded a view of nearly all of the measurers and able to see the shortest possible route as well as note several other's measured path. Some tried to cut every corner as tightly as possible while others were off the shortest route in what appeared to be an effort to see where the group was heading. On several occasions the measured path was several riders wide. My choice was to follow a path that I felt would be the shortest available route to the competitors. Having been over the course in December of 1995 with a group from the USATF convention was extremely beneficial . Jack Grosko led a group over the course and pointed out several of the course's restrictions. This was quite helpful during the actual measurement.

Pete Riegel collected all the data and copied it for distribution to measurers before we all left for home. I have checked my own numbers and he got mine right. To check his math would be a waste of time. He was responsible for the conduct of the measurement as well as the recommendations for course adjustment. He put together a preliminary report detailing all the data collected. That preliminary report is very detailed attesting to the work put into crunching all that data. His work stands as the final word on the distance measured.

Respectfully submitted,

M. A. Wickiser

Michael A. Wickiser, Olympic Measurement Team Member

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NORRIE WILLIAMSON

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14 June 1996
Peter Riegel
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OLYMPIC MARATHON / WALK MEASUREMENT:

Dear Pete

Firstly let me congratulate and thank you for the superb organisation surrounding the Atlanta weekend. It certainly was well worth the time and money invested in the trip, and is an experience I am glad I did not miss. I only hope that you have recovered from having to deal with the "whims and idiosyncrasies " of some 30 different personalities - not to mention a few foreign languages.

I received your package this week and in order to make the deadline am writing this on the train to Burnley where I compete in a 12 hour race. (Thought I had better write it before as I may not have the energy after!!) There is nothing really dynamic in it, as I believe that given the variables, the figures were remarkably close. Hence you may or may not feel there is merit in including the following in your final document. If not please simply record my appreciation of the opportunity and thanks to all involved.

PS: (Wed 19/6/96- Edinburgh). Managed 76 miles 890 yards on the hottest day of summer to date (27oC). I no longer need to wear a vest, I have one burnt onto my skin! This course climbs 20m per 1.1km lap so total ascent 2200m... I was right I'm tired!

OLYMPIC MARATHON MEASUREMENT RESULTS: COMMENTS:

After reviewing the results of the measurement as tabulated in your document I would concur with your judgement on the course length and proposed alteration, since I believe that, given the range or results, deadline time, and relative consistency, this figure can most easily be justified.

In addition to your own justification (bottom page 9) I would add the following comments:-

a) The adoption of 42260 also provides a 30m safety factor over the distance of the shortest individual measurement.

b) The sum of the shortest lengths is 42.2239Km (with safety factor) or 42.1817Km without.

Whilst this would appear to be short, it is interesting to note that this summation included the results of 5 riders. Arguably an indication of their riding technique, (wobble, ability to judge kerb to wheel distance, maintain line etc) is given by the track measurement. In all cases they measured the track as being less than the surveyed distance. In other words they measured closer to the kerb than the 300mm, the average distance, (inc SCPF) being 398.76. (virtually identical to the median of all

NW 1

riders and .030m short of the surveyed distance per lap) Given that this involves a full 360 turn it appears that these "shortest" riders tend to ride about 133mm closer to the kerb than the 300m normally used. (or only 167mm from the kerb). From the diagrammatic map there appears to be the equivalent of at least 11 full 360 turns if one allows for only the actual street corners. This could suggest that these riders would have cut the official line, (i.e 300mm from kerb) by +-9.2 metres. This leaves only another 4.1 metres to be found to make the course 42.195m which would come from tighter riding of bends/ twists /corners along the streets (between corners of different streets).

c) All but two riders measured the lap length as being under the 399.6 (SCPF applied). As indicated above, this may be seen as indicating that riders were riding tighter than the "Official" line.

There seems to be no justification to suggest that the course is not, "at least" 42.195km.

With the above said, there were a number of interesting results, facts and observations which come from the data. Some of these may provide stimulation for Measurement News discussion.

i)It is interesting and disturbing to note the variation in calibrations recorded on 3 solid tyres. (JD, HJ, and NW) In two cases, JD and NW, the post calibration were less than the pre calibration and opposite to that which one would normally experience. HJ however had a substantial increase in post calibration. I think all three tyres were of the same make and this does give some food for thought. What happens to the material in heat? I obviously am unaware of the history of the other tyres, but is it possible that since the wheel I used which is the same one I have used for +- 3 years in South Africa showed the least change because it has been used in heat so often and any bedding down etc has already occurred? Or is it that the other wheels have indeed been more extensively used and I am about to become exposed to such variation in the future? Any thoughts?

ii) In a normal measurement group the rear riders tend to take a tighter line than the lead rider, as they will "learn from the leaders mistakes". This benefit is amplified on unseen courses. If this had been the case we would have expected to see the initials PR appear towards the bottom of each section on page 8, (measurement in order of length), particularly in view of the relatively "competitive" nature of some of the riding. However this was not the case, PR not only made the top half in 6 of the 9 out of stadium sections, but the top five in 33% of cases.
Perhaps the size of the group was so big that there became a "staggered" approach to the lead. In other words those in the first 4-6 followed and improved on Pete's line, but the relative discrepancy between them meant that number 7-9 were redefining a new line based on the compromise of those ahead. Numbers 10-14 would then try
NW2 to improve on this line etc. Certainly towards the rear

of the line there were occasions where we almost felt that we needed to "move out of line" in order to see how to pick the best line. This seems to be supported by the fact that the shortest lines for each section were shared between 5 people and a fairly high repetition of the same people in the higher "rankings". Hugh Jones, who was about 6th in line was well placed to ride the shortest course and his obvious experience as a world class marathoner probably made him most "competitive" in search of a tight line. This is supported by the fact that he rode the 2nd shortest distances in both "in stadium" sections.

Two other areas for "line error" come to mind. The first being the re-grouping stops after the measured points. Whilst the front riders will have taken the shortest line those towards the rear would often be displaced from the line to be in a place of "relative safety". This stagger from and back to the line again would give minor error.
Finally, under normal conditions, one measures in a relatively non-stop format and thus concentration is maintained. Understandably the recording time for the sections was quite extensive, but this tended to break concentration and thus also focus on the shortest line.

These only promote minor "differences", but in this case it is only a relatively minor difference (+- 5 clicks per Km) between 25 riders that we are accounting for!

iii) Those measurers not riding their own bikes may have experienced some "adaption" problems, which may have rendered their readings slightly less accurate than normal.
Perhaps this would partly account for the fact that 11 of the riders had 2 or more "clicks" difference in riding the same calibration length in either the pre or post calibration rides.

iv) Calibration Courses: Although some used thermometers to record temperature for calibration, other figures were estimates. Whilst we each may have a good feel for temperature variation in our own environment, our ability may be somewhat jaded in a strange city. My preference would be to have used figures from those who had thermometers. Even then we could get into the discussion of tape and air temperature.
The Calibration Courses were all measured in a period of about 1 hour yet the variation in temperature is recorded as being between 24 and 30 on the West Side, (ave 26.8) and 23 and 26, (ave 24.8)on the East side. Quite wide ranges in the same time period.
This said per degree of temperature error the difference would be approximately 0.5 metres on the whole course.

Despite the minor "nitpicking" above, I am sure we have achieved an accurate measurement of the Olympic Course, but in all it was a very interesting, educational, and exciting "Adventure" which I am glad I did not miss.

Kind regards
Norrie
NORRIE

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GROUP MEASUREMENT
of the
1996 OLYMPIC MARATHON COURSE

by Pete Riegel

SUMMARY

The Olympic Marathon course was originally measured by Jack Grosko and Woody Cornwell, and certified by the Road Running Technical Council of USA Track & Field as course number GA 96012 WC.

A group measurement was performed on May 25 & 26, 1996. The results of the 25 measurements showed the course to pass its validation, and permitted a reduction of 53 meters from its length.

INTRODUCTION

The organization of this measurement began years ago when it became known that Atlanta would be the site of the 1996 Olympic Games, and that Julia Emmons (Deputy Competition Manager Athletics/Marathons and Race Walks for The Atlanta Committee for the Olympic Games) would be the Race Director. I met with Julia at a USATF Convention a few years ago, and mentioned that we had performed a group measurement at the Los Angeles Games, and that we wanted to conduct a similar exercise in Atlanta. I asked her to provide me with the earliest information regarding the route, so that planning could begin. This she did, at frequent intervals over the next few years.

The best early estimate of the probable course was the route of the existing Atlanta Marathon, modified to accommodate start and finish in the new Olympic Stadium. I procured topographic maps and prepared a course profile based on what was then known of the course. A year later a small diversion was added to the course to route it past the home of Dr. Martin Luther King, Jr. I modified my profile, and published it in **Measurement News**, November 1995, at the same time inviting others to check my work.

Earlier in 1995, while preparing the 1996 budget submission for RRTC, I included a $4000 line item for funding of the group measurement. Although it was intended that people would come at their own expense, it was felt that provision of central hotel accommodation was desirable, as well as provision of bicycles for those who would have difficulty bringing their own bikes. The $4000 was approved. It was overspent by $2500, which will be made up by RRTC belt-tightening.

In September 1995 Jack Grosko (assisted by Georgia USATF/RRTC Course Certifier Woody Cornwell) measured most of the course, including all sections except the stadium, which was

under construction at the time, and a short length on Edgewood, also under construction. About a kilometer on Peachtree Road was left unmeasured, as it was to be the site of a turnaround point, to be established when construction was complete in the stadium and on Edgewood, and those areas could be measured. At this time Hugh Jones took me at my word about checking my profile. I sent him the maps, and he did a meticulous preparation of an independent profile of his own, which discovered some mistakes in my work, and which should be considered as the best work on the subject. **(Page PR13)**

The September 1995 issue of **Measurement News** contained an invitation for those interested in participating in a group measurement to contact me. No limitations were placed on expertise or experience. I made no effort to invite any specific people, preferring to allow people to select themselves by expressing an interest. In this way I felt I could avoid an unpleasant "Why wasn't I invited" situation.

By January 1996 I stopped solicting participants, as I had about 20 lined up. The size of the riding group later rose to 28, including measurers from Australia, Canada, France, Great Britain, Mexico and USA. I cut off further entries in March, as I was concerned that the group would be too big for adequate police protection. In March the pace of construction was such that a date for the measurement could be fixed. It was decided to use the Memorial Day weekend as the date, with Sunday, May 26, as the date of the group ride. I arranged for a block of hotel rooms at the Hyatt Regency Hotel, and contacted all the interested people, instructing them to send me their commitment by May 1. On May 3 I sent the Hyatt our final roster of room requirements. Grosko completed his measurements in late April, and on May 9 the course was certified by Woody Cornwell as GA 96012 WC. **(Pages PR14 & PR15)**

During the entire period I checked frequently with Julia, who assured me that she would see to it that police protection would be available for our ride. I saw this as absolutely essential to the success of the measurement, as Atlanta traffic would make such an effort impossible without police cooperation.

THE MEASUREMENT PLAN & METHODOLOGY

The group ride served two purposes: First, it would serve as a "pre-validation" of the course. In the US we check all courses on which records are set, after the race, to be sure the course was not short. In some cases of large, important races, this is done before the race, and fine-tuning adjustments are made. The Olympic Marathon was seen to be a large, important race. The second purpose of the measurement was to allow the Olympic magnet to draw measurers from many places, in the hope that this would allow geographically-separated measurers to compare techniques and meet others in the measurement game. Measurement knowledge is best transmitted person-to-person, and establishing mutual confidence in the capability of others far away was seen as an important goal.

It was recognized early on that the two purposes conflicted. The best way to check a course is slowly and deliberately, with a small group. The best way to meet many people is to have a large group. Therefore we had to compromise.

There is no established national or international standard for analyzing the results of a large group measurement, but we had some US precedent, which said that when more than two measurements were done, the median measurement was most generally the best one to use. I took this as a good jumping-off place, and decided that we would use the following methodology:

The course would be measured over two days. On the first day we would measure inside the stadium to establish the starting and finishing paths, with the measurements terminating outside the stadium at a reference point. We would also lay out a calibration course. On the second day, we would measure the remainder of the race course, collecting data at each 5 km point. We would use the average constant as official (in accordance with IAAF procedure) and would take the median measured length of each measured segment as the official length, unless a good reason was seen to make this inadvisable. These medians would be summed to establish the "official" length of the course. A final adjustment of the entire course and splits would then be recommended to Julia.

Provision of adequate bicycles was much on my mind. I asked Woody Cornwell to take care of this, and he said he would see that sufficient bikes were available for those who did not bring their own mounts.

I was very worried about time. Our window of availability within the stadium was only two hours, from 7 AM to 9 AM, and we would have to complete all measurements within that span. For the group ride of the course, we needed to begin at first light and finish before traffic started to become heavy, and to preclude undue fatigue in the heat. Also, some of the measurers intended to leave Atlanta Sunday afternoon, and we wanted to finish in time for this. I also wanted to be sure that everyone went home with a complete set of data for the entire measurement.

Iron regimentation seemed to be the answer. I prepared data sheets and instructions, and each measurer was given these upon arrival. Each measurer was also given a copy of the course map, with general restrictions noted on it. For the in-stadium measurements, because of perceived time constraints, I asked for only one precalibration ride, followed by a measurement along a path with several reference points. The data would then provide the start and finish paths, as well as the measured length of one lap of the track. The measurement was to be followed by a single recalibration ride. Each measurer was to fill in his own data sheet, and give it to a data-collector.

For the group ride of the marathon route, I decided to have each person do the standard four precalibration rides and four postcalibration rides, and give the data to the data-collector at the completion of the ride. The enroute counts of each measurer, taken at the stadium reference point and the 5 km marks, was to be collected by a data team, which would travel by automobile ahead of the group, and await their arrival. Data would be read from the counters and recorded by this team. To help the team identify each rider, badges would be provided, which would identify each rider with a name, number and abbreviation of their initials. These initials and numbers were also

printed on the data sheets. Parked cars and other obstructions would simply be noted enroute, and measured around, as though they were permanent objects. I did not believe there would be time to permit each measurer to stop and perform offset maneuvers.

By forcing everybody to use a single methodology and data format, it was the goal to make subsequent data analysis easier. The Los Angeles Olympic Marathon was measured 16 months before the race, and there was plenty of time for discourse and analysis. The first Atlanta race would be held less than two months after the measurement, and quick final recommendations were needed. We did not have the luxury of time for extended debate. I told Julia that I would make course adjustment recommendations a week after the measurement was finished. This would permit ACOG to establish final locations of timing points, water stations etc well before the race.

During the planning of the measurement, Julia suggested that a break be taken by the group in mid-measurement, for rest and refreshment. This seemed to be a good idea. Julia also said she would provide these refreshments, and a "sag wagon" for measurers who experienced mechanical difficulties. If a person developed a problem, there was no way the group would stop and wait. Time was too precious for this.

During the time we were in Atlanta, we also wanted to measure the course of the Men's 20 km and 50 km racewalk courses, and the Women's 10 km racewalk. However, these courses did not yet exist, as the racewalk officials had not made final determination of their requirements. Wayne Nicoll was to lay out the racewalks, and we would validate them as we could.

HOW IT WORKED OUT

Measurers began arriving on Wednesday, May 22. On the morning of Thursday, May 23 a group went to the stadium to explore for places to establish a calibration course, and also do some scouting of the racewalks. I used a measuring wheel to establish two calibration courses on Washington Street just south of Ralph Abernathy. The maximum length available between major intersections was 1575 feet by my wheel, and I nailed two courses, one on each side, at this distance. Wayne Nicoll began his layout of the racewalk courses also.

On Friday, the 24th, most of the people were to arrive, so I remained in the hotel to greet them and give them their data sheets and instructions. Wayne continued his layout of the racewalks. On Friday afternoon the bicycles arrived, and the group spent several hours selecting their bikes and affixing their counters.

Day 1 - Measurements in the Stadium and Measurements of Calibration Courses

The morning of Saturday, May 25, the day for our stadium measurements, was not propitious. At 5 AM it was pouring down rain. It was still raining at 6 AM when we rode our bikes the 2 km to the stadium. The rain quit before 7 AM. We met Phil Henson (Competition Manager, ACOG) at the stadium, and he provided each of us with necessary credentials to enter the stadium. Security was tight. At 7 AM we entered the stadium, and I pointed out the various places where data

would be taken, and cones were placed at those points. The group then went to the calibration courses. They were instructed to precalibrate on one side of the road, and postcalibrate on the other side of the road, so as to maintain one-way traffic on each calibration course and equalize calibration rides on each calibration course. The group followed me to the south end of the east calibration course. I did a calibration ride, wrote down my numbers, and moved directly to the outside-the-stadium reference point on Clarke St. I rode from there, followed by the group, until I had completed my in-stadium ride, and returned to the Clarke reference. I then moved to the north end of the west calibration course, and recalibrated. All the measurers repeated what I did.

Within an hour all the data was collected, and most of it given to Ryan Lamppa, who volunteered to be data-collector. Later in the day he chased down those who had not handed in their data. The rest of our two hours was spent in examining the stadium and taking group photos. A group assembled with Wayne Nicoll, who organized some racewalk data-gathering in the stadium at this time. After we left the stadium at 9 AM, the group broke into teams which measured the lengths of the two calibration courses. Because they had been laid out with a measuring wheel, they were of slightly unequal length. No effort was made to equalize them, as it would have been necessary to do on-the-spot data analysis, and it was felt that the average length of both courses would suffice, as long as people calibrated as instructed - ride south on the west course and ride north on the east course - calibrate equally on both courses.

Wayne took a group to the racewalk course. The rest of the group returned to the hotel. We now had a complete set of data for the in-stadium measurements, and had determined the lengths of the calibration courses. **(Pages PR20 & PR24)**

In the afternoon, Jack Grosko came to the hotel and gave a briefing about what we could expect during our ride of the course next day. Julia Emmons greeted the group, and explained how the enroute support would work. Rodolfo Martinez presented greetings from Mexico. I explained the importance of each rider wearing the yellow t-shirt and the identification badge, as the data takers were not familiar with the names of all the riders.

Day 2 - Measurement of the Marathon Course

The group met at 4:30 AM in the hotel lobby, and when everybody was present we rode to the stadium. Each measurer performed the standard four precalibration rides, and we were ready to measure by 5:30. Julia Emmons arrived with the chase vehicle (an Atlanta Track Club pickup truck) and Jack and Shannon Grosko as well. The police - 6 motorcyclists - arrived on time at 6 AM. Wayne Nicoll and Tom & Mary Anne McBrayer moved to the Clarke reference point, and the measurers queued up to have their initial counts recorded. When this was done, the data team drove onward to the 5 km mark to wait for us. Shannon Grosko drove the car, as she knew the locations of all the 5 km split points.

Jack Grosko served as our course guide, and led the measurement. I followed immediately behind, but guided by my own measuring eye rather than directly following his bike. Course restrictions were explained enroute, and each measurer was instructed to use Jack as a general guide, but to obtain the best possible measurement while staying within the legal confines of the course. The preplanning seemed to work. We were successfully met at each 5 km split, and data taken

smoothly and quickly. As each measurer's data was taken, they would move forward to a position of safety farther up the road, and wait for the data team to depart for the next split.

The group stopped for a refreshment break on Lanier Drive, between 20 km and 25 km. At this point I made an announcement that the group should, while on Peachtree Road to Piedmont, stay to the right of all painted yellow lines, and also consider that the entire right side of the roadway was available. I did this because there were numerous complicated course restrictions here, involving turning lanes into shopping centers, and I wanted to give the group a simple guide they could remember rather than have them ride in doubt. **(Pages PR16 to PR18)**

Until this point traffic had been relatively light. From 25 km onward it began to increase, but the six police escort motorcycles were able to keep our pathway safe and relatively clear. Upon completion of the ascent from Peachtree Creek to Downtown the group took a 5 minute rest at the crest of the hill, then proceeded to the Clarke Street reference point, completing the course ride by 10 AM. All measurers then recalibrated their bikes. I instructed everybody not to leave the area until they had given their data to Ryan Lamppa. When all the data was collected, I rode back to the hotel with a group, while another group went with Wayne Nicoll for more racewalk work.

Measurers were instructed to immediately return their bikes to Woody Cornwell upon return to the hotel. Woody collected them and returned them to the bicycle rental proprietor when he came to the hotel.

A nearby Kinko's was available for copying, and I prepared 35 sets of measurement data, and passed out a set to each measurer. Each measurer went home with a complete set of data for our two days' work.

This completed the course measurement and data-collection phase of the effort.

PRACTICAL RESULTS OF THE MEASUREMENTS

Upon my arrival home I typed all the data into the computer, emailed a copy to Bob Baumel for his use, and began my analysis of the results. I knew that, in addition to Bob, Jean-Francois Delasalle would be conducting a similar effort, and others as well. When I had my results, I concluded that the turnaround could be safely moved to shorten the course by 53 meters. An informal poll of Baumel, Delasalle, John Disley and Hugh Jones revealed no significant objections to this action. Reassured, on June 2 I faxed the recommendations for adjustments to Julia Emmons and Jack Grosko. On June 3 I mailed each participant a preliminary report, including my own calculations and a request for a written commentary, calculation or other input for inclusion in this report. **(Pages PR19 to PR30)**

The immediate practical result of the measurement is that the course will be shortened 53 meters. Also, it passed its validation. No measurer found it short. The system worked.

