MARATHON/RACE WALKS COURSES

STUDY AND MEASUREMENT

GAMES OF THE XXIVTH OLYMPIAD SEOUL 1988

SEOUL OLYMPIC ORGANIZING COMMITTEE

KOREAN SOCIETY OF GEODESY, PHOTOGRAMMETRY & CARTOGRAPHY

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IT IS WITH GREAT PLEASURE THAT WE HEREBY SUBMIT THIS TECHNICAL REPORT ON THE STUDY AND MEASUREMENT OF MARATHON AND RACE WALKS COURSES TO THE SEOUL OLYMPIC ORGANIZING COMMITTEE FOR THE 86 ASIAN GAMES AND 88 SEOUL OLYMPICS.

July 26, 1986

THE KOREAN SOCIETY OF GEODESY, PHOTOGRAMMETRY, AND CARTOGRAPHY

President : Prof. Dr. Chul-Ho Ahn, Seoul National Univ.

Principal Study Officer: Prof. Dr. Chan Lee, Seoul National Univ.

Prof. Dr. Eun-Kee Baick, Seoul City Univ.

Prof. Jae-Hwa Choi, Sung Kyun Kwan Univ.

Prof. Suck-Chan Lee, Hanyang Univ.

Prof. Dr. Bock-Mo Yeu, Yonsei Univ.

Prof. Dr. Kyu-Jon Cho, Kyonggi Univ.

I, THE UNDERSIGNED, HEREBY CERTIFY THAT THE MARATHON AND RACE WALKS COURSES DETERMINED AS INDICATED BELOW IN THIS REPORT HAVE OFFICIALLY BEEN APPROVED FOR ADOPTION IN ACCORDANCE WITH THE ROAD RACE COURSE APPROVAL CODES CONCERNED.

MARATHON COURSE: A SINGLE LOOP COURSE, 42.195 KM LONG, STARTING FROM AND ARRIVING AT THE MAIN STADIUM

RACE WALKS COURSE: A COURSE, COMBINING A POINT-TO-POINT COURSE AND SINGLE CIRCUIT COURSE, WITH THE LENGTH OF 5,000 METERS

July 21, 1986

KOREA AMATEUR ATHLETIC FEDERATION

CONTENTS

CHAPTER 1 – INTRODUCTION

1. General Description
2. Specifications and Requirements
3. Study on Method of Course Measurement

1. GENERAL DESCRIPTION

The Games of the XXIVth Olympiad will be held in Seoul, Korea from September 17 through October 2, 1988, in accordance with the historic decision at the 84th IOC Session held in Baden Baden on September 30, 1981, and the Seoul Olympic Organization Committee (SLOOC) has been organized in order to perform successfully all activities concerned in the Olympic Games.

The SLOOC was in essential need of an accurate and optimum race course for marathon and race walks to ensure that all those who set out to challenge the marathon should compete over the right distance, thereby guaranteeing fair conditions for all.

Under this requirement, the SLOOC had requested the Korean Society of Geodesy, Photogrammetry, and Cartography to perform the measurement and analysis of the marathon and race walks course, and the contract was entered into by and between the two parties, with its effective duration from March 10 to July 26, 1986.

The scope of study includes:

— Analyses of different methods of course measurements, and setting-up of an optimum method to be applied to actual measurement
— Measurement of the marathon and race walks course in accordance with the method previously established
— Process and analysis of the data acquired in the course measurements
— Preparation of the course map for runners
— Distance marking with bronze monuments
— Preparation of the final report
— Miscellaneous

For the project execution, seven departments have been newly organized under the Korean Society of Geodesy, Photogrammetry, and Cartography. Each department has been headed by a college professor specializing in the specific field of his assignment under this project.

Upon reviewing different methods in course measurements, the calibrated bicycle method has finally been adopted. The course measurement by bicycle was performed twice during May 16 through May 18, 1986. A total of 15 cyclists were employed for the purpose, and 13 effective measurements were obtained for each interval.

After preliminary computation and analyses of both measurements made on May 16-17 and May 18 respectively, the 2nd measurement conducted on May 18, 1986 has been chosen as a reliable measurement, and therefore the final computation in this report has been based on the 2nd measurement.

In the course measurement, 13 baselines in the marathon course and 1 baseline in the race walks course have been set up for the calibration of bicycles. A total of 32 intervals with 35 reference points have been selected over the whole course for reading bicycle counters. The Jones Counter has been used in bicycle measurement, and the modernized second generation of EDM systems has been utilized for baseline observation.

We propose 40,147.35 meters as the final adjusted length of all the intervals measured by bicycle with 99.95% confidence.

According to the above proposed length, we have set up the starting and finishing points of the race, and fixed 52 distance markers with bronze monuments at the interval of one kilometer.

This report comprises five major aspects, namely, general aspect of the project execution, description of course measurements and implementation of measurement, analyses of bicycle measurements and proposed lengths, and the final conclusions.

2. SPECIFICATIONS AND REQUIREMENTS

The specifications and fundamental requirements of the course measurement should be in conformity with the IAAF Rules and Guidelines for the Conduct of Road Races, and may be summarized as follows:

— Distance for the marathon race must be between 42,195 and 42,237 meters. Distance for the race walks must measure 2,500 meters for the circuit and also 2,500 meters in total from the stadium to an entry and exit point of the circuit.

— A course is said to have satisfactorily been measured if it was measured with an accuracy of better than one part in one thousand (1/1000). This results in a maximum allowable tolerance of less than 42 meters at the marathon distance.

— The course shall be measured along the ideal line of running or walking; i.e. the shortest possible path in that section of the road permitted for the runners or walkers.

— A calibration course should be established, and bicycles must be calibrated before and after measurement. The calibration course must be a straight stretch of paved road, level and relatively free of traffic.

— Measurement should be implemented twice, and the measurements may not differ by more than 0.08%, or a third measurement must be taken.

— The shortest course must be measured 30 CM from curbs or the edge of curbless roads or lines, or from the edge of drainage along the curbs. In cases of roads with such structures as concrete walls along the edge, the shortest course must be 61 CM from those edges.

For any items not specified herein, please refer to the IAAF Rules and Guidelines for the Conduct of Road Races published by IAAF.

3. STUDY ON METHODS OF COURSE MEASUREMENT

In general, there are many available ways of distance measurement in surveying, ranged from classical to modernized methods.
These methods include:

— Chaining
— Tapes (cloth, steel, invar, fiber glass, etc.)
— Survey Rope
— Surveyor's Wheel
— Bicycle Method
— Odometer
— Electric Distance Measuring System
— Subtensebar
— Triangulation
— Photogrammetry
— Stadia Survey
— Reading from Maps
— Etc.

The above methods have each their own individual characteristics, and therefore, consideration must be given to the following points when we require selecting a measurement technique:

— How large distance is to be measured.
— What accuracy is required.
— What's the condition of measurement; Is it a straight line or curved one?
— What's the surrounding circumstance of work sites.
— Etc.

Each of the methods has both advantages and disadvantages respectively, and we do not think it necessary to go into detail about them since they are all well known to those who are engaged in the professional surveying field.

However, it must be stated that we are in need of distance measurement over road surface along the race line varying frequently in alignment horizontally and/or vertically from straight line to curvilinear form, or vice versa. This fact results in, needless to say, one unique method: a calibrated bicycle method for course measurement. Of course, a measurement of baseline is also required for the purpose of bicycle calibration.

In view of the foregoing, we conclude as follows:

— A calibrated bicycle method will be used for the course measurement.
— A modernized EDM system will be employed for the measurement of baselines.
— As a supplementary measurement, steel tapes will be utilized for very short distances.

This is identical to the recommendations described in "Guidelines for the Conduct of Road Races" published by IAAF, and the method used in the 1984 Los Angeles Olympics. However, our review of precedents discloses that a different method, mainly using steel wire, was used at both Tokyo Olympics and Tokyo International Marathon Race in 1986.

CHAPTER 2 – PERFORMANCE OF MEASUREMENT

1. Organization and Personnel of Work Teams
2. Course Design
3. Reference Point and Interval
4. Baseline Measurement
5. Bicycle Measurement
6. Leveling and Vertical Profile

1. ORGANIZATION AND PERSONNEL OF WORK TEAMS

a. OVERALL ORGANIZATION

For the project execution, one field group has specially been organized within the Korean Society of Geodesy, Photogrammetry and Cartography.

This field group has been composed of seven departments as indicated below:

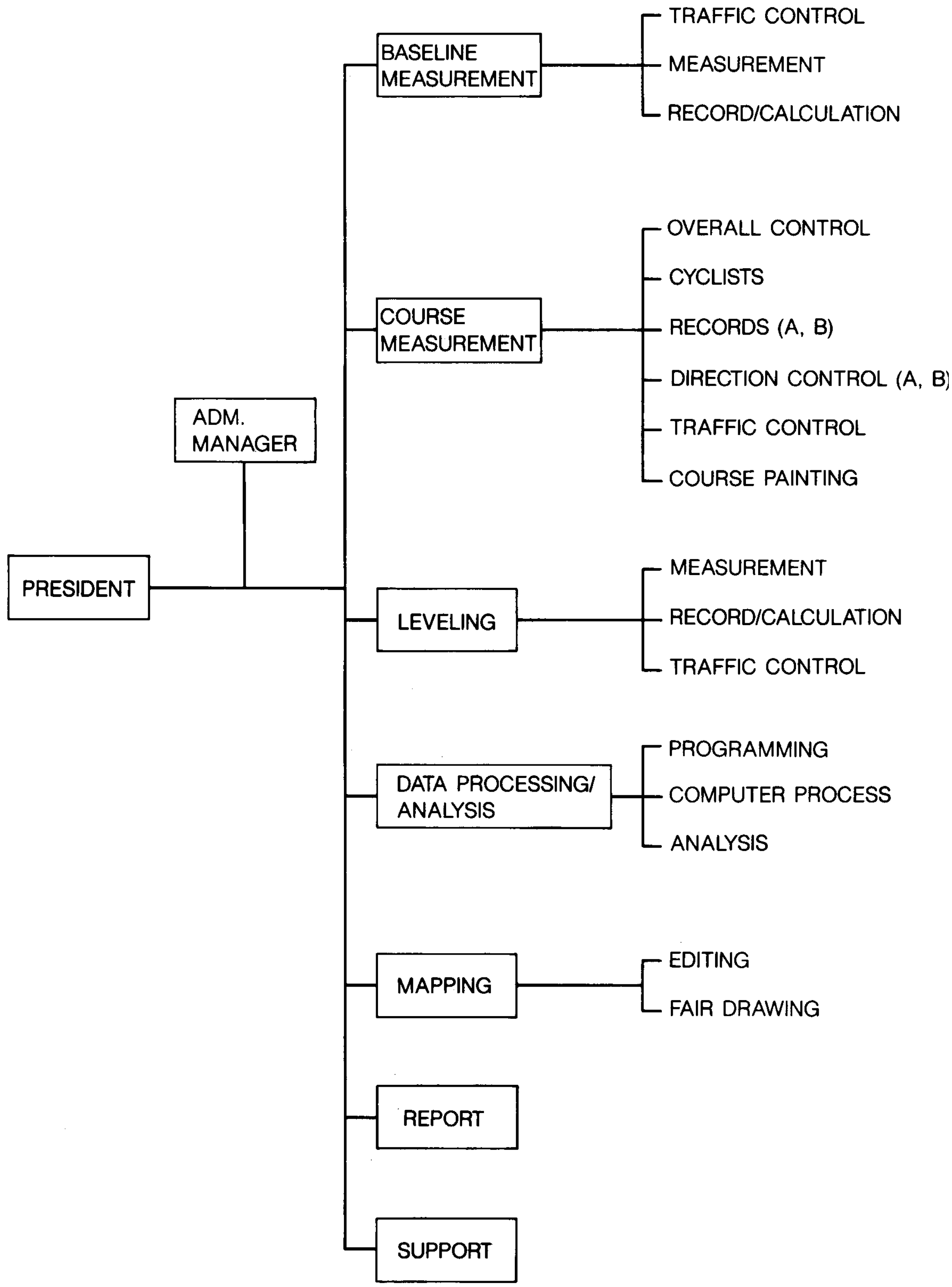
— Baseline Measurement
— Course Measurement
— Leveling and Vertical Profile
— Mapping
— Data Processing and Analysis
— Preparation of Final Report
— Support

Each department has been headed by a college professor specializing in the specific field of his assignment under this project.

Please refer to the following organization diagram for detail.

For reference purposes, we'd like to mention here briefly the status of the Korean Society of Geodesy, Photogrammetry, and Cartography. The Society is an association of scientists and technicians specializing and engaged in the field of surveying, and its legal status is a "corporate juridical person." There are five commissions organized within the Society, and they are: Geodetic Survey; Photogrammetry; Cartography; General Survey; and Remote Sensing. The general assembly meeting is held annually and a journal is published semiannually.

OVERALL ORGANIZATION:



b. PERSONNEL

The overall control and management has been exercised by seven primary study officers listed below:

Chul-Ho Ahn, Prof. Dr. Seoul National University
Chan Lee, Prof. Dr. Seoul National University
Eun-Kee Baick, Prof. Dr. Seoul City University
Jae-Hwa Choi, Prof. Sung Kyun Kwan University
Suck-Chan Lee, Prof. Hanyang University
Bock-Mo Yeu, Prof. Dr. Yonsei University
Kyu-Jon Cho, Prof. Dr. Kyonggi University

Prof. Chul-Ho Ahn, president of the Society has represented officially the group of primary study officers. The data-processing, analysis and report drafting have been the responsibility of Prof. Kyu-Jon Cho, assisted by Mr. Young-Jin Lee.

Mr. Yong-Ho Cheon has acted officially as administrative representative. The work teams their total strength being 101 members, have been composed of as indicated below for respective work stages:

1) ADMINISTRATIVE MANAGEMENT:
   - 1 — Manager
   - 3 — Assistants
   - 2 — drivers

2) BASELINE MEASUREMENT:
   - 1 — Primary Study Officer
   - 1 — Study Officer
   - 4 — Assistant Study Officers
   - 4 — Assistants

3) COURSE MEASUREMENT:

1 — Primary Study Officer

3 — Study Officers

6 — Assistant Study Officers

17 — Cyclists

4 — Assistants

4) LEVELING:

1 — Primary Study Officer

1 — Study Officer

2 — Assistant Study Officers

4 — Assistants

5) DATA PROCESSING/ANALYSIS:

1 — Primary Study Officer

2 — Study Officers

6 — Assistant Study Officers

6) MAPPING:

1 — Primary Study Officer

1 — Study Officer

8 — Assistant Study Officers

16 — Assistants

7) REPORT:

1 — Primary Study Officer

2 — Study Officers

4 — Assistant Study Officers

4 — Assistants

N.B. Indicated above is only the basic manpower directly employed for the study performance.

2. COURSE DESIGN

The Olympic marathon route for 1988 is the final version among many potentially prospective routes studied by the SLOOC, and it was approved by the IAAF Council Meeting held in Canberra, Australia on October 6, 1985. The route was finally confirmed by Mr. Emanuel Rose, Chairman of the IAAF Technical Committee on the occasion of his visit from April 2 through April 9, 1986. During his visit, the SLOOC and Mr. Rose agreed to a single loop course starting from the main stadium in the clockwise direction for the 1988 Seoul Olympic marathon course. The route runs its course through the main stadium — Sunneung Subway Station — Yonsei University Yongdong Hospital — Kangnamro— National Cemetery — Olympicro — Yeouido Plaza — Kangbyunro — Banpodaekyo (Bridge) — the main stadium.

The length of the course was first approximated with vehicular odometers, with two possible bypasses taken into consideration near by the main stadium (Refer to the dashed lines in Fig. 2-1.) in order to use them in adjusting the total length of the course as required according to results of precise measurements.

The final course was closely reviewed by seven primary study officers (Refer to Chapter 2-1.) together with Korean Amateur Athletic Federation officials concerned. The geometrically shortest possible route was discussed and principal rules to be followed decided on. It was also decided to paint a white line along the whole route to allow cyclists to run the course on exact alignment without loss of speed.

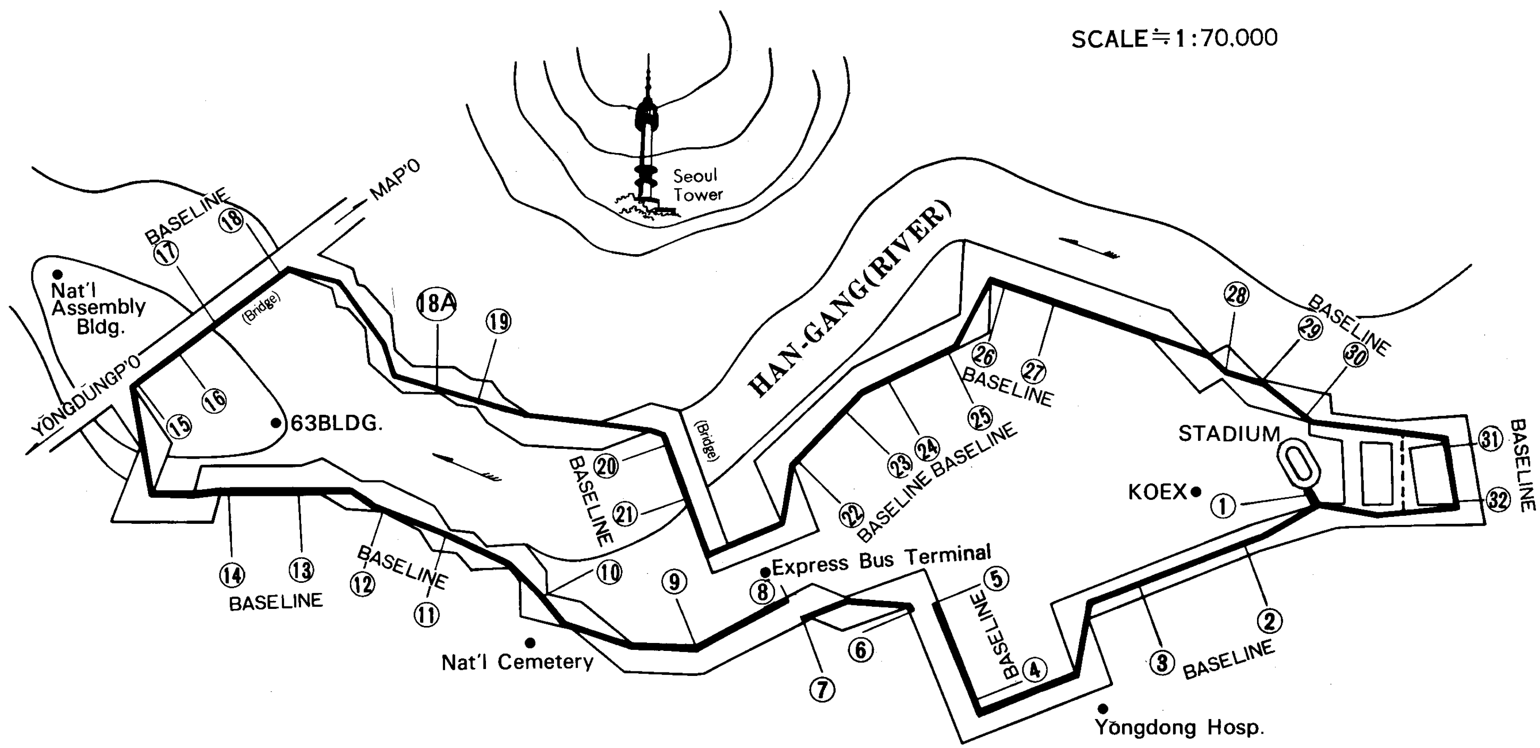


Fig 2-1 1988 SEOUL OLYMPIC MARATHON COURSE

This is to prevent the cyclists from deviating from the course. In other words, the cyclists have just only to follow the premarked alignment with constant speed. We have been sure that this technique would minimize any possible errors on the part of the cyclists and come up with best achievement in measuring.

The exact route measured during the period from May 16 through May 18, 1986 is defined on maps shown in Fig. 2-3 and is identical to the shortest possible route.

The overall sketch map of the route is shown in Fig. 2-1.

3. REFERENCE POINT / INTERVAL

A total of 35 points were selected for reference points, and 33 points out of them used for the measurement conductd on May 18, 1986. Twenty-four points indicate each the end point of 12 baselines, and the remaining nine points are intermediate reading points.

The thirty-three reference points were used as recording points, at which Jones Counters were read. All reference points were located on the marathon course. Nine intermediate recording points were selected considering the consistent cycling speed and traffic control. On the other hand, thirty-one intervals were used for measurements.

Table 2-1 shows the reference points and intervals, and please refer to all Figures shown in Section 5 for details.

Table 2-1. Reference Point/interval

Interval	Ref. Point No.		Measurements EDM	Bike	Baseline Rides/Bike
1	R2-R3	(B1)	3		2
2	R3-R4			13	
3	R4-R5	(B2)	3		1
4	R6-R7			13	
5	R8-R9			13	
6	R9-R10			13	
7	R10-R11			13	
8	R11-R12	(B3)	3		1
9	R12-R13			13	
10	R13-R14	(B4)	3		1
11	R14-R15			13	
12	R15-R16	(B5)	3		1
13	R16-R17			13	
14	R17-R18	(B6)	3		1
15	R18-R18A			13	
16	R18A-R19			13	
17	R19-R20			13	
18	R20-R21	(B7)	3		1
19	R21-R22			13	
20	R22-R23	(B8)	3		1
21	R23-R24			13	
22	R24-R25	(B9)	3		1
23	R25-R26			13	
24	R26-R27	(B10)	3		1
25	R27-R28			13	
26	R28-R29			13	
27	R29-R30	(B11)	3		1
28	R30-R31			13	
29	R31-R32	(B12)	3		1
30	R32-R1			13	
31	R1-R2			13	
32	R2-R3	(B1)	3		4

NOTES:

1) Reference points R5 and R6, R7 and R8 are both identical.

2) Actual measurement by bicycle started at Baseline 1 and also ended at the same baseline.

4. BASELINE MEASUREMENT

A total of 14 baselines were selected, and 13 out of them were located on the marathon course and the other on the race walks course. However, 12 baselines were used for the May 18, 86 marathon route measurement due to changes in the bypass located near by the main stadium. (Please refer to Fig. 2-1 for details.) Each of the baselines is located on a straight, flat, paved surface.

In selecting the baselines, the following principles were taken into consideration:

— All baselines shall be located on the marathon course to the maximum extent possible.

— The location of a baseline shall be on flat, straight, and paved surface.

— As many baselines as possible shall be selected regardless of their lengths.

The thirteen baselines were selected on the basis of the above principles and therefore some baselines are relatively short.

MEASURING INSTRUMENTS:

Two different electronic distance measuring systems were used to establish all the baselines, and thermometers and barometers were also used for atmospheric correction. Instruments used for the May 18, 86 measurement are listed below:

EDM — Laser Ranger III No. 07B-3092 — 1 set
Manufactured by K+E, U.S.A.
Standard deviation ±(5mm + 2ppm)

RED−2 No. 21579 — 1 set
Manufactured by Sokkisha, Japan
Standard deviation ±(5mm + 5ppm)

THERMOMETER	2 sets Operated by DC Volt Type: TA-1 No. 7768, 7769 Manufactured by Tamaya, Japan
BAROMETER	3 sets Arneroid Barometer No. 7512, 7523, 7521 Manufactured in Japan

The EDMs were carefully calibrated by the National Geographic Institute, and the calibration was made on the National Standard Baseline which had specially been set up by that organization. The thermometers and barometers used were also officially standardized by the National Meteorological Observatory.

MEASUREMENTS:

The actual measurement was made on April 23 through June 4, 1986. The observation was carried out according to the standard specifications of baseline observation recommended by the National Geographic Institute. Each baseline was measured three times, and each time, at least 5 repeated observations made. And then the mean value of 5 observations was taken to represent the distance of each measurement. Atmospheric correction for each baseline was automatically effected within the system itself by means of proper ppm setting. In our baseline measurements, the dispersion between minimum and maximum values amongst three-time measurements was found falling within 1mm to 2mm only. Thus, we applied 10mm Safety Factor to each baseline in proposing the final adjusted marathon course length.

The detailed measurements and maps for 14 respective baselines are shown in Fig. 2-2, and the length and location of each baseline is briefly listed below:

Baseline	Length	Location	Date of Measurement
B1	1181.164m	start + 3km	April 4, 1986
B2	1628.700	start + 8km	May 2, 1986
B3	439.595	start + 14km	April 21, 1986
B4	370.808	start + 17km	〃
B5	600.036	start + 19km	April 24, 1986
B6	1114.665	start + 21km	〃
B7	839.220	start + 28km	〃
B8	760.936	start + 31km	〃
B9	529.061	start + 33km	May 2, 1986
B10	568.673	start + 34km	〃
B11	434.330	start + 36km	April 23, 1986
B12	526.956	start + 40km	May 20, 1986
B13	412.853	start + 40km	April 23, 1986
B14	815.896	Race walks course	June 4, 1986

FIG. 2-2. DIAGRAMS AND DETAILS OF BASELINE MEASUREMENT

BASELINE MEASUREMENT

BASELINE : 1

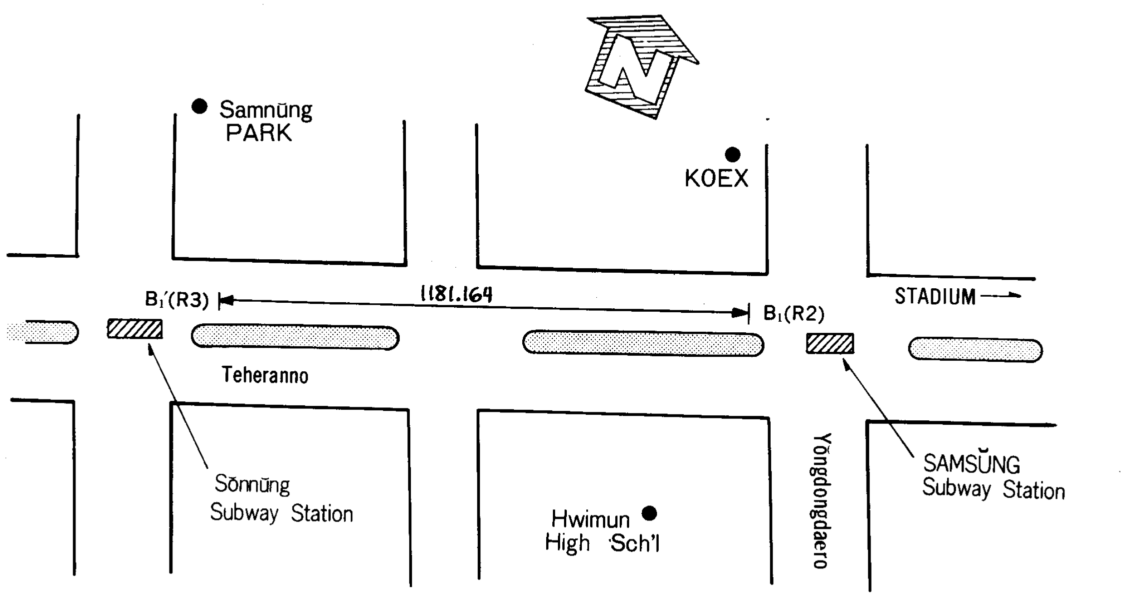
1988 SEOUL OLYMPIC

MEASUREMENTS	
1 ST:	1181.M164
2 ND:	1181.M165
3 RD:	1181.M163

FINAL CORRECTED DISTANCE

1181.M164

DATE	:	1986. 4. 29
OPERATOR	:	Lee, Young-Jin
INSTRUMENT	:	EDM(RED-2)
TEMPERATURE	:	25℃
PRESSURE	:	757mmHg
ATMOSPHERIC CORRECTION	:	10PPM
TYPE	:	Bronze
RECORDER	:	Cheon, Young-Ho



BASELINE MEASUREMENT

BASELINE : 2

1988 SEOUL OLYMPIC

MEASUREMENTS

1ST: 1628.^{M}699

2ND: 1628.^{M}700

3RD: 1628.^{M}701

FINAL CORRECTED DISTANCE

1628.^{M}700

DATE : 1986. 5. 21

OPERATOR : Ahn, Ki-Won

INSTRUMENT : EDM(RED-2)

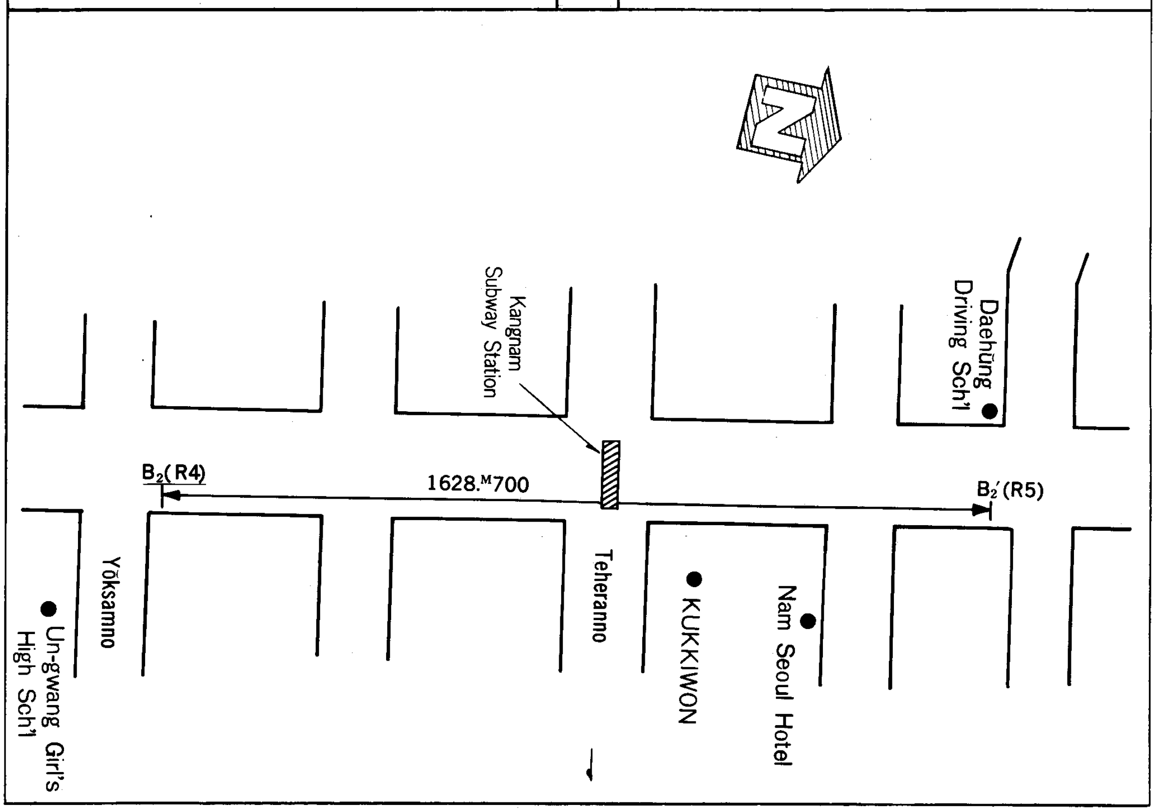
TEMPERATURE : 22℃

PRESSURE : 759mmHg

ATMOSPHERIC CORRECTION : 6PPM

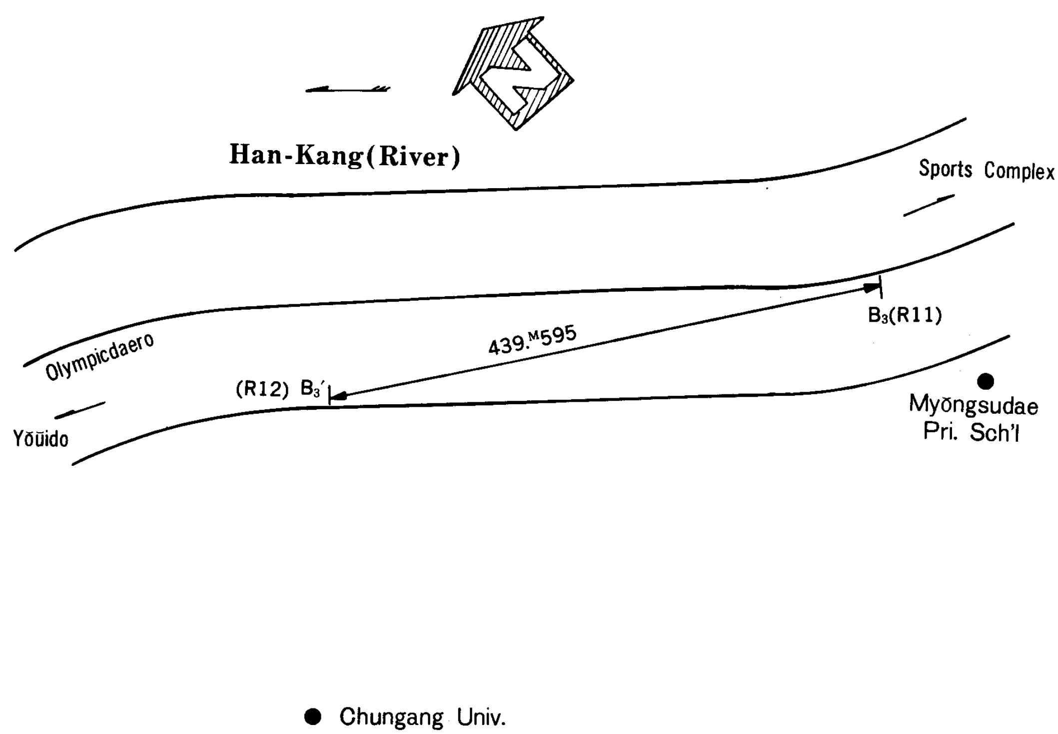
TYPE : Bronze

RECORDER : Cheon, Young-Ho



BASELINE MEASUREMENT

BASELINE : 3	**1988 SEOUL OLYMPIC**
MEASUREMENTS 1^{ST}: 439.^{M}595 2^{ND}: 439.^{M}595 3^{RD}: 439.^{M}595	DATE : 1986. 4. 21 OPERATOR : Cho,Jae-Yoon INSTRUMENT : EDM(RED-2) TEMPERATURE : 21℃ PRESSURE : 762mmHg ATMOSPHERIC CORRECTION : 5PPM TYPE : Bronze RECORDER : Cheon, Young-Ho
FINAL CORRECTED DISTANCE 439.^{M}595	