Future practical results will arise from subsequent analysis of the data, which will help us to improve our methods of measurement and analysis.

ANALYSIS OF THE DATA AND RESULTS

How Well Does Our Measurement System Work? (Page PR31)
This was the question of greatest interest to me. With such a wealth of data to work with, it would be unfortunate if it showed that our present methods were inadequate. In the US system of measurement, two measurements are required. If those two measurements do not agree within 0.08 percent, they cannot be used to define a course. A third measurement is required. If they agree, the lower of the two is used as the official length. The use of the larger constant is recommended, although use of the average constant is permitted. Let's look at how things worked out:

1) 25 individual measurements of the course were completed. This leads to 300 different combinations of two measurements.

2) Of the 300 pairs of measurements, 207 agreed within 0.08 percent.

3) Of these 207 acceptable pairs, 19 would have been found short by one or more measurers if calculated using the average constant for layout. If the larger constant was used, only two would have failed to pass.

Thus:	Larger constant success rate =	99 percent
	Average constant success rate =	91 percent

Bob Baumel, who originated the "larger constant" idea, has been shown correct in his judgment. His argument for those who object to it has always been that if one has decent calibration agreement the larger constant makes little difference. It is only when precal and postcal differ widely that it has a major effect. And the effect is in the direction of safety against shortness.

Change of Calibration Constant (Page PR32)
Four riders used solid tires. The rest used pneumatic tires. Many of the rental bicycles reflected the present consumer taste in bikes. They were mostly fat-tired "mountain bikes." It's well documented that fat, low-pressure pneumatic tires are affected more by temperature change than are thin, high-pressure tires or solid tires. Over half the measurers experienced calibration changes in excess of 10 counts/kilometer. These changes led to uncertainty in their measurements.

On a course layout this would lead to measurer unease, as use of the larger constant might make the course "too long" while the average might not leave the course long enough to withstand a remeasurement.

On a validation ride, a large calibration change would make it difficult to interpret the result if the remeasurement came out close to the nominal distance.

I believe that at one time the Canadian certification process set a limit of 8 counts per kilometer for calibration change. If you measured a course, and your postcalibration differed from the precalibration by more than this, the measurement was invalid. I never liked this, because on a long day of measurement who could tell what the tire would do? The whole day would be wasted. But it has the virtue of reducing error. It forces the measurer to do what it takes to minimize calibration change. This may be using a suitable tire, or performing frequent calibrations enroute.

John Disley, Hugh Jones, Norrie Williamson and some others take a solid tire with them when they travel to measure a course. I tried it once, and the airline gave me a hard time, so I put up with the fat-tired bikes I'd normally be provided with by my host. No more. From now on I bring a solid tire, and demand a bike that will take it.

I also intend to promote greater use of solid tires, and am beginning inquiries to see what can be done to make them generally available.

A final note on our calibration change: While I was planning this exercise, Bob Baumel strongly suggested the use of a midcourse recalibration. He felt that this would reduce wide calibration variation. Although I agreed with him, I was concerned about the time needed to measure another calibration course near the turnaround point, and the time it would take to perform the extra calibration in the middle of our course ride. For those reasons I rejected Bob's suggestion. There is little doubt that our precision would have been improved by the use of a midcourse calibration.

Variation in Riding the Calibration Course (Page PR33)
It is unusual for a measurer to obtain four calibration rides with identical counts. Usually, in 4 rides, a difference of 1 to 3 counts will be obtained by an experienced rider on a calibration course of 500 m or less. I generally think of 3 as being the upper limit of acceptability for good work. Because we used two calibration courses of slightly unequal length, a direct comparison is not possible. However, I have made an attempt, which you will see as you read on. What I found was that if each rider used a counter that recorded exactly 10,000 counts per kilometer, 20 of the 25 measurers would have had a 4-ride average variation less than 3 counts per kilometer. The rider with least variation was Jean-Francois Delasalle.

Measurements of the Calibration Courses (Pages PR20 & PR34)
Eleven teams of measurers measured each calibration course using steel tapes. Reported data included the raw result of their measurement as well as their opinion of the proper temperature to use in correcting for temperature. Precision of steel taping is stated in one surveying text thusly:

"Although changes in temperature and tension will cause slight variations in length of tape, competent tapemen can usually obtain precisions of 1/5000 or less, such as are required on suburban and farm surveys, by assuming the tape to be the length stated by the manufacturer, and provided the temperature does not vary greatly from 68° (20C)." (Surveying by C. B. Breed, John Wiley & Sons, 1971)

Our precision, as measured by the standard deviation of the calibration course measurements, was about 1.3 parts per 10000, or 0.65 parts per 5000. Thus we seem to have performed as "competent tapemen."

In the graph of calibration course measurements it is apparent that teams tended to measure consistently. The two lines are roughly parallel. If a team tended to get a higher-than-average value on one course, they also did it on the other, and vice versa.

Measurements of the Track (Page PR24)
Part of the data gathered on Saturday morning was a measurement of one lap of the 400 meter track. Many people observed that riders seemed to be measuring a bit closer to the inner line (the curb was not in place) than they should have been, and this has been shown in the results. The median measured lap length, by our group, was 398.74 m including 1.001, 399.14 m without. This suggests that the group rode at a median distance of 14 cm from the line rather than the desired 30 cm. I expect if the curbing had been in place we would have seen a different result.

In making my determination of the course length, I took the track surveyor's 400.035 m as accurate, and assigned each lap a length of 400 m, reduced by 1.001 as the track is part of a road course. This action is questionable, but it was what I felt was proper at the time.

THE MEASUREMENT OLYMPICS

Whenever measurers work in groups larger than one person, there is a general desire to perform better than one's companions. In rough terms, this usually means obtaining a shorter measurement for the same distance. When a large group such as our exists, certain statistical practices may be employed to further refine the definition of performance. No standard that is acceptable to all exists, to my knowledge. However, I have looked at many group measurements and have developed a ranking scheme **(Pages PR35 & PR36)** that I am personally willing to submit to, and in the spirit of lighthearted competition will go ahead with my personal medal ceremony:

Shortest Measurement:	1) Hugh Jones 2) Isabelle Marechal 3) Jean-Marie Grall
Most Precise Calibrations:	1) Jean-Francois Delasalle 2) Ryan Lamppa 3) Hugh Jones
Most Accurate Measurement:	1) John Disley 2) Mike Wickiser 3) Ryan Lamppa

Most Precise Measurement:	1) Ryan Lamppa 2) Jay Wight 3) Don Shepan
Best Overall Measurement Combining Accuracy and Precision:	1) Ryan Lamppa 2) Mike Wickiser 3) Don Shepan
Best Overall Measurement By Country:	1) USA 2) Canada 3) Great Britain

The results certainly would have been different if we each had had the chance to do a leisurely, unhurried individual measurement of the course. The above results are clouded by the assumption that the median is the accurate value, by calibration change (outside the control of the measurers), unfamiliar equipment, position in the queue (affecting one's ability to see the best line), and by the method employed for scoring. Nevertheless, I think it's not too unreasonable. Protests may be submitted to a higher Being in the church of your choice.

COMPARISON WITH OTHER GROUP MEASUREMENTS

Olympic Marathon courses have been measured using Jones Counters since 1976. Here is what I know of those measurements:

1976 - Montreal - This course was first measured using conventional surveying techniques, and checked by calibrated bicycle, with Norm Patenaude as lead rider, assisted by R.R. Wallingford (Race Director) and Canadian distance runner Peter Quance. The bike measurements discovered an 81 m discrepancy in the course. The survey was checked, and a 50 m survey error was discovered, leaving a difference of 30 m between the bike measurements and the survey measurements.

1980 - Moscow - I know nothing of the measurement of this course.

1984 - Los Angeles - This measurement was organized by John Brennand and performed by 13 bicycle measurers. Six enroute calibration courses were used (ridden once enroute only) as well as standard precalibration and postcalibration. The measurement took place in April 1983, and protracted and frustrating six-month discussion ensued as to the proper amount by which the course should be adjusted. After the measurement was done, several minor changes to the course were made and measured by smaller teams or individuals. This measurement provided the first database large enough to be analyzed statistically, and it served to reinforce procedures that had been established arbitrarily, and show them to be reasonably correct.

1988 - Seoul - This measurement was organized by the Korean Society of Geodesy, Photogrammetry and Cartography. Using the US report of the 1984 Olympic Measurement as a model, the Koreans used 13 expert cyclists to ride along a prepainted line. The cyclists were not measurers, but were steady riders. Their data was collected, and similar analysis to Los Angeles was performed.

1992 - Barcelona - This measurement was performed by Josep Sole of Spain, an experienced measurer. I know nothing more than that.

Over the years a score of group measurements has entered our RRTC database. How does our measurement compare to others? Its variation (as measured by standard deviation) was greater than most marathon courses. This is partially explained by the large size of the group, which hinders individual performance. **(Page PR37)**

BAD LUCK

Three measurers did not get the measurement experience they had hoped for. Bob Woods brought his personal bike, a one-speed model that he uses because he is uncomfortable with shifting gears. He declined a geared rental bike for this reason. On the course ride, he found that the Atlanta hills were too much for him, and terminated his ride at the hotel.

David Katz, the US's longest-experienced course measurer and veteran of the 1983 Los Angeles ride, brought his personal bike to Atlanta. However, midway through the course ride his shifter malfunctioned, and he was stuck in a high gear. He struggled valiantly to ascend the hills, but was finally forced to abandon his measurement.

Andy Beach's Jones Counter, one of the old ones made by the New York Road Runners Club, gave up the ghost midway through the measurement, and Andy was forced to terminate. Jones Counter failures are rare, but certain. Nothing lasts forever.

All three of these measurers obtained usable data on the in-stadium portion of the measurement, and their work is part of the final result. They are Olympic measurers.

ACKNOWLEDGEMENTS

This measurement would have been impossible without funding. USA Track & Field looked favorably on my budget request, making this measurement possible.

I live in Columbus, Ohio, 900 km from Atlanta. I badly needed on-site support in order to make this thing work. Julia Emmons was willing to give time from her busy schedule, with the Olympic Marathons looming, to provide information, police arrangements, and a day of her time to help us.

Phil Henson, who is in charge of all the Athletics competition at the Games, and a very busy person, got us into the Olympic Stadium, not an easy thing to do with so many rehearsals going on. He had everything ready when we needed it so that we could get full use out of our two hours in the stadium.

Jack Grosko continuously shared his measurement data with me as the planning progressed, and saw to it that the course markings were ready for us on our ride. This work helped us to avoid lost motion and get the job done smoothly. Jack led the group ride, which was essential, as few of the riders had any familiarity with the course.

Shannon Grosko drove the car carrying the data-recording team. Her knowledge of the split locations allowed her to have the team ready to take our data at each split, on time.

Woody and Elaine Cornwell took on the job of finding a reliable bike supplier capable of providing 20 reliable bicycles for our group, and getting them delivered on time. They were successful at this, and none of the equipment we provided failed.

Andrea Townsend of the Hyatt Regency gave me invaluable help while we arranged for rooms and billing. There were no room mixups of which I was aware, and my final bill was what I expected it to be.

I was especially delighted when Wayne Nicoll and Tom and Mary Anne McBrayer said they preferred to serve as data-recorders rather than as bicycle measurers. Reliable data-collection was essential to the success of this operation, and their performance in this role was flawless. I found no observable errors in their recorded data.

Ryan Lamppa was tentative about his role at first. He initially volunteered to be a helper, but wanted a bike as well. In the stadium he did no measuring, but served as data-collector, making sure everybody properly handed in their data. Next day he decided he'd like to measure the course, and serve as data-collector as well. This he did well, and because of his efforts we were able to send everybody away with a complete set of data (except for a bit of Ed Prytherch's, inadvertently miscopied by me when I was making copies of the data sheets).

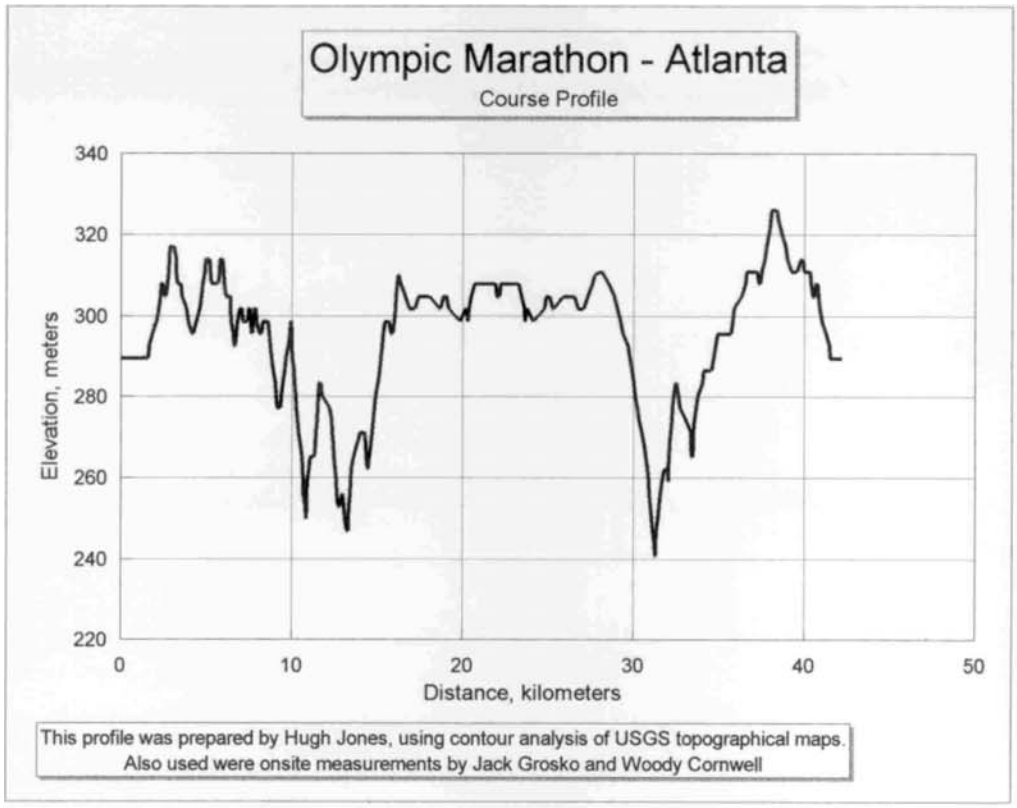
The Atlanta Police provided the motorcycle escort that allowed us to ride the line through curving streets, often straight into the teeth of the traffic.

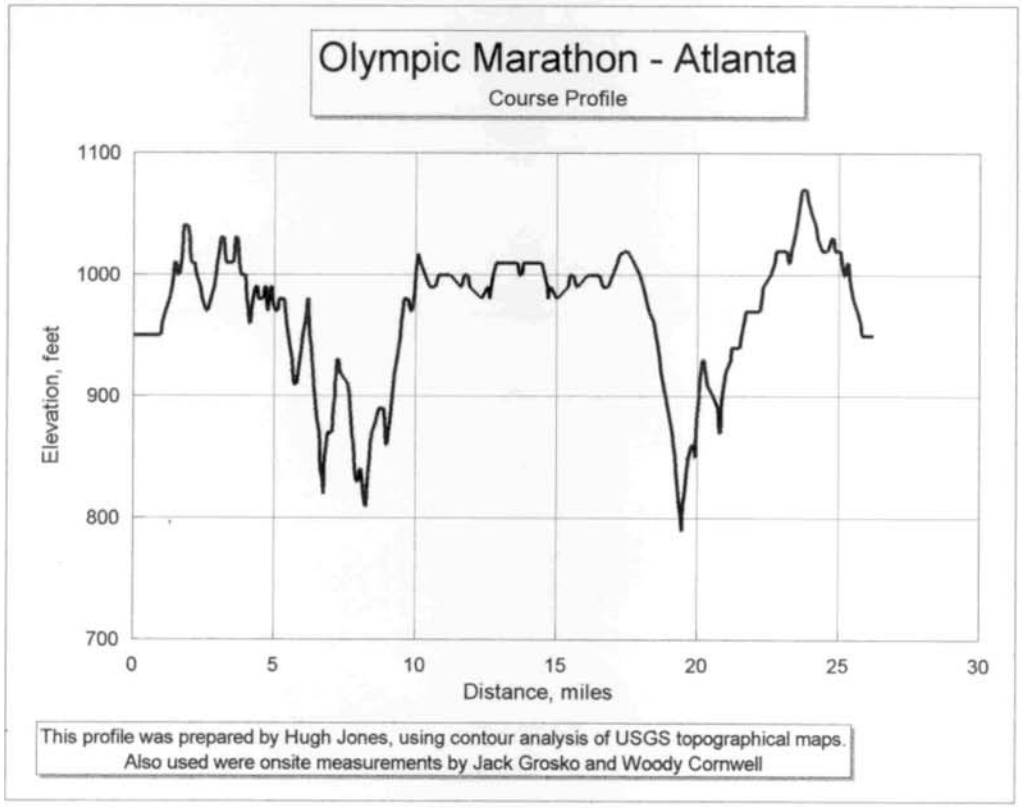
Other who came with the measurers pitched in where they could, and helped out as well. Thanks to: Barb Grass, Fran Seton, and Donna Valaitis.

As far as I am concerned, everybody who was present at the measurement was a help to the cause, and performed as a member of the Olympic Marathon Measuring Team. This was a team effort, and without the non-riding members of the team we riders would never have been able to do the job.

My sincere thanks to all. Pete June 26, 1996

PR 12


Olympic Marathon - Atlanta
Course Profile
Elevation, meters
340
320
300
280
260
240
220
0
10
20
30
40
50
Distance, kilometers
This profile was prepared by Hugh Jones, using contour analysis of USGS topographical maps.
Also used were onsite measurements by Jack Grosko and Woody Cornwell


Olympic Marathon - Atlanta
Course Profile
Elevation, feet
1100
1000
900
800
700
0
5
10
15
20
25
30
Distance, miles
This profile was prepared by Hugh Jones, using contour analysis of USGS topographical maps.
Also used were onsite measurements by Jack Grosko and Woody Cornwell

PR13

GA 96012

Road Running Technical Council
USA Track & Field

recognized by RRCA

Measurement Certificate

Name of the course *1996 Olympic Marathon* Distance *42.195 km*

Location (state) *Georgia* (city) *Atlanta*

Type of course: road race ☒ cross country ☐ calibration ☐ track ☐ Configuration *Out-Loop-Back*

Type of surface: paved *95* % dirt ____ % gravel ____ % grass ____ % track *5* %

Altitude (meters/feet above sea level) Start *290 m* Finish *290 m* Highest *326 m* Lowest *241 m*

Straight line distance between start & finish *64 m* Drop *0* m/km Separation *0.15* %

Measured by (name, address, & phone) *Jack Grosko & Woody Cornwell*

Grosko: 1095 Willow Bend - Roswell, GA 30075 *770-552-3281*

Race contact (name, address, & phone) *Julia Emmons - Atlanta Track Club*

3097 E. Shadowlawn - Atlanta, GA 30305 *404-231-9064*

Measuring methods: bicycle ☒ steel tape ☒ electronic distance meter ☐ measuring wheel ☒

Number of measurements of entire course: *2* Date(s) when course measured: *9/24/95, 1/13/96, 3/23/96*

Race date: *28 July, 4 August 1996* Course paperwork postmark date: *May 2, 1996*

Difference between two best measurements of the course: *~7 m* Certification code: *GA 96012 WC*

Replaces *n/a* (if applicable)

Notice to Race Director
Use this Certification Code in *all* public announcements relating to your race.

PR14

Be It Officially Noted That

Based on examination of data provided by the above named measurer, the course described above and in the map attached is hereby certified as reasonably accurate in measurement according to the standards adopted by the Road Running Technical Council. If *any* changes are made to the course, this certification becomes void, and the course must then be recertified.

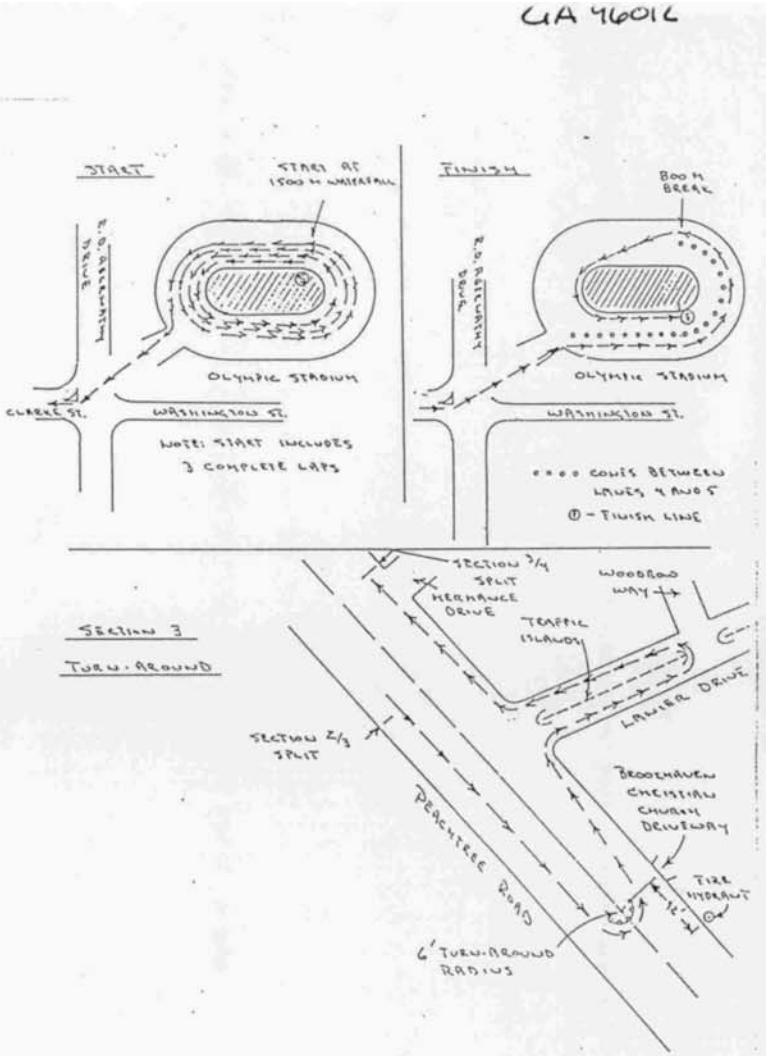
Validation of Course — In the event a National Open Record is set on this course, or at the discretion of USA Track & Field, a validation remeasurement may be required to be performed by a member of the Road Running Technical Council. If such a remeasurement shows the course to be short, then all pending records will be rejected and the course certification will be cancelled.

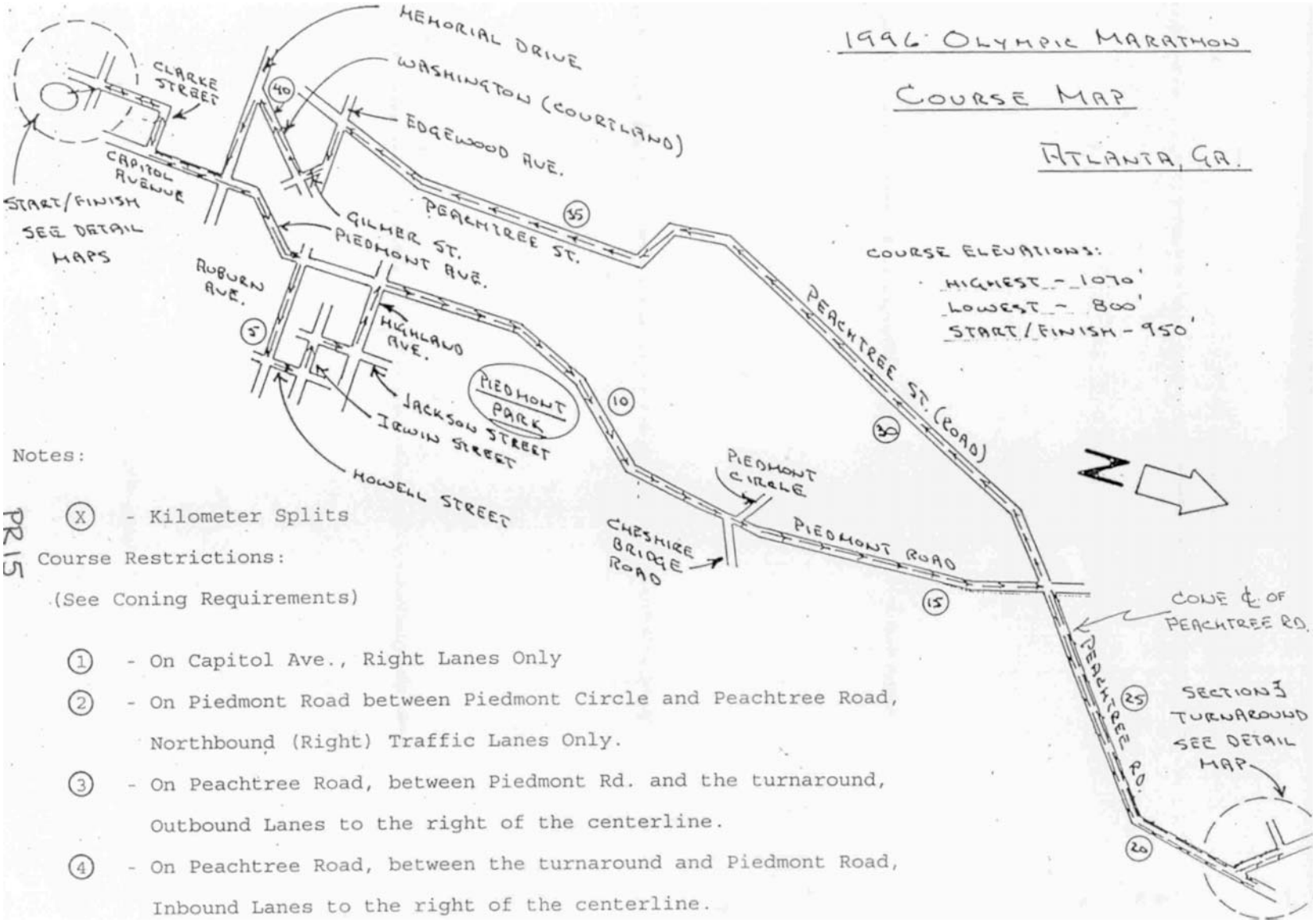
Automatic Expiration — This certification automatically expires ten years after date of issue, although it may be renewed for additional ten-year periods upon testimony to RRTC that the course is still in use, and has not been altered, and that all key points (start, finish, turn-around points, cone positions, etc.) described on the attached map can still be located precisely.

AS NATIONALLY CERTIFIED BY:

Date: 5/9/96

Woody Cornwell - Georgia RRTC State Certifier
1701 Violet Way - Dalton, GA 30720 Phone: 706-226-5207





Notes:

PR15

(X) - Kilometer Splits

Course Restrictions:

(See Coning Requirements)

(1) - On Capitol Ave., Right Lanes Only

(2) - On Piedmont Road between Piedmont Circle and Peachtree Road, Northbound (Right) Traffic Lanes Only.

(3) - On Peachtree Road, between Piedmont Rd. and the turnaround, Outbound Lanes to the right of the centerline.

(4) - On Peachtree Road, between the turnaround and Piedmont Road, Inbound Lanes to the right of the centerline.

1996 Olympic Marathon Course - Coning Requirements

1) First light pole on Clarke (RP 2-1) along "shortest route" tangent to centerline of Clarke. Along centerline to driveway just before Fulton Street overpass. Diagonal over to end of driveway at curb.

2) From left corner of Clarke at Capitol toward right side of storm drain on far curb of Capitol. Stop at right-hand lane line. Cone right lane past Memorial up by Capitol Bldg. and across MLK onto Piedmont all the way to the MARTA overpass on Piedmont.

3) On Capitol, cone across all turn lanes to Memorial as well as Memorial itself.

4) On Auburn, cone right side indent at Fort St.

5) On Highland, cone right side turn lanes to Bedford and from Bedford to Georgia Power entrance.

6) On Highland, turn onto Piedmont goes inside (to the right of) the traffic island.

7) After right turn off Highland and onto Piedmont, cone right lane diagonally to eliminate from course by Ralph McGill intersection.

8) On Piedmont, cone off right-hand lane from Ralph McGill to North Ave.

9) On Piedmont, cone off entrance lane to Burger King at North Rock Springs.

10) On Piedmont, cone across lanes on right to Cheshire Bridge; cone diagonally from left side of Piedmont across southbound lanes to reduce course to northbound lanes only. Start this diagonal set of cones at the southwest corner of Piedmont and Piedmont Circle and extent it to the concrete median separating the lanes of Piedmont.

11) On Piedmont, cone off turn lane into Pep Boys just before Lindbergh.

12) On Piedmont, cone off right turn lane Morosco to Sidney Marcus Blvd.

13) On Piedmont, cone off right turn lane into shopping center just before Miami Circle; cone off lanes to Miami Circle.

14) On Piedmont, cone off right turn lane to Home Depot.

PR16

15) On Piedmont, cone off right turn lane to Apartments at 2901-2951 Piedmont.

16) On Piedmont, turn onto Peachtree goes inside (to the right of) the traffic island.

General note: North of Piedmont, Peachtree is coned off down the center-line. The course out to Oglethorpe is everything to the right of the cones excluding the right-hand lanes as noted below.

17) On Peachtree, cone MARTA station turn lane.

18) On Peachtree, cone right-hand lane from Oak Valley to Wieuca to Roxboro.

19) On Peachtree, cone right turn lane across from Club Drive.

20) On Peachtree, cone right turn lane at Lenox Pointe Luxery Apts.

21) Cone turnaround on Peachtree.

22) On Peachtree, cone to define right turn into Lanier.

23) On Lanier, cone island break.

24) Cone turnaround on Lanier at Woodrow Way.

General note: After turnaround and re-entry onto Peachtree, cone the centerline of Peachtree. Course back to Piedmont is everything to the right of the cones excluding the right-hand turn lanes as noted below.

25) On Peachtree, cone right turn into Oglethorpe U.

26) On Peachtree, cone right turn into Brookhaven Plaza.

27) On Peachtree, cone right turn into new unnamed shopping center.

28) On Peachtree, cone right turn into Big 10 Tires.

29) On Peachtree, cone right lane at corner before Lenox/Phipps Dr. intersection.

30) On Peachtree, cone right lane at corner before Piedmont Avenue intersection; in front of Nikko. Cone line farthest from curb to eliminate the traffic island at Peachtree/Piedmont from course.

General note: Course on Peachtree south of Piedmont is all lanes, curb-to-curb but with some turn lanes on either side of the road eliminated where their inclusion would shorten the course these are noted below.

31) On Peachtree, cone front of Peachtree Plaza.

32) On Peachtree, cone from Buckhead Ave. (Oriental Rugs, etc.) to Beer Gardens.

33) On Peachtree, cone entrance into The Peach, i.e. Starbucks, etc.

34) On Peachtree, cone parking lane from Garden Hills to Fellini's Pizza.

35) On Peachtree, cone front of Mad Italian.

36) On Peachtree, cone turn lane before and into Sfuzzi.

37) On Peachtree, cone turn lane at Brighton St.

38) On Peachtree, cone front of line of shops Bread Market to Black-eyed Pea.

39) On Peachtree, cone front of line of shops Peachtree Cleaners to Intermezzo blending to Pallisades.

40) On Peachtree, cone just past entrance to MARTA station at Forsyth.

41) On Peachtree, cone across Luckie St. and Broad St.

General note: Left turn from Washington onto Memorial is entirely in course.

42) On Capitol, cone right-hand lane to Clarke.

43) On Clarke, cones defined in 1) remain.

Dear Olympic Marathon Measuring Team, June 3, 1996

Here is the early report of the group measurement. It was necessary to do a quick assessment of the work in order to provide Julia Emmons and Jack Grosko with information to permit them to adjust the 5 km splits and the turnaround point. With those splits accurately relocated, layout of the individual miles and kilometers can proceed, using each 5 km point as an accurate reference.

Please examine the data and calculations for errors. If you see any, please let me know. There were some surprises in the results, for me, and I hope none of them arose from my errors.

A final report of our activity will be mailed before July 19. I intend to expand my own work, and I hope you will also contribute something. Some will calculate, while others may contribute commentary, personal impressions, and suggestions for improvement. I made many simplifications in the course of designing this exercise, because I was concerned about the limited time and energy available for simultaneous work done by such a large group. Some may have been wise, some may not. I hope you will let me know. Don't sugar-coat it. If mistakes were made, I want to know. If something was right, I'd appreciate knowing that too.

Let me have your comments, calculations etc. by June 26. Send it in a form that you wish others to see. In the final report I plan no editing. What you send will appear exactly as you send it. Each of you will receive a copy.

I will, of course, do some summarizing of what I receive, but your original submission will be reproduced as sent to me.

On a personal level, I very much appreciate your participation. I hope you feel as I did in 1983 when I participated in the group measurement of the Los Angeles Olympic Marathon. I wouldn't have missed it for the world. It did a lot to hone my skills as a measurer - at the time I had only 5 measured courses to my name. It was a great experience to meet other measurers and work with them. It's not something that happens every day. My only regret is that I did not have more time to sit down and talk with each of you.

Now, get to work! Send me something!

Best regards,

Pete

PS - I'd greatly appreciate some copies of photos you shot enroute. I've got group photos, but didn't get a chance at any others.

PR19

PLEASE REPLY TO: PETER S. RIEGEL, *CHAIR, ROAD RUNNING TECHNICAL COUNCIL*
3354 KIRKHAM ROAD, COLUMBUS, OHIO 43221-1368
HOME PHONE 614/451/5617, FAX 614/451/5610

CALIBRATION COURSES

Two calibration courses were laid out on May 23, using a measuring wheel. The courses were located on Washington Street, on the east and west sides. The northern terminus of each course was adjacent to the first lightpole south of Ralph Abernathy Drive. Lengths as laid out by the measuring wheel were 1576.02 feet, corrected for the bias of the wheel, or 480.4 m. Pete Riegel used the wheel, and put nails and washers at each end of the courses.

West Calibration Course

Measurers	Uncorrected Length	Reported Temperature C	Temperature Correction, m	Corrected Length, m	
SH, DK	480.205	27	0.039	480.244	
DC, DL	480.290	25	0.028	480.318	
JMG, CD	480.270	30	0.056	480.326	
RM, LR	480.290	27	0.039	480.329	
JFD, IM	480.310	26	0.033	480.343	
PR, JD	480.330	24	0.022	480.352	**median**
BC, DY	480.350	26	0.033	480.383	
HJ, NW	480.370	27	0.039	480.409	
MW, AB	1576' 0"	33	0.072	480.437	
BB, DL, DS, WC	480.420	24	0.022	480.442	
JW, BW	480.440	25	0.028	480.468	
			Average	**480.368**	

East Calibration Course

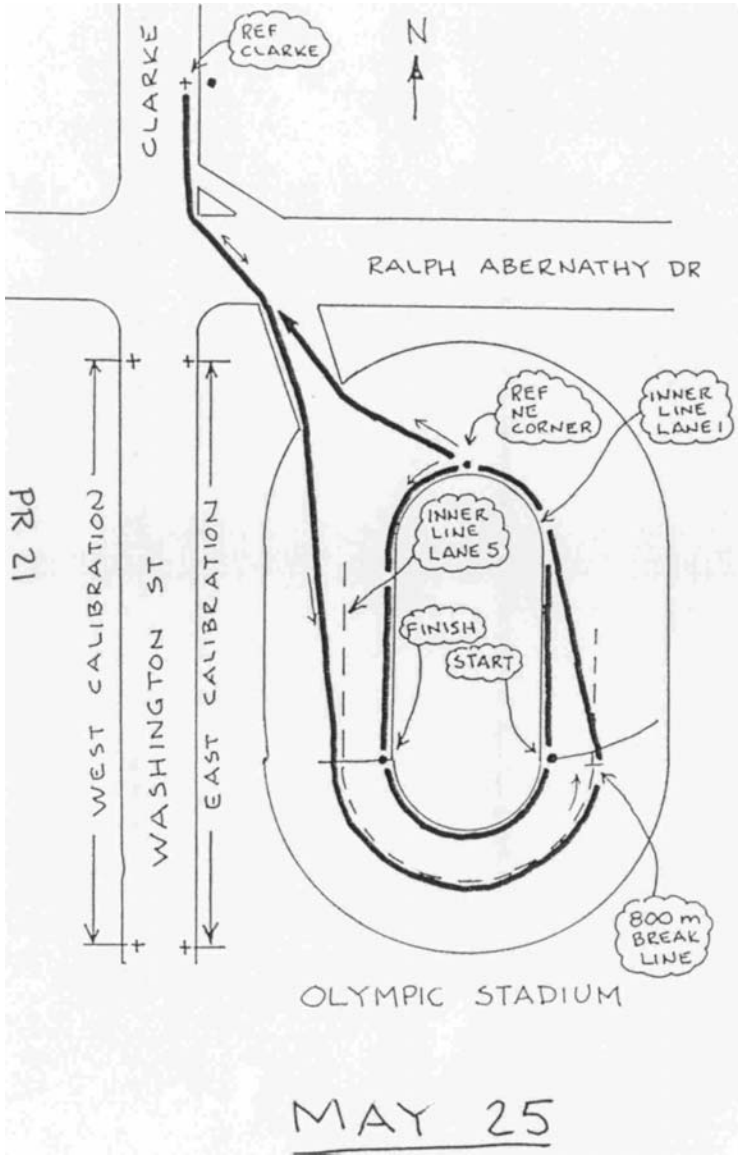
Measurers	Uncorrected Length, m	Reported Temperature C	Temperature Correction, m	Corrected Length, m	
SH, DK	480.870	26	0.033	480.903	
JMG, CD	480.950	25	0.028	480.978	
DC, DL	480.960	24	0.022	480.982	
PR, JD	480.980	23	0.017	480.997	
JFD, IM	480.970	26	0.033	481.003	
BC, DY	481.034	25	0.028	481.062	**median**
BB, DL, DS, WC	481.050	23	0.017	481.067	
RM, LR	481.050	26	0.033	481.083	
MW, AB	1578' 3"	26	0.033	481.084	
NW, HJ	481.060	26	0.033	481.093	
JW, BW	481.090	23	0.017	481.107	
			Average	**481.033**	

West course length (median) = 480.35 meters Postcal for the in-stadium rides
East course length (median) = 481.06 meters Precal for the in-stadium rides

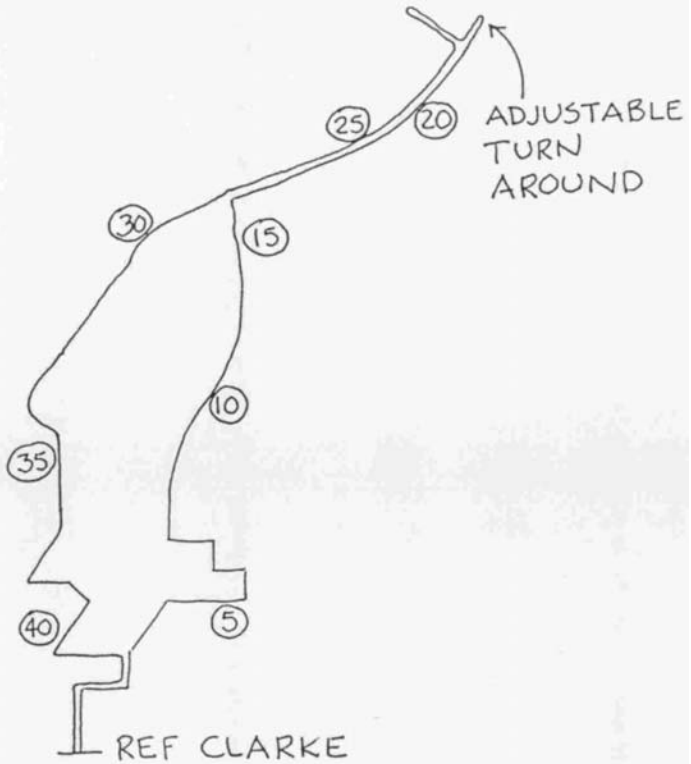
Average of median lengths: 480.71 meters
Average of Average lengths: 480.70 meters

For the rides of the main course loop, 480.71 meters was used as the calibration course length.