BASELINE MEASUREMENT

BASELINE : 4

1988 SEOUL OLYMPIC

MEASUREMENTS

1^{ST}: $370.^{M}808$

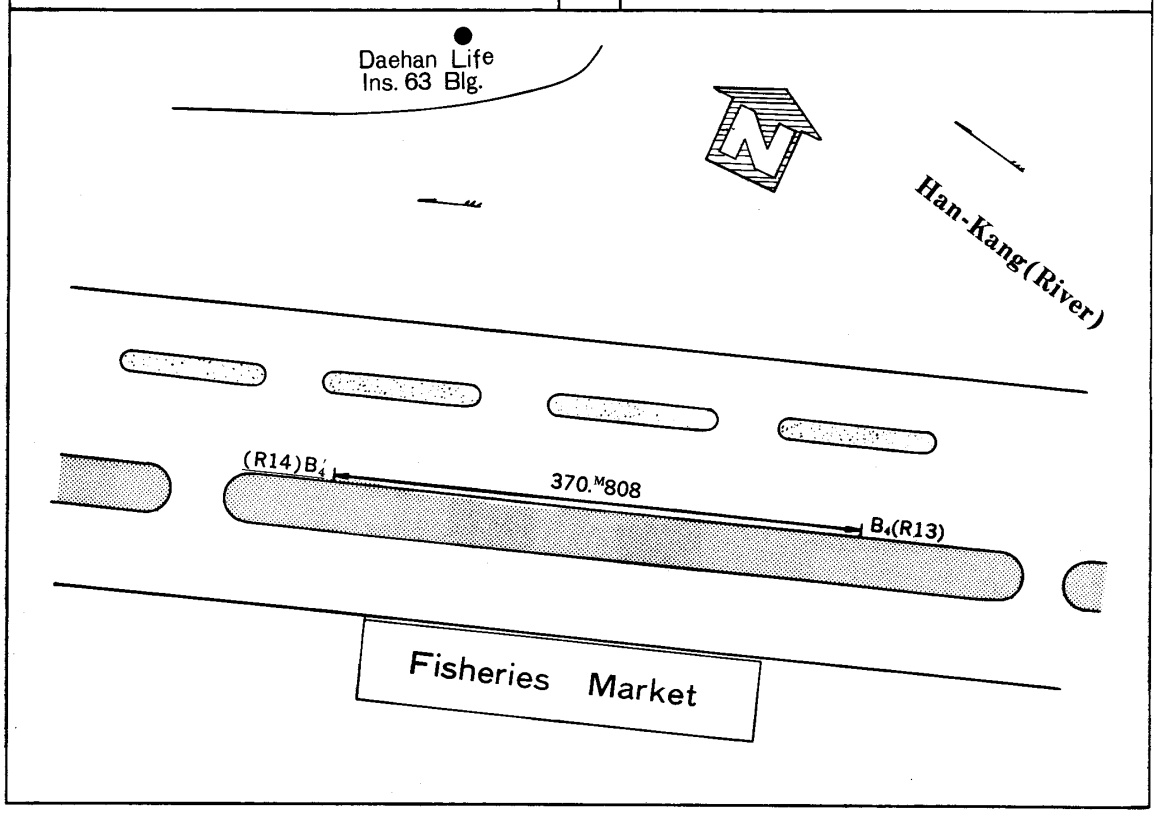
2^{ND}: $370.^{M}808$

3^{RD}: $370.^{M}809$

FINAL CORRECTED DISTANCE

$370.^{M}808$

DATE	:	1986. 4. 21
OPERATOR	:	Cho,Jae-Yoon
INSTRUMENT	:	EDM(RED-2)
TEMPERATURE	:	18℃
PRESSURE	:	765mmHg
ATMOSPHERIC CORRECTION	:	2PPM
TYPE	:	Bronze
RECORDER	:	Cheon, Young-Ho



BASELINE MEASUREMENT

BASELINE : 5

MEASUREMENTS

1ST: 600.^{M}036

2ND: 600.^{M}036

3RD: 600.^{M}035

FINAL CORRECTED DISTANCE

600.^{M}036

1988 SEOUL OLYMPIC

DATE : 1986. 4. 24

OPERATOR : Choi,Yun-Soo

INSTRUMENT : EDM(RED-2)

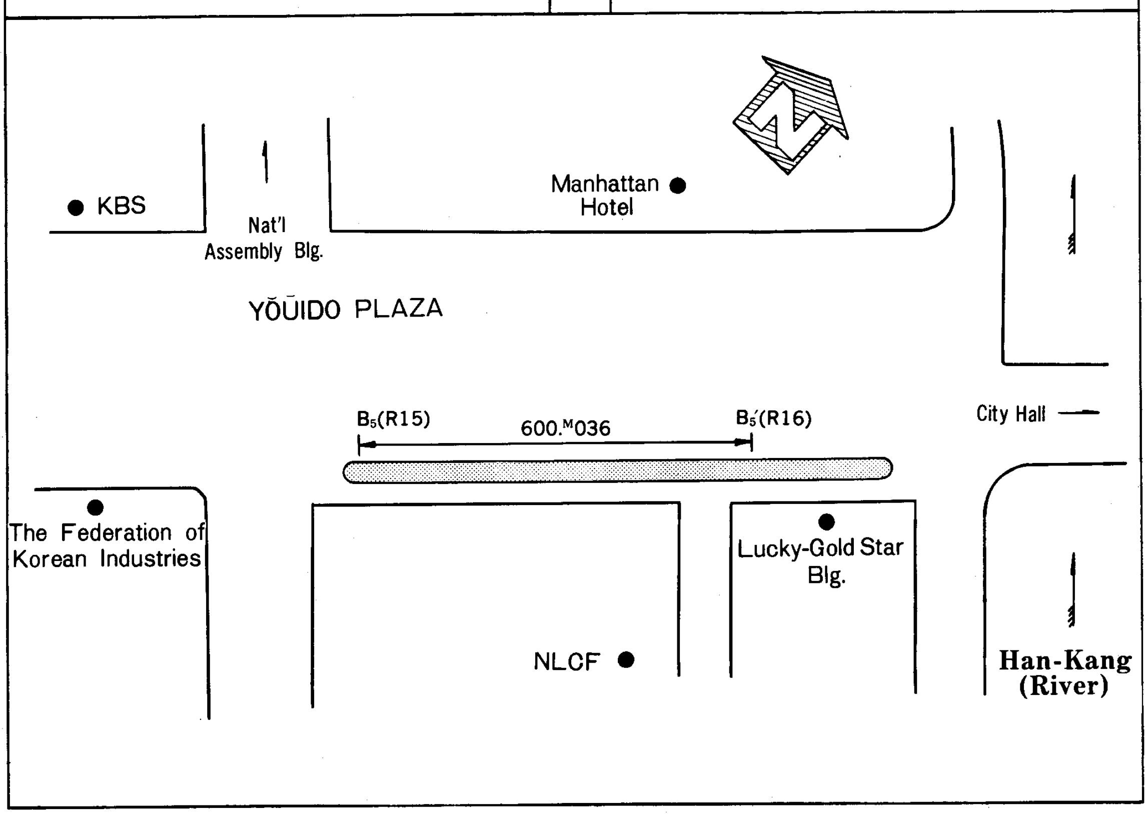
TEMPERATURE : 22°C

PRESSURE : 760mmHg

ATMOSPHERIC CORRECTION : 6PPM

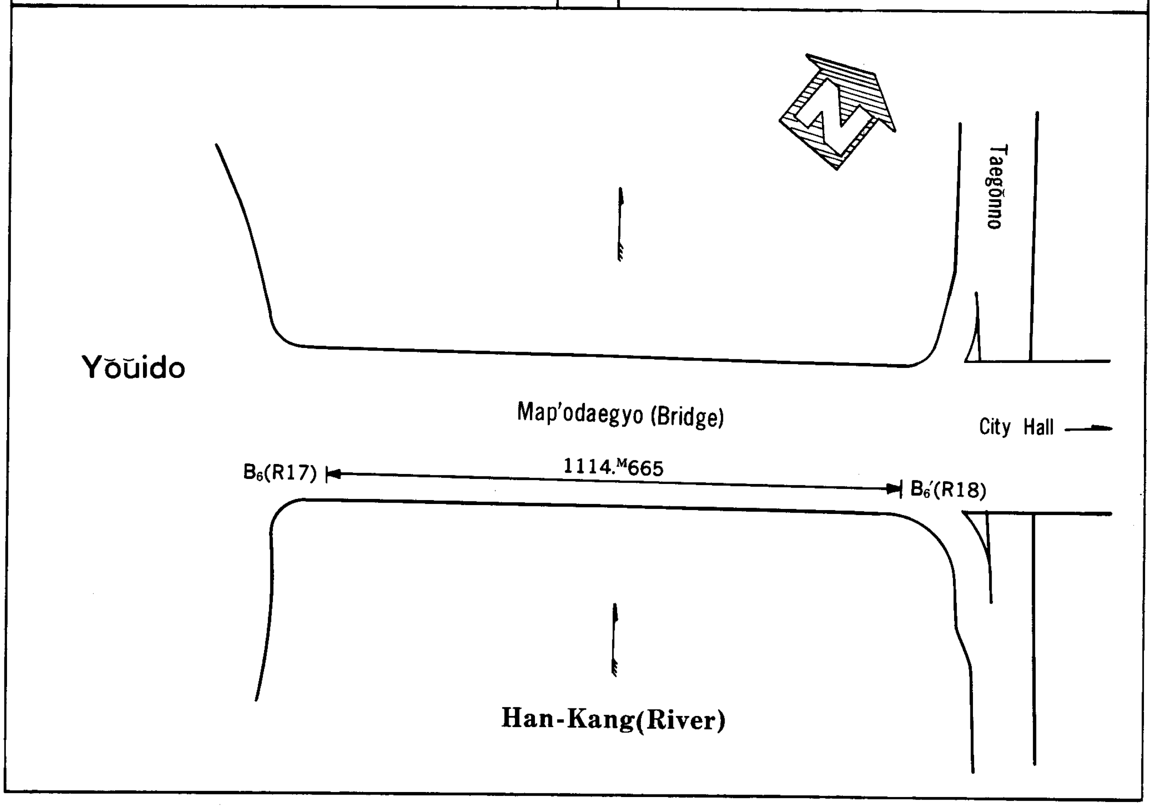
TYPE : Bronze

RECORDER : Cheon, Young-Ho



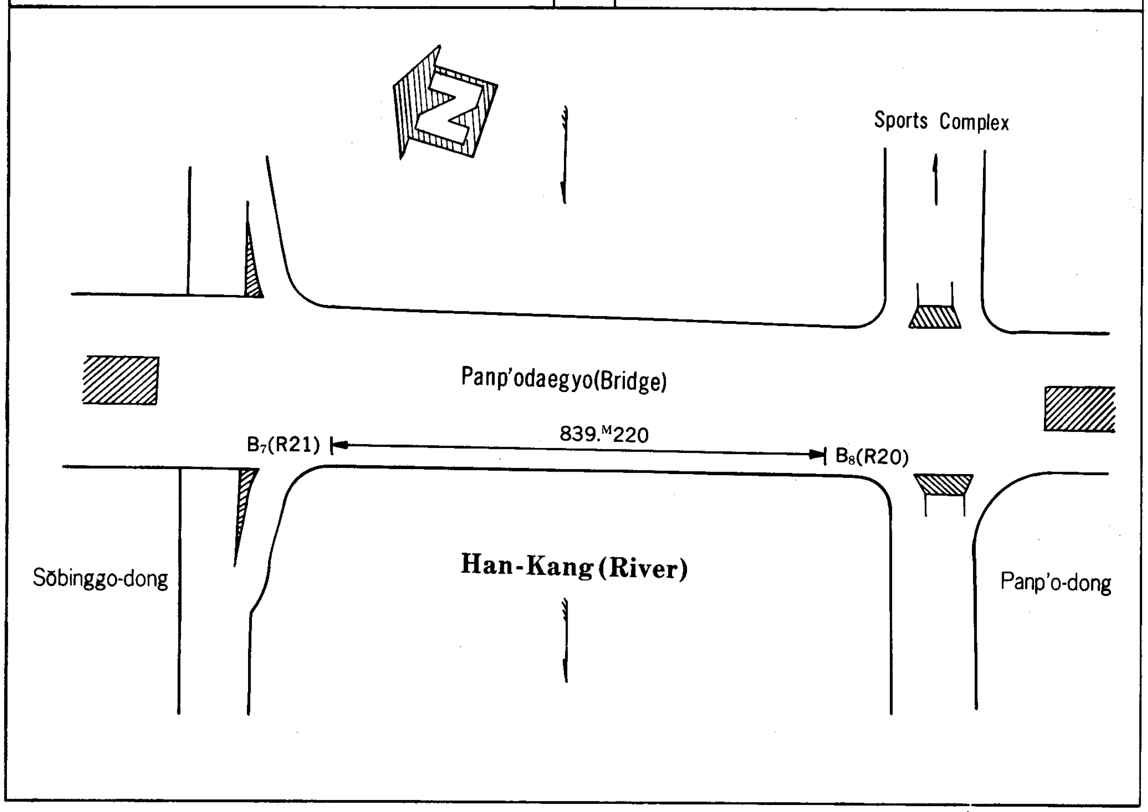
BASELINE MEASUREMENT

BASELINE : 6	**1988 SEOUL OLYMPIC**
MEASUREMENTS 1ST: 1114.M665 2ND: 1114.M665 3RD: 1114.M665	DATE : 1986. 4. 24 OPERATOR : Choi, Yun-Soo INSTRUMENT : EDM(RED-2) TEMPERATURE : 22°C PRESSURE : 760mmHg ATMOSPHERIC CORRECTION : 6PPM TYPE : Bronze RECORDER : Cheon, Young-Ho
FINAL CORRECTED DISTANCE 1114.M665	



BASELINE MEASUREMENT

BASELINE : 7	**1988 SEOUL OLYMPIC**
MEASUREMENTS 1^{ST}: 839. ^{M}220 2^{ND}: 839. ^{M}220 3^{RD}: 839. ^{M}220	DATE : 1986. 4. 24 OPERATOR : Choi,Yun-Soo INSTRUMENT : EDM(RED-2) TEMPERATURE : 22°C PRESSURE : 760mmHg ATMOSPHERIC CORRECTION : 6PPM TYPE : Bronze RECORDER : Cheon, Young-Ho
FINAL CORRECTED DISTANCE 839. ^{M}220	



BASELINE MEASUREMENT

BASELINE : 8

1988 SEOUL OLYMPIC

MEASUREMENTS

1ST: 760.^{M}936

2ND: 760.^{M}936

3RD: 760.^{M}936

FINAL CORRECTED DISTANCE

760.^{M}936

DATE : 1986. 4. 24

OPERATOR : Choi,Yun-Soo

INSTRUMENT : EDM(RED-2)

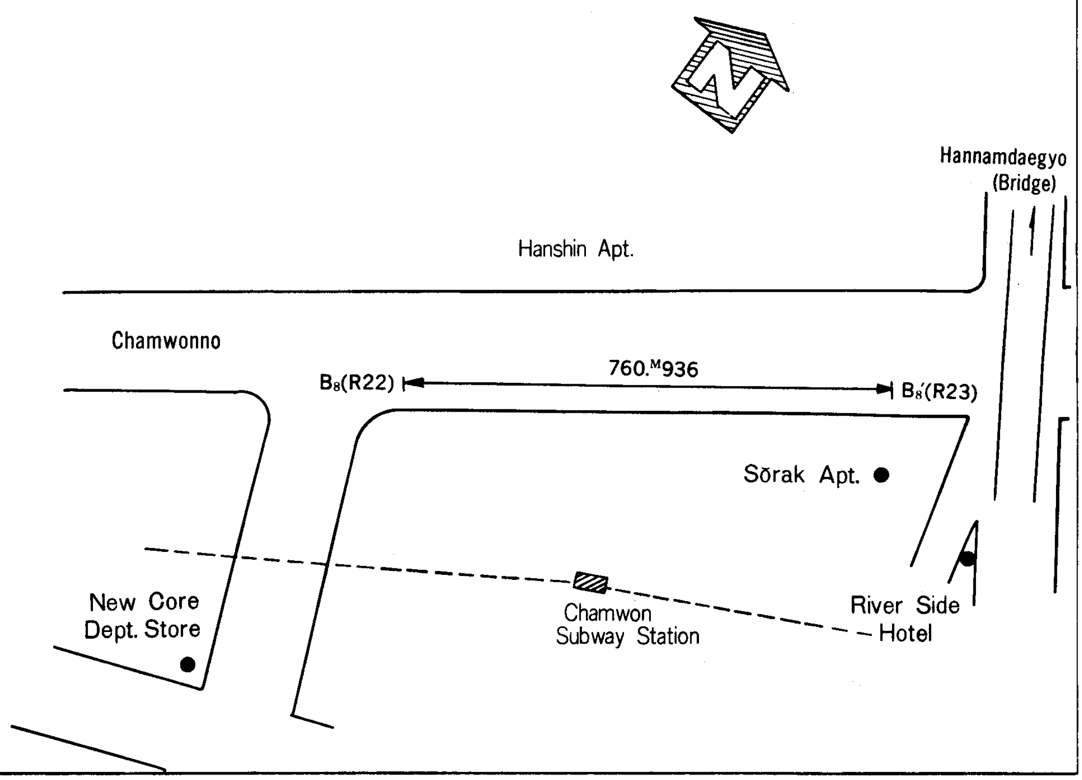
TEMPERATURE : 22°C

PRESSURE : 760mmHg

ATMOSPHERIC CORRECTION : 6PPM

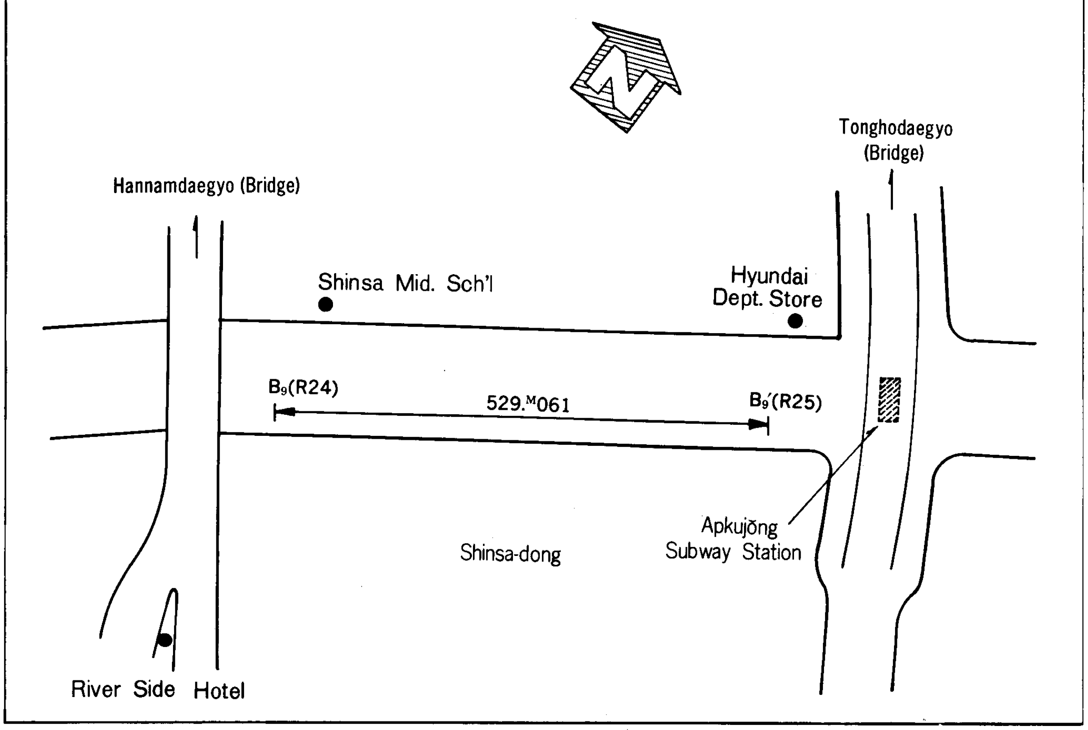
TYPE : Bronze

RECORDER : Cheon, Young-Ho



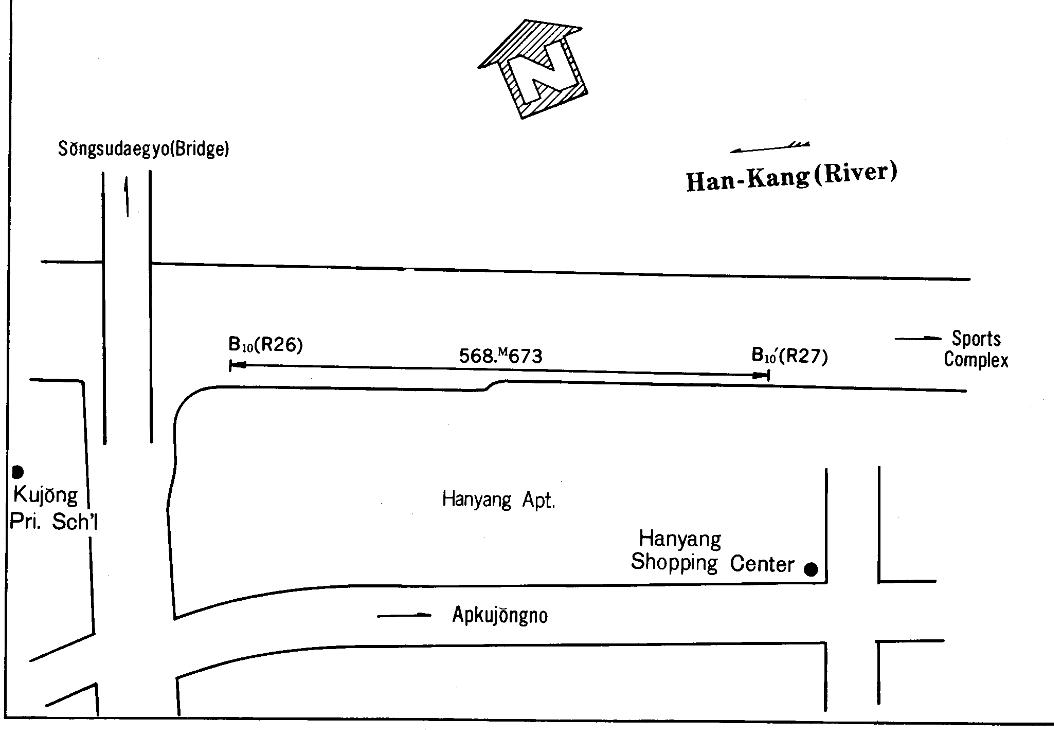
BASELINE MEASUREMENT

BASELINE : 9	**1988 SEOUL OLYMPIC**
MEASUREMENTS 1ST: 529.M061 2ND: 529.M062 3RD: 529.M060	DATE : 1986. 5. 2 OPERATOR : Ahn,Ki-Won INSTRUMENT : EDM(RED-2) TEMPERATURE : 22°C PRESSURE : 762mmHg ATMOSPHERIC CORRECTION : 6PPM TYPE : Bronze RECORDER : Cheon, Young-Ho
FINAL CORRECTED DISTANCE 529.M061	



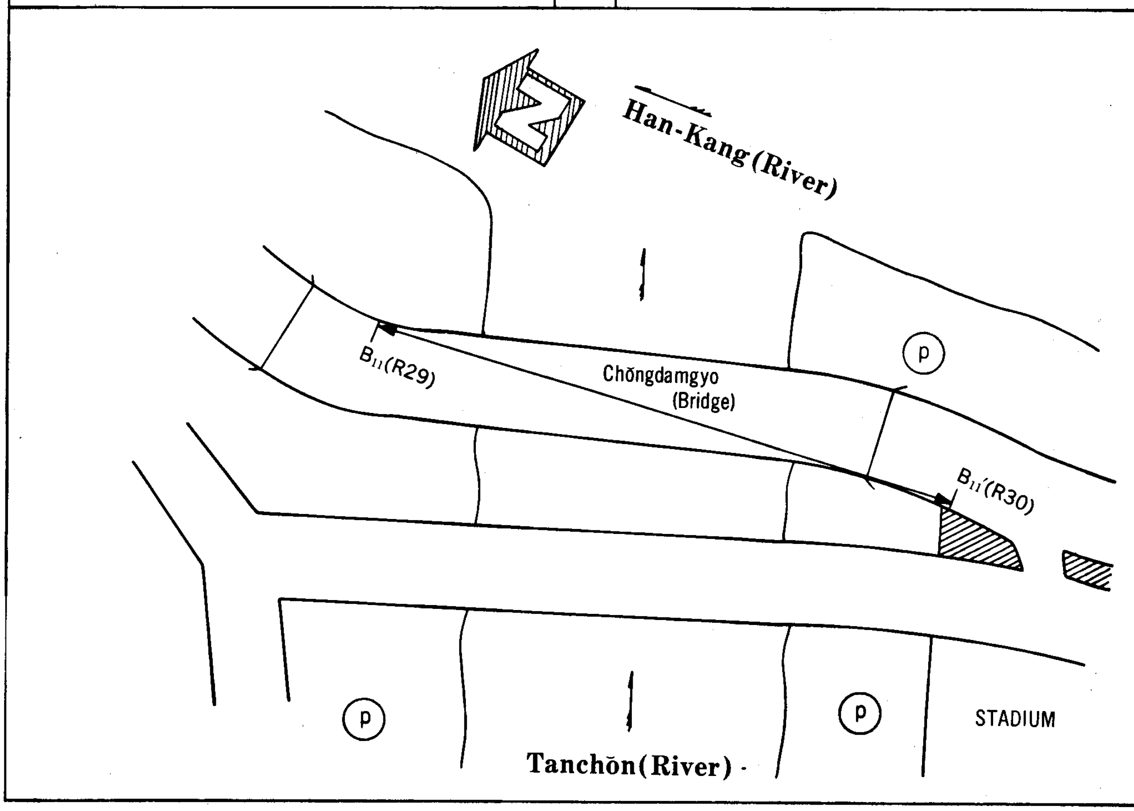
BASELINE MEASUREMENT

BASELINE : 10	1988 SEOUL OLYMPIC
MEASUREMENTS 1 ST: 568. M673 2 ND: 568. M673 3 RD: 568. M672	DATE : 1986. 5. 2 OPERATOR : Ahn,Ki-Won INSTRUMENT : EDM(RED-2) TEMPERATURE : 21°C PRESSURE : 760mmHg ATMOSPHERIC CORRECTION : 6PPM TYPE : Bronze RECORDER : Cheon, Young-Ho
FINAL CORRECTED DISTANCE 568. M673	



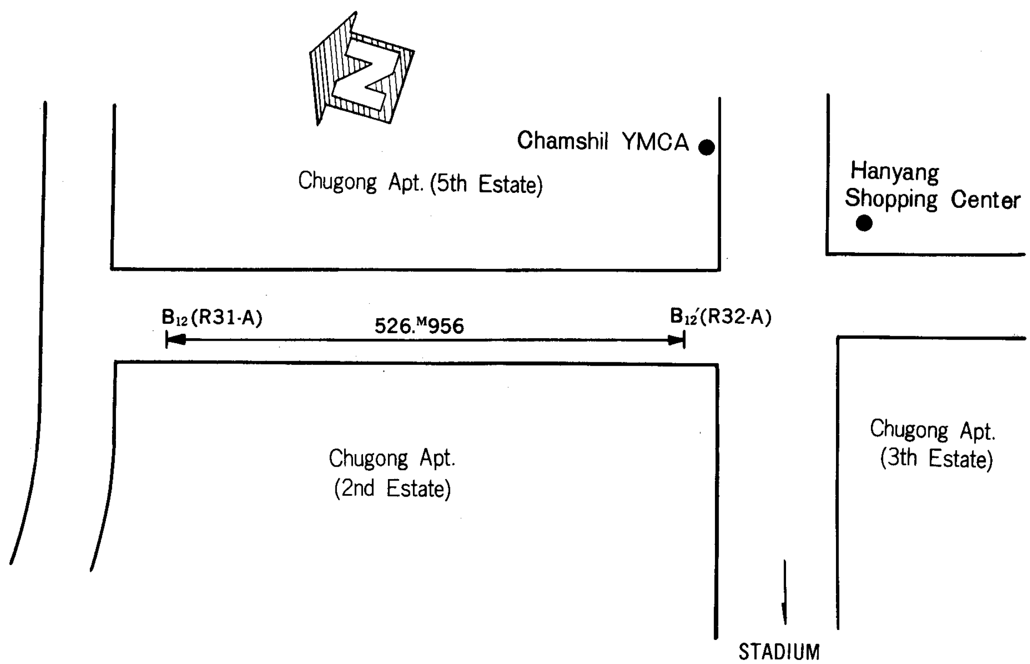
BASELINE MEASUREMENT

BASELINE : 11	**1988 SEOUL OLYMPIC**
MEASUREMENTS 1 ST: 434. M330 2 ND: 434. M331 3 RD: 434. M329	DATE : 1986. 4. 23 OPERATOR : Ahn,Ki-Won INSTRUMENT : EDM(RED-2) TEMPERATURE: 20.2°C PRESSURE : 767mmHg ATMOSPHERIC CORRECTION: 2PPM TYPE : Bronze RECORDER: Cheon, Young-Ho
FINAL CORRECTED DISTANCE 434. M330	



BASELINE MEASUREMENT

BASELINE : 12	**1988 SEOUL OLYMPIC**
MEASUREMENTS	DATE : 1986. 5. 20
1ST: 526.M956	OPERATOR : Lee,Young-Jin
2ND: 526.M956	INSTRUMENT : EDM(RED-2)
3RD: 526.M955	TEMPERATURE : 24.5°C
	PRESSURE : 754mmHg
FINAL CORRECTED DISTANCE	ATMOSPHERIC CORRECTION : 15PPM
526.M956	TYPE : Bronze
	RECORDER : Cheon, Young-Ho



BASELINE MEASUREMENT

BASELINE : 13

1988 SEOUL OLYMPIC

MEASUREMENTS

1ST: 412.M853

2ND: 412.M852

3RD: 412.M853

FINAL CORRECTED DISTANCE

412.M853

DATE : 1986. 4. 23

OPERATOR : Ahn,Ki-Won

INSTRUMENT : EDM(RED-2)

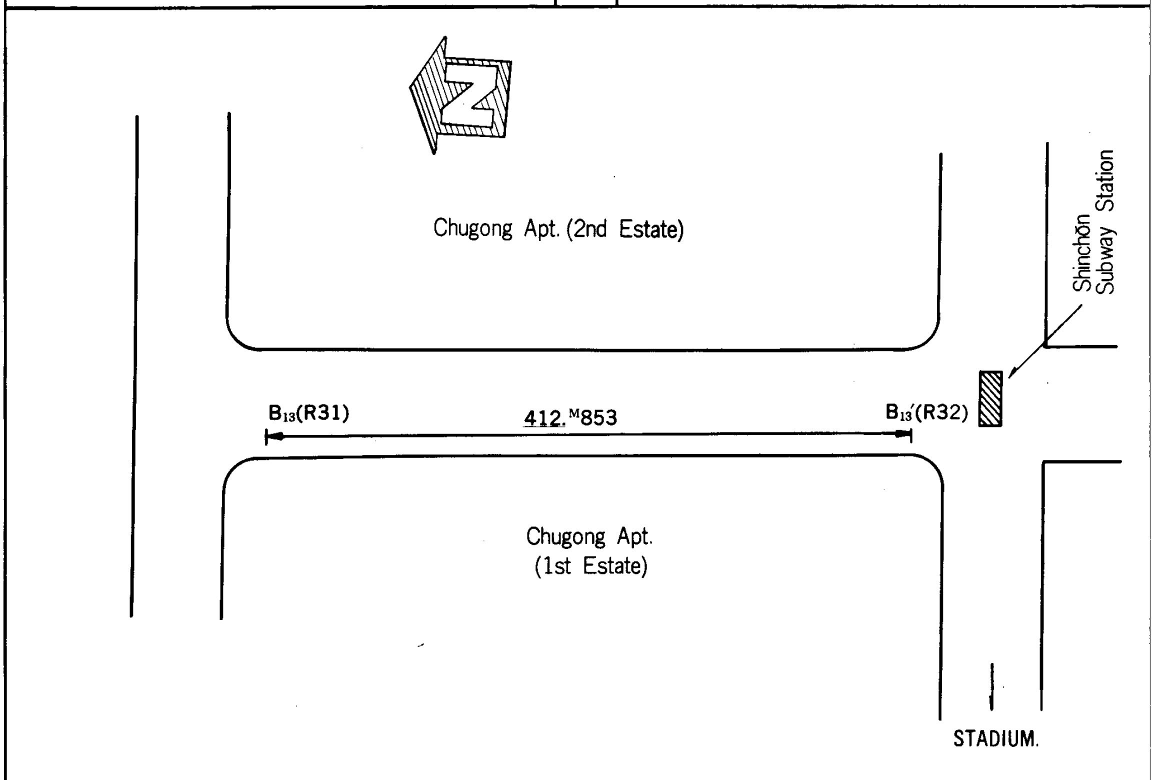
TEMPERATURE : 23.0°C

PRESSURE : 759mmHg

ATMOSPHERIC CORRECTION : 7PPM

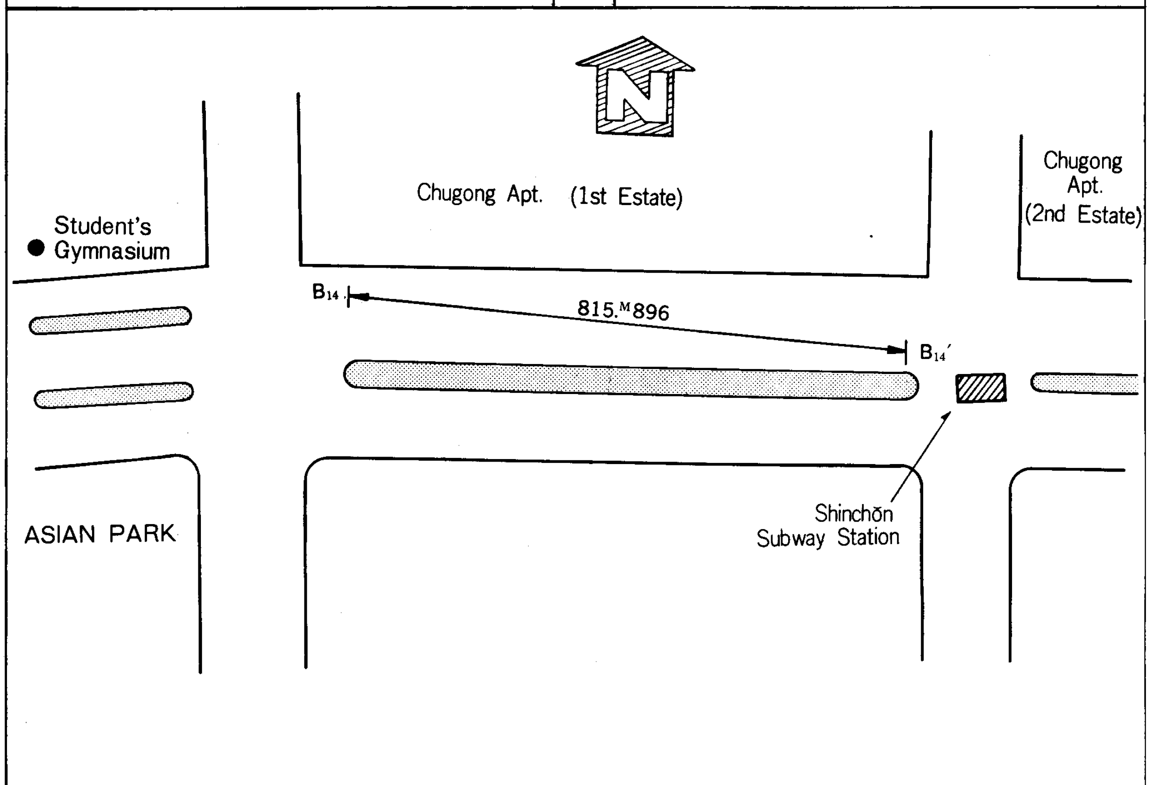
TYPE : Bronze

RECORDER : Cheon, Young-Ho



BASELINE MEASUREMENT

BASELINE : 14	1988 SEOUL OLYMPIC
MEASUREMENTS 1 ST: 815.M896 2 ND: 815.M896 3 RD: 815.M896	DATE : 1986. 6. 4 OPERATOR : Choi,Yun-Soo INSTRUMENT : EDM(RED-2) TEMPERATURE : 20.0°C PRESSURE : 757mmHg ATMOSPHERIC CORRECTION : 4PPM TYPE : Bronze RECORDER : Cheon, Young-Ho
FINAL CORRECTED DISTANCE 815.M896	



5. BICYCLE MEASUREMENT

MEASURING INSTRUMENTS:

"Jones assemblies" were exclusively used for the Olympic marathon course measurement performed on May 16 through May 18, 1986. This device was invented by Alan Jones in 1971, and is now distributed by the New York Road Running Club, New York, U.S.A.. A "Jones assembly" is an industrial Veeder Root Counter mounted on a bicycle odometer axle assembly. It has a direct gear drive, counts 20 digits per revolution, and is guaranteed to operate at 500 revolutions/minute for 100 million counts, which is equivalent to 40 miles/hour for 6,700 miles when mounted on the front wheel of a bicycle.