PR 20


CLARKE
REF CLARKE
N
RALPH ABERNATHY DR
PR 21
WEST CALIBRATION
WASHINGTON ST
EAST CALIBRATION
REF NE CORNER
INNER LINE LANE 1
INNER LINE LANE 5
FINISH
START
800 m BREAK LINE
OLYMPIC STADIUM

MAY 25


25
20
ADJUSTABLE TURN AROUND
30
15
10
35
40
5
REF CLARKE

MAY 26

In - Stadium Data - May 25, 1996 - Counts obtained during the measurements

			East Cal Course 481.06 meters								West Cal Course 480.35 meters	
			Begin Cal	End Cal	Ref Clarke	Ref NE Corner	Finish	Start	Ref NE Corner	Ref Clarke	Begin Cal	End Cal
Andy	Beach	AB	92000	96719	98000	103030	104410	105388	106949	108738	10000	14712
Bob	Baumel	BB	116400	121994	123450	129474.5	131110.5	132271.5	134121.5	136240	137500	143085
Bernie	Conway	BC	84000	88520	90000	94879	96200	97137	98633	100347	1000	5514.5
Bill	Grass	BG	17200	21652.5	22700	27495	28796	29719	31189	32877	33860	38308
Bob	Woods	BW	51817	56493	57833	62829	64196	65166	66712	68492	69628	74294
Christian	Delerue	CD	92850	97308.5	98350	103151	104452.5	105378	106853	108540	9600	14051
Dave	Cundy	DC	12720	18255	19530	25490	27104	28251	30078	32174	33461	38988
David	Katz	DK	13000	17650	19000	23988	25342	26298	27826	29581	31000	35643
Doug	Loeffler	DL	82800	87534.5	88650	93761	95149	96133	97701	99495	500	5223
Dusty	Lewis	DL2	56900	61585	62800	67858	69232	70207	71758.5	73539	74500	79176
Don	Shepan	DS	56900	61491.5	61500	66442	67782	68732	70247.5	71986	73000	77585.5
Dave	Yaeger	DY	60000	65336	67000	72739	74298	75402	77163	79182	80000	85325
Ed	Prytherch	EP	98286	103172	4500	9765	11192	12205	13817	15671	38140	43015
Gerry	Rahill	GR	25500	30242	31300	36414	37798	38780.5	40346	42145	43290	48025
Hugh	Jones	HJ	43000	47455	49000	53793	55094	56015	57486	59171	60000	64448
Isabelle	Marechal	IM	15300	20008	21000	26071	27447	28422	29978	31763	32900	37599
John	Disley	JD	7900	13172	14400	20079	21621	22715	24458	26458	27600	32862
JF	Delasalle	JFD	91000	95718	96700	101781	103159	104138	105696	107480	8500	13212
Jean-Marie	Grall	JMG	13600	18452	19500	24726	26146	27154	28760	30592	31600	36445
Jay	Wight	JW	87265	91751	92914	97757	99067	99998	101485	103188	4213	8692
Luciano	Ramirez	LRG	145600	151123	152500	158458	160074	161220	163047	165143	166500	172020
Mike	Wickiser	MW	40300	44858	46000	50911	52244	53191	54698	56426	57400	61952
Norrie	Williamson	NW	820000	825267.5	826611	832278	833816	834905.5	836646	838645	839830	845089.5
Pete	Riegel	PR	90000	94802.5	95900	101079	102482	103476	105062	106883	7950	12745.5
Rodolfo	Martinez	RMF	311603	317231	318760	324831	326475	327640	329498	331632	332960	338579
Scott	Hubbard	SH	20000	24572	26000	30930	32265	33213	34725	36456	42770	47342
Woody	Cornwell	WC	43635	49023	50400	56203	57775	58889	60668	62712	63933	69313

PR 22

Course Ride Data - May 26, 1996 - Counts obtained during the measurement

These data have been corrected per letter of Jean-Marie Grall

			Pre-Calibrations - 480.71 m avg				Post-Calibrations - 480.71 m avg			
			Pre 1	Pre 2	Pre 3	Pre 4	Post 1	Post 2	Post 3	Post 4
			West	East	West	East	West	East	West	East
			480.35 m	481.06 m	480.35 m	481.06 m	480.35 m	481.06 m	480.35 m	481.06 m
Andy	Beach	AB								
Bob	Baumel	BB	5583	5592	5584	5592.5	5574.5	5581	5575	5583.5
Bernie	Conway	BC	4511	4516	4511	4517.5	4504	4508	4503	4507
Bill	Grass	BG	4444	4452	4443	4450	4437	4445	4438	4445
Bob	Woods	BW								
Christian	Delerue	CD	4449	4459	4451	4458.5	4443.5	4452	4444	4450.5
Dave	Cundy	DC	5525.5	5530.5	5525	5530	5518	5523	5519	5524
David	Katz	DK								
Doug	Loeffler	DL	4726	4735	4729	4734	4717	4722	4715	4722
Dusty	Lewis	DL2	4672.5	4682.5	4670	4679	4666	4677	4668	4678
Don	Shepan	DS	4584.5	4589.5	4584	4590	4582	4588	4583	4588.5
Dave	Yaeger	DY	5313	5323	5314	5324	5306	5314	5307.5	5315
Ed	Prytherch	EP	4877	4886	4879	4885	4870	4876	4872	4880
Gerry	Rahill	GR	4670	4679	4675	4681	4663	4674	4671	4676
Hugh	Jones	HJ	4448	4454	4448	4454	4446	4451	4446	4451
Isabelle	Marechal	IM	4761	4771	4761	4769	4756	4761	4755	4762
John	Disley	JD	5261	5270.5	5261	5269.5	5265	5274	5266.5	5273
JF	Delasalle	JFD	4709	4715	4708	4715	4701	4708	4701	4709
Jean-Marie	Grall	JMG	4839	4849	4840	4849	4836	4843	4835	4843
Jay	Wight	JW	4474	4486	4473	4485	4476	4480	4474	4480
Luciano	Ramirez	LRG	5516	5521	5514	5521	5507	5515	5507	5515
Mike	Wickiser	MW	4552	4556	4550	4557	4549	4556	4549	4557
Norrie	Williamson	NW	5262	5268	5262.5	5267	5263	5267.5	5261.5	5268
Pete	Riegel	PR	4794	4801	4794	4799.5	4789	4793	4789	4792.5
Ryan	Lamppa	RL	5381	5390	5381	5390	5379	5385.5	5379	5386
Rodolfo	Martinez	RMF	5610	5626	5611	5624	5609	5617	5611	5619
Scott	Hubbard	SH	4562	4569	4562	4568	4562	4567	4562	4567
Woody	Cornwell	WC	5380	5387.5	5380.5	5388	5376	5382.5	5377.5	5384

			Ref Clarke	5 km	10 km	15 km	20 km	25 km	30 km	35 km	40 km	Ref Clarke
Andy	Beach	AB	4000	37728	86188	33924	60500					
Bob	Baumel	BB	268208	308547	366652	424806	482942	540944	598957	657009	715759	733751
Bernie	Conway	BC	45000	77604	124556	171534	218510	265382	312256	359160	406632	421172
Bill	Grass	BG	11646	43792	90089	136420	182754	228979	275199	321461	368287	382597
Bob	Woods	BW	76880									
Christian	Delerue	CD	70500	102670	148987	195353	241699	287955	334210	380497	427348	441688
Dave	Cundy	DC	58370	98321	155835	213386	270927	328342	385758	443207	501373	519182
David	Katz	DK	97000	30522	78803	27114	75427					
Doug	Loeffler	DL	14300	48484	97713	146984	196254	245413	294579	343822	393627	408846
Dusty	Lewis	DL2	39600	73421	122116	170847	219605	268262	316905	365589	414846	429927
Don	Shepan	DS	0	33147	80877	128650	176402	224055	271722	319429	367725	382506
Dave	Yaeger	DY	70000	108408	163718	219067	274424	329653	384889	440154	496096	513204
Ed	Prytherch	EP	8000	43266	94043	144836	195621	246310	297006	347752	399119	414833
Gerry	Rahill	GR	38700	72502	121163	169849	218525	267111	315705	364341	413580	428659
Hugh	Jones	HJ	30000	62158	108452	154774	201075	247285	293507	339799	386616	400950
Isabelle	Marechal	IM	26400	60815	110390	159988	209555	259025	308486	357990	408103	423441
John	Disley	JD	56300	94387	149210	204087	258981	313753	368528	423358	478820	495778
JF	Delasalle	JFD	43500	77542	126560	175622	224677	273629	322587	371574	421160	436311
Jean-Marie	Grall	JMG	20000	55024	105438	155864	206315	256673	307034	357431	408438	424043
Jay	Wight	JW	8077	40499	87197	133914	180635	227257	273887	320547	367777	382231
Luciano	Ramirez	LRG	377000	416899	474361	531856	589374	646746	704139	761568	819700	837479
Mike	Wickiser	MW	36000	68911	116302	163726	211156	258482	305828	353206	401164	415842
Norrie	Williamson	NW	30600	68660	123458	178303	233139	287864	342600	397398	452868	469827
Pete	Riegel	PR	89770	124433	174339	224282	274191	324015	373831	423672	474135	489591
Ryan	Lamppa	RL	89938	128859	184919	241005	297086	353047	409017	465031	521734	539085
Rodolfo	Martinez	RMF	520696	561302	619807	678369	736934	795365	853800	912293	971487	989586
Scott	Hubbard	SH	14000	46996	94541	142106	189668	237139	284618	332125	380214	394943
Woody	Cornwell	WC	91877	130778	186799	242852	298889	354816	410743	466730	523423	540768

IN - STADIUM MEASUREMENTS
May 25, 1996

Calculations below contain 1.001 Short Course Prevention Factor except as noted.

Ref Clarke to Finish			Start to Ref Clarke			Lap Length		
AB	652.79		DK	339.30		DK	396.66	
BW	654.18		JFD	340.38		WC	398.25	
DK	655.46		HJ	340.47		DS	398.28	
NW	657.36		JMG	340.52		DC	398.35	
HJ	657.42		DY	340.54		HJ	398.40	
DS	657.46		DS	340.56		GR	398.49	
DY	657.48		DC	340.61		NW	398.52	
DC	657.61		SH	340.63		RMF	398.54	
WC	657.81		BG	340.78		DY	398.56	
BG	657.82		CD	340.87		PR	398.57	
JFD	657.85		RMF	340.90		SH	398.61	
CD	657.85		PR	340.93		BG	398.62	
SH	658.05		BB	340.96		EP	398.70	
BB	658.16	**median**	GR	340.98	**median**	JFD	398.74	**median**
IM	658.24		WC	340.99		IM	398.90	
JMG	658.26		EP	341.04		CD	399.08	
MW	658.29		MW	341.06		BC	399.08	
JD	658.38		IM	341.11		AB	399.11	
EP	658.47		AB	341.16		LRG	399.12	
GR	658.54		NW	341.18		BW	399.21	
PR	658.65		LRG	341.20		BB	399.25	
LRG	658.74		BC	341.25		MW	399.26	
RMF	658.83		JD	341.27		JD	399.26	
BC	659.12		DL	341.43		JW	399.39	
JW	659.19		JW	341.76		JMG	399.55	
DL2	659.93		DL2	341.87		DL	400.12	
DL	660.00		BW	341.95		DL2	400.20	

Median lap length as measured by riders: 398.74 with 1.001
399.14 without 1.001

The lap length of 400 m determined by the Course Surveyor is accepted as accurate in these calculations.

400 m, with 1.001 applied is 399.6 m. 3 laps is 1198.80 m.

Lengths used in subsequent calculations:

Start to Ref Clarke	340.98
Ref Clarke to Finish	658.16
3 laps of track	1198.80 (Includes 1.001)

Total Start to Ref Clarke: 1539.78
Total Ref Clarke to Finish: 658.16

PR 24

RESULTS OF MEASUREMENT

The measurements shown below were calculated based on a calibration course length of 480.71 meters
The Short Course Prevention Factor (SCPF = 1.001) is included in the calculation
The average constant was used. All measurements are in meters.
Because RL did not ride in the stadium, being a data-keeper, the median of
all stadium measurements was used as substitute data for him.

Measurements in alphabetical order of measurer abbreviations

Start to Clarke		Clarke to 5 km		5 km to 10 km		10 km to 15 km		15 km to 20 km		20 km to 25 km	
BB	1539.76	BB	3469.70	BB	4997.82	BB	5002.03	BB	5000.48	BB	4988.96
BC	1540.05	BC	3471.95	BC	4999.85	BC	5002.62	BC	5002.40	BC	4991.33
BG	1539.58	BG	3473.58	BG	5002.69	BG	5006.36	BG	5006.69	BG	4994.91
CD	1539.67	CD	3470.95	CD	4997.33	CD	5002.62	CD	5000.46	CD	4990.75
DC	1539.41	DC	3472.91	DC	4999.65	DC	5002.87	DC	5002.00	DC	4991.04
DL	1540.23	DL	3474.32	DL	5003.44	DL	5007.70	DL	5007.60	DL	4996.32
DL2	1540.67	DL2	3474.84	DL2	5003.03	DL2	5006.73	DL2	5009.50	DL2	4999.13
DS	1539.36	DS	3470.90	DS	4997.91	DS	5002.42	DS	5000.22	DS	4989.85
DY	1539.34	DY	3470.59	DY	4997.87	DY	5001.40	DY	5002.12	DY	4990.55
EP	1539.84	EP	3471.78	EP	4998.77	EP	5000.35	EP	4999.56	EP	4990.11
GR	1539.78	GR	3473.26	GR	5000.07	GR	5002.64	GR	5001.61	GR	4992.37
HJ	1539.27	HJ	3470.58	HJ	4996.18	HJ	4999.20	HJ	4996.94	HJ	4987.12
IM	1539.91	IM	3470.62	IM	4999.45	IM	5001.77	IM	4998.65	IM	4988.86
JD	1540.07	JD	3472.29	JD	4998.07	JD	5002.99	JD	5004.54	JD	4993.42
JFD	1539.18	JFD	3472.20	JFD	4999.71	JFD	5004.20	JFD	5003.49	JFD	4992.98
JMG	1539.32	JMG	3473.86	JMG	5000.32	JMG	5001.51	JMG	5003.99	JMG	4994.77
JW	1540.56	JW	3476.61	JW	5007.43	JW	5009.47	JW	5009.90	JW	4999.28
LRG	1540.00	LRG	3474.60	LRG	5004.07	LRG	5006.95	LRG	5008.95	LRG	4996.24
MW	1539.86	MW	3471.11	MW	4998.31	MW	5001.79	MW	5002.43	MW	4991.46
NW	1539.98	NW	3471.56	NW	4998.28	NW	5002.57	NW	5001.75	NW	4991.62
PR	1539.73	PR	3472.30	PR	4999.24	PR	5002.94	PR	4999.54	PR	4991.02
RL	1539.78	RL	3471.63	RL	5000.37	RL	5002.69	RL	5002.24	RL	4991.54
RMF	1539.70	RMF	3472.34	RMF	5002.93	RMF	5007.81	RMF	5008.06	RMF	4996.60
SH	1539.43	SH	3471.21	SH	5001.79	SH	5003.89	SH	5003.57	SH	4994.00
WC	1539.79	WC	3471.09	WC	4998.69	WC	5001.55	WC	5000.12	WC	4990.30

25 km to 30 km		30 km to 35 km		35 km to 40 km		40 km to Clarke		Clarke to Finish		Total Course	
BB	4989.90	BB	4993.26	BB	5053.30	BB	1547.56	BB	658.16	BB	42240.92
BC	4991.54	BC	4994.74	BC	5055.22	BC	1548.34	BC	659.12	BC	42257.15
BG	4994.37	BG	4998.91	BG	5059.85	BG	1546.29	BG	657.82	BG	42281.03
CD	4990.64	CD	4994.09	CD	5054.95	CD	1547.20	CD	657.85	CD	42246.50
DC	4991.13	DC	4994.00	DC	5056.33	DC	1548.12	DC	657.61	DC	42255.06
DL	4997.03	DL	5004.86	DL	5061.98	DL	1546.80	DL	660.00	DL	42300.28
DL2	4997.69	DL2	5001.90	DL2	5060.77	DL2	1549.45	DL2	659.93	DL2	42303.64
DS	4991.32	DS	4995.50	DS	5057.18	DS	1547.75	DS	657.46	DS	42249.87
DY	4991.19	DY	4993.81	DY	5054.98	DY	1545.90	DY	657.48	DY	42245.22
EP	4990.80	EP	4995.72	EP	5056.85	EP	1546.97	EP	658.47	EP	42249.22
GR	4993.19	GR	4997.50	GR	5059.46	GR	1549.42	GR	658.54	GR	42267.84
HJ	4988.41	HJ	4995.97	HJ	5052.62	HJ	1546.97	HJ	657.42	HJ	42230.67
IM	4987.96	IM	4992.29	IM	5053.71	IM	1546.78	IM	658.24	IM	42238.24
JD	4993.69	JD	4998.71	JD	5056.32	JD	1546.02	JD	658.38	JD	42264.50
JFD	4993.59	JFD	4996.55	JFD	5057.65	JFD	1545.36	JFD	657.85	JFD	42262.78
JMG	4995.06	JMG	4998.63	JMG	5059.14	JMG	1547.78	JMG	658.26	JMG	42272.65
JW	5000.14	JW	5003.35	JW	5064.48	JW	1549.90	JW	659.19	JW	42320.30
LRG	4998.06	LRG	5001.20	LRG	5062.42	LRG	1548.28	LRG	658.74	LRG	42299.51
MW	4993.57	MW	4996.94	MW	5058.11	MW	1548.08	MW	658.29	MW	42259.96
NW	4992.62	NW	4998.28	NW	5059.57	NW	1546.88	NW	657.36	NW	42260.47
PR	4990.22	PR	4992.73	PR	5055.03	PR	1548.28	PR	658.65	PR	42249.68
RL	4992.34	RL	4996.27	RL	5057.72	RL	1547.65	RL	658.16	RL	42260.40
RMF	4996.95	RMF	5001.91	RMF	5061.85	RMF	1547.70	RMF	658.83	RMF	42294.68
SH	4994.84	SH	4997.79	SH	5059.01	SH	1549.51	SH	658.05	SH	42273.10
WC	4990.30	WC	4995.66	WC	5058.65	WC	1547.67	WC	657.81	WC	42251.64

Measurements in order of measured length - All measurements include 1.001 SCPF.

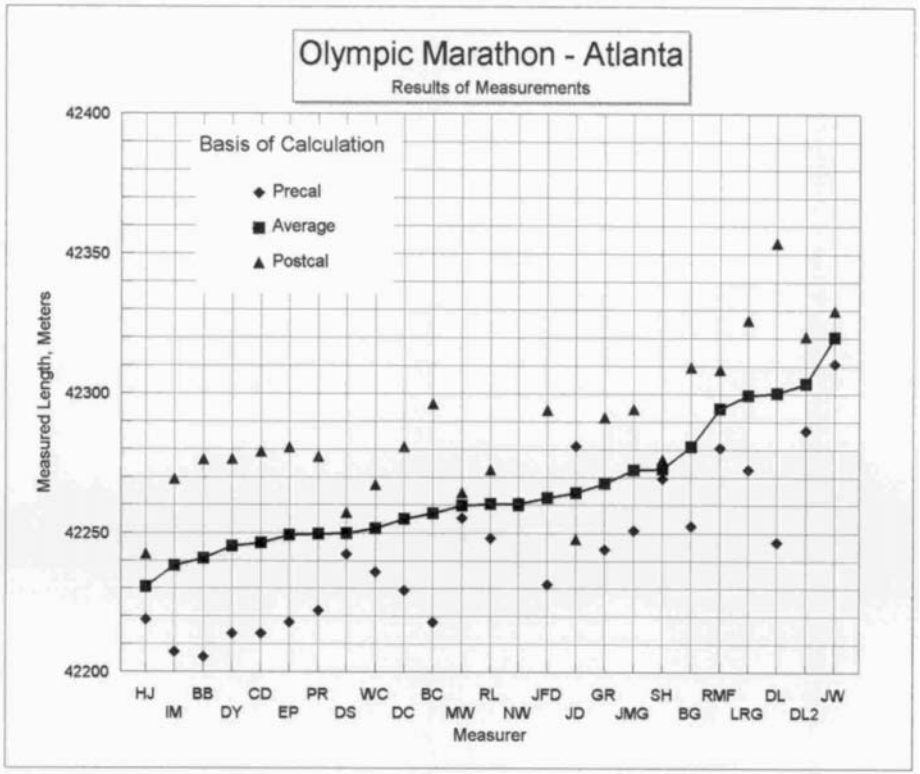
Start to Clarke		Clarke to 5 km		5 km to 10 km		10 km to 15 km		15 km to 20 km		20 km to 25 km	
JFD	1539.18	BB	3469.70	HJ	4996.18	HJ	4999.20	HJ	4996.94	HJ	4987.12
HJ	1539.27	HJ	3470.58	CD	4997.33	EP	5000.35	IM	4998.65	IM	4988.86
JMG	1539.32	DY	3470.59	BB	4997.82	DY	5001.40	PR	4999.54	BB	4988.96
DY	1539.34	IM	3470.62	DY	4997.87	JMG	5001.51	EP	4999.56	DS	4989.85
DS	1539.36	DS	3470.90	DS	4997.91	WC	5001.55	WC	5000.12	EP	4990.11
DC	1539.41	CD	3470.95	JD	4998.07	IM	5001.77	DS	5000.22	WC	4990.30
SH	1539.43	WC	3471.09	NW	4998.28	MW	5001.79	CD	5000.46	DY	4990.55
BG	1539.58	MW	3471.11	MW	4998.31	BB	5002.03	BB	5000.48	CD	4990.75
CD	1539.67	SH	3471.21	WC	4998.69	DS	5002.42	GR	5001.61	PR	4991.02
RMF	1539.70	NW	3471.56	EP	4998.77	NW	5002.57	NW	5001.75	DC	4991.04
PR	1539.73	RL	3471.63	PR	4999.24	BC	5002.62	DC	5002.00	BC	4991.33
BB	1539.76	EP	3471.78	IM	4999.45	CD	5002.62	DY	5002.12	MW	4991.46
GR	1539.78	BC	3471.95	DC	4999.65	GR	5002.64	RL	5002.24	RL	4991.54
RL	1539.78	JFD	3472.20	JFD	4999.71	RL	5002.69	BC	5002.40	NW	4991.62
WC	1539.79	JD	3472.29	BC	4999.85	DC	5002.87	MW	5002.43	GR	4992.37
EP	1539.84	PR	3472.30	GR	5000.07	PR	5002.94	JFD	5003.49	JFD	4992.98
MW	1539.86	RMF	3472.34	JMG	5000.32	JD	5002.99	SH	5003.57	JD	4993.42
IM	1539.91	DC	3472.91	RL	5000.37	SH	5003.89	JMG	5003.99	SH	4994.00
NW	1539.98	GR	3473.26	SH	5001.79	JFD	5004.20	JD	5004.54	JMG	4994.77
LRG	1540.00	BG	3473.58	BG	5002.69	BG	5006.36	BG	5006.69	BG	4994.91
BC	1540.05	JMG	3473.86	RMF	5002.93	DL2	5006.73	DL	5007.60	LRG	4996.24
JD	1540.07	DL	3474.32	DL2	5003.03	LRG	5006.95	RMF	5008.06	DL	4996.32
DL	1540.23	LRG	3474.60	DL	5003.44	DL	5007.70	LRG	5008.95	RMF	4996.60
JW	1540.56	DL2	3474.84	LRG	5004.07	RMF	5007.81	DL2	5009.50	DL2	4999.13
DL2	1540.67	JW	3476.61	JW	5007.43	JW	5009.47	JW	5009.90	JW	4999.28
Median, m	1539.78		3471.95		4999.65		5002.64		5002.24		4991.54
Average, m	1539.77		3472.27		5000.13		5003.48		5003.07		4992.58
Std Dev, m	0.37		1.61		2.54		2.51		3.49		3.08
Std Dev, m/km	0.24		0.46		0.51		0.50		0.70		0.62
High, m	1540.67		3476.61		5007.43		5009.47		5009.90		4999.28
Low, m	1539.18		3469.70		4996.18		4999.20		4996.94		4987.12

25 km to 30 km		30 km to 35 km		35 km to 40 km		40 km to Clarke		Clarke to Finish		Total Course	
IM	4987.96	IM	4992.29	HJ	5052.62	JFD	1545.36	NW	657.36	HJ	42230.67
HJ	4988.41	PR	4992.73	BB	5053.30	DY	1545.90	HJ	657.42	IM	42238.24
BB	4989.90	BB	4993.26	IM	5053.71	JD	1546.02	DS	657.46	BB	42240.92
PR	4990.22	DY	4993.81	CD	5054.95	BG	1546.29	DY	657.48	DY	42245.22
WC	4990.30	DC	4994.00	DY	5054.98	IM	1546.78	DC	657.61	CD	42246.50
CD	4990.64	CD	4994.09	PR	5055.03	DL	1546.80	WC	657.81	EP	42249.22
EP	4990.80	BC	4994.74	BC	5055.22	NW	1546.88	BG	657.82	PR	42249.68
DC	4991.13	DS	4995.50	JD	5056.32	HJ	1546.97	JFD	657.85	DS	42249.87
DY	4991.19	WC	4995.66	DC	5056.33	EP	1546.97	CD	657.85	WC	42251.64
DS	4991.32	EP	4995.72	EP	5056.85	CD	1547.20	SH	658.05	DC	42255.06
BC	4991.54	HJ	4995.97	DS	5057.18	BB	1547.56	BB	658.16	BC	42257.15
RL	4992.34	RL	4996.27	JFD	5057.65	RL	1547.65	RL	658.16	MW	42259.96
NW	4992.62	JFD	4996.55	RL	5057.72	WC	1547.67	IM	658.24	RL	42260.40
GR	4993.19	MW	4996.94	MW	5058.11	RMF	1547.70	JMG	658.26	NW	42260.47
MW	4993.57	GR	4997.50	WC	5058.65	DS	1547.75	MW	658.29	JFD	42262.78
JFD	4993.59	SH	4997.79	SH	5059.01	JMG	1547.78	JD	658.38	JD	42264.50
JD	4993.69	NW	4998.28	JMG	5059.14	MW	1548.08	EP	658.47	GR	42267.84
BG	4994.37	JMG	4998.63	GR	5059.46	DC	1548.12	GR	658.54	JMG	42272.65
SH	4994.84	JD	4998.71	NW	5059.57	PR	1548.28	PR	658.65	SH	42273.10
JMG	4995.06	BG	4998.91	BG	5059.85	LRG	1548.28	LRG	658.74	BG	42281.03
RMF	4996.95	LRG	5001.20	DL2	5060.77	BC	1548.34	RMF	658.83	RMF	42294.68
DL	4997.03	DL2	5001.90	RMF	5061.85	GR	1549.42	BC	659.12	LRG	42299.51
DL2	4997.69	RMF	5001.91	DL	5061.98	DL2	1549.45	JW	659.19	DL	42300.28
LRG	4998.06	JW	5003.35	LRG	5062.42	SH	1549.51	DL2	659.93	DL2	42303.64
JW	5000.14	DL	5004.86	JW	5064.48	JW	1549.90	DL	660.00	JW	42320.30
Median, m	4992.62		4996.55		5057.72		1547.67		658.24		42260.40
Average, m	4993.06		4997.22		5057.89		1547.63		658.31		42265.41
Std Dev, m	3.06		3.30		2.98		1.14		0.70		22.44
Std Dev, m/km	0.61		0.66		0.59		0.74		1.06		0.53
High, m	5000.14		5004.86		5064.48		1549.90		660.00		42320.30
Low, m	4987.96		4992.29		5052.62		1545.36		657.36		42230.67

SUMMARY OF INDIVIDUAL MEASUREMENTS

Values below include 1.001 SCPF

Measurer	Length by Larger	Length by Precal	Length by Average	Length by Postcal	Range, m
HJ	42218.81	42218.81	42230.67	42242.54	23.73
IM	42207.22	42207.22	42238.24	42269.31	62.09
BB	42205.48	42205.48	42240.92	42276.41	70.93
DY	42213.95	42213.95	42245.22	42276.55	62.60
CD	42213.90	42213.90	42246.50	42279.16	65.25
EP	42217.85	42217.85	42249.22	42280.64	62.79
PR	42222.16	42222.16	42249.68	42277.24	55.08
DS	42242.38	42242.38	42249.87	42257.35	14.97
WC	42235.94	42235.94	42251.64	42267.35	31.40
DC	42229.26	42229.26	42255.06	42280.89	51.63
BC	42217.95	42217.95	42257.15	42296.43	78.48
MW	42255.32	42255.32	42259.96	42264.60	9.28
RL	42248.14	42248.14	42260.40	42272.66	24.53
NW	42259.97	42260.97	42260.47	42259.97	1.00
JFD	42231.39	42231.39	42262.78	42294.22	62.83
JD	42247.96	42281.06	42264.50	42247.96	33.10
GR	42244.11	42244.11	42267.84	42291.59	47.48
JMG	42250.84	42250.84	42272.65	42294.49	43.65
SH	42269.62	42269.62	42273.10	42276.57	6.95
BG	42252.51	42252.51	42281.03	42309.59	57.08
RMF	42280.56	42280.56	42294.68	42308.80	28.24
LRG	42272.68	42272.68	42299.51	42326.37	53.69
DL	42246.63	42246.63	42300.28	42354.06	107.43
DL2	42286.68	42286.68	42303.64	42320.62	33.94
JW	42310.85	42310.85	42320.30	42329.75	18.90



Length Chosen	Number of Measurers
42245	12
42250	15
42255	17
42259	17
42260	18
42261	17
42265	16
42270	15
42275	15
42280	10

The chart to the left shows how many measurement ranges included the chosen length.

Why is 42260 a good estimate?

1. The median of all individual full-course measurements was 42260.4 m.
2. The sum of the medians of the individual intervals was 42260.6
3. 42260 is included within the range of more measurers than any other value.
4. 42260 is the average value for the 4 measurers who had least calibration change, thus may be presumed to have used the most precise equipment.

PR 27

ESTIMATES OF DEVIATION FROM THE CERTIFIED ROUTE

The course as certified had many pages of coning restrictions, and there was insufficient time to put these restrictions in the heads of the validators. The main place where this was a problem was on Peachtree Road east of Piedmont. Pete asked the measurers to "stay to the right of all yellow lines" and otherwise use the entire road. This gave them a simple rule they could comprehend.

Interval		**Subtract from our measurement**
Start to 5	Parked car at Clarke/Capitol	1
5 to 10	Parked cars at Auburn/Howell	1
10 to 15	Parked cars on Piedmont	3
15 to 20	Measured within a right-hand turn lane excluded from the course. Lane is taken to be 4 m wide, and to have 30 degrees of curvature.	-2
20 to 25	Did not go to center, but stayed right of yellow line	2
25 to 30	Used excluded turn lane on right	-1
25 to 30	Did not go to center, but stayed right of yellow line twice	4
25 to 30	Intruded into center lane twice where yellow line was staggered	-1
25 to 30	Misc parked cars and traffic	3
30 to 35	Misc parked cars and traffic	1
35 to 40	Misc parked cars	1
40 to Finish	Parked car at Clarke/Capitol	1
Total		13

The route as certified is 13 m shorter than the route validated, by the above reckoning.

Course as measured = 42260.6 m

Course as certified = 42247.6 m

Necessary adjustment to overall length = -52.6 meters

The turnaround will be moved 26.3 meters to shorten the course by 52.6 m.

SUMMARY OF RECOMMENDED COURSE ADJUSTMENTS

	Measured Length, m	Deviation Estimate	Deviated Length	Turn around adjustment	Length after Moving TA	Cumula-tive Length	Desired Distance	Required Adjustment meters	Required Adjustment feet
Start						0.0	0	0.0	0.0
5 km	5011.7	-1	5010.7		5010.7	5010.7	5000	-10.7	-35.2
10 km	4999.6	-1	4998.6		4998.6	10009.4	10000	-9.4	-30.8
15 km	5002.6	-3	4999.6		4999.6	15009.0	15000	-9.0	-29.6
20 km	5002.2	2	5004.2		5004.2	20013.3	20000	-13.3	-43.5
25 km	4991.5	-2	4989.5	-52.6	4936.9	24950.2	25000	49.8	163.4
30 km	4992.6	-5	4987.6		4987.6	29937.8	30000	62.2	204.0
35 km	4996.6	-1	4995.6		4995.6	34933.4	35000	66.6	218.6
40 km	5057.7	-1	5056.7		5056.7	39990.1	40000	9.9	32.5
Finish	2205.9	-1	2204.9		2204.9	42195.0	42195	0.0	0.0
Total	42260.6	-13.0	42247.6		42195.0				

OLYMPIC MARATHON COURSE - ATLANTA
USATF Certified Course GA 96012 WC

Recommended Adjustments Based on Group Validation

1) Move the 5 km mark 10.7 m (35 feet) toward the START
2) Move the 10 km mark 9.4 m (31 feet) toward the START
3) Move the 15 km mark 9.0 m (30 feet) toward the START
4) Move the 20 km mark 13.3 m (44 feet) toward the START
5) Move the TURNAROUND 26.3 m (86 feet) toward the START & FINISH. This will shorten the course by 52.6 m.
6) Move the 25 km mark 49.8 m (163 feet) toward the FINISH
7) Move the 30 km mark 62.2 m (204 feet) toward the FINISH
8) Move the 35 km mark 66.6 m (219 feet) toward the FINISH
9) Move the 40 km mark 9.9 m (33 feet) toward the FINISH

START & FINISH remain unchanged.

Notes:
When all of the above adjustments have been made, the ADJUSTED points may be used as benchmarks to establish other intermediate kilometer and mile points.

All course restrictions as defined by Jack Grosko may be adhered to. Nothing else need change except the locations of the points above.

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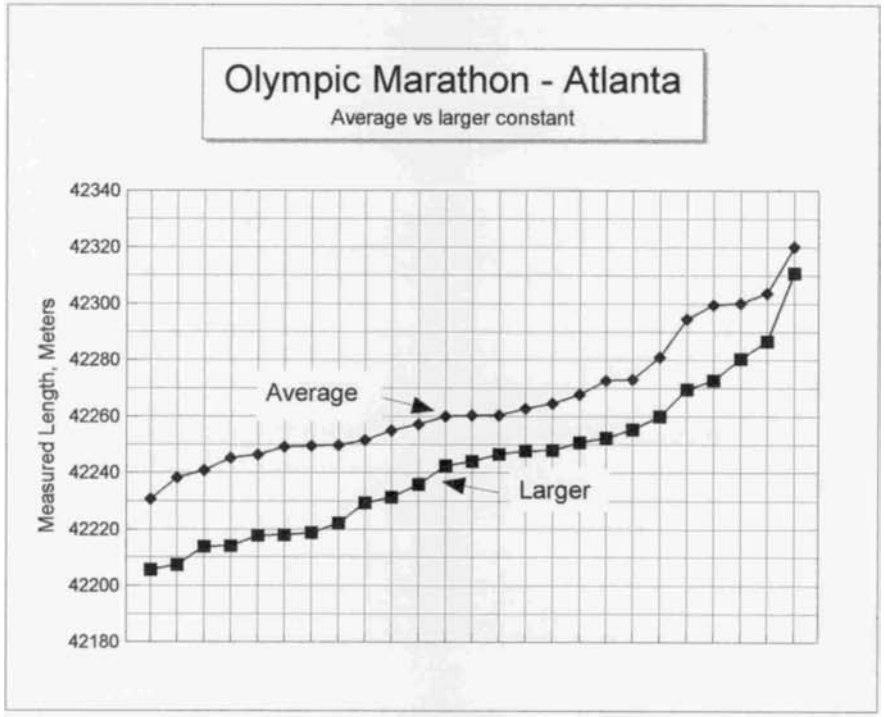
AVERAGE VS LARGER CONSTANT



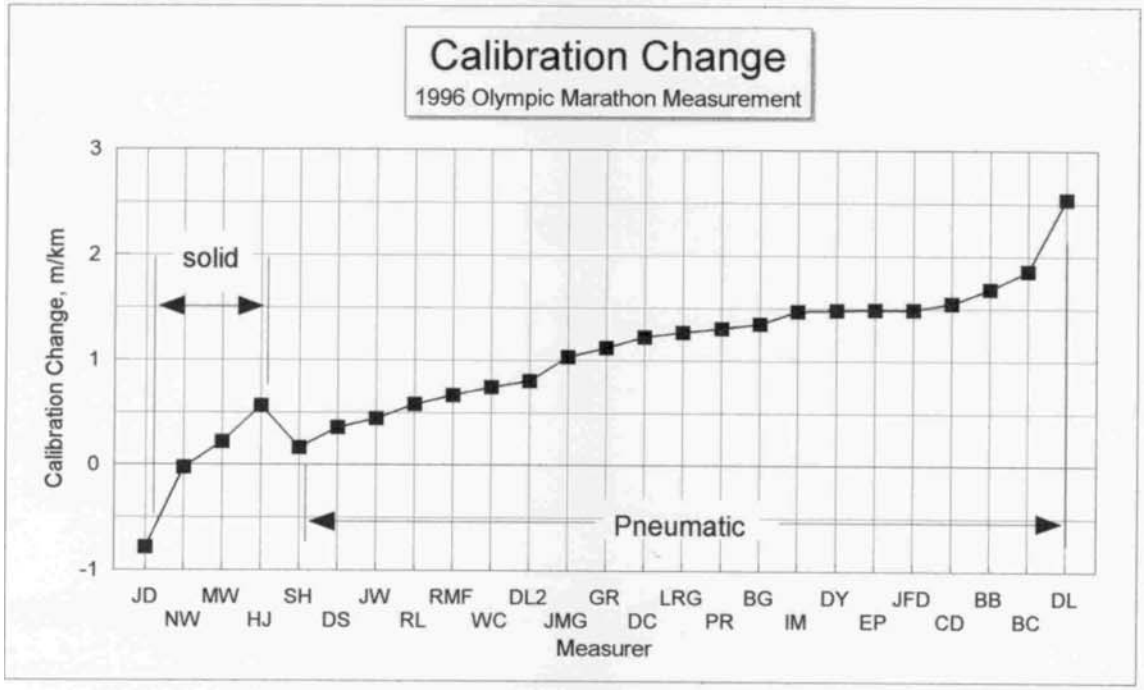
Measurer	Length by Larger Constant
BB	42205.48
IM	42207.22
CD	42213.90
DY	42213.95
EP	42217.85
BC	42217.95
HJ	42218.81
PR	42222.16
DC	42229.26
JFD	42231.39
WC	42235.94
DS	42242.38
GR	42244.11
DL	42246.63
JD	42247.96
RL	42248.14
JMG	42250.84
BG	42252.51
MW	42255.32
NW	42259.97
SH	42269.62
LRG	42272.68
RMF	42280.56
DL2	42286.68
JW	42310.85

MEDIAN

Measurer	Length by Average Constant
HJ	42230.67
IM	42238.24
BB	42240.92
DY	42245.22
CD	42246.50
EP	42249.22
PR	42249.68
DS	42249.87
WC	42251.64
DC	42255.06
BC	42257.15
MW	42259.96
RL	42260.40
NW	42260.47
JFD	42262.78
JD	42264.50
GR	42267.84
JMG	42272.65
SH	42273.10
BG	42281.03
RMF	42294.68
LRG	42299.51
DL	42300.28
DL2	42303.64
JW	42320.30

CHANGE OF CALIBRATION CONSTANT

Rider	Precal Counts/km	Postcal Counts/km	Average Counts/km	Change Counts/km	Change m/km	
JD	10964.66	10973.25	10968.95	-8.59	-0.783	solid tire
NW	10963.36	10963.62	10963.49	-0.26	-0.024	solid tire
MW	9482.54	9480.46	9481.50	2.08	0.220	solid tire
HJ	9268.58	9263.37	9265.97	5.21	0.562	solid tire
SH	9506.49	9504.93	9505.71	1.56	0.164	
DS	9551.78	9548.39	9550.09	3.38	0.354	
JW	9327.92	9323.76	9325.84	4.16	0.446	
RL	11214.54	11208.03	11211.29	6.51	0.580	
RMF	11698.16	11690.36	11694.26	7.80	0.667	
WC	11211.42	11203.09	11207.25	8.33	0.743	
DL2	9737.10	9729.30	9733.20	7.81	0.802	
JMG	10087.46	10077.05	10082.26	10.41	1.033	
GR	9737.63	9726.69	9732.16	10.93	1.123	
DC	11510.76	11496.70	11503.73	14.06	1.222	
LRG	11490.45	11475.88	11483.17	14.58	1.270	
PR	9989.33	9976.32	9982.83	13.01	1.304	
BG	9260.77	9248.27	9254.52	12.49	1.350	
IM	9923.48	9908.90	9916.19	14.57	1.470	
DY	11075.02	11058.62	11066.82	16.40	1.482	
EP	10165.55	10150.46	10158.00	15.10	1.486	
JFD	9811.55	9796.97	9804.26	14.58	1.487	
CD	9275.60	9261.29	9268.45	14.32	1.545	
BB	11635.96	11616.44	11626.20	19.52	1.679	
BC	9399.51	9382.07	9390.79	17.44	1.857	
DL	9851.64	9826.65	9839.14	24.99	2.540	



PR 32

VARIATION IN RIDING THE CALIBRATION COURSE

On May 25, each measurement was preceded and followed by only a single calibration ride, thus little can be said about variation and change. On May 26, the large course ride was pre-calibrated and post-calibrated with four rides by each measurer. This provides some meat for analysis. The comparison of the four rides in each calibration is complicated by the fact that two rides were done on a calibration course of one length, and the other two on a different calibration course of another, slightly different, length.