The Jones Assembly is known as the best device for measuring road race courses. The "Jones assemblies" were mounted on "Goldwin Delhi" bicycle manufactured by Samcholli Co., Ltd., Seoul, Korea, and those bicycles were specially manufactured for professional cyclists. All bicycles used for course measurements were offered by the SLOOC.

BICYCLE RIDERS:

A total of 17 best cyclists were selected from Kyonggi University. All of them had more than 5 years experience in amateur cycling, and they were members of the University Cycling Team and Korean Amateur Cycling Federation.

They were not required to judge the shortest possible path themselves during cycling, since the shortest route had been decided and marked with white paint along the whole course prior to actual measurements.

They were excellent in cycling along the pre-marked lines and their performance was superb for course measurements.

It was proved that the mean dispersion between minimum and maximum counts was by far less than two counts, which was identical to approximately 1/5,000 in the test riding. The test runs were repeated 10 times on Baseline 1 prior to actual measurements.

MEASUREMENT TEAMS:

Seven teams were operated for course measurements on May 16 through May 18, 1986, as indicated below:

TEAM	TEAM CAPTAIN	CHIEF ASSISTANT
Overall Control	Prof. Chul-Ho Ahn	Mr. Ki-Won Ahn
Record Team A	Prof. Eun-Kee Baick	Mr. Yun-Soo Choi
Record Team B	Prof. Jae-Wha Choi	Mr. Jae-Yoon Cho
Bicycle	Prof. Kyu-Jon Cho	Mr. Young-Jin Lee
Direction Control A	Prof. Mock-Mo Yeu	Mr. Hyun-Jik Lee
Direction Control B	Prof. Chan Lee	Mr. Byung-Uk Park
Route Painting	Prof. Chul-Ho Ahn	Mr. Young-Ho Cheon
		Mr. Ki-Won Ahn

Each team had a car allocated for transportation and walkie-talkies for communication. Some instruments were employed for recording and supporting purposes; e.g. cameras, maps, thermometers, survey flags, record-books, etc.

TRAFFIC/WEATHER/TOTAL TIME:

The marathon course is located in one of the heavy traffic areas in Seoul, weaving its way through Olympic Expressway — Seoul Express Bus Terminal — Youido Plaza — Kangbyunro — Hannamdaero.

It was impossible to measure any interval without traffic control. For this reason, we had to enlist the assistance of Seoul Metropolitan Police Department, which dispatched a traffic control team equipped with 14 police motor cycles, two police patrol cars, and wireless communication systems. The police team was assigned with each working group to follow, escort, and support our course measurement effort throughout the period from May 16 to May 18, 1986.

The weather was very fair, no rain, no wind, and no clouds. The variation of temperature was within the range of 12 to 15 degrees, 9 to 14 degrees, and 17 to 24 degrees, all in centigrade, on May 16, May 17, and May 18 respectively.

The first trial of course measurements on May 16 through May 17 was implemented in a time span of 3.5 hours and 2.5 hours beginning at 4:30 AM and 5:30 AM and ending at 8:00 AM respectively.

The second trial of measurements conducted on May 18, 1986 was performed in a time frame of four hours during 5:00 AM through 9:00 AM. The 2nd-trial measurements were used for computation of the final course length.

MEASUREMENT PERFORMANCE:

The shortest possible running path had been pre-determined and premarked with white paint along the whole marathon course before bicycle measurements. Any interval to be measured had been completely blocked from all traffics and cleared of any obstacles for cycling. Two record teams were operated to read the Jones Counter readings and for recordings.

Traffic control and recording teams operated in a leap-frog fashion: while one team was operating, the other traveled to the next reference point. This way of performance helped ensure that all cyclists concentrate on their mission only without any possible interference.

Each bicycle kept the constant tire pressure, 450 kg/cm^2 during the mission, and it was checked at the end of day mission. Each cycle and cyclist was assigned his own code number, and no one was allowed to use any different cycles other than the one assigned to him. By this way, any possible errors arising from instruments and personnel could be minimized.

Each cyclist had been re-educated in and practised how to start and stop in a recording place, and how to ride during cycling. The training and practice had lasted for three days before course measuring.

Each cyclist announced his identity code upon arriving at each recording point and a reading officer read the Jones Counts aloud. Reading and recording were made twice by two different staff members in order to avoid any possible mistakes. The cyclists were not allowed to read the count themselves, and they had to reduce the speed of cycling in arriving at and starting from the reading places in accordance with the instructions of recording team members.

As mentioned above, the course measurement was implemented twice: the first trial on May 16 through May 17, and the second trial on May 18, 1986. In the first trial of measurement, the whole marathon course was separated into two parts as indicated below:

PART I. From Baseline 1 (R2-R3) to Baseline 5 (R15-R16)

PART II. From Baseline 5 to Baseline 1

The 2nd trial of measurement effected on May 18, 1986 along the whole route started from Baseline 1 and ended at the same Baseline 1.

All told, 15 sets of bicycles and cyclists participated in each trial of course measurements. Evaluating the bicycle measurements made at both first and second trials, we found some unreliable readings on a few cyclists indicated below:

Measurement May 16, 1986:

Cycle No. 1, 4 & 9: Tires went flat during cycling.

Cycle No. 12 & 15: Tire pressure was found considerably diminished when gauged after the mission.

Measurement May 18, 1986:

Cycle No. 3 & 6 developed the same sort of trouble as mentioned above.

SUPERVISIONS:

The measurement has been performed under the supervision of, and in consultation with, the Seoul Olympic Organizing Committee and Korea Amateur Athletic Federation. The persons involved with the supervision and consultation are indicated below:

Supervisors: Mr. Kwang-Ho, Cho, Facilities Dept., SLOOC
Mr. Dong-Sick Shin, Athletics Coordinator, Sports Dept., SLOOC

Consultants: Mr. Chang-Keun Kim, Vice President, KAAF
Prof. Choong-Sik Choi, Vice Chairman, Marathon Committee, KAAF
Mr. Tae-Bong Han, Director, KAAF
Mr. Yong-Duk Kim, Director, KAAF

RESULTS OF MEASUREMENTS:

Upon review of the first and second trial measurements, we concluded that the second trial measurement was more reliable than the first because of the following reasons:

1) From the statistical point of view, the samples obtained from the first trial may not be reliable any more than those obtained from the second trial, considering that:
   — The first trial was made on two separate days while the 2nd trial on one same day, and that,
   — In the first trial, there emerged many unreliable readings due to bicycle tire troubles.

2) Preliminary computation of distances indicated that difference in the total length between the first and second trials was no more than 4 meters and was therefore insignificant.

Thus, the final computation of the marathon course was based upon the measurement that resulted from the second trial implemented on May 18, 1986.

A list of Raw Jones Counts made on ~~March~~ May 18, 1986 and detailed diagrams on each interval are shown in the following pages.

RAW JONES COUNTS

REF.POINT		C 1	C 2	C 3	C 4
B01	R03	77198.0	106235.0	65063.0	58631.0
R02		88581.5	117610.0	76383.0	69967.5
B01	R02	88835.0	117805.5	76629.0	70205.0
R03		100220.5	129178.0	87949.0	81540.5
B02	R04	129979.5	158902.0	117531.5	111175.5
R05*		145681.0	174588.5	133140.0	126811.0
R06*		146043.0	174963.0	133579.5	127188.5
R07*		159841.5	188745.5	147294.5	140927.5
R08*		160593.0	189530.0	148066.5	141687.5
R09		174611.5	203535.0	162002.0	155644.5
R10		191835.0	220742.0	179124.0	172795.5
B03	R11	204114.5	233008.0	191331.5	185027.0
R12		208351.5	237243.0	195546.0	189248.0
B04	R13	224183.5	253057.0	211285.0	205012.0
R14		227757.5	256628.5	214840.0	208573.0
B05	R15	251412.5	280255.0	238354.5	232121.0
R16		257196.0	286032.0	244103.5	237879.5
B06	R17	261031.5	289864.0	247916.5	241700.5
R18		271774.0	300597.0	258595.5	252398.0
R18A		294434.0	323243.5	281122.5	274967.5
R19		299908.5	328713.0	286563.0	280417.0
B07	R20	327914.5	356697.5	314404.0	308309.0
R21		336000.5	364777.0	322444.0	316362.0
B08	R22	356264.5	385022.0	342588.0	336540.0
R23		363600.5	392351.0	349878.5	343842.0
B09	R24	371777.0	400523.5	358008.5	351984.5
R25		376875.5	405616.5	363075.5	357062.0
B10	R26	389751.0	418482.5	375874.0	369884.5
R27		395230.0	423956.0	381322.0	375340.5
R28		413121.5	441833.5	399108.5	393163.0
B11	R29	421304.5	450010.5	407245.0	401317.0
R30		425488.0	454192.5	411406.5	405485.5
B12	R31	441909.0	470601.0	427730.0	421839.5
R32		446987.5	475674.0	432778.0	426896.5
R01		465062.5	493731.0	450743.5	444893.0
R01		465391.5	494143.0	451244.0	445434.0
B01	R02	477350.5	506090.5	463132.0	457342.5
R03		488728.5	517455.0	474443.0	468671.5
B01	R03	488920.0	517661.0	474695.0	468969.5
R02		500295.0	529028.5	486006.5	480300.5
B01	R02	500496.5	529188.0	486212.0	480507.0
R03		511873.0	540553.5	497522.0	491835.5
B01	R03	512042.5	540695.0	497793.0	492058.0
R02		523417.0	552062.0	509104.0	503387.5

RAW JONES COUNTS

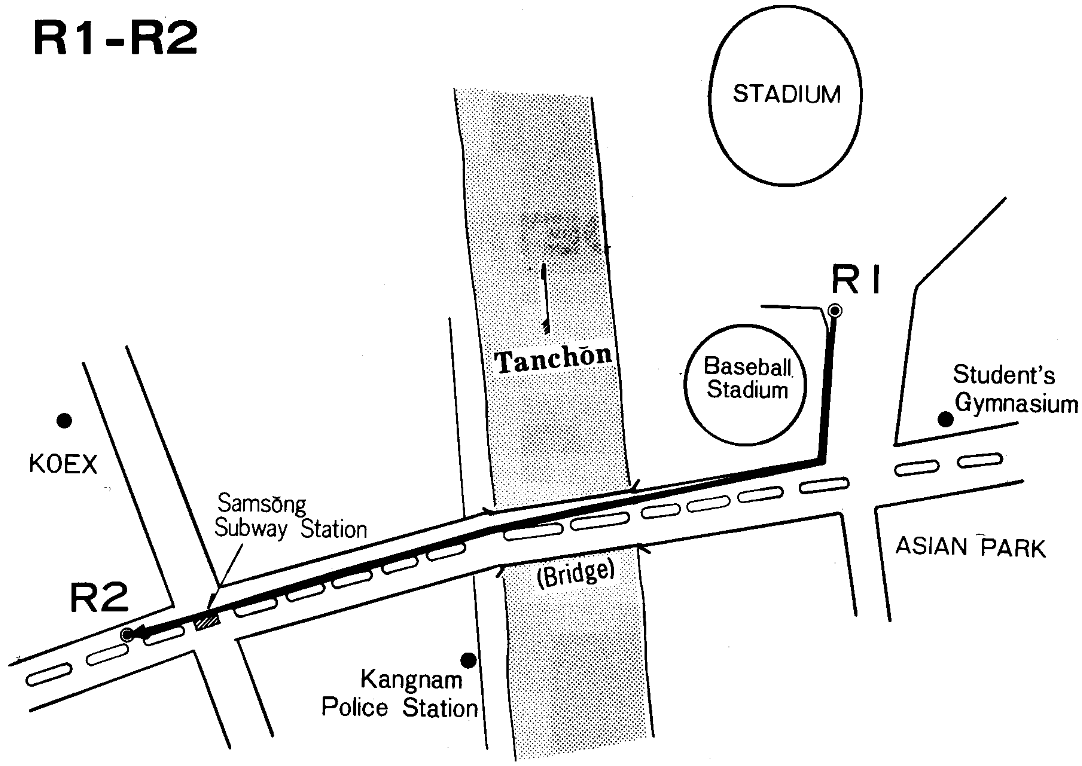
REF.POINT		C 5	C 6	C 7	C 8
B01	R03	64759.0	66227.0	72335.0	28959.0
R02		76095.0	77560.0	83712.0	40300.5
B01	R02	76362.5	77812.0	84150.5	40674.0
R03		87696.0	89143.5	95529.5	52014.0
B02	R04	117315.0	118752.0	125261.0	81650.0
R05*		132939.5	134379.0	140951.5	97290.0
R06*		133423.5	134820.5	141421.5	97801.0
R07*		147155.5	148550.0	155209.5	111543.5
R08*		147868.5	149263.0	155929.0	112277.0
R09		161819.5	163214.5	169937.5	126240.0
R10		178956.5	180356.0	187150.5	143396.0
B03	R11	191172.5	192574.5	199421.5	155627.0
R12		195391.0	196792.0	203657.0	159849.5
B04	R13	211143.0	212544.5	219473.5	175617.5
R14		214701.5	216102.0	223047.0	179176.0
B05	R15	238239.5	239634.5	246679.5	202739.5
R16		243995.5	245388.0	252458.0	208500.0
B06	R17	247814.0	249205.0	256291.0	212321.5
R18		258505.5	259895.0	267026.0	223022.0
R18A		281056.5	282447.0	289681.5	245606.0
R19		286500.0	287893.5	295153.0	251058.0
B07	R20	314375.0	315760.5	323145.0	278957.5
R21		322421.0	323809.0	331227.0	287012.0
B08	R22	342582.5	343973.5	351477.0	307198.0
R23		349880.0	351272.5	358808.0	314502.5
B09	R24	358020.5	359411.0	366982.0	322648.5
R25		363094.0	364486.0	372076.5	327726.5
B10	R26	375911.5	377301.0	384945.5	340554.5
R27		381368.5	382754.0	390422.0	346013.0
R28		399170.5	400559.0	408305.5	363838.0
B11	R29	407316.0	408706.0	416486.5	371990.0
R30		411480.0	412872.0	420667.5	376159.0
B12	R31	427817.0	429213.0	437077.0	392513.5
R32		432872.5	434267.0	442152.0	397570.0
R01		450860.0	452253.5	460211.0	415572.0
R01		451338.0	452642.0	460679.0	416268.0
B01	R02	463239.0	464545.0	472628.5	428181.0
R03		474565.0	475869.0	484001.0	439517.0
B01	R03	474874.5	476141.0	484300.0	440037.5
R02		486199.0	487466.0	495668.5	451370.0
B01	R02	486406.0	487685.5	496153.5	451851.0
R03		497730.5	499008.0	507523.0	463185.5
B01	R03	498058.0	499299.0	507819.0	463590.0
R02		509381.5	510622.5	519187.0	474922.0

RAW JONES COUNT

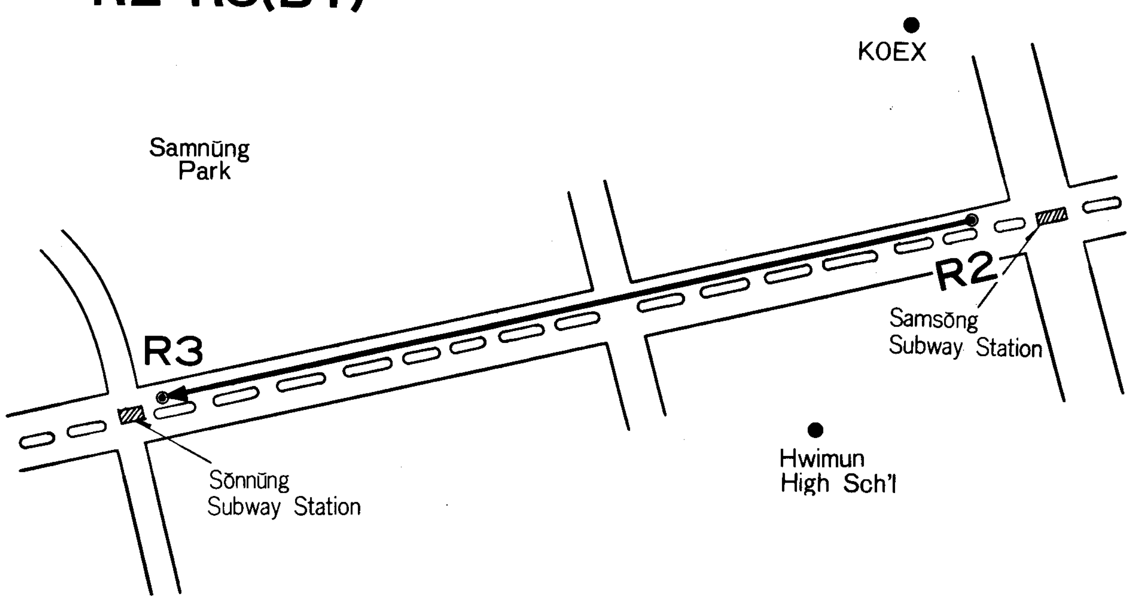
REF.POINT		C 9	C 10	C 11	C 12	C 13
B01	R03	80304.0	23384.0	80449.0	92428.5	93151.0
R02		91684.5	34800.0	91799.0	103818.0	104505.0
B01	R02	92105.5	35302.5	92225.0	104454.5	105127.0
R03		103483.5	46719.5	103576.5	115842.5	116479.5
B02	R04	133218.5	76559.0	133240.0	145602.0	146143.0
R05*		148910.0	92302.0	148894.0	161295.5	161796.5
R06*		149524.5	92900.5	149598.5	161886.5	162430.0
R07*		163310.5	106733.5	163351.0	175679.0	176181.5
R08*		164031.0	107444.5	164063.5	176356.0	176684.0
R09		178039.0	121500.5	178039.5	190369.5	190657.5
R10		195250.0	138769.5	195210.5	207587.0	207828.0
B03	R11	207520.5	151079.5	207450.5	219865.0	220069.5
R12		211756.5	155329.0	211675.0	224105.0	224294.0
B04	R13	227574.5	171195.5	227452.0	239921.0	240070.0
R14		231147.0	174780.0	231016.5	243496.5	243634.5
B05	R15	254783.0	198497.0	254591.0	267155.5	267230.0
R16		260562.0	204294.5	260357.0	272938.0	272995.5
B06	R17	264395.0	208140.0	264180.5	276776.0	276819.0
R18		275129.5	218912.5	274887.0	287514.5	287527.5
R18A		297775.5	241639.5	297473.0	310177.0	310126.5
R19		303245.5	247127.5	302930.0	315651.0	315587.0
B07	R20	331235.0	275204.5	330852.0	343657.0	343515.5
R21		339317.5	283313.5	338914.0	351736.5	351580.0
B08	R22	359562.0	303631.0	359108.0	371994.0	371785.5
R23		366893.0	310985.5	366419.0	379328.0	379098.5
B09	R24	375066.0	319186.0	374569.0	387501.0	387252.5
R25		380159.5	324300.0	379651.0	392597.5	392335.0
B10	R26	393023.0	337210.0	392480.0	405473.5	405173.0
R27		398499.5	342704.5	397941.0	410954.0	410637.5
R28		416380.0	360643.5	415774.0	428837.5	428478.0
B11	R29	424556.5	368850.5	423929.0	437022.0	436638.0
R30		428739.5	373046.5	428100.0	441205.0	440809.5
B12	R31	445146.0	389508.0	444464.0	457622.0	457182.0
R32		450219.5	394599.5	449525.0	462697.5	462244.5
R01		468279.5	412712.5	467536.0	480769.0	480274.5
R01		469557.5	413699.0	468694.0	481477.0	481615.5
B01	R02	481507.0	425685.0	480612.5	493437.5	493538.5
R03		492878.5	437091.0	491954.0	504812.0	504881.0
B01	R03	493389.5	437599.0	492436.5	505312.0	505466.0
R02		504761.5	449006.0	503777.0	516687.0	516812.0
B01	R02	505490.0	449232.0	504319.0	517405.0	517369.5
R03		516859.5	460638.0	515660.0	528779.0	528711.0
B01	R03	517262.0	461240.0	516081.0	529269.0	529286.5
R02		528632.5	472647.0	527421.5	540643.0	540627.5

FIG. 2-3. DETAILED MAPS OF EACH INTERVAL

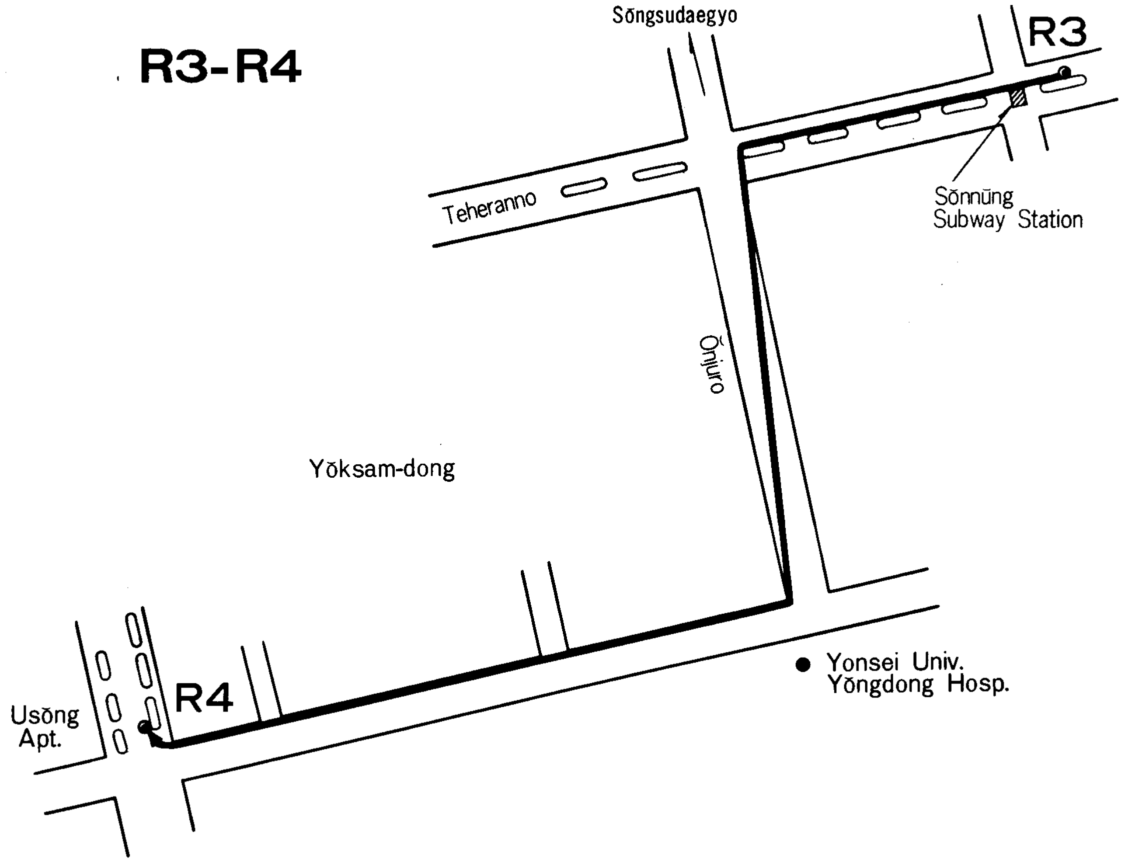
R1-R2


STADIUM
R1
Tanchŏn
Baseball Stadium
Student's Gymnasium
KOEX
Samsŏng Subway Station
R2
ASIAN PARK
(Bridge)
Kangnam Police Station

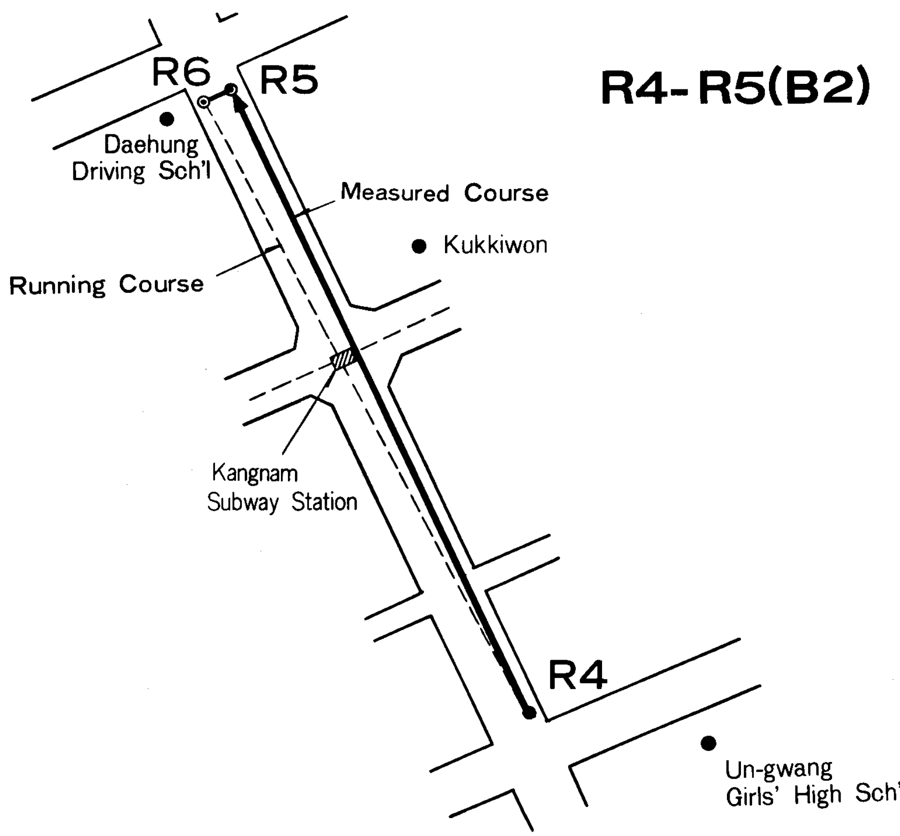
R2-R3(B1)


KOEX
Samnŭng Park
R3
R2
Samsŏng Subway Station
Sŏnnŭng Subway Station
Hwimun High Sch'l

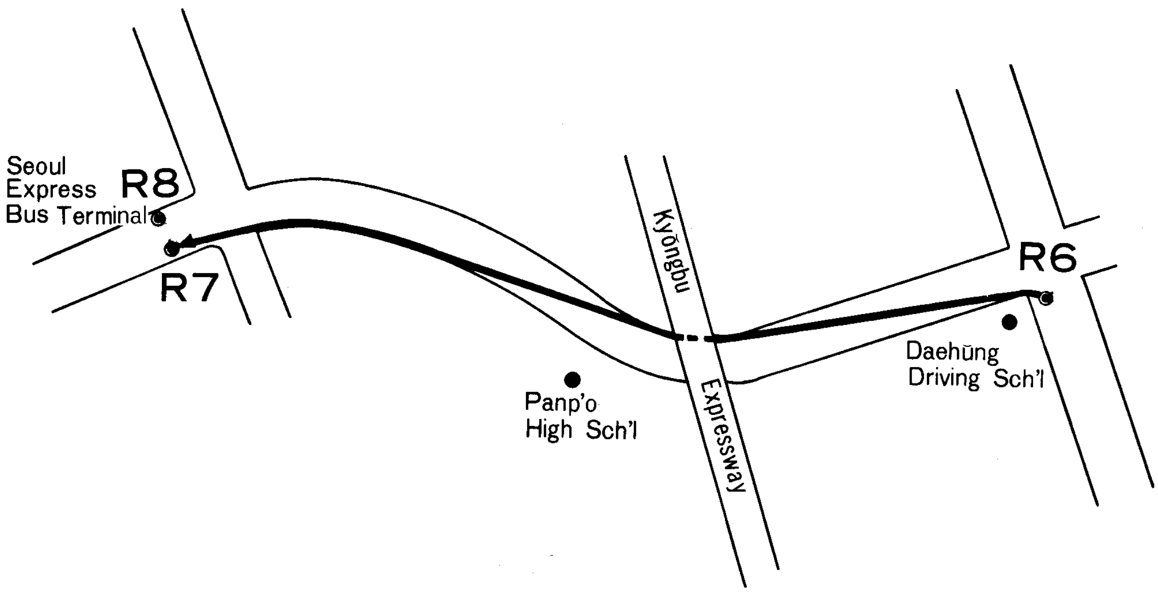
R3-R4


Sŏngsudaegyo
R3
Teheranno
Sŏnnŭng
Subway Station
Ŏnjuro
Yŏksam-dong
Usŏng
Apt.
R4
Yonsei Univ.
Yŏngdong Hosp.

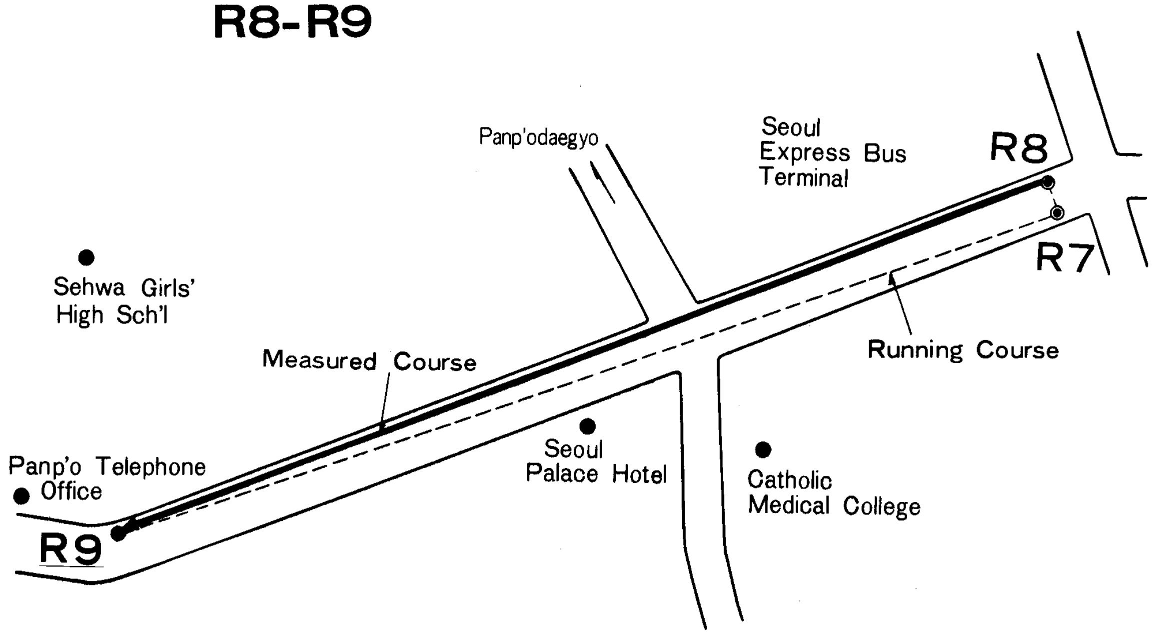
R4-R5(B2)

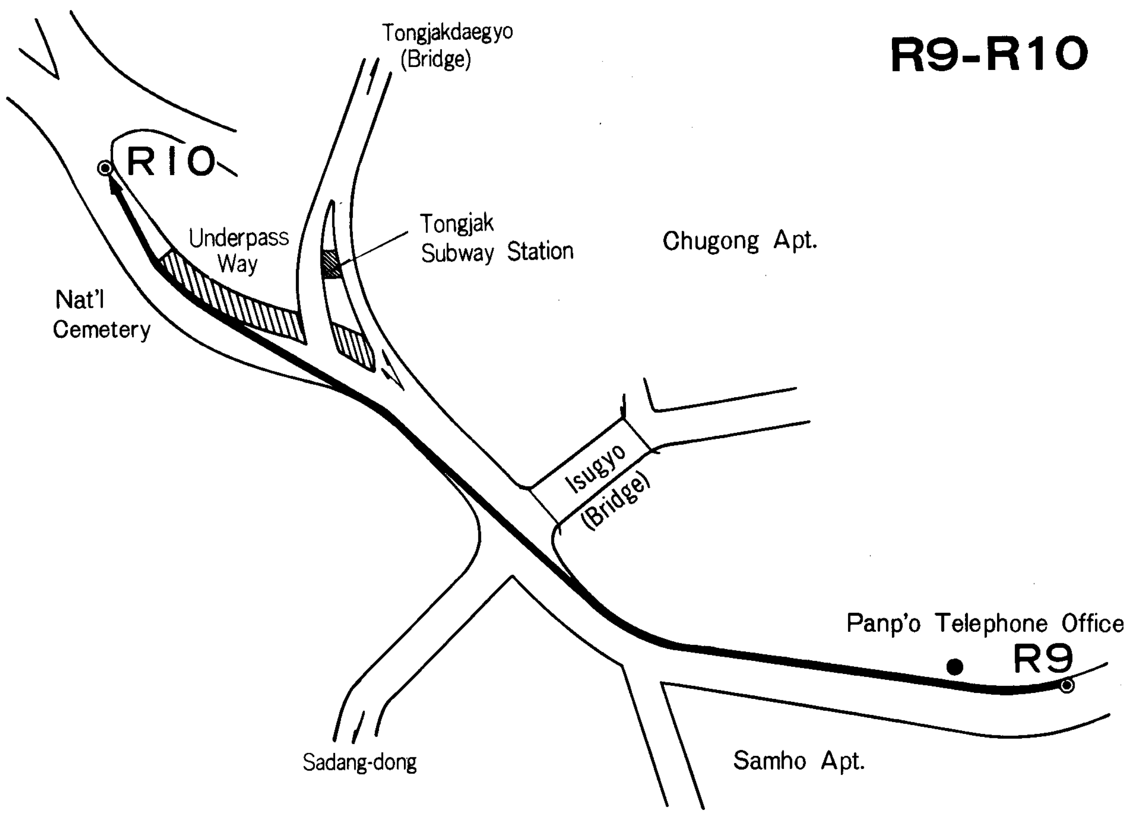

R6
R5
Daehung
Driving Sch'l
Measured Course
Kukkiwon
Running Course
Kangnam
Subway Station
R4
Un-gwang
Girls' High Sch'l

R6-R7

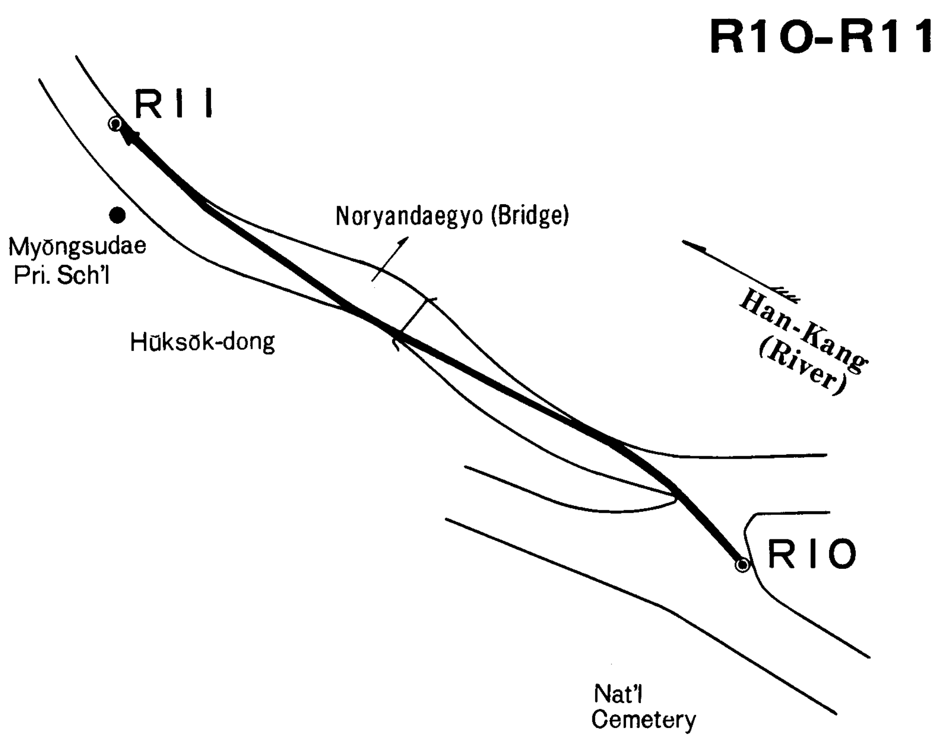

Seoul
Express
Bus Terminal
R8
R7
Kyŏngbu
Expressway
R6
Daehŭng
Driving Sch'l
Panp'o
High Sch'l

R8-R9


Panp'odaegyo
Seoul
Express Bus
Terminal
R8
R7
Sehwa Girls'
High Sch'l
Measured Course
Running Course
Panp'o Telephone
Office
R9
Seoul
Palace Hotel
Catholic
Medical College

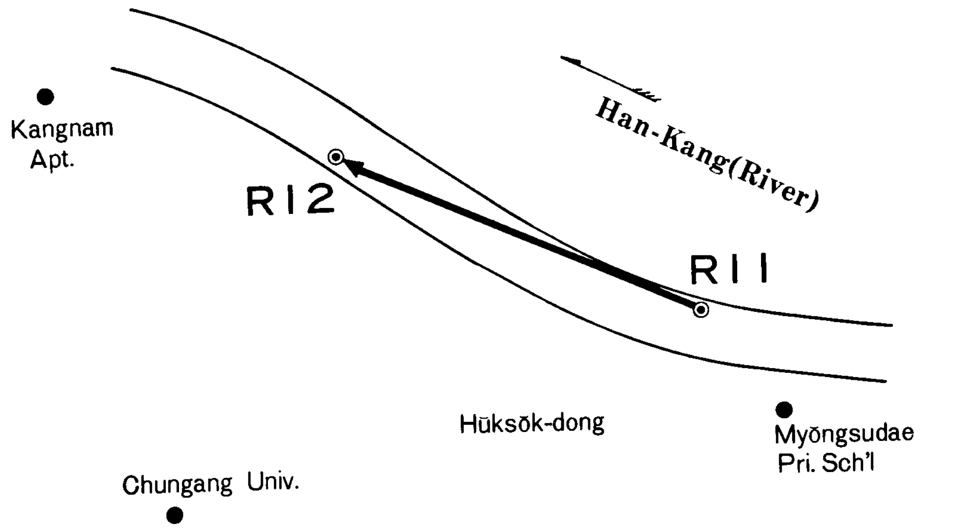


R9-R10
Tongjakdaegyo
(Bridge)
R10
Underpass
Way
Tongjak
Subway Station
Chugong Apt.
Nat'l
Cemetery
Isugyo
(Bridge)
Panp'o Telephone Office
R9
Sadang-dong
Samho Apt.

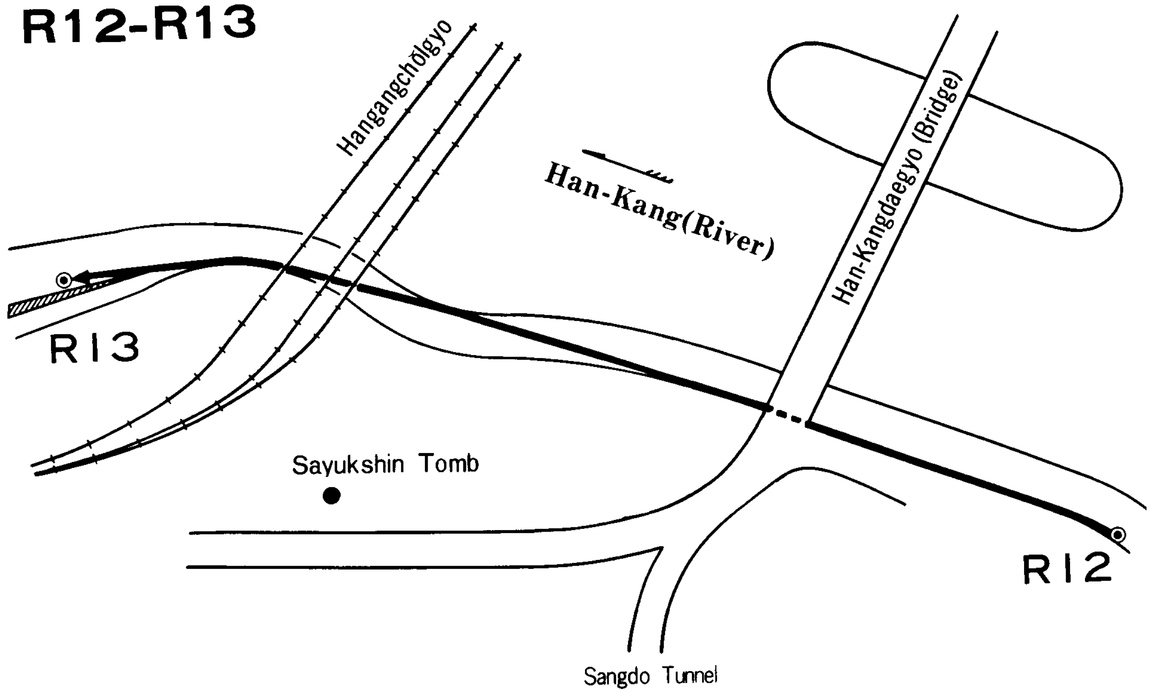


R10-R11
R11
Noryandaegyo (Bridge)
Myŏngsudae
Pri. Sch'l
Hŭksŏk-dong
Han-Kang
(River)
R10
Nat'l
Cemetery

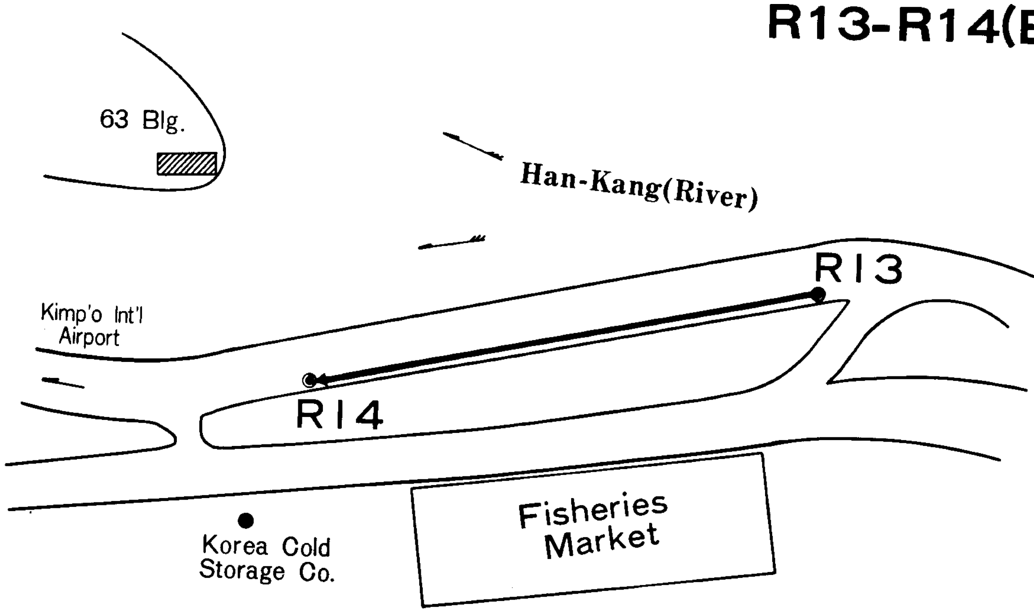
R11-R12(B3)



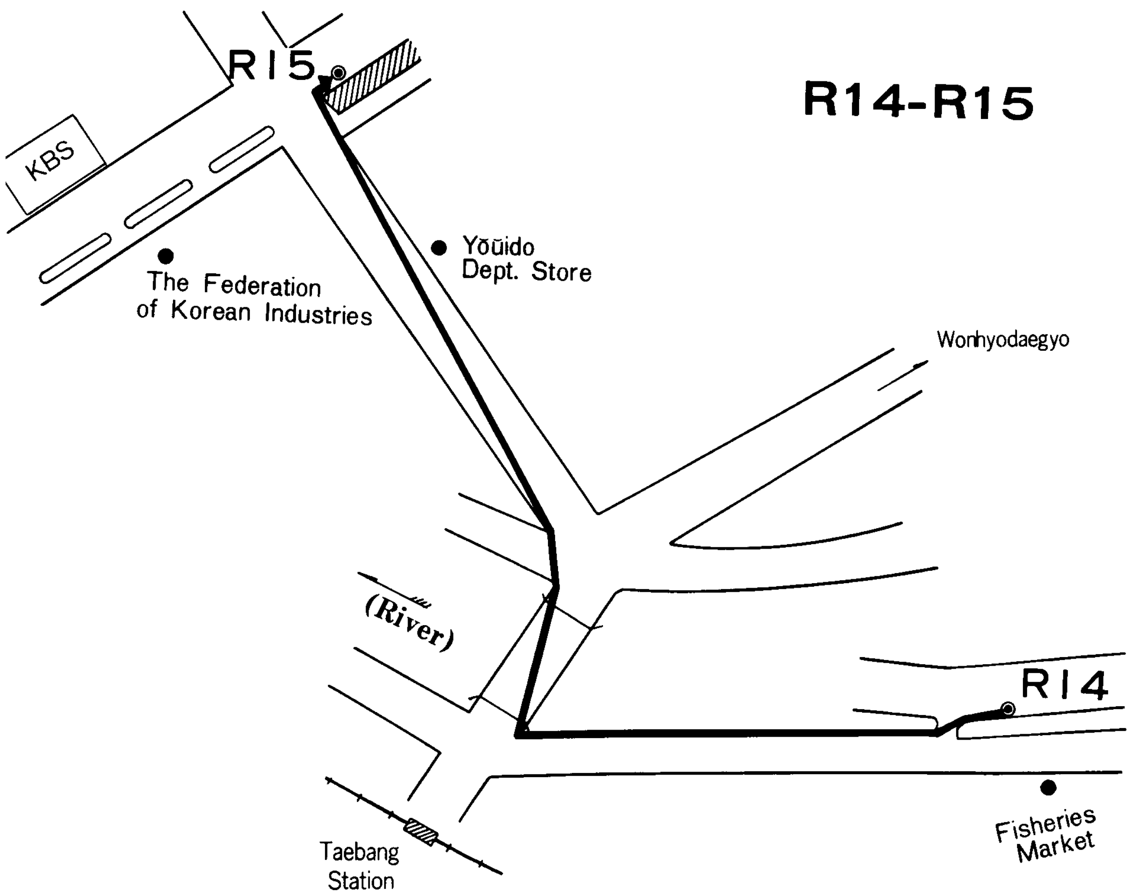
R12-R13

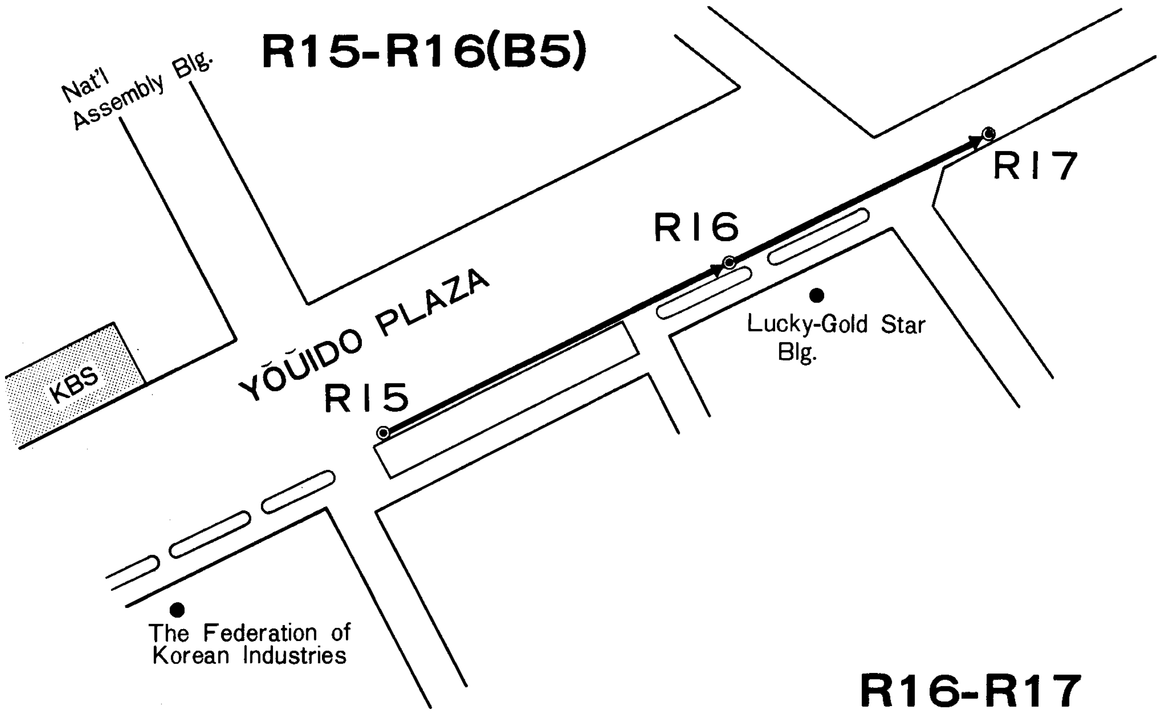


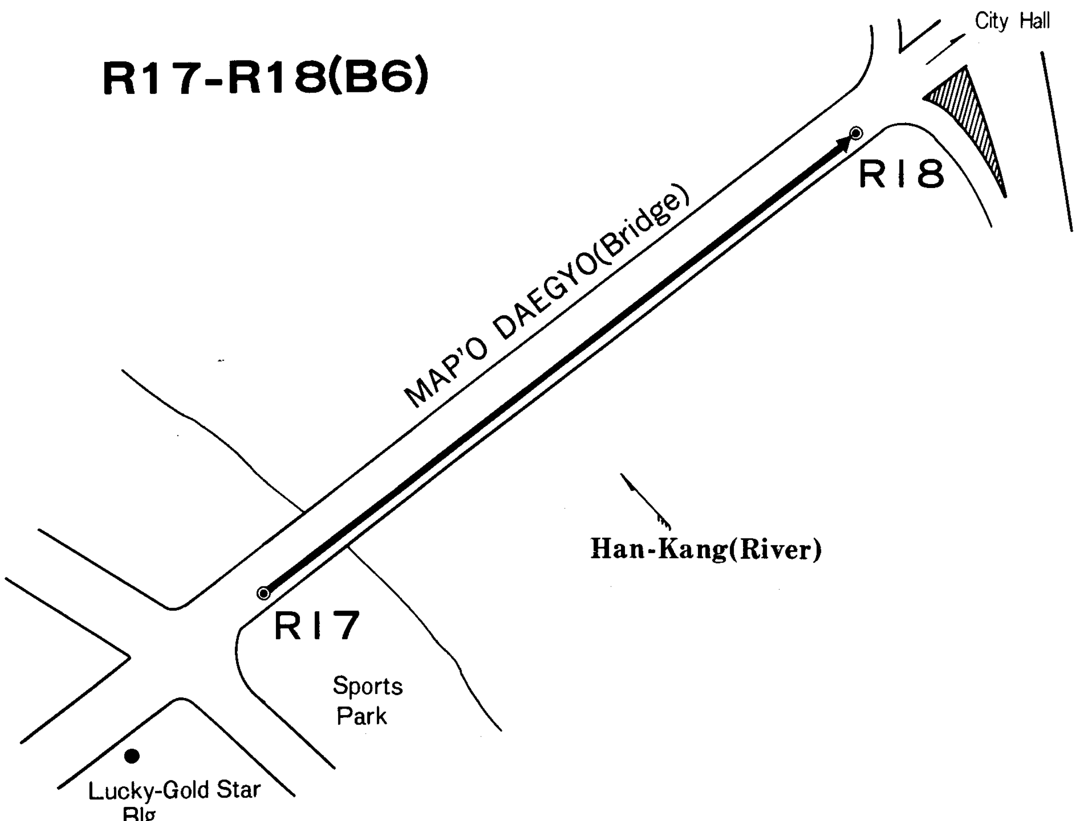
R13-R14(B4)



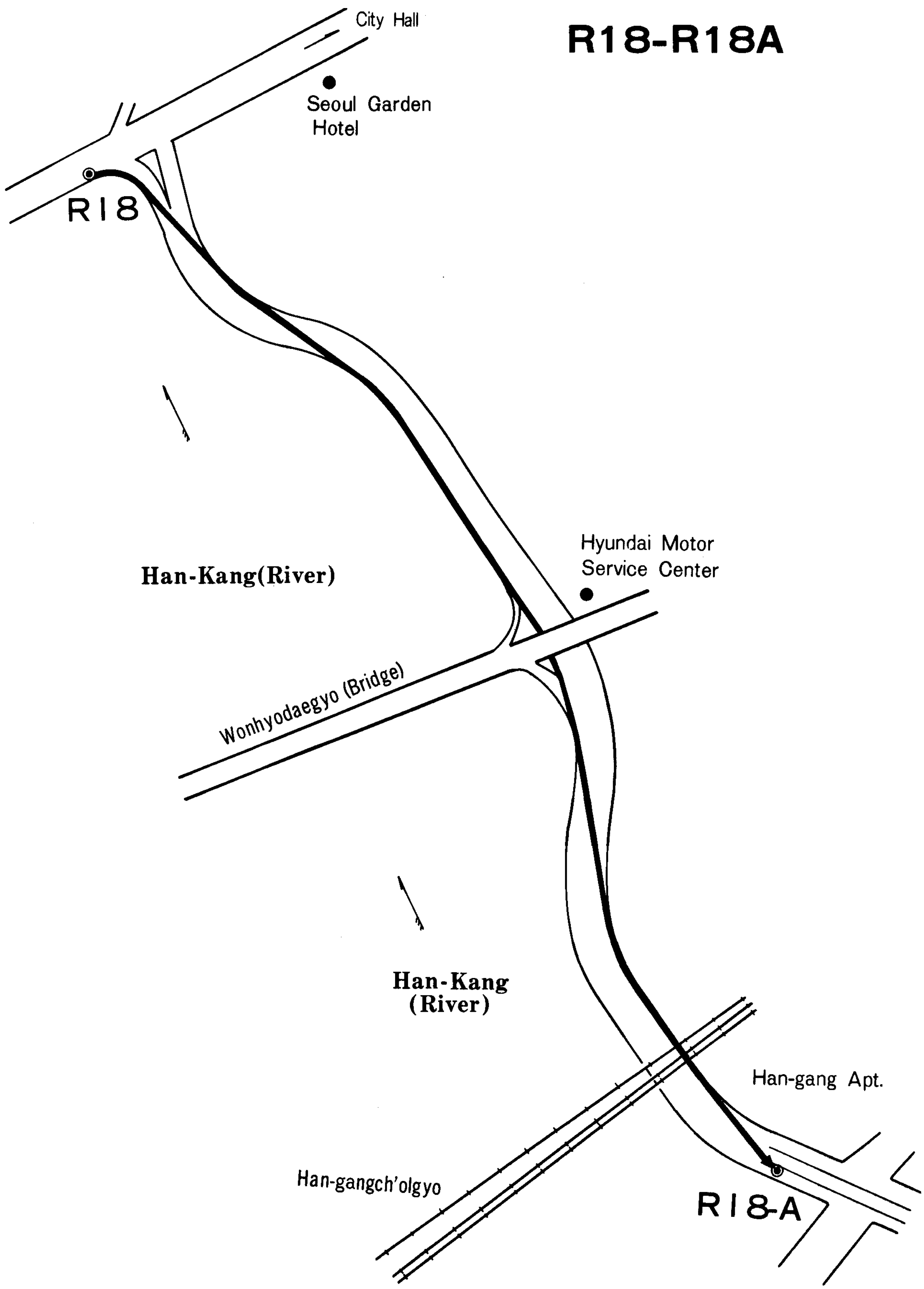
R14-R15



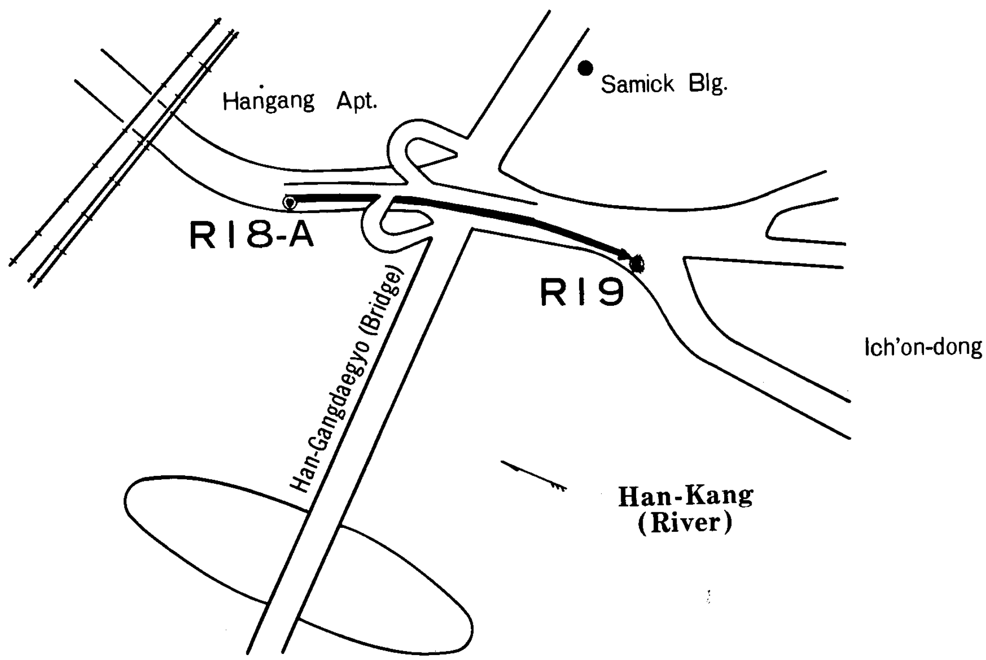

R15-R16(B5)
Nat'l Assembly Blg.
KBS
YŎUIDO PLAZA
R15
R16
R17
Lucky-Gold Star Blg.
The Federation of Korean Industries
R16-R17


R17-R18(B6)
City Hall
R18
MAP'O DAEGYO(Bridge)
Han-Kang(River)
R17
Sports Park
Lucky-Gold Star Blg.