To resolve the difference, the rides on the two different courses were first multiplied by factors to convert the counts to an equivalent four counts on a calibration course of a single length. An example follows:

Data Obtained by BB

	Counts on West 480.35 m	Counts on East 481.06 m	Converted Counts on Average 480.71 m	
Pre 1	5583		5587.18	Precal range =
Pre 2		5592	5587.93	5588.43 - 5587.18 =
Pre 3	5584		5588.18	1.25 counts
Pre 4		5592.5	5588.43	
Post 1	5574.5		5578.68	Postcal Range =
Post 2		5581	5576.94	5579.44 - 5576.94 =
Post 3	5575		5579.18	2.50 counts
Post 4		5583.5	5579.44	

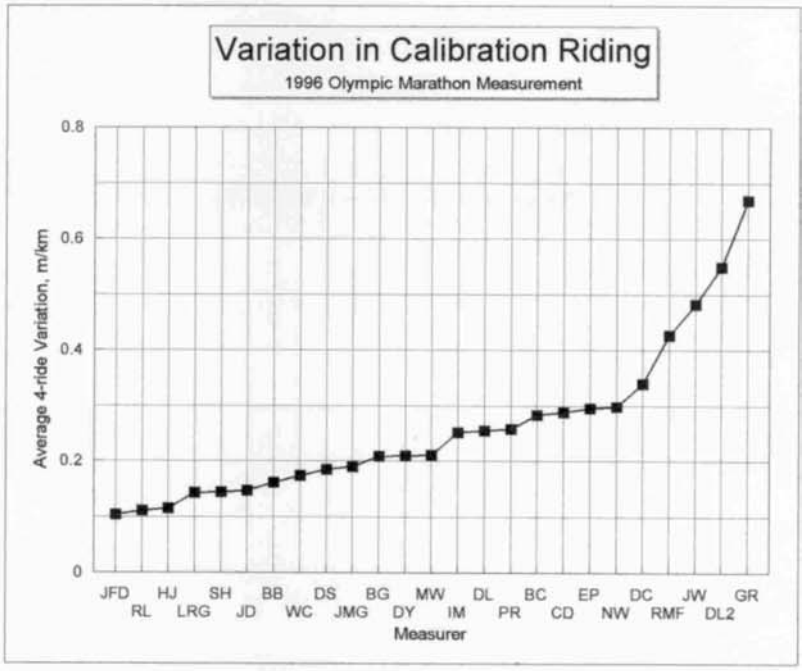
Average variation in 4 rides = (1.25 + 2.50)/2 = 1.875 counts
Average constant = 11626.20 counts/km

Each rider had a different constant, thus a count for one rider is not the same as a count for another. To permit an accurate comparison, the count variation was converted to meters/km, which yields the same standard for all. In the specific case of BB, this calculates to:

Average variation in 4 rides = (1000 x 1.875)/11626.20 = 0.161 m/km

This calculation has been done for all riders, with the results shown below:

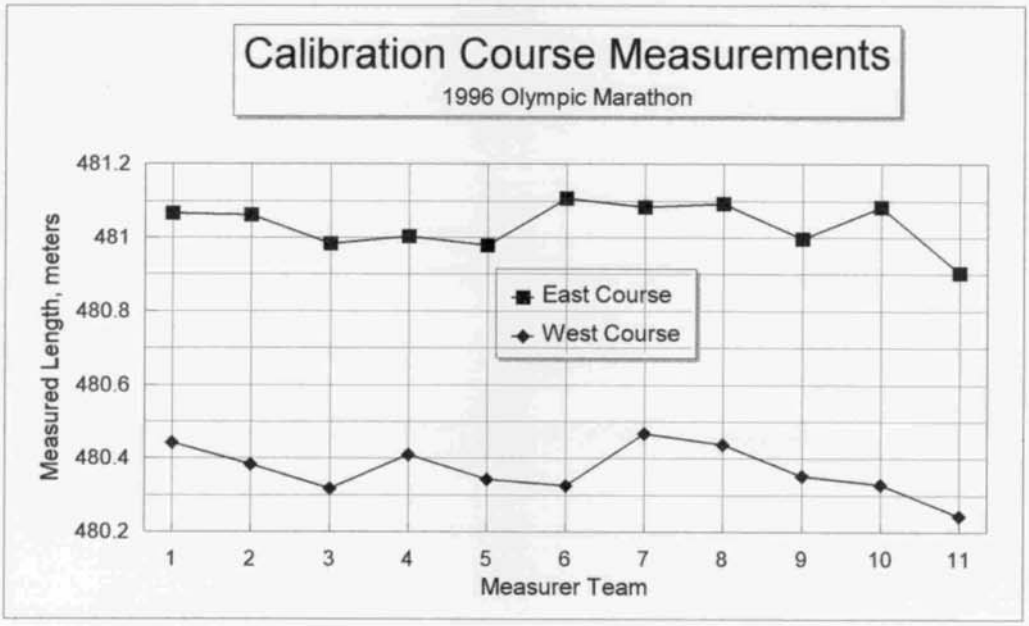
Rider	Average Variation 4 rides counts	Average Variation 4 rides m/km
JFD	1.03	0.105
RL	1.25	0.111
HJ	1.07	0.116
LRG	1.65	0.143
SH	1.37	0.144
JD	1.61	0.147
BB	1.87	0.161
WC	1.95	0.174
DS	1.77	0.186
JMG	1.92	0.191
BG	1.94	0.209
DY	2.32	0.210
MW	2.00	0.211
IM	2.49	0.252
DL	2.50	0.254
PR	2.58	0.258
BC	2.66	0.283
CD	2.68	0.289
EP	3.00	0.295
NW	3.28	0.299
DC	3.91	0.340
RMF	5.00	0.427
JW	4.50	0.482
DL2	5.35	0.549
GR	6.50	0.668



PR 33

Calibration Course Measurements

	West Calibration Course		East Calibration Course	
Team	Measurers	Corrected Length, m	Measurers	Corrected Length, m
1	BB, DL, DS, WC	480.442	BB, DL, DS, WC	481.067
2	BC, DY	480.383	BC, DY	481.062
3	DC, DL	480.318	DC, DL	480.982
4	HJ, NW	480.409	HJ, NW	481.003
5	JFD, IM	480.343	JFD, IM	480.978
6	JMG, CD	480.326	JMG, CD	481.107
7	JW, BW	480.468	JW, BW	481.084
8	MW, AB	480.437	MW, AB	481.093
9	PR, JD	480.352	PR, JD	480.997
10	RM, LR	480.329	RM, LR	481.083
11	SH, DK	480.244	SH, DK	480.903
Average		480.368		481.033
Std Dev		0.063		0.061
Std Dev, parts/10000		1.320		1.266



THE MEASUREMENT OLYMPICS

WARNING! THIS COMPARISON IS ARBITRARY AND UNFAIR! DO NOT READ FARTHER IF YOU HAVE DELICATE SENSIBILITIES!

This analysis is based on the assumption that, for each interval, the median value is absolutely correct. This is not true, but it is generally a good estimate. Think of it as being similar to decathlon tables, which are also slightly unfair.

A good measurer is both accurate and precise. Accuracy means that the measurer, on the average, obtains answers that are close to the correct value. Precision means that the measurer's work has little variation.

The following is an attempt to rank the measurement performances of all the measurers. Below are the measurements obtained on Day 2 by each measurer.

	Clarke to 5 km	5 km to 10 km	10 km to 15 km	15 km to 20 km	20 km to 25 km	25 km to 30 km	30 km to 35 km	35 km to 40 km	40 km to Clarke
BB	3469.70	4997.82	5002.03	5000.48	4988.96	4989.90	4993.26	5053.30	1547.56
BC	3471.95	4999.85	5002.62	5002.40	4991.33	4991.54	4994.74	5055.22	1548.34
BG	3473.58	5002.69	5006.36	5006.69	4994.91	4994.37	4998.91	5059.85	1546.29
CD	3470.95	4997.33	5002.62	5000.46	4990.75	4990.64	4994.09	5054.95	1547.20
DC	3472.91	4999.65	5002.87	5002.00	4991.04	4991.13	4994.00	5056.33	1548.12
DL	3474.32	5003.44	5007.70	5007.60	4996.32	4997.03	5004.86	5061.98	1546.80
DL2	3474.84	5003.03	5006.73	5009.50	4999.13	4997.69	5001.90	5060.77	1549.45
DS	3470.90	4997.91	5002.42	5000.22	4989.85	4991.32	4995.50	5057.18	1547.75
DY	3470.59	4997.87	5001.40	5002.12	4990.55	4991.19	4993.81	5054.98	1545.90
EP	3471.78	4998.77	5000.35	4999.56	4990.11	4990.80	4995.72	5056.85	1546.97
GR	3473.26	5000.07	5002.64	5001.61	4992.37	4993.19	4997.50	5059.46	1549.42
HJ	3470.58	4996.18	4999.20	4996.94	4987.12	4988.41	4995.97	5052.62	1546.97
IM	3470.62	4999.45	5001.77	4998.65	4988.86	4987.96	4992.29	5053.71	1546.78
JD	3472.29	4998.07	5002.99	5004.54	4993.42	4993.69	4998.71	5056.32	1546.02
JFD	3472.20	4999.71	5004.20	5003.49	4992.98	4993.59	4996.55	5057.65	1545.36
JMG	3473.86	5000.32	5001.51	5003.99	4994.77	4995.06	4998.63	5059.14	1547.78
JW	3476.61	5007.43	5009.47	5009.90	4999.28	5000.14	5003.35	5064.48	1549.90
LRG	3474.60	5004.07	5006.95	5008.95	4996.24	4998.06	5001.20	5062.42	1548.28
MW	3471.11	4998.31	5001.79	5002.43	4991.46	4993.57	4996.94	5058.11	1548.08
NW	3471.56	4998.28	5002.57	5001.75	4991.62	4992.62	4998.28	5059.57	1546.88
PR	3472.30	4999.24	5002.94	4999.54	4991.02	4990.22	4992.73	5055.03	1548.28
RL	3471.63	5000.37	5002.69	5002.24	4991.54	4992.34	4996.27	5057.72	1547.65
RMF	3472.34	5002.93	5007.81	5008.06	4996.60	4996.95	5001.91	5061.85	1547.70
SH	3471.21	5001.79	5003.89	5003.57	4994.00	4994.84	4997.79	5059.01	1549.51
WC	3471.09	4998.69	5001.55	5000.12	4990.30	4990.30	4995.66	5058.65	1547.67
Median, m	3471.95	4999.65	5002.64	5002.24	4991.54	4992.62	4996.55	5057.72	1547.67

DIFFERENCES FROM THE MEDIAN INTERVAL MEASUREMENT, M/KM

	Clarke to 5 km	5 km to 10 km	10 km to 15 km	15 km to 20 km	20 km to 25 km	25 km to 30 km	30 km to 35 km	35 km to 40 km	40 km to Clarke	Std Dev	Average
BB	-0.648	-0.366	-0.122	-0.352	-0.517	-0.545	-0.658	-0.874	-0.071	0.246	-0.461
BC	0.000	0.040	-0.004	0.032	-0.042	-0.216	-0.362	-0.494	0.433	0.252	-0.068
BG	0.469	0.608	0.744	0.890	0.675	0.351	0.472	0.421	-0.892	0.489	0.415
CD	-0.288	-0.464	-0.004	-0.356	-0.158	-0.397	-0.492	-0.548	-0.304	0.162	-0.334
DC	0.277	0.000	0.046	-0.048	-0.100	-0.298	-0.510	-0.275	0.291	0.249	-0.069
DL	0.683	0.758	1.011	1.072	0.958	0.883	1.663	0.842	-0.562	0.554	0.812
DL2	0.832	0.676	0.818	1.451	1.521	1.015	1.071	0.603	1.150	0.303	1.015
DS	-0.302	-0.348	-0.044	-0.404	-0.339	-0.260	-0.210	-0.107	0.052	0.145	-0.218
DY	-0.392	-0.356	-0.248	-0.024	-0.198	-0.286	-0.548	-0.542	-1.144	0.301	-0.415
EP	-0.049	-0.176	-0.458	-0.536	-0.286	-0.365	-0.166	-0.172	-0.452	0.157	-0.296
GR	0.377	0.084	0.000	-0.126	0.166	0.114	0.190	0.344	1.131	0.343	0.253
HJ	-0.395	-0.694	-0.688	-1.060	-0.885	-0.843	-0.116	-1.008	-0.452	0.293	-0.682
IM	-0.383	-0.040	-0.174	-0.718	-0.537	-0.933	-0.853	-0.793	-0.575	0.290	-0.556
JD	0.098	-0.316	0.070	0.460	0.377	0.214	0.432	-0.277	-1.066	0.461	-0.001
JFD	0.072	0.012	0.312	0.250	0.288	0.194	0.000	-0.014	-1.493	0.527	-0.042
JMG	0.550	0.134	-0.226	0.350	0.647	0.489	0.416	0.281	0.071	0.256	0.301
JW	1.342	1.556	1.365	1.531	1.551	1.506	1.361	1.337	1.441	0.088	1.443
LRG	0.763	0.884	0.862	1.341	0.942	1.090	0.931	0.929	0.394	0.238	0.904
MW	-0.242	-0.268	-0.170	0.038	-0.016	0.190	0.078	0.077	0.265	0.176	-0.005
NW	-0.112	-0.274	-0.014	-0.098	0.016	0.000	0.346	0.366	-0.510	0.259	-0.031
PR	0.101	-0.082	0.060	-0.540	-0.104	-0.481	-0.765	-0.532	0.394	0.358	-0.216
RL	-0.092	0.144	0.010	0.000	0.000	-0.056	-0.056	0.000	-0.013	0.063	-0.007
RMF	0.112	0.656	1.033	1.163	1.014	0.867	1.073	0.817	0.019	0.393	0.751
SH	-0.213	0.428	0.250	0.266	0.493	0.445	0.248	0.255	1.189	0.348	0.373
WC	-0.248	-0.192	-0.218	-0.424	-0.248	-0.465	-0.178	0.184	0.000	0.186	-0.199

		PRECISION		ACCURACY		CROSS-COUNTRY SCORING			
		Std Dev of Differences m/km	Rank	Average of Differences m/km	Rank	Sum of Ranks	Overall Place	Average Place by Country	
RL	USA	0.063	1	-0.007	3	4	1	USA	11.17
MW	USA	0.176	6	-0.005	2	8	2	CAN	12.00
DS	USA	0.145	3	-0.218	10	13	3	GBR	12.33
WC	USA	0.186	7	-0.199	8	15	4	FRA	13.25
EP	USA	0.157	4	-0.296	12	16	5	AUS	14.50
NW	GBR	0.259	13	-0.031	4	17	6	MEX	20.50
BC	CAN	0.252	11	-0.068	6	17	6		
DC	AUS	0.249	10	-0.069	7	17	6		
CD	FRA	0.162	5	-0.334	14	19	9		
JD	GBR	0.461	22	-0.001	1	23	10		
JMG	FRA	0.256	12	0.301	13	25	11		
BB	USA	0.246	9	-0.461	18	27	12		
JW	USA	0.088	2	1.443	25	27	12		
JFD	FRA	0.527	24	-0.042	5	29	14		
PR	USA	0.358	20	-0.216	9	29	14		
GR	USA	0.343	18	0.253	11	29	14		
LRG	MEX	0.238	8	0.904	23	31	17		
DY	CAN	0.301	16	-0.415	16	32	18		
IM	FRA	0.290	14	-0.556	19	33	19		
SH	USA	0.348	19	0.373	15	34	20		
HJ	GBR	0.293	15	-0.682	20	35	21		
BG	USA	0.489	23	0.415	17	40	22		
DL2	AUS	0.303	17	1.015	24	41	23		
RMF	MEX	0.393	21	0.751	21	42	24		
DL	USA	0.554	25	0.812	22	47	25		

Group Measurement Results - Statistical Summary

Category	City	Country	Year	Median Meters	Average Meters	High Meters	Low Meters	Std Dev Meters	Std Dev m/km	Number
Mixed	Nice	FRA	1993	788.63	788.81	791.98	787.36	1.164	1.476	19
Beginners	Carcavelos	POR	1996	1293.65	1295.01	1302.58	1291.21	3.219	2.486	13
Beginners	Allentown	USA	1995	1335.28	1335.69	1339.89	1333.25	1.625	1.217	26
Beginners	Montry	FRA	1990	1990.55	1991.11	2004.00	1973.30	8.406	4.223	20
Beginners	Penang	MAL	1991	2003.90	2004.55	2010.00	2000.30	2.190	1.093	20
Beginners	Mexico	MEX	1995	2283.11	2287.29	2316.79	2279.84	9.756	4.273	18
Beginners	Bogota	COL	1996	2508.55	2508.71	2521.39	2472.06	9.615	3.833	18
Mixed	Crystal Palace	GBR	1989	2592.87	2592.98	2594.43	2591.21	1.051	0.406	8
Mixed	Gap	FRA	1992	2639.87	2641.85	2648.38	2639.25	2.282	0.864	35
Beginners	Manaus	BRA	1995	2750.52	2752.25	2757.34	2749.37	2.586	0.940	12
Experts	Santa Barbara	USA	1995	2828.87	2829.06	2832.10	2825.38	1.936	0.684	11
Experts	West Jefferson	USA	1990	5018.81	5018.93	5023.29	5015.16	1.995	0.398	14
Beginners	West Jefferson	USA	1992	5020.55	5020.75	5031.40	5016.00	3.954	0.788	12
Experts	Phoenix	USA	1994	7417.74	7421.90	7431.08	7415.85	4.281	0.577	17
Experts	Seoul (IAAF)	KOR	1986	8135.20	8135.60	8143.10	8130.00	3.550	0.436	9
Mixed	Bobigny	FRA	1994	9368.87	9369.30	9376.78	9362.17	3.274	0.349	19
Mixed	Orleans	FRA	1995	9496.53	9495.97	9504.24	9492.37	3.534	0.372	11
Experts	Corbie	FRA	1995	10338.98	10339.46	10343.67	10336.16	2.429	0.235	10
Mixed	Salouel	FRA	1991	19991.39	19992.46	19995.68	19988.75	2.661	0.133	7
Mixed	London	GBR	1991	21270.10	21274.45	21295.10	21262.50	13.303	0.625	4
Mixed	London	GBR	1994	23576.71	23577.37	23590.84	23565.23	10.569	0.448	4
Experts	Los Angeles	USA	1983	30911.38	30911.02	30918.41	30905.55	3.862	0.125	13
Experts	Seoul (Koreans)	KOR	1986	31166.73	31166.14	31169.94	31162.69	2.827	0.091	13
Mixed	New York City	USA	1985	33734.39	33732.91	33742.70	33719.17	7.649	0.227	6
Experts	Pittsburgh	USA	1988	42203.49	42203.43	42215.32	42191.41	9.787	0.232	4
Experts	Columbus	USA	1991	42253.42	42257.83	42282.60	42240.54	13.895	0.329	5
Experts	Houston	USA	1991	42254.35	42254.15	42259.80	42248.10	5.035	0.119	4
Experts	Atlanta	USA	1996	42260.40	42265.41	42320.30	42230.67	22.440	0.530	27
Experts	Columbia	USA	1995	42305.13	42302.07	42315.92	42280.94	11.495	0.272	5

OVERALL ACCURACY OF THE MEASUREMENT

One way to look at the accuracy of the measurement is in a gross, overall way.

When we calibrated, we rode each calibration course 4 times each, 2 times each on precalibration, and 2 times each on postcalibration. This gave us a total of 100 rides on each calibration course. Let us look at the data:

Total counts obtained on the west calibration course:	491419.5	
Number of rides:	100	
Average count per ride:	4914.195	
Steel-taped length of the calibration course (average):	480.368	meters
Average constant obtained during the 100 rides:	10.230063	counts per meter (without 1.001)
Total counts obtained on the east calibration course:	492142.5	
Number of rides:	100	
Average count per ride:	4921.425	
Steel-taped length of the calibration course (average):	481.033	meters
Average constant obtained during the 100 rides:	10.230956	counts per meter (without 1.001)

Bicycle Measurements of the Calibration Courses:

Average count obtained on the east calibration course:	4921.425
Constant determined by riding the west course:	10.230063
Measured length of the east course:	481.075
Average count obtained on the west calibration course:	4914.195
Constant determined by riding the east course:	10.230956
Measured length of the west course:	480.326

Comparison of Measured Lengths

	By Steel Tape	By Bike	Difference Parts per 10000	Difference meters per marathon
East Calibration Course	481.033	481.075	0.873	3.68
West Calibration Course	480.368	480.326	-0.873	-3.68

Riding on each calibration course was unidirectional i.e. the west course was ridden north-to-south while the east course was ridden south-to-north.

If the marathon course had been an absolutely straight out-back, we would probably have seen a closer grouping of measurements. However, individual abilities and decisions as to the proper route, as well as individual variations in calibration, widened the window of variation.

This field remains fertile for investigation of individual measurements of the calibration courses. The above is a rough calculation, based only on average values obtained.

Riley, Park, Hayden & Associates, Inc.

RPH

Consulting Engineers & Surveyors
Atlanta • Louisville • New Orleans
Tele: (770) 447-0041

2395 Pleasantdale Road • Suite 14
Atlanta, Georgia 30340-3157
Fax: (770) 447-0410

May 14, 1996

Mr. Joe Hoekstra
Mondo, U.S.A., Inc.
250 Spring Street
Suite 2, North 101
Atlanta, Georgia 30303

Dear Joe:

We have taken the measurements necessary to verify the length of the track at the Olympic Stadium and have found the track to be 400.035 meters in length along the measurement line as set out in the Handbook of the International Amateur Athletic Federation for tracks with curbs. Also we have verified the positions of the Start Lines to be correct.

Sincerely,

Riley, Park, Hayden & Associates, Inc.

Larry W. Clark, LS
Vice President

LWC/dj

PR 39

PR 40

Certification of Accuracy and Approval of Track Computations and Field Layout

PROJECT _____ LOCATION _____

By my signature hereby attest and certify that I have personally completed all of the required calculations and computations for the above described project and that to the best of my knowledge and belief all of the attached documents showing track dimensions such as measurements are true and accurate.

Signed _____ Date 4-12-95

By my signature below, do hereby certify and attest that I personally have completed all work regarding measurements for the above described track project, and I further swear that to the best of my knowledge or ability, all measurements are accurate to within a ¼" tolerance.

Signed _____ Date 19-12-95

By my signature below do hereby certify that the above described track project is under the international rules recomended by I.A.A.F. and N.C.A.A.

Signed _____ Date _____

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

SOUTHWEST ATLANTA, GA.

(FORMERLY EAST POINT)

33084-F4-TF-024

1954
PHOTOREVISED 1983
DMA 4151 III NW—SERIES V845

PR 41

Pete Riegel
3354 Kirkham Rd
Columbus, Oh 43221

Dear Pete,

It's obvious, now that the measurement weekend is over, that a great deal of pre-planning was involved to make our jobs easier. Permission and assistance were available that shouldn't go unrecognized or unappreciated. Thanks mostly to Pete for overseeing details of the weekend, Tom and Wayne who gave up riding for notetaking and Julia Emmons for making sure we got where we needed to be and safely. Thanks also to USATF for accomodations and Jack Grosko for leading the way over 'his' layout.