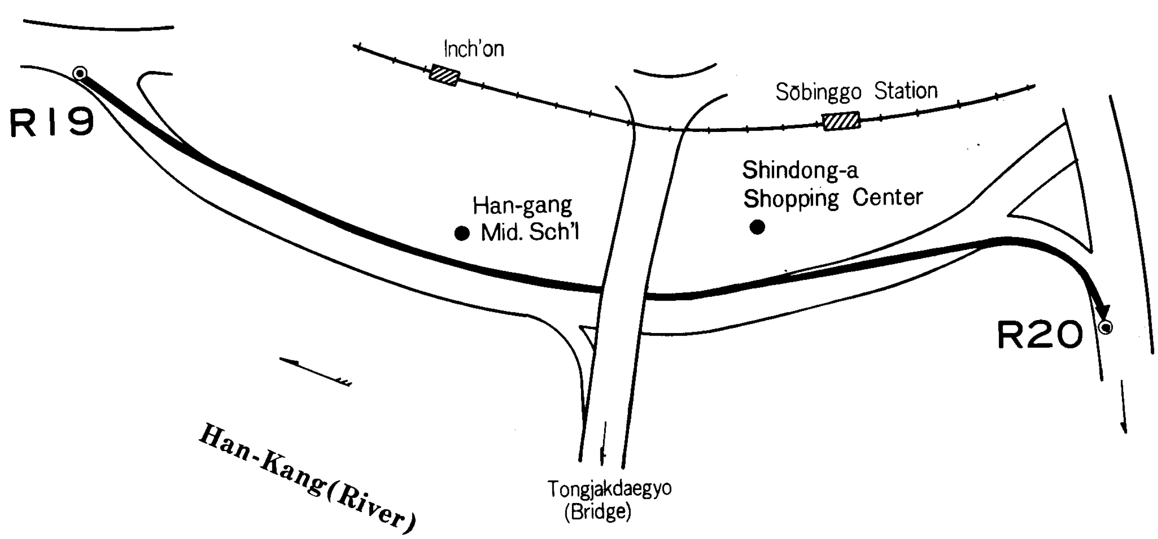
R18-R18A

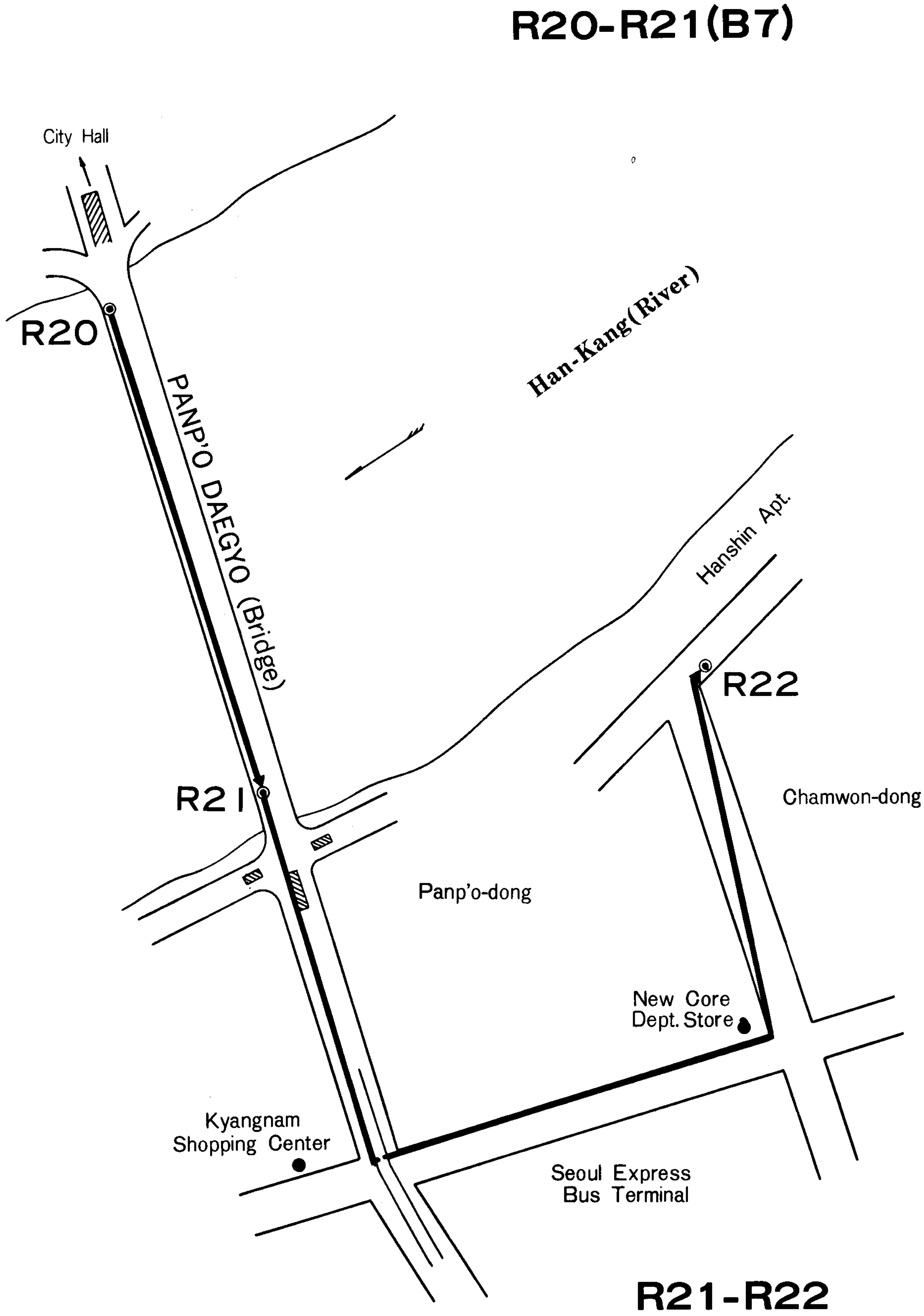

City Hall
Seoul Garden Hotel
R18
Han-Kang(River)
Hyundai Motor Service Center
Wonhyodaegyo (Bridge)
Han-Kang (River)
Han-gang Apt.
Han-gangch'olgyo
R18-A

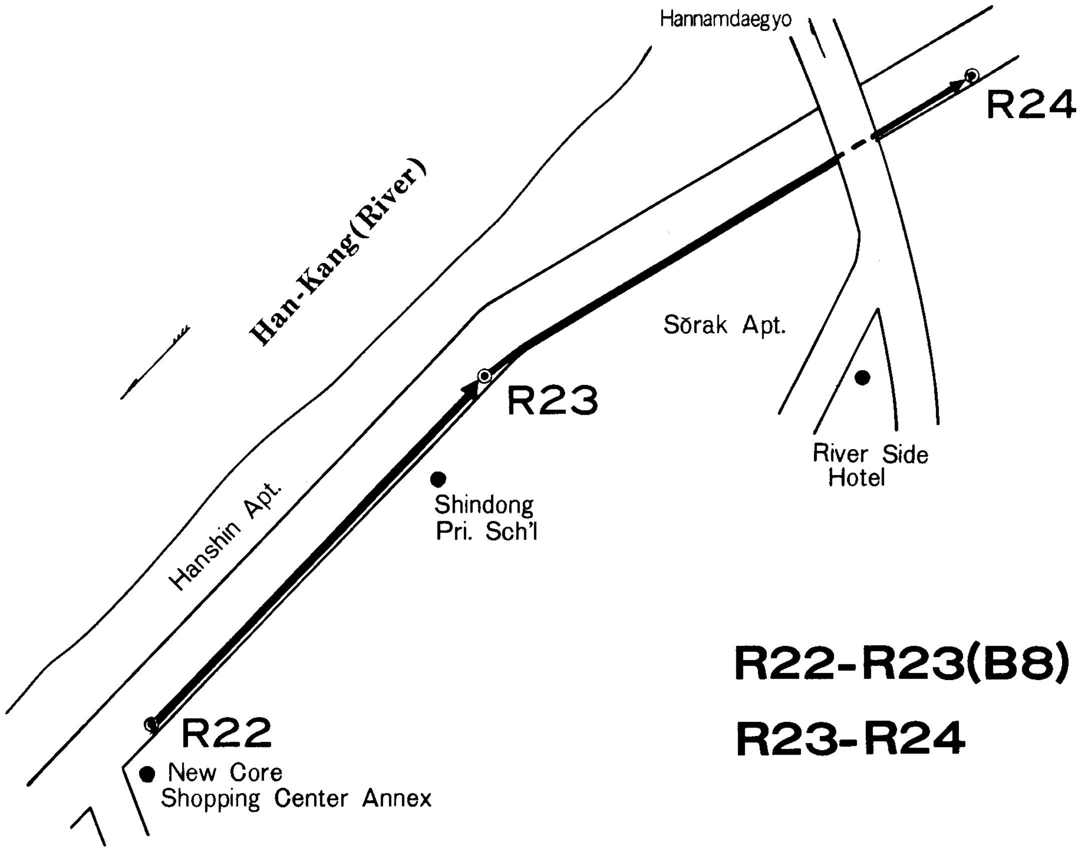
R18-R19



R19-R20

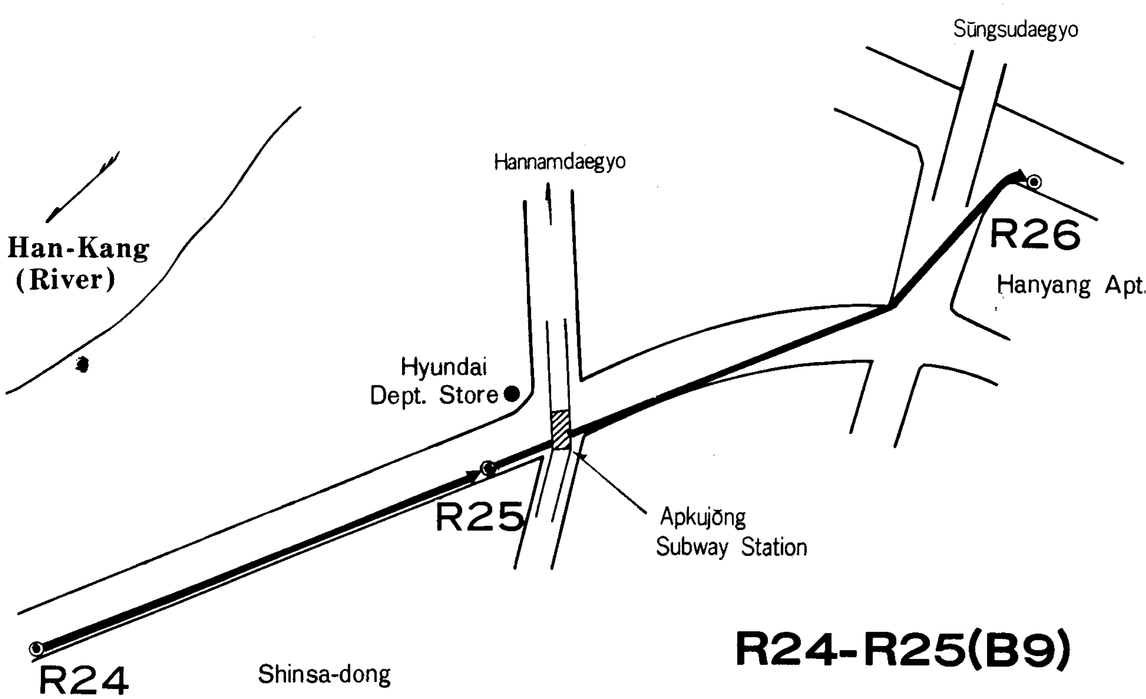



R20-R21(B7)
City Hall
R20
PANP'O DAEGYO (Bridge)
Han-Kang(River)
Hanshin Apt.
R22
R21
Chamwon-dong
Panp'o-dong
New Core
Dept. Store
Kyangnam
Shopping Center
Seoul Express
Bus Terminal
R21-R22



R22-R23(B8)

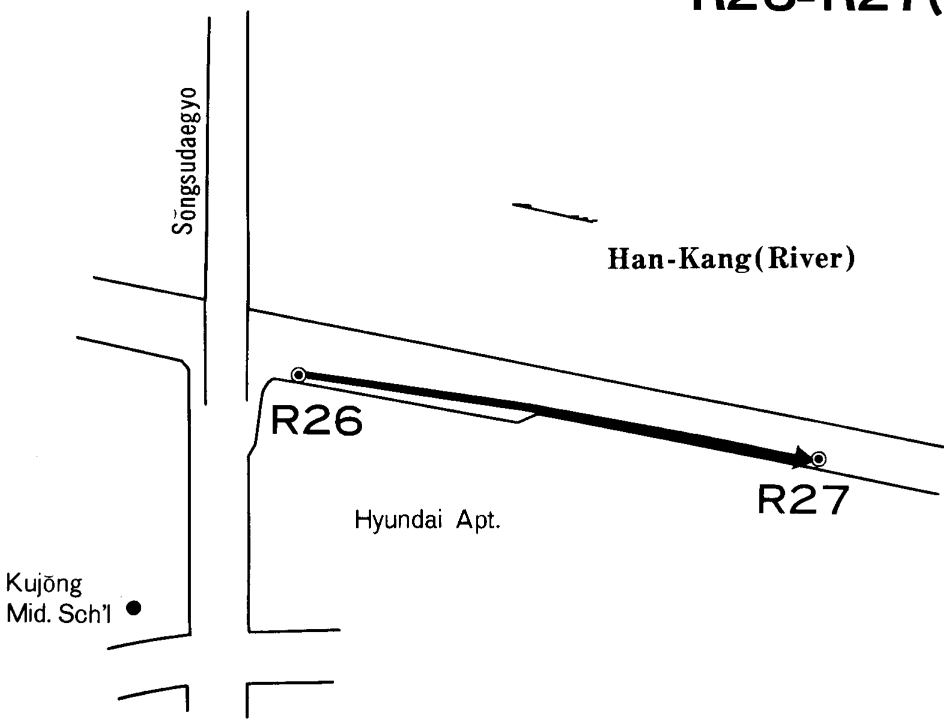
R23-R24

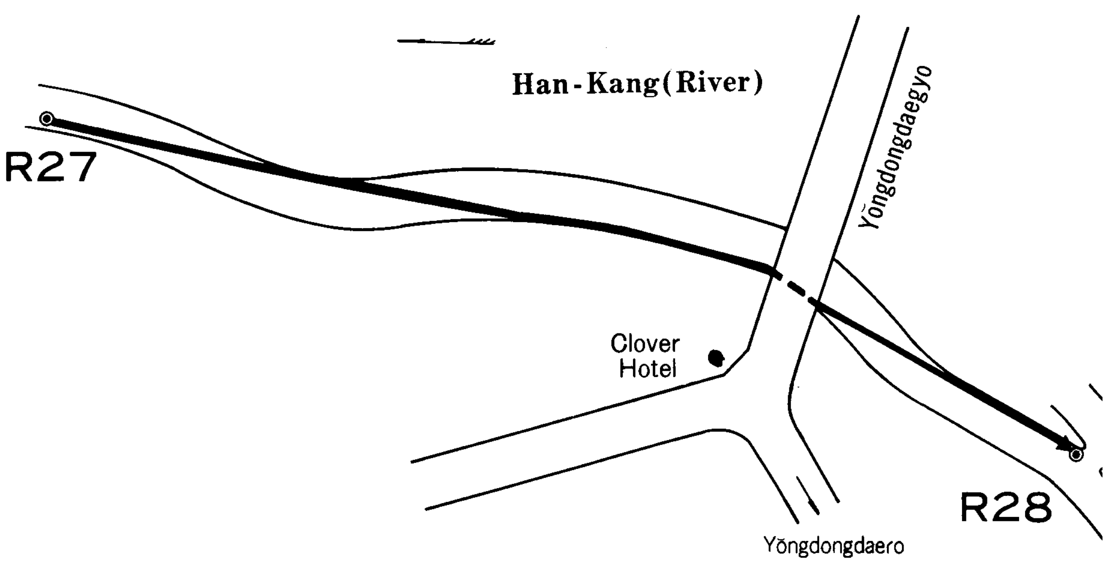


R24-R25(B9)

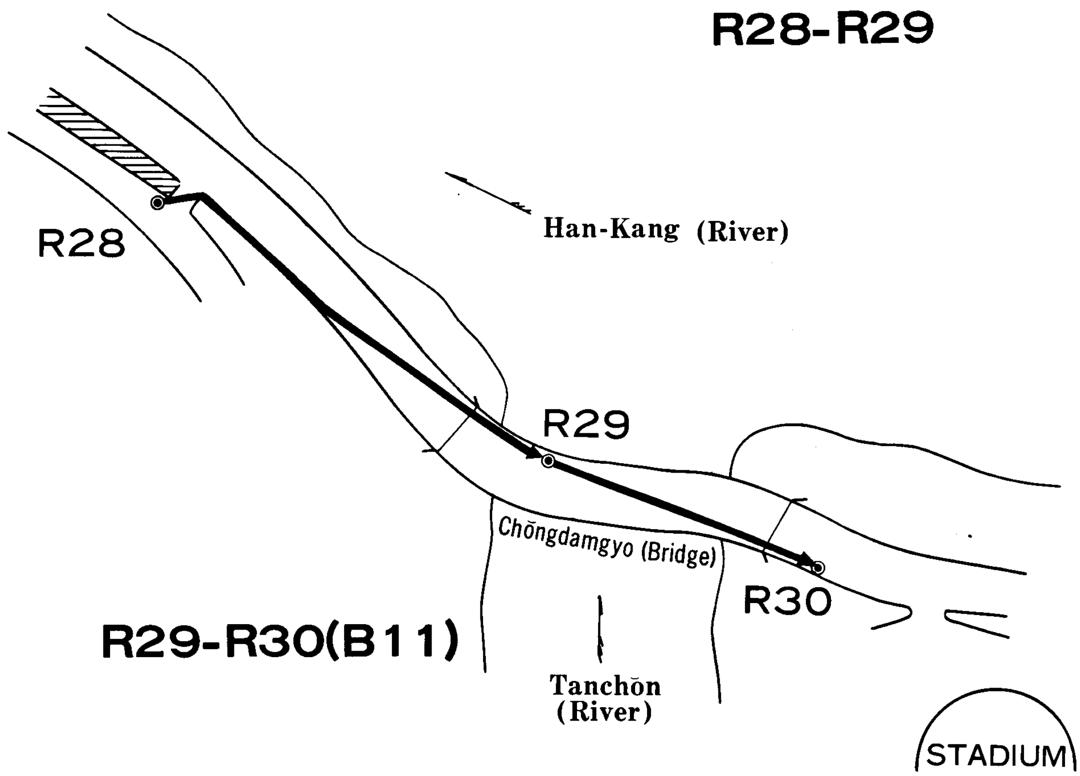
R25-R26

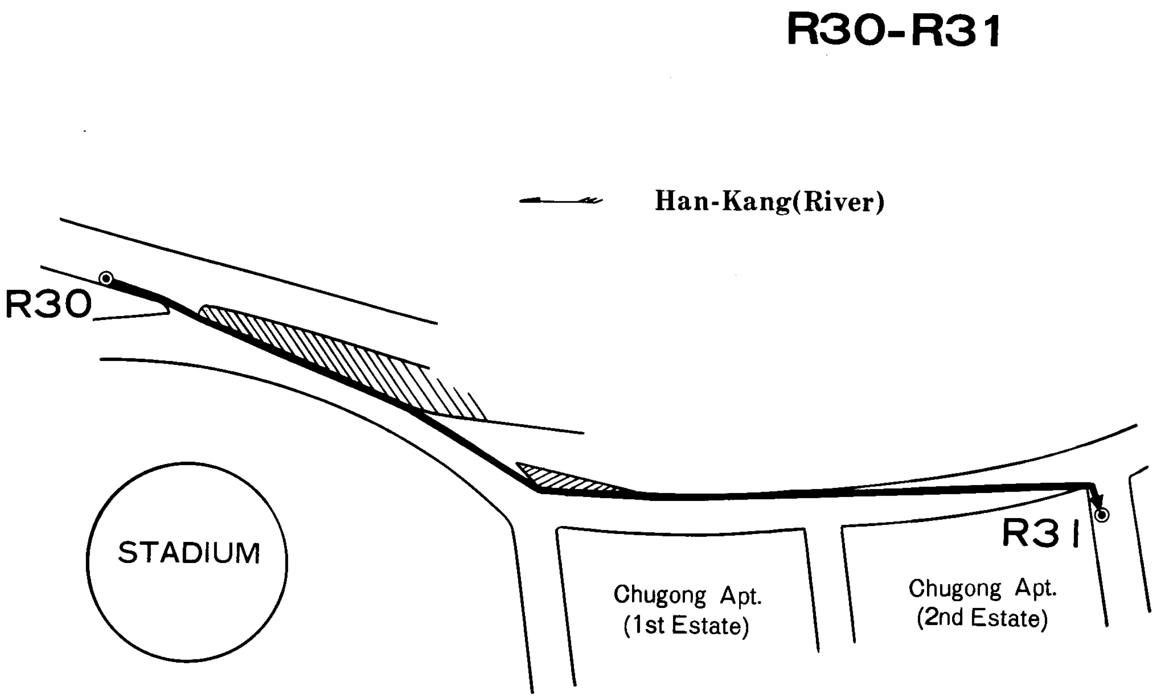
R26-R27(B10)



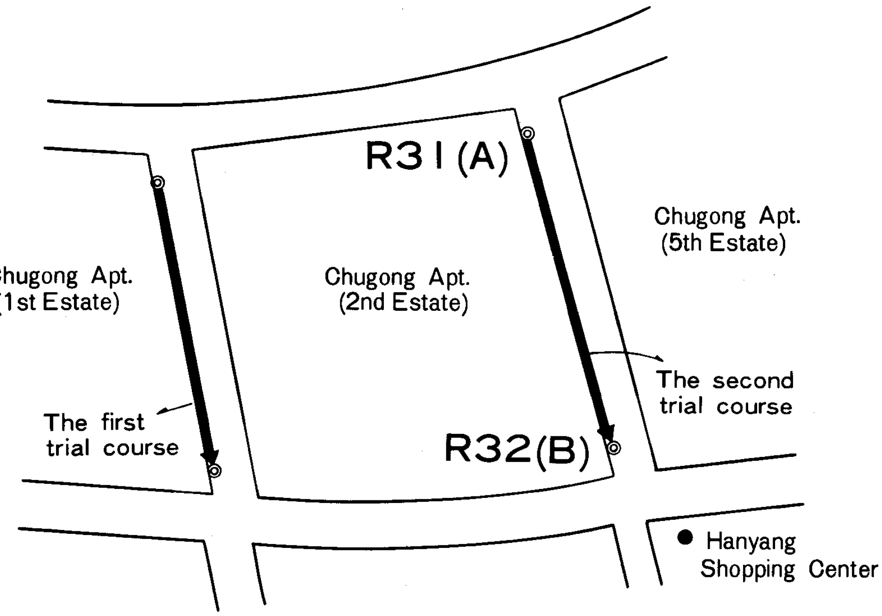


R27-R28

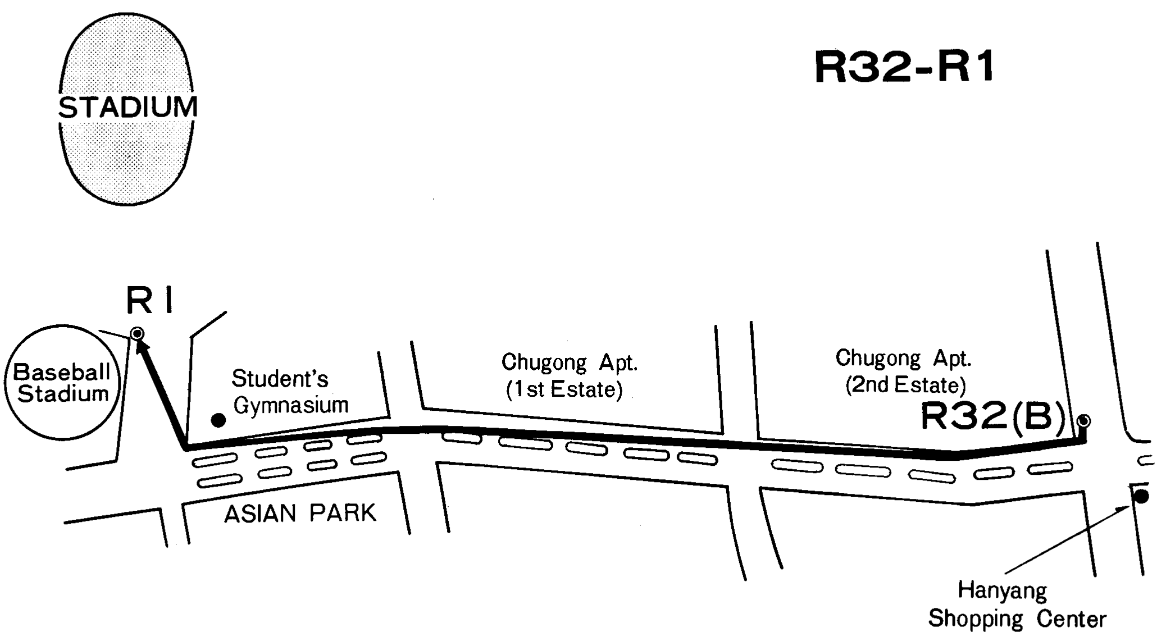

R28-R29
Han-Kang (River)
R28
R29
Chŏngdamgyo (Bridge)
R30
R29-R30(B11)
Tanchŏn
(River)
STADIUM


R30-R31
Han-Kang(River)
R30
STADIUM
Chugong Apt.
(1st Estate)
R31
Chugong Apt.
(2nd Estate)

R31-R32(B12)



R32-R1



6. LEVELING AND VERTICAL PROFILE

Leveling survey was carried out along the whole course in order to obtain a vertical profile of the course.

Each turning point for height coordinates was observed at the interval of one kilometer at minimum, and all of them were connected to the National Bench Marks. Height shown in this phase of the work indicated over Mean Sea Level.

Observation was made with precision levels, Wild N2 and Sokkisha PL-5 under the direction of Prof. Jae-Hwa Choi and the assistance of Mr. Young-Ho Cheon.

A brief vertical profile of the marathon course is shown in the Fig. 2-4.

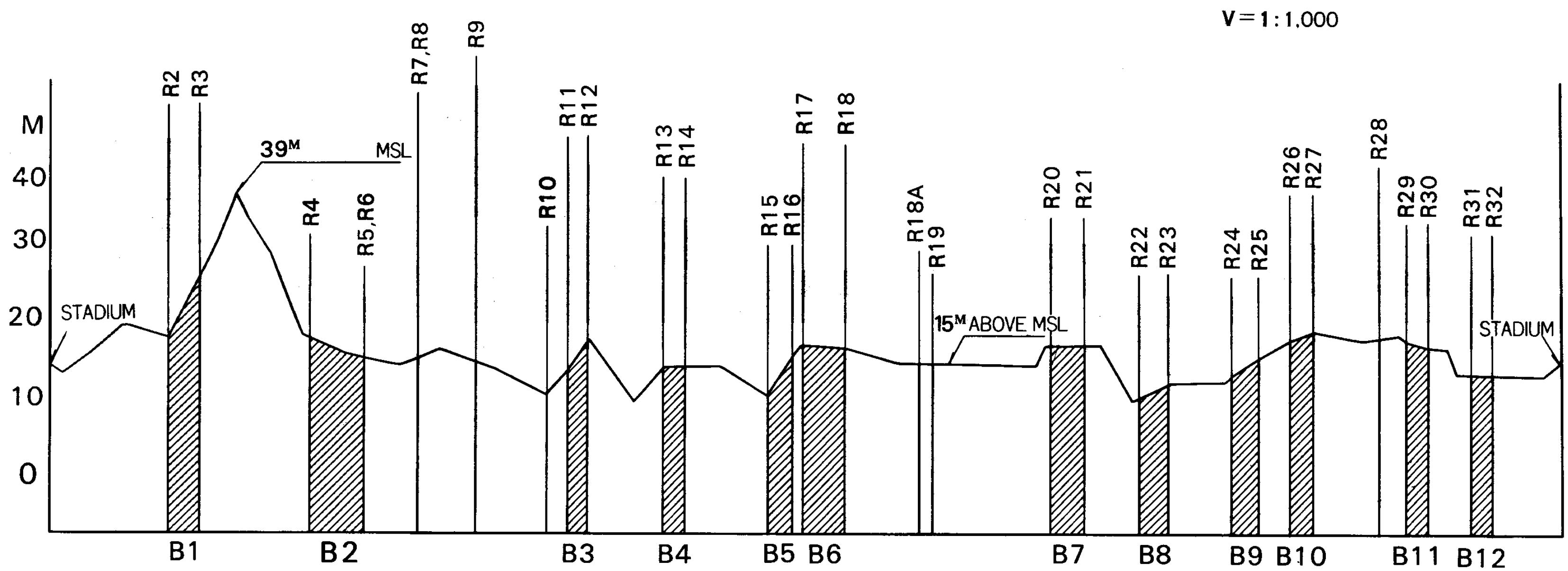


Fig. 2-4 VERTICAL PROFILE
BASE LINES & REFERENCE POINTS

CHAPTER 3 – ANALYSIS OF BICYCLE MEASUREMENT

1. INTRODUCTION

The measurement of the Olympic Marathon Course has been made in three different ways as described in the previous chapter. The measurements with steel tapes and EDM were comparatively simpler in deciding the final distances than with bicycles. This only required to take into account some corrections and adjustments of the actually measured distances, e.g. atmospheric correction, systematic errors and accuracy of instruments, etc.

The distance-measuring with bicycles, however, was not so simple as discussed in the previous cases, and therefore, some statistical approaches were required in order to determine the Most Probable Value of bicycle-measured distances (i.e. Counts per KM for each interval).

To accomplish this, we have used five different methods. They are:

— Linear Regression Method
— Fitting on 2nd Order Polynomial
— Fitting on 3rd Order Polynomial
— Two Baseline Method
— Weighted Mean Baseline Method

As a result of analysis, the first four were considered only in the final decision making, and the last one, Weighted Mean Baseline Method, was excluded from the consideration due to its unreliability. The details will be discussed later on.

Finally, the concept of "SAFETY FACTOR" has been discussed in order to meet the condition of "THE SHORTEST POSSIBLE PATH OF RACE COURSE".

2. THE BASIC CONCEPT OF REGRESSION METHODS

2-1. LINEAR REGRESSION METHOD

In our discussion of the statistical analysis of data, one of the most common and interesting types of experiment involves the measurement of several values of two different physical variables intended to investigate the mathematical relationship between two variables. Probably the most important experiment of this type are those where the expected relation is "Linear", and this is the case we consider first.

We will consider any two physical variables X and Y that we suspect are connected by a linear relation of the form:

$$Y = A + BX$$

where A and B are constants.

Then, the next problem is to find the straight line, $Y = A + BX$ that best fits the measurements; that is, to find the best estimates for the constants A and B based on the data X_i and Y_i, where $i = 1, 2, 3, \ldots, n$.

For the computation of the constants A and B, we assume that the measurement of each Y_i is governed by the Gauss distribution (or Normal distribution) centered on the true value, with width parameter σ_y. Then, the probability of obtaining our complete set of measurements $Y_1, Y_2, Y_3, \ldots, Y_N$ is the product.

$$P(Y_1, Y_2, \cdots, Y_N) = P(Y_1) \cdot P(Y_2) \cdots P(Y_N) \propto \frac{1}{\sigma_y^N} e^{-\chi^2/2}$$

where the exponent is given by:

$$\chi^2 = \sum_{i=1}^{N} \frac{(Y_i - A - BX_i)^2}{\sigma_y^2}$$

Now, applying the least squares method, we obtain the normal equations as indicated below:

$$AN + B\Sigma X_i = \Sigma Y_i$$
$$A\Sigma X_i + B\Sigma X_i^2 = \Sigma X_i Y_i$$

From the above equations, we can compute the constants A and B as follows:

$$A=\frac{(\Sigma X_i^2)(\Sigma Y_i)-(\Sigma X_i)(\Sigma X_i Y_i)}{N(\Sigma X_i^2)-(\Sigma X_i)^2}$$

$$B=\frac{N(\Sigma X_i Y_i)-(\Sigma X_i)(\Sigma Y_i)}{N(\Sigma X_i^2)-(\Sigma X_i)^2}$$

In our report, we assume that the counts/km for each measurer is to vary linearly with elapsed Jones Counts, and can therefore be computed by the following formula:

$$Y = A + BX$$

where Y = counts/km

X = elapsed Jones Counts.

Linear Regression Method uses all baseline data to compute the best-fit straight line that most closely matches the actual counts/km sampled at each baseline.

There is a total of nineteen bicycle-measured intervals over the whole course. Linear Regression was used to compute the best estimate of the counts/km at the mid-point of each interval. These counts/km for each interval were then used to compute the lengths of the 19 intervals, as determined by Linear Regression.

2-2. POLYNOMIAL REGRESSION

So far, we have discussed the observation of two variables satisfying a linear relation. This important problem is a special case of a wide class of curve fitting problems, many of which can be solved in a similar way.

It often happens that one variable, Y, is expected to be expressible as a polynomial in a second variable X,

$$Y=A+BX+CX^2+\cdots\cdots+HX^n$$

where A, B, ..., H are constants.

Finding the best estimate of constants A .... H, we apply the same principle and same technique as discussed in Section 2-1, and then obtain the normal equations as follows:

$$
\begin{array}{l}
AN \quad +B\Sigma X_i +C\Sigma X_i^2+D\Sigma X_i^3+\cdots=\Sigma Y_i \\
A\Sigma X_i +B\Sigma X_i^2+C\Sigma X_i^3+D\Sigma X_i^4+\cdots=\Sigma X_iY_i \\
A\Sigma X_i^2+B\Sigma X_i^3+C\Sigma X_i^4+D\Sigma X_i^5+\cdots=\Sigma X_i^2Y_i \\
A\Sigma X_i^3+B\Sigma X_i^4+C\Sigma X_i^5+D\Sigma X_i^6+\cdots=\Sigma X_i^3Y_i \\
\vdots \qquad \vdots \qquad \vdots \qquad \vdots \qquad \vdots
\end{array}
$$

For any given set of measurements (X_i, Y_i), these simultaneous equations for A, B, C, ... can be solved to find the best estimates for A, B, C, ...

In our report, we assume that the counts/km for each measurer is to vary in a curvilinear form, and therefore have attempted to fit a 2nd order polynomial and 3rd order polynomial curve separately.

If we assume that the measurement has been done under theoretically perfect ideal circumstances, then the counts/km for each baseline shall be distributed on a straight line. We know, however, that the counts/km is affected by many factors: e.g. temperature, wind, hills, surface conditions, skill of cyclists, etc. These factors tend to vary during any measuring occasion, and consequently cause actual counts/km to vary, wandering up and down with changes in circumstances. Thus, it is possible that the actual counts/km is most accurately approximated by curvilinear forms such as 2nd or 3rd order polynomials.

2-3. TWO BASELINE METHOD

This method is considered on the assumption that the calibration data for counts/km can be most closely fitted to the intervals located nearest to the calibrated baselines.

The basic rule of the Two Baseline Method is: the counts/km for any interval are taken to be the average of the counts/km obtained on the baselines immediately preceding and following the interval concerned. For example, the arithmatic mean of the counts/km obtained on baselines 2 and 3 is used for calculating the length of all intervals contained between baselines 2 and 3.

2-4. WEIGHTED MEAN BASELINE METHOD

The basic idea of the method is to use one unique value of the counts/km, Weighted Mean Value, in calculating the distance of each interval. The Weighted Mean Value of the counts/km is calculated according to the following basic rules:

1) A "Weight" is assigned proportionally to the distance of each baseline. A simple rule is to apply in determining the weight coefficient of each baseline, i.e. the distance of any baseline is to represent the weight coefficient of the baseline itself. For the baseline ridden more than twice, the weight coefficient is also assigned by factor two of the distance, but not exceeding a "weight" of 2.00 Km.

2) Each measurer has a "total weight" equal to the sum of the weights for all baselines.

3) Weighted Mean of the counts/km for each measurer is computed as follows:

$$\text{counts/km} = \frac{C_1 \times W_1 + C_2 \times W_2 + \cdots + C_N \times W_N}{W_1 + W_2 + \cdots + W_N}$$

where $C_1 \cdots C_N$: Counts/km for baseline 1, 2, ... correspondingly.
$W_1 \cdots W_N$: Weight coefficients for baseline 1, 2, ... correspondingly.

This method assumes that the accuracy of a baseline is directly proportional to its length, and therefore assigns a "Weight" that is equal to the length traveled during each calibration. Theoretically, this reduces the effect of a short baseline error to the level that is experienced by a long baseline.

The weights used in our calculation are as follows:

Baseline 1 : 2.000000	Baseline 7 : 0.839220
Baseline 2 : 1.628700	Baseline 8 : 0.760936
Baseline 3 : 0.439595	Baseline 9 : 0.529061
Baseline 4 : 0.370808	Baseline 10: 0.568673
Baseline 5 : 0.600036	Baseline 11: 0.434330
Baseline 6 : 1.114665	Baseline 12: 0.526956

3. COMPUTATION AND COMPUTER PROGRAM

Three computer programs have been developed for the best estimation of counts/km of each interval, computation of distances, and the final statistical analysis. They are OLYM1. BAS, OLYM2. BAS, and OLYM3. BAS.

OLYM1. BAS consists of 1-main program and 4-subroutines, and OLYM2. BAS of 1-main program and 1-subprogram. The text of the programs has been written in BASIC language and the lists are shown in the end of this section. Computation has been made on 16-Bits Microcomputer.

PROGRAM 1: OLYM1. BAS

1) Handling the input and output data files. There are 14 input-files and 13 output-files on disks.

2) Arrangement of Raw Jones Counts and computation of counts/interval, counts/km for each baseline and elapsed count/interval.

3) Performance of each regression method, i.e. linear, 2nd/3rd order polynomial regression, two baseline method, and weighted mean baseline method.

4) All computations have been made for each bicycle rider.

5) Gauss Elimination Method has been applied to the solution of normal equations.

PROGRAM 2: OLYM2. BAS

1) Rearrangement of output files resulting from Program 1 for further computation.

2) Computation of reference statistical data for each interval. The data are Median, Mean, Standard Deviation, 99% Confidence Level, and 0.999 Median Value.

PROGRAM 3: OLYM3. BAS

1) Rearrangement of output files obtained from previous programs for each baseline.