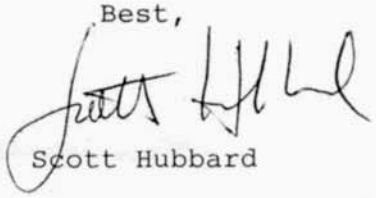
Fears of a miserable ride in the rain thankfully disappeared Saturday morning. The measuring was routine, albeit in the inspiring setting of the Olympic stadium. Now, would somebody explain to me how 25 of 27 measurers would find the Olympic track shy of 400 meters?

Except for being part of a long line of measurers, all following each other and trying to ride the SPR at the same time, Sunday's measuring was largely routine also. I think my position near the back of the bike parade cost me a good look at the SPR but can't say how much the net effect was. After looking over the final numbers it appears we had an agreeable mass measurement and I have a lot of confidence in our median distance of 42247 meters.

Validating the Olympic courses was a fun exercise and proved valuable in revealing the too-long distance between 35-40 kms. on the marathon course. I look forward to seeing how others feel about their measuring, the measurement overall and the multiple ways Pete will crunch the numbers, line them up for analysis and suggest conclusions.

6/25/96

Best,



Scott Hubbard

SH 1

WAYNE B. NICOLL
Ragged Mountain Club
Potter Place, New Hampshire 03216
(603) 735-5721

1996 Olympic Racewalk Course Measurements Report

Background - I was a volunteer for this measurement project. As a lifelong racewalker I have given special attention to the design and measurement of championship racewalk courses. I was not yet a part of the measurement community when the Olympic Games were held in Los Angeles so I missed being exposed to Bob Letson's experience there. In 1992 I gained considerable experience in measuring from a stadium to racewalk loops for the USA Olympic Trials in New Orleans. My current home is 1100 miles from Atlanta but I had lived for many years in Augusta, GA, so I knew the Atlanta area quite well. The Games organizing committee would have preferred to have had the measurements done by local measurers, and there were times when I wished I had simply let that happen.

The original venue for the racewalks was in a suburban Atlanta neighborhood east of the stadium in a very hilly area. I made two trips to Atlanta to design and measure the courses to be used for the 1994 Pan Am Cup Racewalk Championships. Woody Cornwell and Jack Grosko were both involved in the 1994 measurements. The outcome was that the courses were rejected by the international racewalk community because the courses were too hilly, a fact most obvious to the measurers from the onset. At the 1995 USATF Convention we were toured around the new racewalk venue west of the stadium. In March 1996 I returned to Atlanta, measured the 2K loop in LaGrange for the USA Olympic 50K Trials, and spent part of 2 days in Atlanta doing preliminary measurements on the current courses under severely cold conditions (20 degrees F, strong winds). I was not permitted inside the stadium at this time, although I could peer in and see the track surface was already completed. In May I returned midweek before the marathon rides and worked some more on the racewalk courses under extremely warm conditions. I had what appeared to me to be two well measured courses when I finished on Friday before the international team rode the courses on Saturday. The huge error in the women's measurements is mine, and I am still trying to find in my notes where I made the math error that created a 186 meter surplus. The error occurred after I completed the road distances and finally had the opportunity to work inside the stadium to obtain the distance from the outside fence gate to the tunnel entrance at the track. I will continue to go through reams of notes to find that error. The mistake was easily corrected on the track. The error was especially frustrating to me since my early planning notes, using that particular design option, show the starts at the approximate locations they are now. The women's 1K mark was moved forward an equal distance to a point between C and A and fits nicely with the 2 through 9 kilometer point on the women's 1K loop.

My earlier planning had been based on the assumption the walks would take one lap inside the stadium before proceeding to the finish line. The decision to proceed direct to the finish was made shortly before we arrived in May. Since I could not gain access to the stadium after we discovered the error, the final corrections were made on the track by Joe Rogers, the OG Race Walk Coordinator. I checked the adjusted locations on the track in June while observing the USA Olympic Trials Women's 10K and Men's 20K Racewalks. An IAAF Technical Committee team, led by Amadeo Francis of Puerto Rico, inspected the course and had only one suggested course modification - remove the traffic posts at the north turnaround to allow more turn space for the walkers. ACOG is working on that change. It does not affect the loop distance.

Included are two diagrams showing the relative location of reference points on the two courses. The sections on which I failed to have team members record reference points are marked by a dashed line. Each course was broken out into three measured sections - loop, outgoing, and incoming. I was not well prepared for the response when I asked the group if they would like to ride the racewalk courses. It was such a large group I ended up not insuring that they measured every segment of both race courses. In a couple cases I passed up recording at a reference point because the 15 riders were dangerously stopped on traffic lanes. I substituted my best ride of the measuring I did on May 23 and 27 where we had a missing team segment. On both courses I had the problem of depicting the need for excluding the small segment of the last loop that each walker would never walk. On the womens loop I have a column which subtracts the distance around the south turn (G1 to G2), and on the mens loop I had a reference point called K (I later re-labeled it K1) which was the entry point to the men's loop, and a point K2, which was the exit point from the men's loop and the same as the distance from point B to point K1, the loop entry point.

Several of the team measurers did not measure the track and the racewalk arcs correctly. Again I accept the responsibility for this by not having a comprehensive briefing. As Phil Henson, the ACOG stadium representative, pointed out, on the track many of the riders were well within the 30 centimeter distance from the rail holes. At the road turnaround arcs I saw several people riding the nails, when the path was actually 30 cm from the nails. On the Trials race day we placed the cones directly over the nails. There was no SCPF added for the stadium wheel measurements, but it was in all of the road measurements. When we made the final adjustments we insured the incoming/outgoing sections each totalled to 2002 meters. I had some "fat tire" problems with excessive change in my calibration figures, so I generally used the calibration or recalibration figure that was closest to the time of measurement. Typically I was calibrating at 68F and recalibrating at 100+F. Most of my May measurements were at or above 90 degrees F.

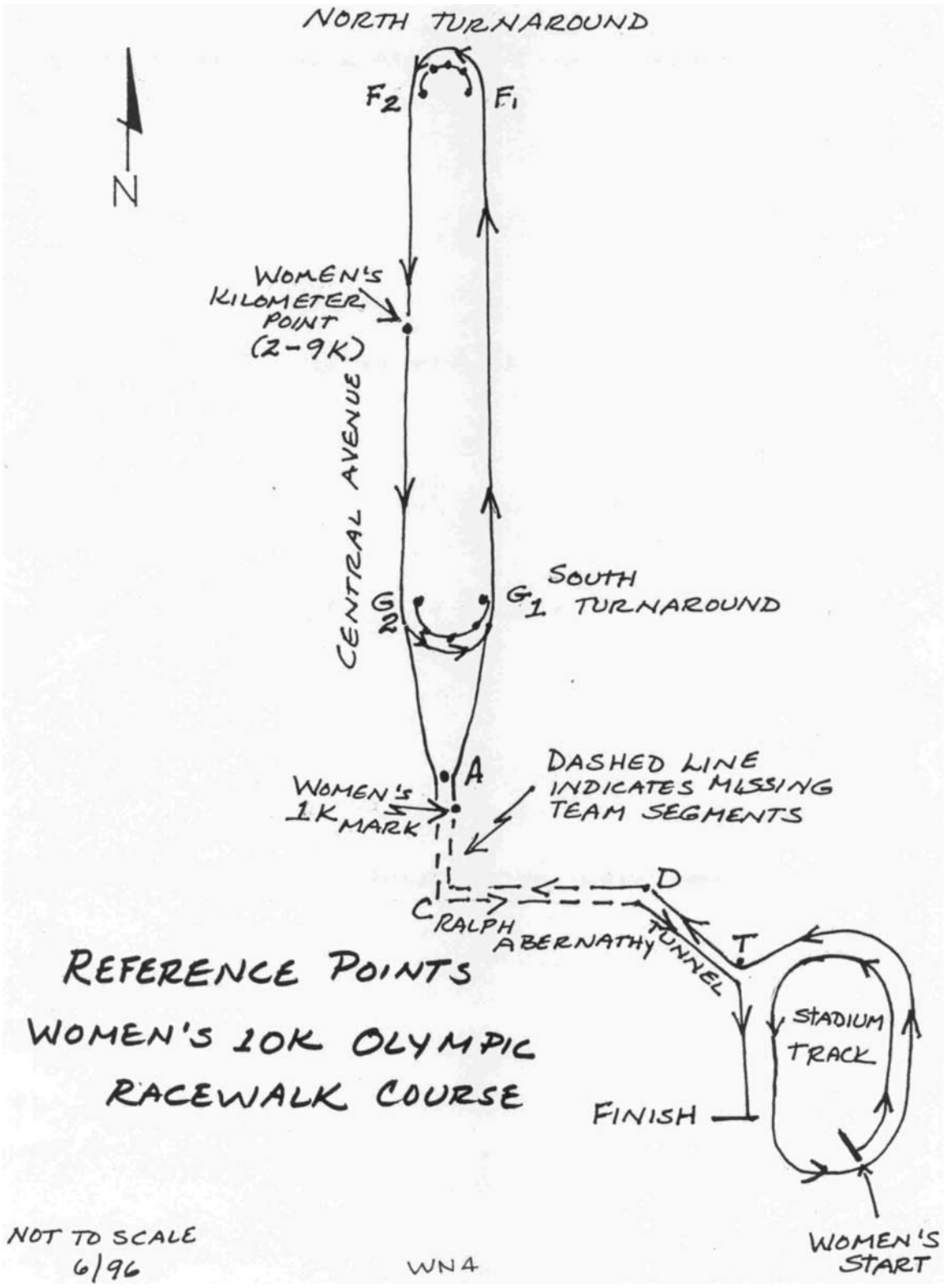
After my May departure ACOG announced the walks would proceed along the westbound lanes of Ralph Abernathy rather than the eastbound lanes. Fortunately, I had measured the path on both sides of the road. My best measurements of both sides reflected the westbound route is shorter than the eastbound side. We added twice the difference (it is walked twice) to the start of both races and adjusted the mens 1K mark on the track. These adjustments occurred after the team results were prepared so they are not reflected in the computerized results.

I would like to express my deepest appreciation to the members of the international team who volunteered to check the racewalk courses. It certainly has brought attention to the measurement community the need to give the same measurement emphasis to the racewalk courses as we give to the marathon course.

I would like to thank Bob Bowman, the Chairman of the IAAF Walking Committee for his continued support in my volunteer efforts to see the courses were properly prepared. Also, throughout this process Joe Rogers, volunteer coordinator of the racewalk events, has kept me informed, provided transportation and on-site assistance, insured expenses were covered, and remained a loyal friend. And finally, my thanks to Pete Riegel, for his capable organization of the marathon measurements, his advice and counsel on the racewalk measurements, and his skilled preparation of computerized racewalk measurement results.

Any questions or comments regarding this project are welcome. I will provide in MN any other information that may develop from now until the end of the Olympic Games.

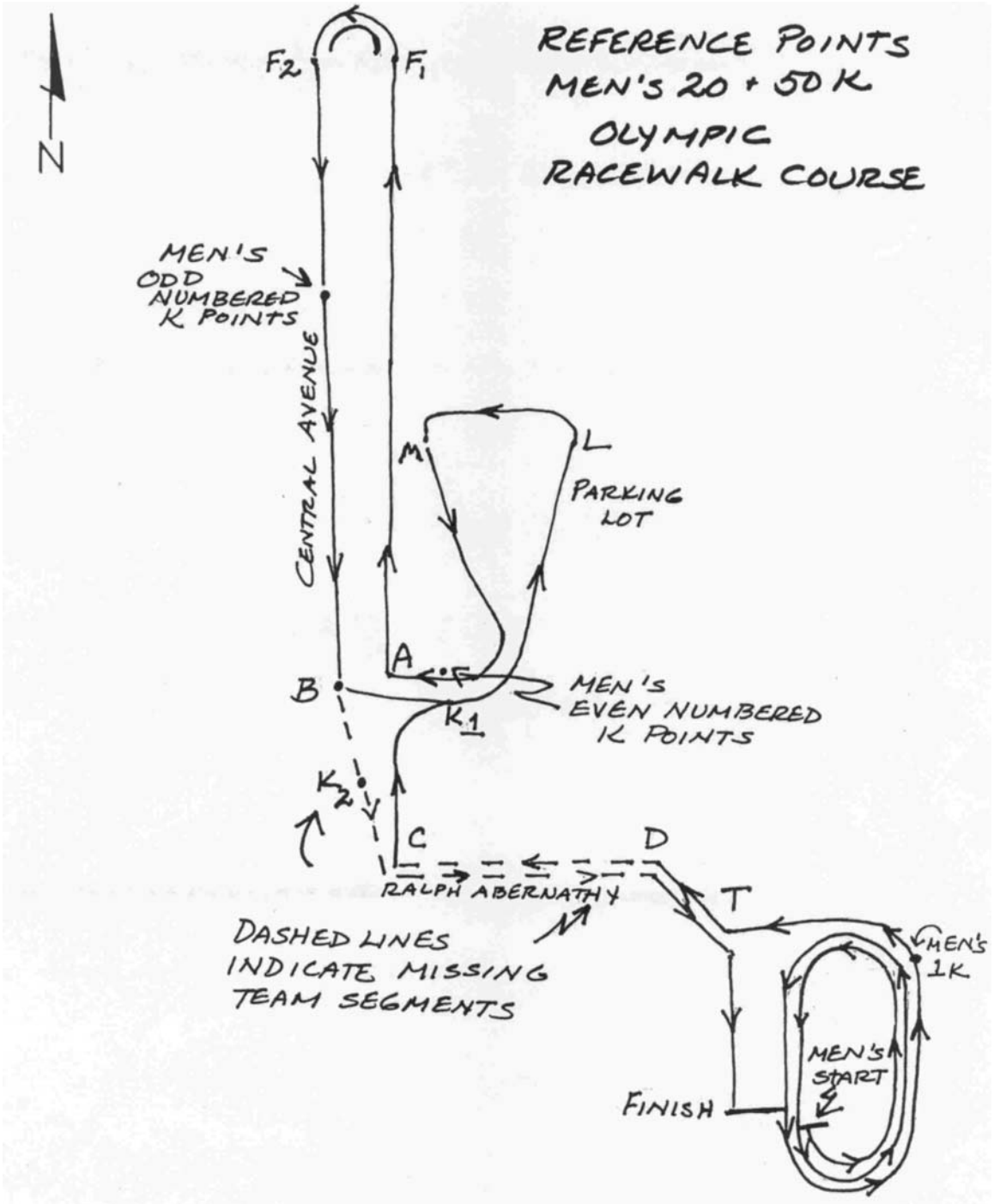
Wayne B. Nicoll
Road Running Technical Committee
USATF



REFERENCE POINTS
WOMEN'S 10K OLYMPIC RACEWALK COURSE

NOT TO SCALE
6/96

WN4



NOT TO SCALE
6/96

WN 5

RACEWALK DATA

	SH	MW	LRG	JMG	NW	GR	JFD	HJ	EP	DY	DK	CD	BG	BC	AB
Precal 481.06(east)	4572	4558	5523	4852	5267.5	4742	4718	4455	4886	5336	4650	4458.5	4452.5	4520	4719
Postcal 480.35 (west)	4572	4552	5520	4845	5259.5	4735	4712	4448	4875	5325	4643	4451	4448	4514.5	4712
Postcal 1	4572	4551	5513	4839	5260	4732	4704	4448		5313.5	4636	4445.5	4442	4510	4708
postcal 2	4572	4556	5520	4847	5268	4740.5	4712	4454		5324	4636	4452.5	4452	4515	4704
postcal 3	Used east	4550	5514	4839	5260.5	4733	4705	4449		5315		4445.5	4443	4510	4709
postcal 4	cal course	4557	5516	4846.5	5267.5	4740	4713	4455		5323		4452.5	4451	4516	4704
Women's start	50000	77400	194725	54000	53280	55268	45400	72000	29600	94000	45000	23200	66350	16000	22000
Men's Start	51072	78468	196019	55136	54514	56377	46505	73044	30743	95248	46086	24242	67393	17059	23106
Men's 1 km	52971	80361	198319	57151	56699.5	58343	48463	74893	32771	97461	48006	26093	69242	18937	25069
Tunnel line	53738	81126	199242	57966	57585	59140	49254	75642	33592	98356	48782	26841.5	69989	19697	25856
Finish	55000	82300	200580	59300	58956	60412	50500	77000	35000	0	50000	28000	71150	21000	27000
Tunnel line	56042	83339	201844	60405	60157	61494	51575	78016	36114	1213	51056	29014	72165	22031	28074
Tunnel line	61600	84750	202550	65400	62100	62500	62138	81000	49500	3400	51000	31300	72750	28000	28100
D	62339	85488	203442	66180	62952	63266	62900	81722	50289	4261	51751	32020	73469	28731	28864
Women's 1 km	63570	86713	204927	67484	64369.5		64168	82920	51603	5694	53000	33218	74667	29946	30115
K	65656	88798	207457	69700	66780.5	66707	66317	84951	53838	8127	55099	35250	76703	32018	32262
L	67752	90885	209987	71919		68878	68476	86990	56075	10563	57222	37286		34087	34420
M	68292	91429	210637	72489	69812	69439	69031	87514	56653	11190	57765	37810	79268	34623	34978
Men's 2 km		93539	213192	74728	72248	71630	71210	89573	58914	13653	59907	39868	81326		37159
A	70620	93754	213451	74955	72495.5	71849	71430	89781	59144	13904	60123	40076.5	81535	36928	37380
G1	72773	95904	216059	77242	74984	74084	73653	91884	61448	16414	62313	42178	83636		39604
F1	77435	100555	221489	82181	80363.5	78916	78463	96431	66426	21841	67050	46723	88188	43665	44400
F2	77500	100617	221767	82247	80437.5	78986	78533	96494	66499	21914	67113	46783.5	88253	43729	44466
G2	82167	105267	227407	87196	85817	83824	83345	101043	71482	27348	71855	51328.5	92795	48339	49280
K2	84684	107779	230452	89866	88721	86440	85942	103496	74172	30277	74408	53780.5	95247	50827	51867
G1	87300	110200	233705	94300	91489	89000	88500	6000	77806	33000	77000	56100	97520	53000	54550
G2	87425	110324	233845	94428	91634	89131	88628	6122	77218	33144	77121	56219	97642	53124	54675
Precal cts/m	9.52044	9.48504	11.49762	10.09621	10.96038	9.86715	9.81822	9.26952	10.16284	11.09989	9.67558	9.27629	9.26892	9.40643	9.81926
Postcal cts/m	9.51352	9.48192	11.48565	10.08450	10.96142	9.86273	9.80468	9.26952		11.07569	9.65371	9.26432	9.26015	9.39706	9.80000
Average cts/m	9.51698	9.48348	11.49163	10.09035	10.96090	9.86494	9.81145	9.26952		11.08779	9.66464	9.27030	9.26353	9.40175	9.80963
Day's Constant (post)	9.51352	9.48192	11.48565	10.08450	10.96142	9.86273	9.80468	9.26952		11.07569	9.65371	9.26432	9.26015	9.39706	9.80000

WNG

LENGTHS BELOW ARE CALCULATED USING POSTCALIBRATION AND INCLUDING 1.001

Men - Loop-to-Finish

	SH	MW	LRG	JMG	NW	GR	JFD	HJ	EP	DY	DK	CD	BG	BC	AB
K1 to C															
C to D															
D to T	739	738	892	780	852	766	762	722	789	861	751	720	719	731	764
T to Finish	1042	1039	1264	1105	1201	1082	1075	1016	1114	1213	1056	1014	1015	1031	1074
Total Counts	1781	1777	2156	1885	2053	1848	1837	1738	1903	2074	1807	1734	1734	1762	1838
Meters by Postcal	187.2	187.4	187.7	186.9	187.3	187.4	187.4	187.5		187.3	187.2	187.2	187.3	187.5	187.6
Meters by Precal	187.1	187.3	187.5	186.7	187.3	187.3	187.1	187.5		186.8	186.8	186.9	187.1	187.3	187.2
Meters by Average	187.1	187.4	187.6	186.8	187.3	187.3	187.2	187.5		187.1	187.0	187.0	187.2	187.4	187.4

Men - Start-to-Loop

	SH	MW	LRG	JMG	NW	GR	JFD	HJ	EP	DY	DK	CD	BG	BC	AB
Start to 1 km	1899	1893	2300	2015	2185.5	1966	1958	1849	2028	2213	1920	1851	1849	1878	1963
1 km to T	767	765	923	815	885.5	797	791	749	821	895	776	748.5	747	760	787
T to D	739	738	892	780	852	766	762	722	789	861	751	720	719	731	764
D to K	3317	3310	4015	3520	3828.5	3441	3417	3229	3549	3866	3348	3230	3234	3287	3398
Total Counts	6722	6706	8130	7130	7751.5	6970	6928	6549	7187	7835	6795	6549.5	6549	6656	6912
Meters by Postcal	706.6	707.2	707.8	707.0	707.2	706.7	706.6	706.5		707.4	703.9	707.0	707.2	708.3	705.3
Meters by Precal	706.1	707.0	707.1	706.2	707.2	706.4	705.6	706.5		705.9	702.3	706.0	706.7	707.6	703.9
Meters by Average	706.3	707.1	707.5	706.6	707.2	706.5	706.1	706.5		706.6	703.1	706.5	707.0	708.0	704.6