2) Computation of mean distance, standard deviation, error, etc. for the purpose of predictability study for each regression method.

NOTE: All programs have specially been devloped by Prof. Dr. CHO, Kyu-Jon, Kyonggi University, presently acting as a director of the Korean Society of Geodesy, Photogrammetry, and Cartography.

LISTS OF

COMPUTER PROGRAM

```
10    'PROGRAM -- OLYM1.BAS
20    'THIS  PROGRAM  HAS SPECIALLY  BEEN  DEVISED  IN ORDER TO
30    'DETERMINE THE MOST APPROPRIATE LENGTHS OF MARATHON COURSE
40    'IN 1988 SEOUL OLYMPIC GAMES.
50    '
60    'THE PROGRAM WILL PERFORMS THE STATISTICAL ANALYSIS OF THE
70    'CALIBRATED BICYCLE MEASUREMENTS,  AND  THE LEAST  SQUARES
80    'FITTING HAS.BEEN APPLIED  ON  A STRAIGHT LINE    AND SOME
90    'CURVES FOR THE BEST ESTIMATION.
100    '
110   'THE PROGRAM HAS WRITTEN BY DR. KYU-JON CHO,    WHO IS THE
120   'PRINCIPAL  WRITER OF THE FINAL REPORT.
130   '
140   '
150    OPTION BASE 1
160    DEFINT I - K,   H
170    DEFDBL A,B,C,U,P,X,Y,R,W
180    DIM REF$(44),  TINT$(45),  TNAME$(44),  BL(44),C$(13),D$(13)
190    DIM RAW1(44),RAW2(34),RAW3(33),CPI1(33),CPI2(33),CPKM1(33)
200    DIM REG1(32),REG2(32),REG3(32),CDIST1(19),CDIST2(19)
210    DIM X(32),Y(32),Y1(32),A(4,5),S(7),U(4),PAR1(2),PAR2(3)
220    DIM CDIST4(19),CDIST5(19),W(13),CPIB(13),CPKM2(33)
230    DIM DDIST1(13),DDIST2(13),DDIST3(13),DDIST4(13)
240    DIM CDIST3(19),  PAR3(4),  B(4),E$(13)
250    '
260    OPEN "I",  #1,  "A:CHO1.DAT"
270    H9=1
280   'INPUT BASIC REFERENCE DATA FROM FILES
290    FOR I = 1 TO 44
300    INPUT #1,  REF$(I),TINT$(I),TNAME$(I),BL(I)
310    NEXT  I
320    CLOSE #1
330    GOSUB 4190
340    F$  =  "A:"+C$(H9)
350    G$  =  "B:"+D$(H9)
360    OPEN "O",  #2,  G$
370    OPEN "I",  #1,  F$
380    FOR I = 1 TO 44
390    INPUT #1,  RAW1(I)
400    NEXT I
410    CLOSE #1
420    FOR I = 1 TO 44
430    LPRINT RAW1(I)
440    NEXT I
450    FOR I = 1 TO 34
460    IF I>=1    AND   I<=6    THEN  RAW2(I)  = RAW1(I)
470    IF I>=7    AND   I<=14   THEN  RAW2(I)  = RAW1(I+5)
480    IF I>=15   AND   I<=22   THEN  RAW2(I)  = RAW1(I+7)
490    IF I>=23   AND   I<=26   THEN  RAW2(I)  = RAW1(I+8)
500    IF I>=27   AND   I<=34   THEN  RAW2(I)  = RAW1(I+10)
```

```
510    NEXT  I
520    FOR I = 1 TO 33
530    IF  I >= 3 THEN 560
540    RAW3(I) = RAW1(I+3)
550    GOTO 570
560    RAW3(I) = RAW1(I+4)
570    NEXT  I
580    REM .COMPUTATION OF COUNTS PER INTERVALS
590    FOR I = 1 TO 17
600    CPI1(I) = RAW2(I*2) - RAW2(I*2-1)
610    NEXT  I
620    FOR I = 1 TO 17
630    IF  I>=3  AND  I<=13  THEN 660
640    CPKM1(I) = CPI1(I)*1000 / BL(1)
650    GOTO  670
660    CPKM1(I) = CPI1(I)*1000 / BL(I-1)
670    NEXT  I
680    CPKM2(1) = (CPKM1(1)+CPKM1(2))/2
690    CPKM2(13) =(CPKM1(14)+CPKM1(15)+CPKM1(16)+CPKM1(17))/4
700    FOR I = 2 TO 12
710    CPKM2 (I) = CPKM1(I+1)
720    NEXT  I
730    FOR I = 1 TO 3
740    CPI2(I) = RAW3(I*2) - RAW3(I*2-1)
750    NEXT  I
760    FOR I = 5 TO 9
770    CPI2(I) = RAW3(I*2-2) - RAW3(I*2-3)
780    NEXT  I
790    FOR I = 11 TO 15
800    CPI2(I) = RAW3(I*2-4) - RAW3(I*2-5)
810    NEXT  I
820    FOR I = 16 TO 19
830    CPI2(I) = RAW3(I*2-5) - RAW3(I*2-6)
840    NEXT  I
850    CPI2(4) = RAW3(7) - RAW3(6)
860    CPI2(10)= RAW3(17) - RAW3(16)
870 '
880 '
890 '  PRINT OUT THE RESULTS
900    LPRINT CHR$(27)"Q":LPRINT CHR$(12)
910    LPRINT CHR$(14)TAB(9);TNAME$(H9+13)":";TNAME$(H9):LPRINT
920    LPRINT:LPRINT:LPRINT TAB(8)"INTERVAL"TAB(27)"LENGTH";
930    LPRINT TAB(39)"CNTS/INT"TAB(54)"CNTS/KM"
940    LPRINT TAB(8)"========"TAB(27)"======"TAB(39)"========";
950    LPRINT TAB(54)"=======":LPRINT
960    FOR I = 1 TO 17
970    LPRINT TAB(5) USING "¥               ¥";TINT$(I);
980    IF  I<=2 OR I>=14  THEN 1010
990    LPRINT TAB(21) USING "      ####.###";BL(I-1);
1000    GOTO  1020
```

```
1010  LPRINT TAB(21)USING "      ####.###";BL(1);
1020  LPRINT TAB(34)USING "      #####.###"; CPI1(I);CPKM1(I)
1030  LPRINT
1040  NEXT  I
1050 '
1060 'ARRANGEMENT OF THE DATA FOR LEAST SQUARES FITTING
1070 'COMPUTATION OF ELAPSED COUNTS
1080 '
1090  X(1)=0
1100  X(2)=(CPI1(1) + CPI1(2))/2 + CPI2(1) + CPI1(3)/2
1110  X(3)=X(2)+CPI1(3)/2+CPI2(2)+CPI2(3)+CPI2(4)+CPI2(5)+CPI1(4)
/2
1120  FOR I = 4 TO 6
1130  X(I)=X(I-1)+CPI1(I)/2+CPI2(I+2)+CPI1(I+1)/2
1140  NEXT  I
1150  X(7)=X(6)+CPI1(7)/2+CPI2(9)+CPI2(10)+CPI2(11)+CPI1(8)/2
1160  FOR I = 8 TO 10
1170  X(I)=X(I-1)+CPI1(I)/2+CPI2(I+4)+CPI1(I+1)/2
1180  NEXT  I
1190  X(11)=X(10)+CPI1(11)/2+CPI2(15)+CPI2(16)+CPI1(12)/2
1200  X(12)=X(11)+CPI1(12)/2+CPI2(17)+CPI1(13)/2
1210  X(13)=X(12)+CPI1(13)/2+CPI2(18)+CPI2(19)+(CPI1(14)+CPI1(15)
+CPI1(16)+CPI1(17))/2
1220  X(14)=(CPI1(1)+CPI1(2))/2+CPI2(1)/2
1230  X(15)=X(14)+CPI2(1)/2+CPI1(3)+CPI2(2)/2
1240  FOR I = 16 TO 18
1250  X(I)=X(I-1)+CPI2(I-14)/2+CPI2(I-13)/2
1260  NEXT  I
1270  FOR I = 19 TO 22
1280  X(I)=X(I-1)+CPI2(I-14)/2+CPI1(I-15)+CPI2(I-13)/2
1290  NEXT  I
1300  FOR I = 23 TO 24
1310  X(I)=X(I-1)+CPI2(I-14)/2+CPI2(I-13)/2
1320  NEXT  I
1330  FOR I = 25 TO 28
1340  X(I)=X(I-1)+CPI2(I-14)/2+CPI1(I-17)+CPI2(I-13)/2
1350  NEXT  I
1360  X(29)=X(28)+CPI2(15)/2+CPI2(16)/2
1370  X(30)=X(29)+CPI2(16)/2+CPI1(12)+CPI2(17)/2
1380  X(31)=X(30)+CPI2(17)/2+CPI1(13)+CPI2(18)/2
1390  X(32)=X(31)+CPI2(18)/2+CPI2(19)/2
1400  FOR I = 1 TO 13
1410  Y(I)=CPKM2(I)
1420  NEXT  I
1430  N=13
1440  NN=19
1450 '
1460 '
1470 '
1480 '
1490 'START TO LEAST SQUARES FITTING ON STRAIGHT LINE
1500 '
```

```
1510  C1=0 :C2=0 :C3=0 :C4=0
1520  FOR I = 1 TO 2
1530  PAR1(I)=0
1540  NEXT I
1550  FOR I = 1 TO N
1560  C1=C1+X(I)
1570  C2=C2+Y(I)
1580  C3=C3+X(I)*Y(I)
1590  C4=C4+X(I)^2
1600  NEXT  I
1610  A=(C2*C4-C1*C3)/(N*C4-C1*C1)
1620  B=(N*C3-C1*C2)/(N*C4-C1*C1)
1630  PAR1(1)=A  : PAR1(2)=B
1640  'ADJUSTED Y - COORDINATES
1650  '
1660  FOR I = 1 TO 32
1670  Y1(I)=A+B*X(I)
1680  REG1(I)=Y1(I)
1690  NEXT  I
1700  R1=0:R2=0:R3=0
1710 '
1720 'COPUTATION OF STANDARD DEVIATION
1730  X5=C1/N :Y5=C2/N
1740  FOR I = 1 TO N
1750  R1=R1+(X(I)-X5)^2
1760  R2=R2+(Y(I)-Y5)^2
1770  R3=R3+(X(I)-X5)*(Y(I)-Y5)
1780  NEXT  I
1790  R4=SQR(R1/(N-1))
1800  R5=SQR(R2/(N-1))
1810  R6=R3^2/(R1*R2)
1820 '
1830 '
1840 '
1850 ' START TO POLYNOMIALS FITTING
1860  N5 = 4
1870  N7 = 3
1880  FOR I = 1 TO 7
1890  S(I) = 0
1900  IF I > = 5 THEN 1920
1910  B(I) = 0
1920  NEXT  I
1930  FOR I = 1 TO N5
1940  FOR J = 1 TO  N
1950  S(I) = S(I) + X(J) ^I
1960  I1 = I - 1
1970  IF I > = 5 THEN 2020
1980  IF I = 1 THEN 2010
1990  B(I) = B(I) + Y(J) * X(J)^I1
2000  GOTO 2020
```

```
2010  B(I) = B (I) + Y(J)
2020  NEXT J
2030  NEXT I
2040  K9 = 1
2050  FOR J = 1 TO N7
2060  J4 = N7 + 1
2070  IF K9 = 1 THEN 2090
2080  A ( 1, J) = S(J-1)
2090  K9 = 10
2100  A ( 2, J) = S(J)
2110  A ( 3, J) = S(J+1)
2120  A ( 4, J) = S(J+2)
2130  A ( J,J4) = B(J)
2140  NEXT J
2150  A ( 1, 1 ) = N
2160  GOSUB 2370
2170  IF N7=4 THEN 2220
2180  FOR I= 1 TO 3
2190  PAR2(I)=U(I)
2200  NEXT  I
2210  GOTO  2250
2220  FOR I = 1 TO 4
2230  PAR3(I)=U(I)
2240  NEXT  I
2250  FOR I = 1 TO 32
2260  IF N5 = 6 THEN 2300
2270  Y1(I) = U(1) + U(2)*X(I) + U(3)*X(I)^2
2280  REG2(I)=Y1(I)
2290  GOTO 2320
2300  Y1(I) = U(1) + U(2)*X(I) + U(3)*X(I)^2 + U(4)*X(I)^3
2310  REG3(I)=Y1(I)
2320  NEXT I
2330  N5 = 6
2340  N7 = N7 + 1
2350  IF N7 > = 5 THEN 2770
2360  GOTO 1880
2370  '
2380  'SOLUTION OF NORMAL EQUATIONS BY GAUSS ELIMINATION
2390  '
2400  N1 = N7 - 1
2410  FOR K = 1 TO N1
2420  K1 = K + 1
2430  L = K
2440  FOR I = K1 TO N7
2450  D1 = ABS(A(I,K))
2460  D2 = ABS(A(L,K))
2470  IF D1 > D2 THEN L=I
2480  NEXT I
2490  IF L = K THEN 2560
2500  N2 = N7 + 1
```

```
2510  FOR J = K TO N2
2520  TEMP = A(K , J)
2530  A(K, J) = A(L, J)
2540  A(L, J) = TEMP
2550  NEXT J
2560  FOR I = K1 TO N7
2570  F = A(I, K)/A(K, K)
2580  FOR J = K1 TO N2
2590  A(I, J) = A(I, J) - F*A(K, J)
2600  NEXT J
2610  NEXT I
2620  NEXT K
2630  U(N7) = A(N7, N2) / A(N7, N7)
2640  I = N1
2650  I1 = I + 1
2660  S9 = 0
2670  FOR J = I1 TO N7
2680  S9 = S9 + A(I, J) * U(J)
2690  NEXT J
2700  U(I) = (A(I, N2)-S9)/A(I, I)
2710  I = I - 1
2720  IF  I>=1  THEN  2650
2730  RETURN
2740 '
2750 '
2760 '
2770  LPRINT CHR$(12)
2780  LPRINT CHR$(14)TAB(10);TNAME$(H9+13)":";TNAME$(H9):LPRINT:L
PRINT
2790  LPRINT TAB(19)"ELAPSED"TAB(30)"RAW COUNT"TAB(42)"PREDICTED
COUNTS PER KM"
2800  LPRINT "    INTERVAL"TAB(18)"COUNTS(X)"TAB(30)"PER KM(Y)";
2810  LPRINT TAB(41)"LINEAR"TAB(50)"2ND ORDER"TAB(60)"3RD ORDER"
2820  LPRINT "    ========"TAB(18)"========="TAB(30)"=========";
2830  LPRINT TAB(41)"======"TAB(50)"========="TAB(60)"=========":
LPRINT
2840  FOR I = 1 TO 32
2850  IF  I = 14  THEN LPRINT:LPRINT
2860  IF  I>= 14 THEN 2910
2870  LPRINT USING "¥                    ¥";TINT$(I+1);
2880  LPRINT TAB(18) USING "######.##";X(I);
2890  LPRINT TAB(28) USING "    ####.##";Y(I);REG1(I);REG2(I);REG3
(I)
2900  GOTO  2940
2910  LPRINT TAB(6) USING "¥          ¥";TINT$(I+4);
2920  LPRINT TAB(18) USING "######.##";X(I);
2930  LPRINT TAB(38) USING " ######.##";REG1(I);REG2(I);REG3(I)
2940  NEXT  I
2950  LPRINT CHR$(12)
2960  LPRINT :LPRINT
2970  LPRINT TAB(18)"R E G R E S S I O N     P A R A M E T E R S"
```

```
2980  LPRINT TAB(18)"============================================="
2990  LPRINT:LPRINT
3000  LPRINT TAB(15)"LINEAR   REGRESSION":LPRINT
3010  LPRINT TAB(20)"A0 =";PAR1(1)
3020  LPRINT TAB(20)"A1 =";PAR1(2)
3030  LPRINT :LPRINT TAB(15)"2ND ORDER POLYNOMIAL"
3040  LPRINT TAB(20)"A0 =";PAR2(1)
3050  LPRINT TAB(20)"A1 =";PAR2(2)
3060  LPRINT TAB(20)"A2 =";PAR2(3)
3070  LPRINT:LPRINT TAB(15)"3RD ORDER POLYNOMIAL"
3080  LPRINT TAB(20)"A0 =";PAR3(1)
3090  LPRINT TAB(20)"A1 =";PAR3(2)
3100  LPRINT TAB(20)"A2 =";PAR3(3)
3110  LPRINT TAB(20)"A3 =";PAR3(4)
3120  LPRINT :LPRINT
3130  LPRINT TAB(15) "STANDARD DEVIATION IN Y =";R5
3140  LPRINT TAB(15) "COEFFICIENT OF DETERMINANT = ";R6
3150  LPRINT CHR$(12):LPRINT CHR$(14)
3160  '
3170  'COMPUTATION OF LENGTHS OF EACH INTERVALS
3180  SUM1=0 :SUM2=0 :SUM3=0
3190  FOR I = 1 TO 19
3200  CDIST1(I)=CPI2(I)*1000/REG1(I+13)
3210  CDIST2(I)=CPI2(I)*1000/REG2(I+13)
3220  CDIST3(I)=CPI2(I)*1000/REG3(I+13)
3230  SUM1=SUM1+CDIST1(I)
3240  SUM2=SUM2+CDIST2(I)
3250  SUM3=SUM3+CDIST3(I)
3260  NEXT  I
3270  '
3280  GOSUB 3750
3290  '
3300  LPRINT CHR$(14)TAB(9);TNAME$(H9+13)",";TNAME$(H9):LPRINT:LP
RINT:LPRINT
3310  LPRINT TAB(15)"COMPUTED DISTANCE OF EACH INTERVALS"
3320  LPRINT TAB(15)"====================================":LPRINT:
LPRINT
3330  LPRINT "  INTERVAL"TAB(15)"LINEAR"TAB(25)"2ND-ORDER"TAB(36)"
3RD-ORDER";
3340  LPRINT TAB(48)"TWO BASE"TAB(58)"WGT-MEAN"
3350  LPRINT "  ========"TAB(15)"======"TAB(25)"========="TAB(36)"
=========";
3360  LPRINT TAB(48)"========"TAB(58)"========":LPRINT
3370  FOR I = 1 TO 19
3380  LPRINT USING "¥          ¥";TINT$(I+17);
3390  LPRINT USING "   ######.##";CDIST1(I);CDIST2(I);CDIST3(I);
3400  LPRINT USING "   ######.##";CDIST4(I);  CDIST5(I)
3410  NEXT  I
3420  LPRINT :LPRINT "T O T A L ";
3430  LPRINT TAB(11) USING "    #####.##";SUM1;SUM2;SUM3;SUM4;SUM5
3440  '
```

```
3450  FOR I = 1 TO 19
3460  PRINT #2, CDIST1(I),CDIST2(I),CDIST3(I),CDIST4(I),CDIST5(I)
3470  NEXT  I
3480  CLOSE #2
3490  GOSUB 4390
3500  LPRINT CHR$(12)
3510  FOR I = 1 TO 44
3520  IF  I>=33  THEN 3550
3530  RAW1(I)=0 :RAW2(I)=0 :RAW3(I)=0
3540  GOTO 3590
3550  IF  I>34  THEN 3580
3560  RAW1(I)=0 :RAW2(I)=0
3570  GOTO  3590
3580  RAW1(I)=0
3590  NEXT  I
3600  FOR I = 1 TO 32
3610  REG1(I)=0:REG2(I)=0:REG3(I)=0:X(I)=0:Y(I)=0:Y1(I)=0
3620  NEXT  I
3630  FOR I = 1 TO 19
3640  CDIST1(I)=0:CDIST2(I)=0:CDIST3(I)=0
3650  NEXT  I
3660  FOR I = 1 TO 4
3670  FOR J = 1 TO 5
3680  A(I,J)=0
3690  NEXT  J
3700  U(I)=0
3710  NEXT  I
3720  IF H9>13 THEN END
3730  H9 = H9 + 1
3740  GOTO  340
3750  '
3760 ' SUBROUTINE, TVC AND WEIGHTED MEAN BASE LINE
3770  '
3780  CDIST4(1)=CPI2(1)*1000/((CPKM2(1)+CPKM2(2))/2)
3790  FOR I = 2 TO 5
3800  CDIST4(I)=CPI2(I)*1000/((CPKM2(2)+CPKM2(3))/2)
3810  NEXT  I
3820  FOR I = 6 TO 8
3830  CDIST4(I)=CPI2(I)*1000/((CPKM2(I-3)+CPKM2(I-2))/2)
3840  NEXT  I
3850  FOR I = 9 TO 11
3860  CDIST4(I)=CPI2(I)*1000/((CPKM2(6)+CPKM2(7))/2)
3870  NEXT  I
3880  FOR I = 12 TO 14
3890  CDIST4(I)=CPI2(I)*1000/((CPKM2(I-5)+CPKM2(I-4))/2)
3900  NEXT  I
3910  FOR I = 15 TO 16
3920  CDIST4(I)=CPI2(I)*1000/((CPKM2(10)+CPKM2(11))/2)
3930  NEXT  I
3940  CDIST4(17)=CPI2(17)*1000/((CPKM2(11)+CPKM2(12))/2)
3950  CDIST4(18)=CPI2(18)*1000/((CPKM2(12)+CPKM2(13))/2)
```

```
3960  CDIST4(19)=CPI2(19)*1000/((CPKM2(12)+CPKM2(13))/2)
3970  '
3980  'WEIGHTED MEAN BASE LINE METHOD
3990  '
4000  FOR I = 1 TO 13
4010  W(I)=BL(I)/1000#
4020  IF W(I)>=2#  THEN W(I)=2#
4030  NEXT  I
4040  FOR I = 1 TO 13
4050  W9=W9+W(I)
4060  W8=W8+W(I)*CPKM2(I)
4070  NEXT  I
4080  AVER=W8/W9
4090  FOR  I = 1 TO 19
4100  CDIST5(I)=CPI2(I)*1000/AVER
4110  NEXT  I
4120  SUM4=0:SUM5=0
4130  FOR I = 1 TO 19
4140  SUM4=SUM4+CDIST4(I)
4150  SUM5=SUM5+CDIST5(I)
4160  NEXT  I
4170  RETURN
4180  '
4190  'SUBROUTINE, READ THE NAME OF FILES
4200  FOR I = 1 TO 13
4210  READ C$(I)
4220  NEXT  I
4230  FOR I = 1 TO 13
4240  READ D$(I)
4250  NEXT  I
4260  FOR I = 1 TO 13
4270  READ E$(I)
4280  NEXT  I
4290  DATA C1.DAT,C2.DAT,C3.DAT,C4.DAT,C5.DAT,C6.DAT,C7.DAT,C8.DA
T
4300  DATA C9.DAT,C10.DAT,C11.DAT,C12.DAT,C13.DAT
4310  DATA DSTC1.DAT,DSTC2.DAT,DSTC3.DAT,DSTC4.DAT,DSTC5.DAT,DSTC
6.DAT
4320  DATA DSTC7.DAT,DSTC8.DAT,DSTC9.DAT,DSTC10.DAT,DSTC11.DAT
4330  DATA DSTC12.DAT,  DSTC13.DAT
4340  DATA  DDST1.DAT,DDST2.DAT,DDST3.DAT,DDST4.DAT,DDST6,DAT
4350  DATA  DDST7.DAT,DDST8.DAT,DDST9.DAT,DDST10.DAT,DDST11.DAT
4360  DATA  DDST12.DAT,DDST13.DAT
4370  RETURN
4380  '
4390  '
4400  'SUBROUTINE
4410  'COMPUTATION OF DISTANCE FOR EACH BASELINES
4420  'ACCORDING TO DIFFERENT METHODS
4430  '
```

```
4440  H$="B:"+E$(H9)
4450  OPEN "O", #2, H$
4460  CPIB(1)=CPI1(1)+CPI1(2)
4470  CPIB(13)=CPI1(14)+CPI1(15)+CPI1(16)+CPI1(17)
4480  FOR I = 2 TO 12
4490  CPIB(I)=CPI1(I-1)
4500  NEXT I
4510  FOR I = 1 TO 13
4520  DDIST1(I)=CPIB(I)*1000/REG1(I)
4530  DDIST2(I)=CPIB(I)*1000/REG2(I)
4540  DDIST3(I)=CPIB(I)*1000/REG3(I)
4550  DDIST4(I)=CPIB(I)*1000/AVER
4560  NEXT I
4570  FOR I = 1 TO 13
4580  PRINT #2, DDIST1(I),DDIST2(I),DDIST3(I),DDIST4(I)
4590  NEXT I
4600  CLOSE #2
4610  RETURN
4620  END
```

```
10    'PROGRAM -- OLYM2.BAS
20    'THE PROGRAM WILL PERFORMS THE COMPUTATION OF THE FINAL
30    'DISTANCE FROM DATA OBTAINED BY DIFFERENT REGRESSION METHOD.
40    'THE STATISTICAL ANALYSIS WILL BE  PERFORMED SIMULTANOUSELY.
50    'IN THIS PROGRAM, THE 13 FILES WILL BE READ FROM DISKS AND
60    'ALL DATA WILL BE REARRANGED FOR FURTHER PROCESS.
70    'AND ALL DATA WILL BE REARRANGED FOR FURTHER PROCESS.
80    '
90    '
100    OPTION BASE 1
110    DEFDBL D
120    DIM DIST1(19,5), DIST2(13,5),C$(13),MD(5),XBAR(5),STD(5)
130    DIM CONF(5), MD9(5), SORT(13,5),X1(5) ,TINT$(19)
140    K=1  :L=1:M=1 :P=1
150    FOR I = 1 TO 13
160    READ C$(I)
170    NEXT  I
180    DATA DSTC1.DAT,DSTC2.DAT,DSTC3.DAT,DSTC4.DAT,DSTC5.DAT,DSTC
6.DAT
190    DATA DSTC7.DAT, DSTC8.DAT,DSTC9.DAT,DSTC10.DAT,DSTC11.DAT,D
STC12.DAT,DSTC13.DAT
200    GOSUB 1310
210    F$="A:"+C$(K)
220    OPEN "I", #1, F$
230    WHILE NOT EOF(1)
240    FOR I = 1 TO 19
250     FOR J = 1 TO 5
260     INPUT #1, DIST1(I,J)
270     NEXT  J
280    NEXT  I
290    WEND
300    FOR J = 1 TO 5
310    DIST2(K,J)=DIST1(L,J)
320    NEXT J
330    FOR I = 1 TO 19
340     FOR J = 1 TO 5
350     DIST1(I,J)=0
360     NEXT  J
370    NEXT  I
380    CLOSE #1
390    K=K+1
400    IF K>=14 THEN 420
410    GOTO 210
420    K=1
430    'SORT THE ARRAYS
440    FOR I = 1 TO 13
450     FOR J = 1 TO 5
460     SORT(I,J)=DIST2(I,J)
470     NEXT J
```

```
480   NEXT  I
490   FOR J = 1 TO 5
500   FOR I1 = 1 TO 12
510    FOR I = 1 TO 12
520    IF SORT(I,J)>SORT(I+1,J) THEN 560
530   TMP=SORT(I,J)
540   SORT(I,J)=SORT(I+1,J)
550   SORT(I+1,J)=TMP
560   NEXT  I
570   NEXT  I1
580   NEXT  J
590   FOR J = 1 TO 5
600   MD(J)=SORT(7,J)
610   NEXT  J
620   '
630   FOR J = 1 TO 5
640  FOR I = 1 TO 13
650  X1(J)=X1(J)+DIST2(I,J)
660  NEXT  I
670  NEXT  J
680  FOR I = 1 TO 5
690  XBAR(I)=X1(I)/13
700  NEXT  I
710  FOR  I = 1 TO 5
720  SUM(I)=0
730  NEXT I
740  FOR J = 1 TO 5
750  FOR I = 1 TO 13
760  SUM(J)=SUM(J)+(DIST2(I,J)-XBAR(J))^2
770  NEXT  I
780  STD(J)=SQR(SUM(J)/12)
790  NEXT  J
800  FOR I = 1 TO 5
810  CONF(I)=XBAR(I)-2.78*STD(I)
820  MD9(I)=.999*MD(I)
830  NEXT  I
840  LPRINT CHR$(27)"Q":LPRINT CHR$(12):LPRINT:LPRINT
850  LPRINT CHR$(14)TAB(10)"INTERVAL:";TINT$(M):LPRINT:LPRINT:LPR
INT CHR$(20)
860  LPRINT TAB(18)"COMPUTED DISTANCES OF EACH RIDERS"
870  LPRINT TAB(18)"================================="
880  LPRINT:LPRINT
890  LPRINT "RIDER"TAB(12)"LINEAR"TAB(23)"2ND-ORDER"TAB(35)"3RD-O
RDER";
900  LPRINT TAB(47)"TWO-BASE"TAB(59)"WGT MEAN"
910  LPRINT "====="TAB(12)"======"TAB(23)"========="TAB(35)"=====
====";
920  LPRINT TAB(47)"========"TAB(59)"========":LPRINT
930  FOR I = 1 TO 13
```

```
940  LPRINT "C";:LPRINT USING "#####";I;
950  LPRINT USING "      ####.##";DIST2(I,1);DIST2(I,2);DIST2(I,3)
;DIST2(I,4);DIST2(I,5)
960  NEXT  I
970  LPRINT :LPRINT
980  LPRINT "MEDIAN";
990  LPRINT USING "      ####.##";MD(1);MD(2);MD(3);MD(4);MD(5)
1000  LPRINT "MEAN  ";
1010  LPRINT USING "      ####.##";XBAR(1);XBAR(2);XBAR(3);XBAR(4)
;XBAR(5)
1020  LPRINT "ST.DEV";
1030  LPRINT USING "      ####.##";STD(1);STD(2);STD(3);STD(4);STD
(5)
1040  LPRINT "99%CON";
1050  LPRINT USING "      ####.##";CONF(1);CONF(2);CONF(3);CONF(4)
;CONF(5)
1060  LPRINT "0.999M";
1070  LPRINT USING "      ####.##";MD9(1);MD9(2);MD9(3);MD9(4);MD9
(5)
1080  LPRINT:LPRINT:LPRINT
1090  LPRINT TAB(12)"* R E M A R K S *"
1100  LPRINT TAB(15)"TOTAL NR OF MEASUREMENTS  ..................
  13
1110  LPRINT TAB(15)"U N I T                   ...............  M
ETER
1120  LPRINT TAB(15)"99% OF CONFIDENCE LEVEL   ....... 2.78 * ST.
 DEV.
1130  L=L+1
1140  M=M+1
1150  IF L>=20 THEN 1390
1160  FOR I = 1 TO 19
1170  FOR J = 1 TO 5
1180  DIST1(I,J)=0
1190  NEXT  J
1200  NEXT  I
1210  FOR I = 1 TO 13
1220  FOR J = 1 TO 5
1230  DIST2(I,J)=0
1240  SORT(I,J)=0
1250  NEXT  J
1260  NEXT  I
1270  FOR I = 1 TO 5
1280  MD(I)=0:XBAR(I)=0:STD(I)=0:CONF(I)=0:MD9(I)=0:X1(I)=0
1290  NEXT  I
1300  GOTO 210
```

```
1310  'SUBROUTINE
1320  FOR I = 1 TO 19
1330  READ TINT$(I)
1340  NEXT  I
1350  DATA R3-R4,R6-R7,R8-R9,R9-R10,R10-R11,R12-R13,R14-R15,R16-R
17
1360  DATA R18-R18A,R18A-R19,R19-R20,R21-R22,R23-R24,R25-R26,R27-
R28
1370  DATA R28-R29,R30-R31,R32-R1,R1-R2
1380  RETURN
1390  END
```

```
4380  'THE NAME OF SUBROUTINE --- OLYM3.BAS
4382  'THIS SUBROUTINE WILL PERFORMS THE COMPUTATION OF
4384  'DISTANCES FOR EACH BASELINE.
4386  'THIS SUBROUTINE SHOULD BE CONNECTED TO "OLYM1.BAS".
4390  '
4400  'SUBROUTINE
4410  'COMPUTATION OF DISTANCE FOR EACH BASELINES
4420  'ACCORDING TO DIFFERENT METHODS
4430  '
4460  CPIB(1)=CPI1(1)+CPI1(2)
4480  FOR I = 2 TO 12
4490  CPIB(I)=CPI1(I+1)
4500  NEXT I
4505  CPIB(13)=CPI1(14)+CPI1(15)+CPI1(16)+CPI1(17)
4510  FOR I = 1 TO 13
4520  DDIST(I,1)=CPIB(I)*1000/REG1(I)
4530  DDIST(I,2)=CPIB(I)*1000/REG2(I)
4540  DDIST(I,3)=CPIB(I)*1000/REG3(I)
4550  DDIST(I,4)=CPIB(I)*1000/AVER
4560  NEXT I
4570  FOR J = 1 TO 4
4580  BS1(H9,J)=DDIST(1,J)
4590  BS2(H9,J)=DDIST(2,J)
4600  BS3(H9,J)=DDIST(3,J)
4610  BS4(H9,J)=DDIST(4,J)
4620  BS5(H9,J)=DDIST(5,J)
4630  BS6(H9,J)=DDIST(6,J)
4640  BS7(H9,J)=DDIST(7,J)
4650  BS8(H9,J)=DDIST(8,J)
4660  BS9(H9,J)=DDIST(9,J)
4670  BS10(H9,J)=DDIST(10,J)
4680  BS11(H9,J)=DDIST(11,J)
4690  BS12(H9,J)=DDIST(12,J)
4700  BS13(H9,J)=DDIST(13,J)
4710  NEXT  J
4720  RETURN
5000  KK=1 :K0=2
5010  GOSUB 5750
5050  FOR I = 1 TO 4
5060  SUM(I)=0
5070  NEXT  I
5080  FOR I = 1 TO 13
5090  SUM(1)=SUM(1)+TEMP(I,1)
5100  SUM(2)=SUM(2)+TEMP(I,2)
5110  SUM(3)=SUM(3)+TEMP(I,3)
5120  SUM(4)=SUM(4)+TEMP(I,4)
5130  NEXT  I
5140  FOR I = 1 TO 4
5150  XBAR(I)=SUM(I)/13
```

```
5160   NEXT  I
5170   SUM1=0:SUM2=0:SUM3=0:SUM4=0
5180   FOR I = 1 TO 13
5190   SUM1=SUM1+(TEMP(I,1)-XBAR(1))^2
5200   SUM2=SUM2+(TEMP(I,2)-XBAR(2))^2
5210   SUM3=SUM3+(TEMP(I,3)-XBAR(3))^2
5220   SUM4=SUM4+(TEMP(I,4)-XBAR(4))^2
5230   NEXT  I
5240   ST(1)=SQR(SUM1/12)
5250   ST(2)=SQR(SUM2/12)
5260   ST(3)=SQR(SUM3/12)
5270   ST(4)=SQR(SUM4/12)
5280   FOR I = 2 TO 12
5290   B9(I)=BL(I)
5300   NEXT  I
5310   B9(1)=2362.828
5320   B9(13)=4724.756
5330   FOR I = 1 TO 4
5340   ER1(I)=XBAR(I)-B9(KK)
5350   ER2(I)=ER1(I)*1000#/B9(KK)
5360   NEXT  I
5370   LPRINT CHR$(27)"Q":LPRINT CHR$(12):LPRINT
5380   LPRINT CHR$(14)TAB(12)"BASELINE:";KK:LPRINT:LPRINT
5390   LPRINT TAB(18)"COMPUTED DISTANCES OF BASELINES"
5400   LPRINT TAB(18)"==============================="
5410   LPRINT:LPRINT
5420   LPRINT "   CYCLIST"TAB(18)"LINEAR"TAB(29)"2ND-ORDER"TAB(4
3)"3RD-ORDER";
5430   LPRINT TAB(56)"WGT MEAN"
5440   LPRINT "   ======="TAB(18)"======"TAB(29)"========="TAB(4
3)"=========";
5450   LPRINT TAB(56)"========":LPRINT
5460   FOR I = 1 TO 13
5470   LPRINT "CYCLIST";:LPRINT USING "####";I;
5480   LPRINT USING "      ####.###";TEMP(I,1);TEMP(I,2);TEMP(I,
3);TEMP(I,4)
5490   LPRINT
5500   NEXT  I
5510   LPRINT :LPRINT
5520   LPRINT "MEAN  DIST.";
5530   LPRINT USING "      ####.###";XBAR(1);XBAR(2);XBAR(3);XBA
R(4)
5540   LPRINT "STD.DEVIAT.";
5550   LPRINT USING "      ####.###";ST(1);ST(2);ST(3);ST(4)
5560   LPRINT "ERROR 1   = "  ;
5570   LPRINT USING "      ####.###";ER1(1);ER1(2);ER1(3);ER1(4)
5580   LPRINT "ERROR(m/km)";
5590   LPRINT USING "      ####.###";ER2(1);ER2(2);ER2(3);ER2(4)
5600   LPRINT:LPRINT
5610   FOR I = 1 TO 13
5620   FOR J = 1 TO 4
```

```
5630  TEMP(I,J)=0
5640  NEXT  J
5650  NEXT  I
5670  FOR I = 1 TO 4
5680  XBAR(I)=0
5690  ST(I)=0
5700  ER1(I)=0
5710  ER2(I)=0
5720  NEXT  I
5730  IF KK=13 THEN END
5740  KK=KK+1 :K0=K0+1
5745  GOTO 5010
5750  FOR I = 1 TO 13
5760  FOR J = 1 TO 4
5770  ON K0-1 GOTO 5780,5790,5800,5810,5820,5830,5840,5850,586
0,5870,5880,5890,5900
5780  TEMP(I,J)=BS1(I,J):GOTO 5910
5790  TEMP(I,J)=BS2(I,J):GOTO 5910
5800  TEMP(I,J)=BS3(I,J):GOTO 5910
5810  TEMP(I,J)=BS4(I,J):GOTO 5910
5820  TEMP(I,J)=BS5(I,J):GOTO 5910
5830  TEMP(I,J)=BS6(I,J):GOTO 5910
5840  TEMP(I,J)=BS7(I,J):GOTO 5910
5850  TEMP(I,J)=BS8(I,J):GOTO 5910
5860  TEMP(I,J)=BS9(I,J)  :GOTO 5910
5870  TEMP(I,J)=BS10(I,J):GOTO 5910
5880  TEMP(I,J)=BS11(I,J):GOTO 5910
5890  TEMP(I,J)=BS12(I,J):GOTO 5910
5900  TEMP(I,J)=BS13(I,J)
5910  NEXT J
5920  NEXT I
5930  RETURN
5940  END
```

4. PRESENTATION OF THE RESULTS OF COMPUTATION

The results of the computation have been presented in five groups as described below:

1) Counts/Intervals and Counts/Km for Baselines:
   Tables of Group I represent the counts/intervals and counts/km for each baseline and for each bicycle rider respectively.

2) Predicted Counts/Km for Intervals Beside Baseline:
   The MPV of counts/km for the intervals beside baselines has been estimated according to the regression methods previously mentioned in Section 2, and the results of the computation have been presented in Tables of Group II and V.

3) Distances of Each Interval:
   Tables of Group III represent distances of each interval on the basis of computation results shown in Tables of Group II.

4) Computed Distance of Each Rider for Each Interval:
   Tables of Group IV represent the computed distance of each interval according to the five different methods applied herein. Some computed statistical data have also been shown in the tables.

All tables of Group I, II, III, IV and V are attached hereto, immediately following this page.

TABLES OF GROUP I

COUNTS / INTERVALS

COUNTS / KM (BASELINES)

FOR

13 BICYCLE RIDERS

C1 : CHOI SANG-IL

INTERVAL	LENGTH	CNTS/INT	CNTS/KM
B01 R03 - R02	1181.164	11383.500	9637.527
B01 R02 - R03	1181.164	11385.500	9639.220
B02 R04 - R05	1628.700	15701.500	9640.511
B03 R11 - R12	439.595	4237.000	9638.417
B04 R13 - R14	370.808	3574.000	9638.411
B05 R15 - R16	600.036	5783.500	9638.588
B06 R17 - R18	1114.665	10742.500	9637.425
B07 R20 - R21	839.220	8086.000	9635.137
B08 R22 - R23	760.936	7336.000	9640.758
B09 R24 - R25	529.061	5098.500	9636.885
B10 R26 - R27	568.673	5479.000	9634.711
B11 R29 - R30	434.330	4183.500	9632.077
B12 R31 - R32	526.956	5078.500	9637.427
B01 R02 - R03	1181.164	11378.000	9632.871
B01 R03 - R02	1181.164	11375.000	9630.331
B01 R02 - R03	1181.164	11376.500	9631.601
B01 R03 - R02	1181.164	11374.500	9629.907

C2: KIM DONG-MOK

INTERVAL		LENGTH	CNTS/INT	CNTS/KM
B01	R03 - R02	1181.164	11375.000	9630.331
B01	R02 - R03	1181.164	11372.500	9628.214
B02	R04 - R05	1628.700	15686.500	9631.301
B03	R11 - R12	439.595	4235.000	9633.868
B04	R13 - R14	370.808	3571.500	9631.669
B05	R15 - R16	600.036	5777.000	9627.756
B06	R17 - R18	1114.665	10733.000	9628.902
B07	R20 - R21	839.220	8079.500	9627.392
B08	R22 - R23	760.936	7329.000	9631.559
B09	R24 - R25	529.061	5093.000	9626.489
B10	R26 - R27	568.673	5473.500	9625.039
B11	R29 - R30	434.330	4182.000	9628.623
B12	R31 - R32	526.956	5073.000	9626.990
B01	R02 - R03	1181.164	11364.500	9621.441
B01	R03 - R02	1181.164	11367.500	9623.981
B01	R02 - R03	1181.164	11365.500	9622.288
B01	R03 - R02	1181.164	11367.000	9623.558

C3: YOON CHANG-SOO

INTERVAL		LENGTH	CNTS/INT	CNTS/KM
B01	R03 - R02	1181.164	11320.000	9583.767
B01	R02 - R03	1181.164	11320.000	9583.767
B02	R04 - R05	1628.700	15608.500	9583.410
B03	R11 - R12	439.595	4214.500	9587.234
B04	R13 - R14	370.808	3555.000	9587.172
B05	R15 - R16	600.036	5749.000	9581.092
B06	R17 - R18	1114.665	10679.000	9580.457
B07	R20 - R21	839.220	8040.000	9580.325
B08	R22 - R23	760.936	7290.500	9580.963
B09	R24 - R25	529.061	5067.000	9577.346
B10	R26 - R27	568.673	5448.000	9580.198
B11	R29 - R30	434.330	4161.500	9581.424
B12	R31 - R32	526.956	5048.000	9579.547
B01	R02 - R03	1181.164	11311.000	9576.147
B01	R03 - R02	1181.164	11311.500	9576.570
B01	R02 - R03	1181.164	11310.000	9575.300
B01	R03 - R02	1181.164	11311.000	9576.147

C4 : KANG MOO-SUNG

INTERVAL		LENGTH	CNTS/INT	CNTS/KM
B01	R03 - R02	1181.164	11336.500	9597.736
B01	R02 - R03	1181.164	11335.500	9596.889
B02	R04 - R05	1628.700	15635.500	9599.988
B03	R11 - R12	439.595	4221.000	9602.020
B04	R13 - R14	370.808	3561.000	9603.353
B05	R15 - R16	600.036	5758.500	9596.924
B06	R17 - R18	1114.665	10697.500	9597.054
B07	R20 - R21	839.220	8053.000	9595.815
B08	R22 - R23	760.936	7302.000	9596.076
B09	R24 - R25	529.061	5077.500	9597.192
B10	R26 - R27	568.673	5456.000	9594.266
B11	R29 - R30	434.330	4168.500	9597.541
B12	R31 - R32	526.956	5057.000	9596.627
B01	R02 - R03	1181.164	11329.000	9591.386
B01	R03 - R02	1181.164	11331.000	9593.079
B01	R02 - R03	1181.164	11328.500	9590.963
B01	R03 - R02	1181.164	11329.500	9591.809

C5 : LEE HAN-SUB

INTERVAL		LENGTH	CNTS/INT	CNTS/KM
B01	R03 - R02	1181.164	11336.000	9597.312
B01	R02 - R03	1181.164	11333.500	9595.196
B02	R04 - R05	1628.700	15624.500	9593.234
B03	R11 - R12	439.595	4218.500	9596.333
B04	R13 - R14	370.808	3558.500	9596.611
B05	R15 - R16	600.036	5756.000	9592.758
B06	R17 - R18	1114.665	10691.500	9591.671
B07	R20 - R21	839.220	8046.000	9587.474
B08	R22 - R23	760.936	7297.500	9590.163
B09	R24 - R25	529.061	5073.500	9589.631
B10	R26 - R27	568.673	5457.000	9596.024
B11	R29 - R30	434.330	4164.000	9587.180
B12	R31 - R32	526.956	5055.500	9593.780
B01	R02 - R03	1181.164	11326.000	9588.846
B01	R03 - R02	1181.164	11324.500	9587.576
B01	R02 - R03	1181.164	11324.500	9587.576
B01	R03 - R02	1181.164	11323.500	9586.730

C6: SON CHANG-WOO

INTERVAL		LENGTH	CNTS/INT	CNTS/KM
B01	R03 - R02	1181.164	11333.000	9594.773
B01	R02 - R03	1181.164	11331.500	9593.503
B02	R04 - R05	1628.700	15627.000	9594.769
B03	R11 - R12	439.595	4217.500	9594.058
B04	R13 - R14	370.808	3557.500	9593.914
B05	R15 - R16	600.036	5753.500	9588.591
B06	R17 - R18	1114.665	10690.000	9590.325
B07	R20 - R21	839.220	8048.500	9590.453
B08	R22 - R23	760.936	7299.000	9592.134
B09	R24 - R25	529.061	5075.000	9592.467
B10	R26 - R27	568.673	5453.000	9588.991
B11	R29 - R30	434.330	4166.000	9591.785
B12	R31 - R32	526.956	5054.000	9590.934
B01	R02 - R03	1181.164	11324.000	9587.153
B01	R03 - R02	1181.164	11325.000	9588.000
B01	R02 - R03	1181.164	11322.500	9585.883
B01	R03 - R02	1181.164	11323.500	9586.730

C7: CHA JOO-MIN

INTERVAL		LENGTH	CNTS/INT	CNTS/KM
B01	R03 - R02	1181.164	11377.000	9632.024
B01	R02 - R03	1181.164	11379.000	9633.717
B02	R04 - R05	1628.700	15690.500	9633.757
B03	R11 - R12	439.595	4235.500	9635.005
B04	R13 - R14	370.808	3573.500	9637.063
B05	R15 - R16	600.036	5778.500	9630.256
B06	R17 - R18	1114.665	10735.000	9630.696
B07	R20 - R21	839.220	8082.000	9630.371
B08	R22 - R23	760.936	7331.000	9634.187
B09	R24 - R25	529.061	5094.500	9629.324
B10	R26 - R27	568.673	5476.500	9630.315
B11	R29 - R30	434.330	4181.000	9626.321
B12	R31 - R32	526.956	5075.000	9630.785
B01	R02 - R03	1181.164	11372.500	9628.214
B01	R03 - R02	1181.164	11368.500	9624.828
B01	R02 - R03	1181.164	11369.500	9625.674
B01	R03 - R02	1181.164	11368.000	9624.404

C8: KIM DONG-WON

INTERVAL		LENGTH	CNTS/INT	CNTS/KM
B01	R03 - R02	1181.164	11341.500	9601.969
B01	R02 - R03	1181.164	11340.000	9600.699
B02	R04 - R05	1628.700	15640.000	9602.751
B03	R11 - R12	439.595	4222.500	9605.432
B04	R13 - R14	370.808	3558.500	9596.611
B05	R15 - R16	600.036	5760.500	9600.257
B06	R17 - R18	1114.665	10700.500	9599.745
B07	R20 - R21	839.220	8054.500	9597.603
B08	R22 - R23	760.936	7304.500	9599.362
B09	R24 - R25	529.061	5078.000	9598.137
B10	R26 - R27	568.673	5458.500	9598.662
B11	R29 - R30	434.330	4169.000	9598.692
B12	R31 - R32	526.956	5056.500	9595.678
B01	R02 - R03	1181.164	11336.000	9597.312
B01	R03 - R02	1181.164	11332.500	9594.349
B01	R02 - R03	1181.164	11334.500	9596.043
B01	R03 - R02	1181.164	11332.000	9593.926

C9 : CHO HEE-GON

INTERVAL		LENGTH	CNTS/INT	CNTS/KM
B01	R03 - R02	1181.164	11380.500	9634.987
B01	R02 - R03	1181.164	11378.000	9632.871
B02	R04 - R05	1628.700	15691.500	9634.371
B03	R11 - R12	439.595	4236.000	9636.142
B04	R13 - R14	370.808	3572.500	9634.366
B05	R15 - R16	600.036	5779.000	9631.089
B06	R17 - R18	1114.665	10734.500	9630.248
B07	R20 - R21	839.220	8082.500	9630.967
B08	R22 - R23	760.936	7331.000	9634.187
B09	R24 - R25	529.061	5093.500	9627.434
B10	R26 - R27	568.673	5476.500	9630.315
B11	R29 - R30	434.330	4183.000	9630.926
B12	R31 - R32	526.956	5073.500	9627.939
B01	R02 - R03	1181.164	11371.500	9627.368
B01	R03 - R02	1181.164	11372.000	9627.791
B01	R02 - R03	1181.164	11369.500	9625.674
B01	R03 - R02	1181.164	11370.500	9626.521

C10:KIM KEE-SOO

INTERVAL		LENGTH	CNTS/INT	CNTS/KM
B01	R03 - R02	1181.164	11416.000	9665.042
B01	R02 - R03	1181.164	11417.000	9665.889
B02	R04 - R05	1628.700	15743.000	9665.991
B03	R11 - R12	439.595	4249.500	9666.852
B04	R13 - R14	370.808	3584.500	9666.728
B05	R15 - R16	600.036	5797.500	9661.920
B06	R17 - R18	1114.665	10772.500	9664.339
B07	R20 - R21	839.220	8109.000	9662.544
B08	R22 - R23	760.936	7354.500	9665.070
B09	R24 - R25	529.061	5114.000	9666.182
B10	R26 - R27	568.673	5494.500	9661.967
B11	R29 - R30	434.330	4196.000	9660.857
B12	R31 - R32	526.956	5091.500	9662.097
B01	R02 - R03	1181.164	11406.000	9656.576
B01	R03 - R02	1181.164	11407.000	9657.423
B01	R02 - R03	1181.164	11406.000	9656.576
B01	R03 - R02	1181.164	11407.000	9657.423

C11: YUN SUN-HO

INTERVAL	LENGTH	CNTS/INT	CNTS/KM
B01 R03 - R02	1181.164	11350.000	9609.165
B01 R02 - R03	1181.164	11351.500	9610.435
B02 R04 - R05	1628.700	15654.000	9611.346
B03 R11 - R12	439.595	4224.500	9609.982
B04 R13 - R14	370.808	3564.500	9612.792
B05 R15 - R16	600.036	5766.000	9609.423
B06 R17 - R18	1114.665	10706.500	9605.128
B07 R20 - R21	839.220	8062.000	9606.539
B08 R22 - R23	760.936	7311.000	9607.904
B09 R24 - R25	529.061	5082.000	9605.698
B10 R26 - R27	568.673	5461.000	9603.058
B11 R29 - R30	434.330	4171.000	9603.297
B12 R31 - R32	526.956	5061.000	9604.217
B01 R02 - R03	1181.164	11341.500	9601.969
B01 R03 - R02	1181.164	11340.500	9601.122
B01 R02 - R03	1181.164	11341.000	9601.546
B01 R03 - R02	1181.164	11340.500	9601.122

C12: SONG JUNG-YUEL

INTERVAL	LENGTH	CNTS/INT	CNTS/KM
B01 R03 - R02	1181.164	11389.500	9642.607
B01 R02 - R03	1181.164	11388.000	9641.337
B02 R04 - R05	1628.700	15693.500	9635.599
B03 R11 - R12	439.595	4240.000	9645.242
B04 R13 - R14	370.808	3575.500	9642.456
B05 R15 - R16	600.036	5782.500	9636.922
B06 R17 - R18	1114.665	10738.500	9633.836
B07 R20 - R21	839.220	8079.500	9627.392
B08 R22 - R23	760.936	7334.000	9638.130
B09 R24 - R25	529.061	5096.500	9633.105
B10 R26 - R27	568.673	5480.500	9637.349
B11 R29 - R30	434.330	4183.000	9630.926
B12 R31 - R32	526.956	5075.500	9631.734
B01 R02 - R03	1181.164	11374.500	9629.907
B01 R03 - R02	1181.164	11375.000	9630.331
B01 R02 - R03	1181.164	11374.000	9629.484
B01 R03 - R02	1181.164	11374.000	9629.484

C13:MUN HEE-BOK

INTERVAL		LENGTH	CNTS/INT	CNTS/KM
B01	R03 - R02	1181.164	11354.000	9612.552
B01	R02 - R03	1181.164	11352.500	9611.282
B02	R04 - R05	1628.700	15653.500	9611.039
B03	R11 - R12	439.595	4224.500	9609.982
B04	R13 - R14	370.808	3564.500	9612.792
B05	R15 - R16	600.036	5765.500	9608.590
B06	R17 - R18	1114.665	10708.500	9606.922
B07	R20 - R21	839.220	8064.500	9609.518
B08	R22 - R23	760.936	7313.000	9610.532
B09	R24 - R25	529.061	5082.500	9606.643
B10	R26 - R27	568.673	5464.500	9609.213
B11	R29 - R30	434.330	4171.500	9604.448
B12	R31 - R32	526.956	5062.500	9607.064
B01	R02 - R03	1181.164	11342.500	9602.816
B01	R03 - R02	1181.164	11346.000	9605.779
B01	R02 - R03	1181.164	11341.500	9601.969
B01	R03 - R02	1181.164	11341.000	9601.546

TABLES OF GROUP II

PREDICTED COUNTS ⁄ KM

FOR

EACH INTERVAL BESIDE BASELINE

C1 : CHOI SANG-IL

INTERVAL		ELAPSED COUNTS (X)	RAW COUNT PER KM (Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9638.37	9640.45	9638.83	9639.14
B02	R04 - R05	48994.25	9640.51	9639.65	9639.07	9638.96
B03	R11 - R12	116283.50	9638.42	9638.57	9638.94	9638.69
B04	R13 - R14	136021.00	9638.41	9638.25	9638.80	9638.58
B05	R15 - R16	164354.75	9638.59	9637.79	9638.52	9638.37
B06	R17 - R18	176453.25	9637.42	9637.59	9638.38	9638.26
B07	R20 - R21	242008.00	9635.14	9636.53	9637.28	9637.39
B08	R22 - R23	269983.00	9640.76	9636.08	9636.66	9636.83
B09	R24 - R25	284376.75	9636.88	9635.85	9636.30	9636.50
B10	R26 - R27	302541.00	9634.71	9635.55	9635.82	9636.03
B11	R29 - R30	333446.75	9632.08	9635.05	9634.91	9635.07
B12	R31 - R32	354498.75	9637.43	9634.71	9634.22	9634.30
B01	R02 - R03	409824.00	9631.18	9633.82	9632.18	9631.78
	R03 - R04	26264.00		9640.02	9638.99	9639.04
	R06 - R07	63744.25		9639.42	9639.08	9638.91
	R08 - R09	77652.75		9639.19	9639.08	9638.86
	R09 - R10	93273.75		9638.94	9639.04	9638.80
	R10 - R11	108025.25		9638.70	9638.98	9638.73
	R12 - R13	126318.00		9638.40	9638.87	9638.63
	R14 - R15	149635.50		9638.03	9638.68	9638.48
	R16 - R17	169164.25		9637.71	9638.47	9638.33
	R18 - R18A	193154.50		9637.32	9638.14	9638.08
	R18A- R19	207221.75		9637.10	9637.92	9637.91
	R19 - R20	223962.00		9636.82	9637.63	9637.68
	R21 - R22	256183.00		9636.30	9636.98	9637.12
	R23 - R24	277739.25		9635.96	9636.47	9636.66
	R25 - R26	293363.75		9635.70	9636.07	9636.27
	R27 - R28	314226.25		9635.37	9635.49	9635.69
	R28 - R29	327263.50		9635.15	9635.10	9635.28
	R30 - R31	343749.00		9634.89	9634.58	9634.71
	R32 - R01	366075.50		9634.53	9633.83	9633.84
	R01 - R02	381092.50		9634.28	9633.29	9633.19

R E G R E S S I O N   P A R A M E T E R S

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LINEAR REGRESSION

```
      A0 = 9640.446618383173
      A1 =-1.617138026045352D-05

2ND ORDER POLYNOMIAL
      A0 = 9638.828268684789
      A1 = 7.756934207002949D-06
      A2 =-5.851558706968967D-11

3RD ORDER POLYNOMIAL
      A0 = 9639.144209702785
      A1 =-4.382385928379933D-06
      A2 = 1.869486191938999D-11
      A3 =-1.265009906182447D-16
```

STANDARD DEVIATION IN Y = 2.91534161567688

C2 : KIM DONG-MOK

INTERVAL		ELAPSED COUNTS (X)	RAW COUNT PER KM (Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9629.27	9632.20	9630.38	9630.07
B02	R04 - R05	48941.00	9631.30	9631.39	9630.73	9630.84
B03	R11 - R12	116162.25	9633.87	9630.28	9630.70	9630.94
B04	R13 - R14	135879.50	9631.67	9629.95	9630.58	9630.80
B05	R15 - R16	164180.25	9627.76	9629.48	9630.31	9630.46
B06	R17 - R18	176267.25	9628.90	9629.28	9630.16	9630.28
B07	R20 - R21	241774.00	9627.39	9628.20	9629.04	9628.93
B08	R22 - R23	269723.25	9631.56	9627.74	9628.39	9628.21
B09	R24 - R25	284106.75	9626.49	9627.50	9628.01	9627.82
B10	R26 - R27	302256.00	9625.04	9627.20	9627.50	9627.29
B11	R29 - R30	333138.25	9628.62	9626.69	9626.52	9626.36
B12	R31 - R32	354174.25	9626.99	9626.34	9625.79	9625.71
B01	R02 - R03	409447.50	9622.82	9625.42	9623.58	9623.97
	R03 - R04	26235.75		9631.77	9630.61	9630.56
	R06 - R07	63675.50		9631.15	9630.78	9630.95
	R08 - R09	77569.25		9630.92	9630.79	9631.00
	R09 - R10	93175.25		9630.66	9630.78	9631.02
	R10 - R11	107911.75		9630.42	9630.73	9630.98
	R12 - R13	126186.75		9630.11	9630.64	9630.88
	R14 - R15	149478.50		9629.73	9630.46	9630.65
	R16 - R17	168984.75		9629.40	9630.25	9630.39
	R18 - R18A	192957.00		9629.01	9629.93	9629.99
	R18A- R19	207015.00		9628.78	9629.71	9629.72
	R19 - R20	223742.00		9628.50	9629.40	9629.36
	R21 - R22	255936.25		9627.96	9628.72	9628.58
	R23 - R24	277474.00		9627.61	9628.19	9628.00
	R25 - R26	293086.25		9627.35	9627.76	9627.56
	R27 - R28	313931.50		9627.00	9627.14	9626.95
	R28 - R29	326958.75		9626.79	9626.73	9626.55
	R30 - R31	343433.50		9626.52	9626.17	9626.05
	R32 - R01	365739.25		9626.15	9625.36	9625.35
	R01 - R02	380741.50		9625.90	9624.78	9624.87

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R E G R E S S I O N    P A R A M E T E R S
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LINEAR   REGRESSION

      A0 = 9632.203415421432
      A1 =-1.656060907782045D-05

2ND ORDER POLYNOMIAL
      A0 = 9630.383145092178
      A1 = 1.037421547911333D-05
      A2 =-6.592208849921375D-11

3RD ORDER POLYNOMIAL
      A0 = 9630.067996561509
      A1 = 2.232957251326724D-05
      A2 =-1.417931836148289D-10
      A3 = 1.242347110620884D-16

STANDARD DEVIATION IN Y = 3.015283584594727
```

C3: YOON CHANG-SOO

	INTERVAL	ELAPSED COUNTS(X)	RAW COUNT PER KM(Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9583.77	9585.75	9584.66	9583.90
B02	R04 - R05	48706.75	9583.41	9584.79	9584.40	9584.63
B03	R11 - R12	115598.25	9587.23	9583.47	9583.72	9584.29
B04	R13 - R14	135222.00	9587.17	9583.08	9583.45	9583.97
B05	R15 - R16	163388.50	9581.09	9582.52	9583.02	9583.38
B06	R17 - R18	175415.50	9580.46	9582.28	9582.81	9583.09
B07	R20 - R21	240583.50	9580.32	9581.00	9581.50	9581.26
B08	R22 - R23	268392.75	9580.96	9580.45	9580.83	9580.44
B09	R24 - R25	282701.50	9577.35	9580.16	9580.47	9580.02
B10	R26 - R27	300757.50	9580.20	9579.81	9579.98	9579.51
B11	R29 - R30	331485.25	9581.42	9579.20	9579.10	9578.73
B12	R31 - R32	352413.50	9579.55	9578.78	9578.45	9578.27
B01	R02 - R03	407412.75	9576.04	9577.70	9576.59	9577.49
	R03 - R04	26111.25		9585.24	9584.54	9584.41
	R06 - R07	63368.50		9584.50	9584.28	9584.67
	R08 - R09	77193.75		9584.23	9584.15	9584.65
	R09 - R10	92722.50		9583.92	9583.99	9584.55
	R10 - R11	107387.25		9583.63	9583.82	9584.40
	R12 - R13	125575.00		9583.27	9583.59	9584.14
	R14 - R15	148756.75		9582.81	9583.25	9583.71
	R16 - R17	168169.50		9582.43	9582.94	9583.27
	R18 - R18A	192018.50		9581.96	9582.51	9582.66
	R18A- R19	206002.25		9581.68	9582.24	9582.27
	R19 - R20	222643.00		9581.35	9581.89	9581.79
	R21 - R22	254675.50		9580.72	9581.17	9580.84
	R23 - R24	276103.00		9580.29	9580.64	9580.21
	R25 - R26	291634.25		9579.99	9580.23	9579.77
	R27 - R28	312374.75		9579.58	9579.66	9579.20
	R28 - R29	325336.25		9579.32	9579.28	9578.87
	R30 - R31	341727.75		9579.00	9578.79	9578.49
	R32 - R01	363920.25		9578.56	9578.08	9578.05
	R01 - R02	378847.00		9578.26	9577.59	9577.80

R E G R E S S I O N   P A R A M E T E R S
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LINEAR   REGRESSION

A0 = 9585.751308471405
A1 =-1.976973758404489D-05

2ND ORDER POLYNOMIAL
A0 = 9584.664042006503
A1 =-3.573387847296863D-06
A2 =-3.986403989174252D-11

3RD ORDER POLYNOMIAL
A0 = 9583.900480613852
A1 = 2.493265465465552D-05
A2 =-2.203798991971776D-10
A3 = 2.958628887104683D-16

STANDARD DEVIATION IN Y = 3.282601356506348

C4 : KANG MOO-SUNG

INTERVAL		ELAPSED COUNTS(X)	RAW COUNT PER KM(Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9597.31	9600.85	9599.05	9598.11
B02	R04 - R05	48788.75	9599.99	9600.08	9599.42	9599.71
B03	R11 - R12	115795.50	9602.02	9599.01	9599.42	9600.14
B04	R13 - R14	135450.50	9603.35	9598.69	9599.31	9599.96
B05	R15 - R16	163658.25	9596.92	9598.24	9599.06	9599.51
B06	R17 - R18	175707.25	9597.05	9598.05	9598.92	9599.27
B07	R20 - R21	240993.50	9595.82	9597.01	9597.84	9597.55
B08	R22 - R23	268849.00	9596.08	9596.56	9597.21	9596.71
B09	R24 - R25	283181.25	9597.19	9596.33	9596.84	9596.28
B10	R26 - R27	301270.50	9594.27	9596.04	9596.34	9595.76
B11	R29 - R30	332059.25	9597.54	9595.55	9595.39	9594.93
B12	R31 - R32	353026.00	9596.63	9595.22	9594.67	9594.44
B01	R02 - R03	408118.50	9591.81	9594.34	9592.51	9593.62
	R03 - R04	26153.50		9600.44	9599.29	9599.12
	R06 - R07	63476.00		9599.84	9599.47	9599.96
	R08 - R09	77324.00		9599.62	9599.49	9600.11
	R09 - R10	92878.00		9599.37	9599.49	9600.19
	R10 - R11	107569.25		9599.14	9599.45	9600.18
	R12 - R13	125788.00		9598.85	9599.37	9600.06
	R14 - R15	149005.00		9598.48	9599.20	9599.77
	R16 - R17	168448.00		9598.17	9599.01	9599.42
	R18 - R18A	192340.75		9597.78	9598.70	9598.88
	R18A- R19	206350.25		9597.56	9598.48	9598.52
	R19 - R20	223021.00		9597.29	9598.19	9598.07
	R21 - R22	255109.00		9596.78	9597.53	9597.13
	R23 - R24	276571.25		9596.44	9597.01	9596.48
	R25 - R26	292131.25		9596.19	9596.60	9596.02
	R27 - R28	312909.75		9595.86	9596.00	9595.43
	R28 - R29	325898.00		9595.65	9595.59	9595.08
	R30 - R31	342320.50		9595.39	9595.05	9594.68
	R32 - R01	364552.75		9595.03	9594.25	9594.21
	R01 - R02	379505.25		9594.80	9593.68	9593.95

R E G R E S S I O N   P A R A M E T E R S

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LINEAR   REGRESSION

      A0 = 9600.854978974103
      A1 =-1.596701622908654D-05

2ND ORDER POLYNOMIAL
      A0 = 9599.048836808201
      A1 = 1.084111441943812D-05
      A2 =-6.582652042703989D-11

3RD ORDER POLYNOMIAL
      A0 = 9598.107068548192
      A1 = 4.607604723028127D-05
      A2 =-2.888236259491820-10
      A3 = 3.650723779271791D-16

STANDARD DEVIATION IN Y = 3.02526926994323?7
```