Men - Loop

	SH	MW	LRG	JMG	NW	GR	JFD	HJ	EP	DY	DK	CD	BG	BC	AB
Counts on Loop	19028	18981	22995	20166	21940.5	19733	19625	18545	20334	22150	19309	18530.5	18544	18809	19605
Meters by Postcal	2000.1	2001.8	2002.1	1999.7	2001.6	2000.8	2001.6	2000.6		1999.9	2000.2	2000.2	2002.6	2001.6	2000.5
Meters by Precal	1998.6	2001.2	2000.0	1997.4	2001.8	1999.9	1998.8	2000.6		1995.5	1995.6	1997.6	2001.1	1999.6	1996.6
Meters by Average	1999.4	2001.5	2001.0	1998.5	2001.7	2000.3	2000.2	2000.6		1997.7	1997.9	1998.9	2001.8	2000.6	1998.5

Women - Start-to-Loop

	SH	MW	LRG	JMG	NW	GR	JFD	HJ	EP	DY	DK	CD	BG	BC	AB
Start to T	3738	3726	4517	3966	4305	3872	3854	3642	3992	4356	3782	3641.5	3639	3697	3856
T to D	739	738	892	780	852	766	762	722	789	861	751	720	719	731	764
D to A															
A to G	2153	2150	2608	2287	2488.5	2235	2223	2103	2304	2510	2190	2101.5	2101		2224
Total Counts	6630	6614	8017	7033	7645.5	6873	6839	6467	7085	7727	6723	6463	6459		6844
Meters by Postcal	696.9	697.5	698.0	697.4	697.5	696.9	697.5	697.7		697.7	696.4	697.6	697.5		698.4
Meters by Precal	696.4	697.3	697.3	696.6	697.6	696.6	696.6	697.7		696.1	694.8	696.7	697.0		697.0
Meters by Average	696.6	697.4	697.6	697.0	697.5	696.7	697.0	697.7		696.9	695.6	697.2	697.3		697.7

Women - Loop-to-Finish

	SH	MW	LRG	JMG	NW	GR	JFD	HJ	EP	DY	DK	CD	BG	BC	AB
G to A	2153	2150	2608	2287	2488.5	2235	2223	2103	2304	2510	2190	2101.5	2101		2224
A to D															
D to T	739	738	892	780	852	766	762	722	789	861	751	720	719	731	764
T to Finish	1042	1039	1264	1105	1201	1082	1075	1016	1114	1213	1056	1014	1015	1031	1074
Less G1 to G2	-125	-124	-140	-128	-145	-131	-128	-122	588	-144	-121	-119	-122	-124	-125
Total Counts	3809	3803	4624	4044	4396.5	3952	3932	3719	4795	4440	3876	3716.5	3713		3937
Meters by Postcal	400.4	401.1	402.6	401.0	401.1	400.7	401.0	401.2		400.9	401.5	401.2	401.0		401.7
Meters by Precal	400.1	400.9	402.2	400.5	401.1	400.5	400.5	401.2		400.0	400.6	400.6	400.7		400.9
Meters by Average	400.2	401.0	402.4	400.8	401.1	400.6	400.8	401.2		400.4	401.0	400.9	400.8	0.0	401.3

Women - Loop

	SH	MW	LRG	JMG	NW	GR	JFD	HJ	EP	DY	DK	CD	BG	BC	AB
G1 to F	4662	4651	5430	4939	5379.5	4832	4810	4547	4978	5427	4737	4545	4552		4796
F to F	65	62	278	66	74	70	70	63	73	73	63	60.5	65	64	66
F to G2	4667	4650	5640	4949	5379.5	4838	4812	4549	4983	5434	4742	4545	4542	4610	4814
G2 to G1	125	124	140	128	145	131	128	122		144	121	119	122	124	125
Counts on Loop	9519	9487	11488	10082	10978	9671	9820	9281		11078	9663	9269.5	9281		9801
Meters by Postcal	1000.6	1000.5	1000.2	999.8	1001.5	1000.8	1001.6	1001.2		1000.2	1001.0	1000.6	1002.3		1000.1
Meters by Precal	999.8	1000.2	999.2	998.6	1001.6	1000.4	1000.2	1001.2		998.0	998.7	999.3	1001.5		998.1
Meters by Average	1000.2	1000.4	999.7	999.2	1001.6	1000.6	1000.9	1001.2		999.1	999.8	999.9	1001.9	0.0	999.1

Discard EP - No Postcal data

Calculation by Postcalibration Constant

	Men Start to Loop	Men Loop	Men Loop to Finish	Women Start to Loop	Women Loop	Women Loop to Finish
SH	706.6	2000.1	187.2	696.9	1000.6	400.4
MW	707.2	2001.8	187.4	697.5	1000.5	401.1
LRG	707.8	2002.1	187.7	698.0	1000.2	402.6
JMG	707.0	1999.7	186.9	697.4	999.8	401.0
NW	707.2	2001.6	187.3	697.5	1001.5	401.1
GR	706.7	2000.8	187.4	696.9	1000.8	400.7
JFD	706.6	2001.6	187.4	697.5	1001.6	401.0
HJ	706.5	2000.6	187.5	697.7	1001.2	401.2
DY	707.4	1999.9	187.3	697.7	1000.2	400.9
DK	703.9	2000.2	187.2	696.4	1001.0	401.5
CD	707.0	2000.2	187.2	697.6	1000.6	401.2
BG	707.2	2002.6	187.3	697.5	1002.3	401.0
BC	708.3	2001.6	187.5			
AB	705.3	2000.5	187.6	698.4	1000.1	401.7
Average	706.8	2000.9	187.3	697.5	1000.8	401.2

Calculation by Precalibration Constant

	Men Start to Loop	Men Loop	Men Loop to Finish	Women Start to Loop	Women Loop	Women Loop to Finish
SH	706.1	1998.6	187.1	696.4	999.8	400.1
MW	707.0	2001.2	187.3	697.3	1000.2	400.9
LRG	707.1	2000.0	187.5	697.3	999.2	402.2
JMG	706.2	1997.4	186.7	696.6	998.6	400.5
NW	707.2	2001.8	187.3	697.6	1001.6	401.1
GR	706.4	1999.9	187.3	696.6	1000.4	400.5
JFD	705.6	1998.8	187.1	696.6	1000.2	400.5
HJ	706.5	2000.6	187.5	697.7	1001.2	401.2
DY	705.9	1995.5	186.8	696.1	998.0	400.0
DK	702.3	1995.6	186.8	694.8	998.7	400.6
CD	706.0	1997.6	186.9	696.7	999.3	400.6
BG	706.7	2001.1	187.1	697.0	1001.5	400.7
BC	707.6	1999.6	187.3			
AB	703.9	1996.6	187.2	697.0	998.1	400.9
Average	706.0	1998.9	187.1	696.7	999.8	400.8

Calculation by Average Constant

	Men Start to Loop	Men Loop	Men Loop to Finish	Women Start to Loop	Women Loop	Women Loop to Finish
SH	706.3	1999.4	187.1	696.6	1000.2	400.2
MW	707.1	2001.5	187.4	697.4	1000.4	401.0
LRG	707.5	2001.0	187.6	697.6	999.7	402.4
JMG	706.6	1998.5	186.8	697.0	999.2	400.8
NW	707.2	2001.7	187.3	697.5	1001.6	401.1
GR	706.5	2000.3	187.3	696.7	1000.6	400.6
JFD	706.1	2000.2	187.2	697.0	1000.9	400.8
HJ	706.5	2000.6	187.5	697.7	1001.2	401.2
DY	706.6	1997.7	187.1	696.9	999.1	400.4
DK	703.1	1997.9	187.0	695.6	999.8	401.0
CD	706.5	1998.9	187.0	697.2	999.9	400.9
BG	707.0	2001.8	187.2	697.3	1001.9	401.0
BC	708.0	2000.6	187.4			
AB	704.6	1998.5	187.4	697.7	999.1	401.3
Average	706.4	1999.9	187.2	697.1	1000.3	401.0

SUMMARY OF RACEWALK MEASUREMENTS

	Men Start to Loop	Men Loop	Men Loop to Finish	Women Start to Loop	Women Loop	Women Loop to Finish
Length by Precal	706.0	1998.9	187.1	696.7	999.8	400.8
Length by Average	706.4	1999.9	187.2	697.1	1000.3	401.0
Length by Postcal	706.8	2000.9	187.3	697.5	1000.8	401.2
Add Laps	800.0			400.0		
Add Wayne's value			305.8	343.2		343.2
Length by Precal	1506.0	1998.9	492.9	1440.0	999.8	744.0
Length by Average	1506.4	1999.9	493.0	1440.3	1000.3	744.2
Length by Postcal	1506.8	2000.9	493.1	1440.7	1000.8	744.4

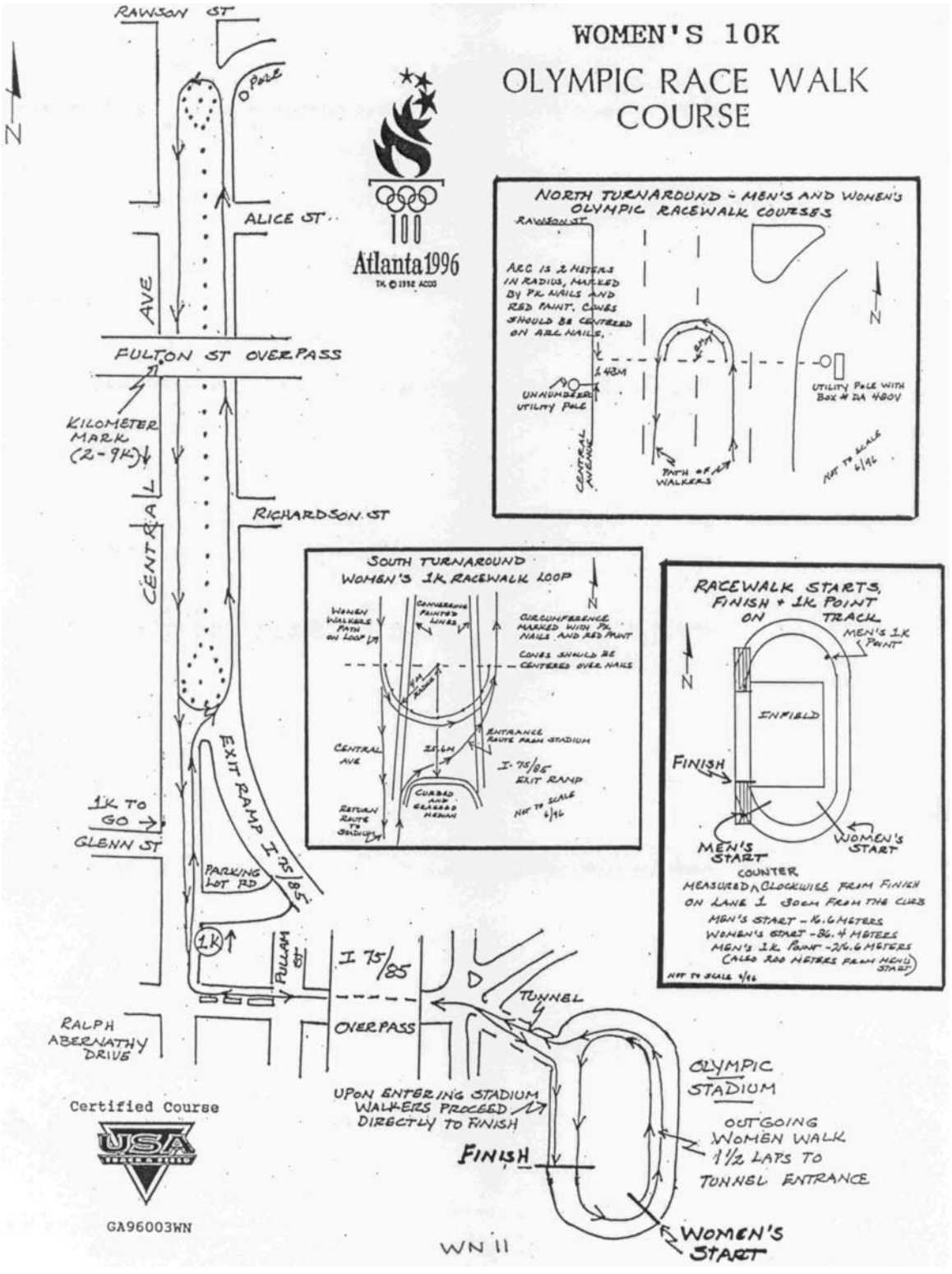
MEN - 20 km	By Precal	By Postcal	By Average
Out + Back	1998.9	1999.9	1999.4
9 Laps	17989.9	18008.5	17999.2
Total	19988.9	20008.3	19998.6
Total after adding 5 m	19993.9	20013.3	20003.6

MEN - 50 km	By Precal	By Postcal	By Average
Out + Back	1998.9	1999.9	1999.4
24 Laps	47973.2	48022.6	47997.9
Total	49972.1	50022.5	49997.3
Total after adding 5 m	49977.1	50027.5	50002.3

WOMEN - 10 km	By Precal	By Postcal	By Average
Out + Back	2183.9	2185.1	2184.5
8 Laps	7998.1	8006.3	8002.2
Total	10182.0	10191.4	10186.7
Total after deducting 178 m	10004.0	10013.4	10008.7

WOMEN'S 10K

OLYMPIC RACE WALK COURSE



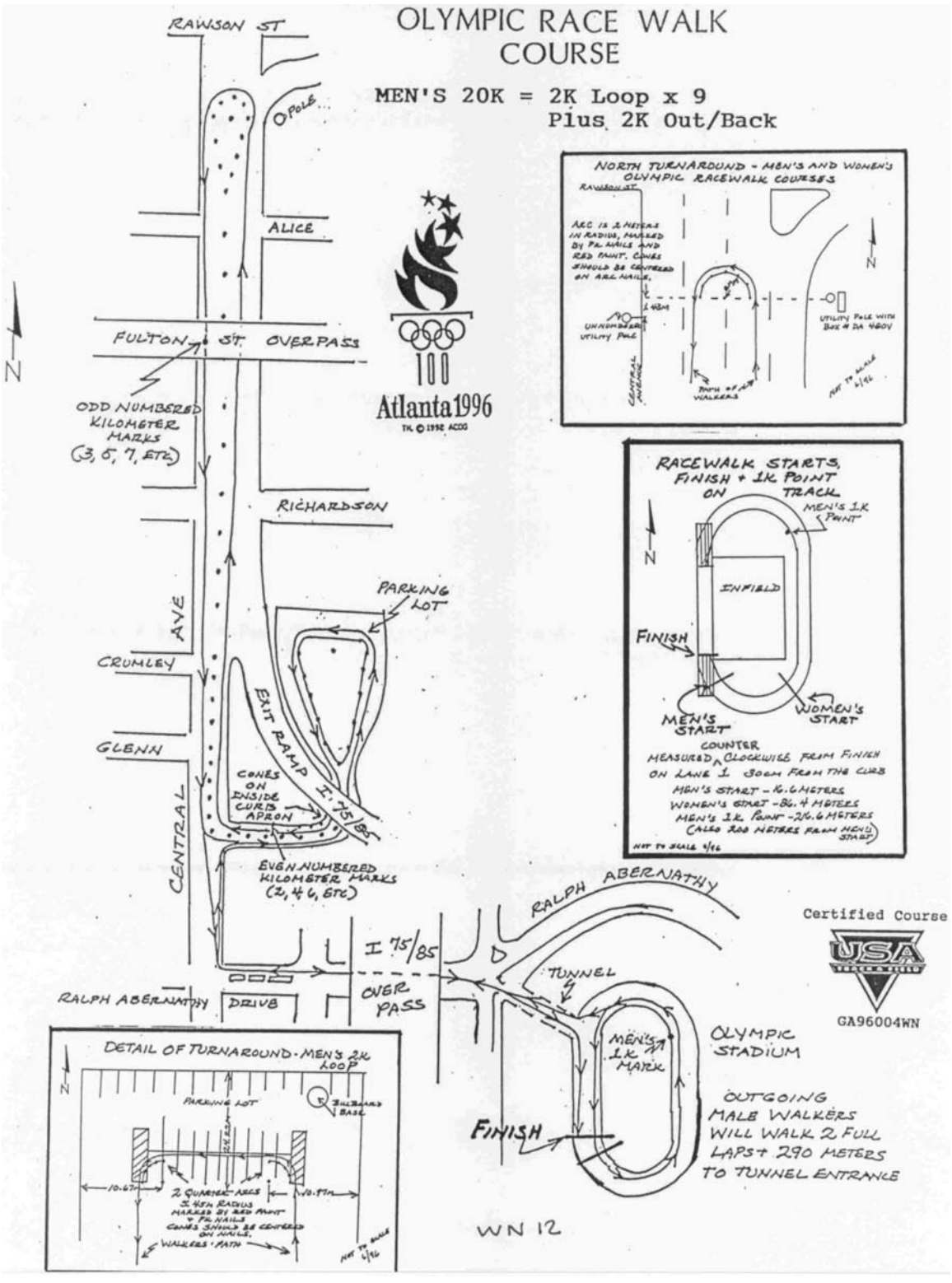
Certified Course

GA96003WN

WN 11

OLYMPIC RACE WALK COURSE

MEN'S 20K = 2K Loop x 9
Plus 2K Out/Back



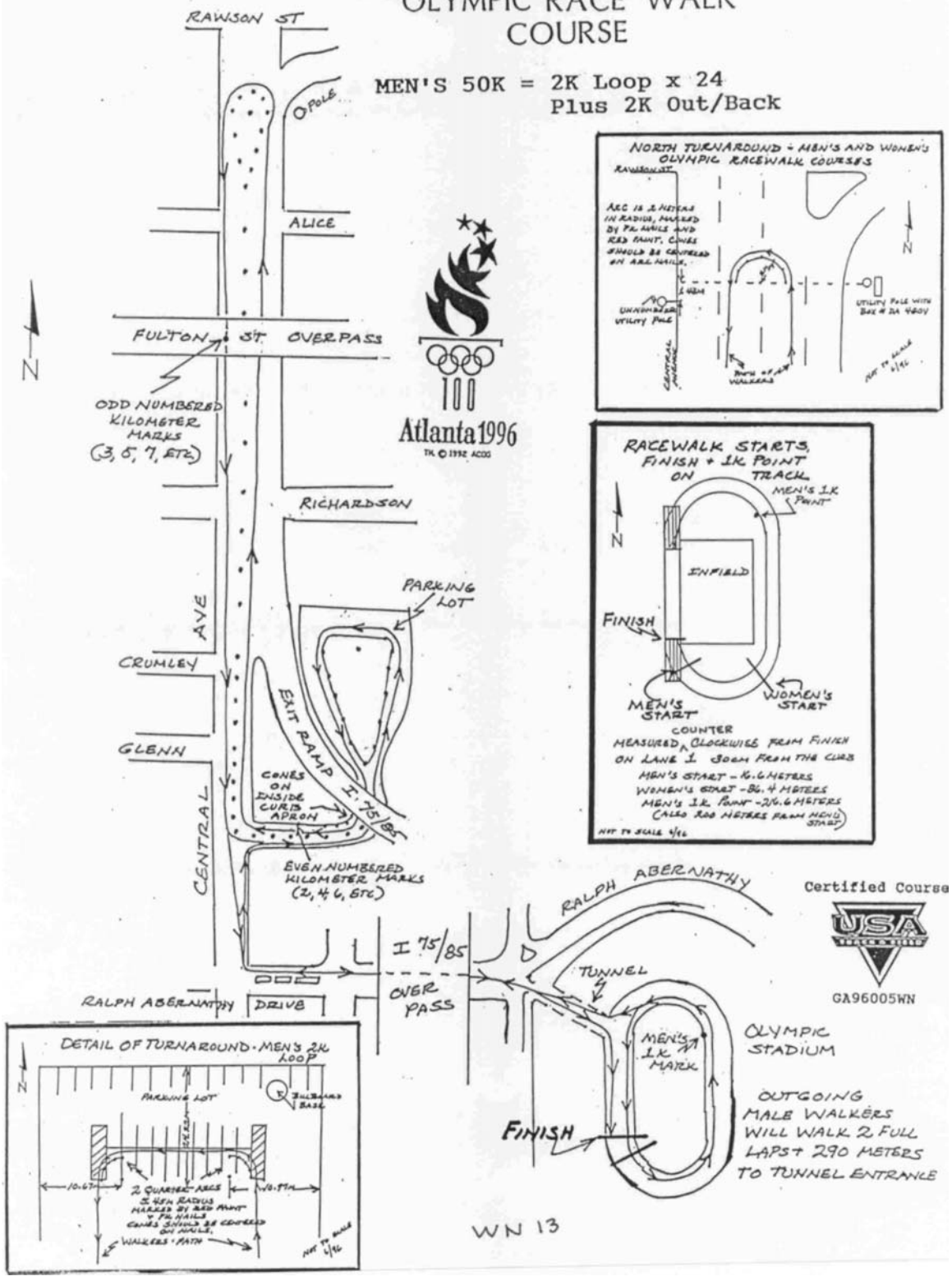
Certified Course

GA96004WN

WN 12

OLYMPIC RACE WALK COURSE

MEN'S 50K = 2K Loop x 24
Plus 2K Out/Back



Certified Course

GA96005WN

WN 13