C5 : LEE HAN-SUB

INTERVAL		ELAPSED COUNTS (X)	RAW COUNT PER KM (Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9596.25	9596.00	9596.13	9595.97
B02	R04 - R05	48766.00	9593.23	9595.15	9595.20	9595.25
B03	R11 - R12	115723.50	9596.33	9593.99	9593.95	9594.08
B04	R13 - R14	135364.00	9596.61	9593.64	9593.60	9593.71
B05	R15 - R16	163559.25	9592.76	9593.15	9593.09	9593.17
B06	R17 - R18	175601.50	9591.67	9592.94	9592.88	9592.94
B07	R20 - R21	240839.75	9587.47	9591.81	9591.74	9591.69
B08	R22 - R23	268673.00	9590.16	9591.32	9591.27	9591.19
B09	R24 - R25	282999.00	9589.63	9591.07	9591.03	9590.94
B10	R26 - R27	301081.75	9596.02	9590.75	9590.73	9590.63
B11	R29 - R30	331839.75	9587.18	9590.22	9590.23	9590.15
B12	R31 - R32	352786.50	9593.78	9589.85	9589.89	9589.85
B01	R02 - R03	407852.00	9587.68	9588.89	9589.03	9589.22
	R03 - R04	26144.25		9595.55	9595.63	9595.60
	R06 - R07	63444.25		9594.90	9594.92	9595.01
	R08 - R09	77285.75		9594.66	9594.66	9594.77
	R09 - R10	92829.75		9594.38	9594.38	9594.50
	R10 - R11	107506.25		9594.13	9594.10	9594.23
	R12 - R13	125708.75		9593.81	9593.77	9593.89
	R14 - R15	148912.25		9593.41	9593.35	9593.45
	R16 - R17	168346.50		9593.07	9593.01	9593.08
	R18 - R18A	192222.75		9592.65	9592.59	9592.62
	R18A- R19	206220.00		9592.41	9592.34	9592.35
	R19 - R20	222879.25		9592.12	9592.05	9592.03
	R21 - R22	254943.50		9591.56	9591.50	9591.43
	R23 - R24	276392.00		9591.19	9591.14	9591.05
	R25 - R26	291944.50		9590.91	9590.88	9590.78
	R27 - R28	312711.25		9590.55	9590.54	9590.44
	R28 - R29	325685.00		9590.33	9590.33	9590.24
	R30 - R31	342090.25		9590.04	9590.07	9590.00
	R32 - R01	364308.00		9589.65	9589.71	9589.70
	R01 - R02	379252.25		9589.39	9589.47	9589.52

R E G R E S S I O N   P A R A M E T E R S

LINEAR   REGRESSION

A0 = 9596.002826993323
A1 =-1.742995163133150D-05

2ND ORDER POLYNOMIAL
A0 = 9596.133112006345
A1 =-1.938261322088846D-05
A2 = 4.813748464659591D-12

3RD ORDER POLYNOMIAL
A0 = 9595.966055281711
A1 =-1.314741364886495D-05
A2 =-3.457264800368181D-11
A3 = 6.440039955425542D-17

STANDARD DEVIATION IN Y = 3.540753841400147

C6: SON CHANG-WOO

INTERVAL		ELAPSED COUNTS(X)	RAW COUNT PER KM(Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9594.14	9594.44	9594.42	9595.26
B02	R04 - R05	48754.25	9594.77	9593.78	9593.77	9593.51
B03	R11 - R12	115717.50	9594.06	9592.87	9592.88	9592.24
B04	R13 - R14	135357.50	9593.91	9592.61	9592.61	9592.04
B05	R15 - R16	163545.50	9588.59	9592.23	9592.23	9591.83
B06	R17 - R18	175584.25	9590.33	9592.06	9592.07	9591.76
B07	R20 - R21	240819.00	9590.45	9591.18	9591.19	9591.45
B08	R22 - R23	268657.25	9592.13	9590.81	9590.81	9591.25
B09	R24 - R25	282982.75	9592.47	9590.61	9590.62	9591.11
B10	R26 - R27	301061.75	9588.99	9590.37	9590.37	9590.89
B11	R29 - R30	331823.25	9591.79	9589.95	9589.95	9590.36
B12	R31 - R32	352774.25	9590.93	9589.67	9589.66	9589.87
B01	R02 - R03	407838.25	9586.94	9588.92	9588.91	9587.92
	R03 - R04	26136.50		9594.08	9594.08	9594.22
	R06 - R07	63432.50		9593.58	9593.58	9593.14
	R08 - R09	77273.00		9593.39	9593.39	9592.84
	R09 - R10	92819.50		9593.18	9593.18	9592.56
	R10 - R11	107499.50		9592.98	9592.99	9592.34
	R12 - R13	125702.50		9592.74	9592.74	9592.13
	R14 - R15	148902.50		9592.42	9592.43	9591.93
	R16 - R17	168330.75		9592.16	9592.17	9591.80
	R18 - R18A	192205.25		9591.84	9591.85	9591.68
	R18A- R19	206204.50		9591.65	9591.66	9591.62
	R19 - R20	222861.25		9591.42	9591.43	9591.54
	R21 - R22	254925.50		9590.99	9591.00	9591.36
	R23 - R24	276376.00		9590.70	9590.71	9591.18
	R25 - R26	291927.75		9590.49	9590.49	9591.01
	R27 - R28	312690.75		9590.21	9590.21	9590.72
	R28 - R29	325666.75		9590.03	9590.03	9590.49
	R30 - R31	342076.75		9589.81	9589.81	9590.14
	R32 - R01	364294.50		9589.51	9589.51	9589.55
	R01 - R02	379239.25		9589.31	9589.30	9589.06

R E G R E S S I O N   P A R A M E T E R S

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LINEAR   REGRESSION

      A0 = 9594.437719314743
      A1 =-1.351937153454524D-05

2ND ORDER POLYNOMIAL
      A0 = 9594.423454508703
      A1 =-1.329228981067331D-05
      A2 =-5.689122373583859D-13

3RD ORDER POLYNOMIAL
      A0 = 9595.2607673177
      A1 =-4.474274475974595D-05
      A2 = 1.987091087161968D-10
      A3 =-3.265043279069468D-16

STANDARD DEVIATION IN Y = 2.411198377609253
```

C7:CHA JOO-MIN

INTERVAL		ELAPSED COUNTS (X)	RAW COUNT PER KM (Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9632.87	9635.28	9633.58	9633.28
B02	R04 - R05	48954.75	9633.76	9634.38	9633.77	9633.86
B03	R11 - R12	116198.25	9635.00	9633.15	9633.55	9633.77
B04	R13 - R14	135919.25	9637.06	9632.79	9633.38	9633.58
B05	R15 - R16	164227.75	9630.26	9632.28	9633.05	9633.19
B06	R17 - R18	176317.50	9630.70	9632.05	9632.88	9632.98
B07	R20 - R21	241845.00	9630.37	9630.85	9631.64	9631.55
B08	R22 - R23	269801.50	9634.19	9630.34	9630.95	9630.79
B09	R24 - R25	284188.25	9629.32	9630.08	9630.56	9630.38
B10	R26 - R27	302342.75	9630.31	9629.75	9630.03	9629.84
B11	R29 - R30	333236.00	9626.32	9629.18	9629.03	9628.88
B12	R31 - R32	354273.50	9630.79	9628.80	9628.28	9628.21
B01	R02 - R03	409558.75	9625.78	9627.79	9626.06	9626.42
	R03 - R04	26243.75		9634.80	9633.71	9633.66
	R06 - R07	63694.00		9634.11	9633.77	9633.92
	R08 - R09	77592.25		9633.86	9633.74	9633.94
	R09 - R10	93203.00		9633.57	9633.68	9633.91
	R10 - R11	107945.00		9633.30	9633.60	9633.83
	R12 - R13	126224.25		9632.97	9633.47	9633.68
	R14 - R15	149522.25		9632.54	9633.23	9633.41
	R16 - R17	169033.50		9632.19	9632.98	9633.11
	R18 - R18A	193012.75		9631.75	9632.61	9632.67
	R18A- R19	207076.25		9631.49	9632.36	9632.37
	R19 - R20	223808.00		9631.18	9632.03	9631.99
	R21 - R22	256011.00		9630.60	9631.30	9631.17
	R23 - R24	277554.00		9630.20	9630.74	9630.57
	R25 - R26	293170.00		9629.92	9630.30	9630.12
	R27 - R28	314022.75		9629.53	9629.66	9629.48
	R28 - R29	327055.00		9629.30	9629.24	9629.08
	R30 - R31	343531.25		9628.99	9628.67	9628.55
	R32 - R01	365840.50		9628.59	9627.85	9627.84
	R01 - R02	380844.75		9628.31	9627.26	9627.35

R E G R E S S I O N   P A R A M E T E R S

LINEAR   REGRESSION

```
A0 = 9635.280178872083
A1 =-1.829883366403292D-05
```

2ND ORDER POLYNOMIAL

```
A0 = 9633.576169706074
A1 = 6.906692109838002D-06
A2 =-6.16722984071767D-11
```

3RD ORDER POLYNOMIAL

```
A0 = 9633.278399765935
A1 = 1.802992955579049D-05
A2 =-1.319391042197195D-10
A3 = 1.147720888461664D-16
```

STANDARD DEVIATION IN Y = 3.246685028076172

C8:KIM DONG-WON

INTERVAL		ELAPSED COUNTS(X)	RAW COUNT PER KM(Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9601.33	9602.79	9602.27	9602.14
B02	R04 - R05	48796.75	9602.75	9601.99	9601.80	9601.84
B03	R11 - R12	115820.50	9605.43	9600.88	9601.01	9601.10
B04	R13 - R14	135479.00	9596.61	9600.56	9600.74	9600.82
B05	R15 - R16	163702.00	9600.26	9600.09	9600.33	9600.39
B06	R17 - R18	175754.00	9599.75	9599.89	9600.15	9600.19
B07	R20 - R21	241067.00	9597.60	9598.82	9599.06	9599.02
B08	R22 - R23	268932.50	9599.36	9598.36	9598.54	9598.48
B09	R24 - R25	283269.75	9598.14	9598.12	9598.27	9598.20
B10	R26 - R27	301366.00	9598.66	9597.82	9597.91	9597.83
B11	R29 - R30	332156.75	9598.69	9597.31	9597.27	9597.21
B12	R31 - R32	353124.00	9595.68	9596.97	9596.81	9596.78
B01	R02 - R03	408234.75	9595.41	9596.06	9595.53	9595.67
	R03 - R04	26158.75		9602.36	9602.03	9602.01
	R06 - R07	63488.00		9601.75	9601.64	9601.70
	R08 - R09	77340.75		9601.52	9601.48	9601.56
	R09 - R10	92900.25		9601.26	9601.30	9601.39
	R10 - R11	107593.75		9601.02	9601.11	9601.20
	R12 - R13	125815.75		9600.72	9600.87	9600.96
	R14 - R15	149040.00		9600.33	9600.55	9600.62
	R16 - R17	168493.00		9600.01	9600.26	9600.31
	R18 - R18A	192396.25		9599.62	9599.89	9599.91
	R18A- R19	206414.25		9599.39	9599.66	9599.66
	R19 - R20	223090.00		9599.11	9599.38	9599.36
	R21 - R22	255187.25		9598.58	9598.80	9598.75
	R23 - R24	276657.75		9598.23	9598.40	9598.33
	R25 - R26	292222.75		9597.97	9598.09	9598.02
	R27 - R28	313007.75		9597.63	9597.67	9597.60
	R28 - R29	325996.25		9597.42	9597.40	9597.33
	R30 - R31	342418.50		9597.15	9597.04	9597.00
	R32 - R01	364653.25		9596.78	9596.55	9596.55
	R01 - R02	379610.75		9596.53	9596.21	9596.24

R E G R E S S I O N   P A R A M E T E R S

LINEAR REGRESSION

A0 = 9602.792702327572
A1 =-1.649177601420220D-05

2ND ORDER POLYNOMIAL

A0 = 9602.270361642709
A1 =-8.707805145383609D-06
A2 =-1.913604426009154D-11

3RD ORDER POLYNOMIAL

A0 = 9602.144457949788
A1 =-4.085986185063082D-06
A2 =-4.832043610931281D-11
A3 = 4.776351129034728D-17

STANDARD DEVIATION IN Y = 2.816097497940064

C9: CHO HEE-GON

INTERVAL		ELAPSED COUNTS (X)	RAW COUNT PER KM (Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9633.93	9635.46	9634.54	9634.36
B02	R04 - R05	48960.00	9634.37	9634.56	9634.23	9634.28
B03	R11 - R12	116199.25	9636.14	9633.32	9633.53	9633.67
B04	R13 - R14	135921.50	9634.37	9632.96	9633.27	9633.40
B05	R15 - R16	164233.25	9631.09	9632.44	9632.85	9632.94
B06	R17 - R18	176323.00	9630.25	9632.21	9632.65	9632.72
B07	R20 - R21	241837.00	9630.97	9631.01	9631.43	9631.37
B08	R22 - R23	269788.25	9634.19	9630.49	9630.82	9630.72
B09	R24 - R25	284173.50	9627.43	9630.23	9630.48	9630.38
B10	R26 - R27	302322.00	9630.31	9629.89	9630.04	9629.93
B11	R29 - R30	333208.75	9630.93	9629.32	9629.24	9629.15
B12	R31 - R32	354243.50	9627.94	9628.94	9628.66	9628.62
B01	R02 - R03	409531.50	9626.84	9627.92	9626.99	9627.21
	R03 - R04	26246.75		9634.98	9634.39	9634.36
	R06 - R07	63698.75		9634.29	9634.10	9634.20
	R08 - R09	77595.75		9634.03	9633.97	9634.09
	R09 - R10	93205.25		9633.74	9633.80	9633.94
	R10 - R11	107946.00		9633.47	9633.63	9633.77
	R12 - R13	126226.25		9633.14	9633.40	9633.54
	R14 - R15	149525.75		9632.71	9633.07	9633.18
	R16 - R17	169039.25		9632.35	9632.77	9632.85
	R18 - R18A	193013.25		9631.91	9632.37	9632.41
	R18A- R19	207071.25		9631.65	9632.11	9632.12
	R19 - R20	223801.00		9631.34	9631.79	9631.77
	R21 - R22	256000.50		9630.75	9631.13	9631.05
	R23 - R24	277540.25		9630.35	9630.64	9630.54
	R25 - R26	293152.00		9630.06	9630.27	9630.16
	R27 - R28	314000.50		9629.68	9629.75	9629.64
	R28 - R29	327029.00		9629.44	9629.41	9629.31
	R30 - R31	343503.50		9629.13	9628.96	9628.89
	R32 - R01	365810.25		9628.72	9628.33	9628.32
	R01 - R02	380815.00		9628.45	9627.88	9627.94

R E G R E S S I O N   P A R A M E T E R S

```
LINEAR   REGRESSION

      A0 = 9635.461001141459
      A1 =-1.84162758508033D-05

2ND ORDER POLYNOMIAL
      A0 = 9634.543138107129
      A1 =-4.867300703787825D-06
      A2 =-3.313182822174876D-11

3RD ORDER POLYNOMIAL
      A0 = 9634.363833702334
      A1 = 1.914303241702908D-06
      A2 =-7.599030032550186D-11
      A3 = 6.995828237056442D-17

STANDARD DEVIATION IN Y = 2.969100475311279
```

C10:KIM KEE-SOO

INTERVAL		ELAPSED COUNTS(X)	RAW COUNT PER KM(Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9665.47	9667.28	9665.31	9666.09
B02	R04 - R05	49127.50	9665.99	9666.46	9665.74	9665.50
B03	R11 - R12	116591.75	9666.85	9665.33	9665.78	9665.18
B04	R13 - R14	136375.25	9666.73	9665.00	9665.67	9665.13
B05	R15 - R16	164783.25	9661.92	9664.52	9665.42	9665.04
B06	R17 - R18	176913.75	9664.34	9664.32	9665.27	9664.98
B07	R20 - R21	242646.50	9662.54	9663.22	9664.13	9664.37
B08	R22 - R23	270695.75	9665.07	9662.75	9663.45	9663.87
B09	R24 - R25	285130.50	9666.18	9662.51	9663.06	9663.53
B10	R26 - R27	303344.75	9661.97	9662.20	9662.53	9663.02
B11	R29 - R30	334336.00	9660.86	9661.69	9661.51	9661.90
B12	R31 - R32	355441.25	9662.10	9661.33	9660.74	9660.93
B01	R02 - R03	410899.00	9657.00	9660.40	9658.41	9657.47
	R03 - R04	26336.25		9666.84	9665.59	9665.72
	R06 - R07	63915.50		9666.21	9665.81	9665.39
	R08 - R09	77860.00		9665.98	9665.84	9665.32
	R09 - R10	93522.50		9665.71	9665.84	9665.25
	R10 - R11	108312.00		9665.47	9665.81	9665.21
	R12 - R13	126649.75		9665.16	9665.73	9665.16
	R14 - R15	150026.00		9664.77	9665.56	9665.09
	R16 - R17	169604.75		9664.44	9665.36	9665.02
	R18 - R18A	193663.50		9664.04	9665.04	9664.89
	R18A- R19	207771.00		9663.80	9664.81	9664.78
	R19 - R20	224553.50		9663.52	9664.50	9664.61
	R21 - R22	256859.75		9662.98	9663.80	9664.14
	R23 - R24	278473.25		9662.62	9663.25	9663.69
	R25 - R26	294142.50		9662.36	9662.80	9663.29
	R27 - R28	315061.50		9662.01	9662.16	9662.63
	R28 - R29	328134.50		9661.79	9661.72	9662.15
	R30 - R31	344664.75		9661.51	9661.14	9661.45
	R32 - R01	367043.50		9661.14	9660.28	9660.32
	R01 - R02	382093.00		9660.89	9659.67	9659.45

R E G R E S S I O N   P A R A M E T E R S

LINEAR REGRESSION

```
      A0 = 9667.279730175478
      A1 =-1.673176604637528D-05
```

2ND ORDER POLYNOMIAL

```
      A0 = 9665.310313403358
      A1 = 1.232942908308056D-05
      A2 =-7.089500420732986D-11
```

3RD ORDER POLYNOMIAL

```
      A0 = 9666.090033017375
      A1 =-1.690369594909678D-05
      A2 = 1.132587013316901D-10
      A3 =-2.997470853074415D-16
```

STANDARD DEVIATION IN Y = 2.870623111724854

C11 : YUN SUN-HO

INTERVAL		ELAPSED COUNTS (X)	RAW COUNT PER KM (Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9609.80	9612.31	9610.98	9610.20
B02	R04 - R05	48841.25	9611.35	9611.11	9610.63	9610.87
B03	R11 - R12	115920.00	9609.98	9609.47	9609.77	9610.37
B04	R13 - R14	135591.50	9612.79	9608.98	9609.44	9609.98
B05	R15 - R16	163831.25	9609.42	9608.29	9608.89	9609.27
B06	R17 - R18	175891.00	9605.13	9608.00	9608.64	9608.92
B07	R20 - R21	241240.25	9606.54	9606.39	9607.00	9606.76
B08	R22 - R23	269120.75	9607.90	9605.71	9606.18	9605.77
B09	R24 - R25	283467.25	9605.70	9605.36	9605.73	9605.27
B10	R26 - R27	301567.75	9603.06	9604.91	9605.13	9604.64
B11	R29 - R30	332371.75	9603.30	9604.16	9604.04	9603.65
B12	R31 - R32	353351.75	9604.22	9603.64	9603.24	9603.05
B01	R02 - R03	408493.50	9601.44	9602.29	9600.95	9601.88
	R03 - R04	26182.50		9611.67	9610.82	9610.68
	R06 - R07	63544.50		9610.75	9610.48	9610.89
	R08 - R09	77408.75		9610.41	9610.32	9610.83
	R09 - R10	92982.25		9610.03	9610.11	9610.70
	R10 - R11	107687.75		9609.67	9609.90	9610.50
	R12 - R13	125920.75		9609.22	9609.61	9610.18
	R14 - R15	149161.00		9608.65	9609.19	9609.66
	R16 - R17	168626.00		9608.17	9608.79	9609.13
	R18 - R18A	192537.25		9607.59	9608.26	9608.41
	R18A- R19	206558.75		9607.24	9607.92	9607.96
	R19 - R20	223248.25		9606.83	9607.49	9607.39
	R21 - R22	255368.25		9606.05	9606.60	9606.26
	R23 - R24	276851.25		9605.52	9605.94	9605.50
	R25 - R26	292422.75		9605.14	9605.44	9604.96
	R27 - R28	313214.75		9604.63	9604.73	9604.26
	R28 - R29	326208.75		9604.31	9604.27	9603.84
	R30 - R31	342639.25		9603.91	9603.66	9603.35
	R32 - R01	364887.75		9603.36	9602.79	9602.75
	R01 - R02	379852.50		9602.99	9602.18	9602.40

R E G R E S S I O N   P A R A M E T E R S

```
LINEAR   REGRESSION

     A0 = 9612.309205643081
     A1 =-2.452376037945106D-05

2ND ORDER POLYNOMIAL
     A0 = 9610.97943957192
     A1 =-4.824753699650216D-06
     A2 =-4.830568914089092D-11

3RD ORDER POLYNOMIAL
     A0 = 9610.196570405434
     A1 = 2.447879658650168D-05
     A2 =-2.336898321649497D-10
     A3 = 3.033118389880076D-16

STANDARD DEVIATION IN Y = 3.525689601898193
```

C12: SONG JUNG-YUEL

INTERVAL		ELAPSED COUNTS (X)	RAW COUNT PER KM (Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9641.97	9641.98	9641.34	9640.65
B02	R04 - R05	48995.00	9635.60	9640.58	9640.35	9640.56
B03	R11 - R12	116263.25	9645.24	9638.65	9638.80	9639.33
B04	R13 - R14	135987.00	9642.46	9638.09	9638.30	9638.78
B05	R15 - R16	164325.00	9636.92	9637.27	9637.56	9637.90
B06	R17 - R18	176423.50	9633.84	9636.93	9637.23	9637.49
B07	R20 - R21	241975.00	9627.39	9635.05	9635.34	9635.12
B08	R22 - R23	269939.25	9638.13	9634.25	9634.48	9634.11
B09	R24 - R25	284327.50	9633.10	9633.84	9634.02	9633.60
B10	R26 - R27	302492.00	9637.35	9633.32	9633.42	9632.99
B11	R29 - R30	333391.75	9630.93	9632.43	9632.38	9632.03
B12	R31 - R32	354438.00	9631.73	9631.83	9631.64	9631.47
B01	R02 - R03	409756.50	9629.80	9630.25	9629.60	9630.44
	R03 - R04	26268.50		9641.23	9640.82	9640.70
	R06 - R07	63738.00		9640.16	9640.02	9640.39
	R08 - R09	77641.00		9639.76	9639.71	9640.17
	R09 - R10	93256.50		9639.31	9639.35	9639.87
	R10 - R11	108004.25		9638.89	9639.00	9639.54
	R12 - R13	126291.25		9638.36	9638.55	9639.06
	R14 - R15	149604.25		9637.70	9637.95	9638.37
	R16 - R17	169135.25		9637.14	9637.43	9637.74
	R18 - R18A	193124.00		9636.45	9636.77	9636.90
	R18A- R19	207192.25		9636.05	9636.37	9636.40
	R19 - R20	223932.25		9635.57	9635.88	9635.79
	R21 - R22	256143.50		9634.65	9634.91	9634.60
	R23 - R24	277692.75		9634.03	9634.23	9633.83
	R25 - R26	293313.75		9633.58	9633.72	9633.29
	R27 - R28	314174.00		9632.98	9633.03	9632.61
	R28 - R29	327208.00		9632.61	9632.59	9632.21
	R30 - R31	343691.75		9632.14	9632.02	9631.74
	R32 - R01	366011.50		9631.50	9631.22	9631.19
	R01 - R02	381027.50		9631.07	9630.68	9630.88

```
R E G R E S S I O N     P A R A M E T E R S
===========================================


LINEAR   REGRESSION

      A0 = 9641.981206148875
      A1 =-2.864098164130658D-05

2ND ORDER POLYNOMIAL
      A0 = 9641.342839961547
      A1 =-1.922900179488285D-05
      A2 =-2.299707442252893D-11

3RD ORDER POLYNOMIAL
      A0 = 9640.650095227863
      A1 = 6.787965473496591D-06
      A2 =-1.874164825532166D-10
      A3 = 2.684836135315419D-16


STANDARD DEVIATION IN Y = 5.312626361846924
```

C13: MUN HEE-BOK

	INTERVAL	ELAPSED COUNTS (X)	RAW COUNT PER KM (Y)	PREDICTED COUNTS PER KM LINEAR	2ND ORDER	3RD ORDER
B01	R02 - R03	0.00	9611.92	9612.52	9611.35	9612.10
B02	R04 - R05	48843.50	9611.04	9611.64	9611.21	9610.98
B03	R11 - R12	115919.50	9609.98	9610.43	9610.70	9610.13
B04	R13 - R14	135590.00	9612.79	9610.07	9610.47	9609.96
B05	R15 - R16	163850.50	9608.59	9609.56	9610.09	9609.73
B06	R17 - R18	175911.00	9606.92	9609.35	9609.91	9609.63
B07	R20 - R21	241285.50	9609.52	9608.17	9608.70	9608.94
B08	R22 - R23	269179.75	9610.53	9607.66	9608.08	9608.47
B09	R24 - R25	283531.50	9606.64	9607.40	9607.73	9608.18
B10	R26 - R27	301643.00	9609.21	9607.08	9607.27	9607.74
B11	R29 - R30	332461.50	9604.45	9606.52	9606.42	9606.79
B12	R31 - R32	353451.00	9607.06	9606.14	9605.79	9605.97
B01	R02 - R03	408620.75	9603.03	9605.15	9603.96	9603.07
	R03 - R04	26185.00		9612.05	9611.30	9611.43
	R06 - R07	63546.00		9611.37	9611.13	9610.74
	R08 - R09	77408.50		9611.12	9611.04	9610.55
	R09 - R10	92980.50		9610.84	9610.92	9610.36
	R10 - R11	107686.50		9610.58	9610.78	9610.20
	R12 - R13	125919.75		9610.25	9610.59	9610.04
	R14 - R15	149170.00		9609.83	9610.30	9609.85
	R16 - R17	168645.00		9609.48	9610.02	9609.69
	R18 - R18A	192564.75		9609.05	9609.64	9609.49
	R18A- R19	206594.50		9608.79	9609.39	9609.36
	R19 - R20	223289.00		9608.49	9609.07	9609.17
	R21 - R22	255420.50		9607.91	9608.40	9608.72
	R23 - R24	276913.25		9607.52	9607.89	9608.32
	R25 - R26	292491.75		9607.24	9607.51	9607.97
	R27 - R28	313295.50		9606.87	9606.96	9607.41
	R28 - R29	326295.75		9606.63	9606.59	9607.00
	R30 - R31	342733.50		9606.34	9606.11	9606.41
	R32 - R01	364997.25		9605.93	9605.43	9605.46
	R01 - R02	379973.75		9605.66	9604.94	9604.73

R E G R E S S I O N   P A R A M E T E R S

LINEAR   REGRESSION

A0 = 9612.52007006049
A1 =-1.804519351508843D-05

2ND ORDER POLYNOMIAL
A0 = 9611.348595112084
A1 =-7.016763139761815D-07
A2 =-4.251370535140418D-11

3RD ORDER POLYNOMIAL
A0 = 9612.100321249223
A1 =-2.881206401315297D-05
A2 = 1.352592873002614D-10
A3 =-2.907792988459411D-16

STANDARD DEVIATION IN Y = 2.867650032043457

TABLES OF GROUP III

COMPUTED DISTANCE

FOR

EACH INTERVAL

C1, CHOI SANG-IL

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3087.03	3087.36	3087.34	3087.21	3087.96
R06 - R07	1431.47	1431.52	1431.54	1431.46	1431.81
R08 - R09	1454.32	1454.34	1454.37	1454.28	1454.64
R09 - R10	1786.87	1786.85	1786.89	1786.77	1787.21
R10 - R11	1273.98	1273.94	1273.97	1273.88	1274.19
R12 - R13	1642.60	1642.52	1642.56	1642.59	1642.82
R14 - R15	2454.34	2454.17	2454.22	2454.22	2454.58
R16 - R17	397.97	397.94	397.94	397.96	397.99
R18 - R18A	2351.28	2351.08	2351.09	2351.53	2351.33
R18A- R19	568.07	568.02	568.02	568.11	568.06
R19 - R20	2906.14	2905.90	2905.89	2906.31	2906.06
R21 - R22	2102.88	2102.73	2102.70	2102.52	2102.71
R23 - R24	848.54	848.50	848.48	848.29	848.44
R25 - R26	1336.23	1336.18	1336.15	1336.22	1336.03
R27 - R28	1856.86	1856.83	1856.80	1857.24	1856.52
R28 - R29	849.29	849.29	849.27	849.44	849.11
R30 - R31	1704.33	1704.38	1704.36	1704.35	1703.94
R32 - R01	1876.07	1876.20	1876.20	1876.11	1875.56
R01 - R02	1241.30	1241.42	1241.44	1241.29	1240.93
T O T A L	31169.53	31169.16	31169.24	31169.78	31169.90

C2, KIM DONG-MOK

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3086.04	3086.41	3086.43	3086.51	3085.71
R06 - R07	1431.03	1431.09	1431.06	1430.82	1430.79
R08 - R09	1454.17	1454.19	1454.16	1453.92	1453.89
R09 - R10	1786.69	1786.67	1786.62	1786.33	1786.29
R10 - R11	1273.67	1273.63	1273.60	1273.39	1273.36
R12 - R13	1642.14	1642.05	1642.01	1641.69	1641.68
R14 - R15	2453.50	2453.31	2453.26	2453.50	2452.71
R16 - R17	397.95	397.91	397.91	397.99	397.81
R18 - R18A	2351.90	2351.68	2351.66	2352.11	2350.98
R18A- R19	568.04	567.98	567.98	568.07	567.80
R19 - R20	2906.42	2906.15	2906.16	2906.53	2905.13
R21 - R22	2102.73	2102.56	2102.60	2102.40	2101.67
R23 - R24	848.86	848.81	848.83	848.74	848.40
R25 - R26	1336.40	1336.34	1336.37	1336.62	1335.65
R27 - R28	1857.02	1856.99	1857.03	1857.05	1855.90
R28 - R29	849.40	849.41	849.42	849.40	848.87
R30 - R31	1704.51	1704.57	1704.59	1704.28	1703.40
R32 - R01	1875.83	1875.98	1875.98	1876.07	1874.53
R01 - R02	1241.18	1241.33	1241.32	1241.31	1240.29
T O T A L	31167.48	31167.07	31166.99	31166.73	31154.86

C3, YOON CHANG-SOO

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3086.26	3086.48	3086.52	3086.79	3076.51
R06 - R07	1430.96	1430.99	1430.93	1430.83	1426.33
R08 - R09	1454.00	1454.02	1453.94	1453.84	1449.26
R09 - R10	1786.53	1786.52	1786.42	1786.27	1780.65
R10 - R11	1273.79	1273.76	1273.68	1273.56	1269.55
R12 - R13	1642.34	1642.29	1642.19	1641.67	1636.82
R14 - R15	2453.82	2453.71	2453.59	2453.48	2445.45
R16 - R17	397.92	397.89	397.88	397.98	396.54
R18 - R18A	2350.98	2350.85	2350.81	2351.37	2342.75
R18A- R19	567.80	567.77	567.77	567.88	565.80
R19 - R20	2905.75	2905.58	2905.61	2906.04	2895.40
R21 - R22	2102.56	2102.46	2102.53	2102.57	2094.93
R23 - R24	848.62	848.59	848.62	848.72	845.50
R25 - R26	1335.96	1335.93	1335.99	1336.13	1331.01
R27 - R28	1856.71	1856.69	1856.78	1856.47	1849.75
R28 - R29	849.38	849.39	849.42	849.25	846.18
R30 - R31	1704.09	1704.13	1704.18	1703.83	1697.60
R32 - R01	1875.60	1875.69	1875.70	1875.75	1868.37
R01 - R02	1241.14	1241.23	1241.20	1241.20	1236.32
T O T A L	31164.22	31163.96	31163.78	31163.63	31054.73

C4, KANG MOO-SUNG

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3086.84	3087.21	3087.26	3087.41	3083.46
R06 - R07	1431.17	1431.22	1431.15	1431.00	1429.51
R08 - R09	1453.91	1453.93	1453.84	1453.70	1452.19
R09 - R10	1786.68	1786.66	1786.53	1786.38	1784.52
R10 - R11	1274.23	1274.19	1274.09	1273.98	1272.66
R12 - R13	1642.28	1642.19	1642.07	1641.62	1640.21
R14 - R15	2453.31	2453.12	2452.98	2452.88	2450.12
R16 - R17	398.10	398.06	398.04	398.15	397.57
R18 - R18A	2351.53	2351.31	2351.26	2351.86	2348.31
R18A- R19	567.80	567.75	567.74	567.87	567.01
R19 - R20	2906.24	2905.96	2906.00	2906.50	2902.10
R21 - R22	2102.58	2102.42	2102.50	2102.76	2099.48
R23 - R24	848.49	848.44	848.49	848.47	847.21
R25 - R26	1336.21	1336.15	1336.23	1336.27	1334.15
R27 - R28	1857.31	1857.29	1857.39	1857.30	1854.39
R28 - R29	849.76	849.77	849.81	849.74	848.41
R30 - R31	1704.36	1704.42	1704.49	1704.06	1701.60
R32 - R01	1875.61	1875.76	1875.77	1875.77	1872.50
R01 - R02	1241.14	1241.29	1241.25	1241.22	1239.05
T O T A L	31167.54	31167.12	31166.91	31166.94	31124.44

C5. LEE HAN-SUB

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3086.74	3086.72	3086.73	3087.00	3083.01
R06 - R07	1431.18	1431.17	1431.16	1431.19	1429.35
R08 - R09	1454.04	1454.04	1454.02	1454.02	1452.14
R09 - R10	1786.15	1786.15	1786.13	1786.07	1783.77
R10 - R11	1273.28	1273.28	1273.26	1273.19	1271.55
R12 - R13	1641.89	1641.90	1641.88	1641.44	1639.61
R14 - R15	2453.56	2453.57	2453.55	2453.23	2450.04
R16 - R17	398.05	398.05	398.05	398.08	397.46
R18 - R18A	2350.86	2350.88	2350.87	2351.62	2347.31
R18A- R19	567.48	567.48	567.48	567.65	566.61
R19 - R20	2906.03	2906.05	2906.06	2906.80	2901.48
R21 - R22	2102.00	2102.02	2102.03	2102.61	2098.59
R23 - R24	848.75	848.75	848.76	848.86	847.33
R25 - R26	1336.42	1336.43	1336.44	1336.15	1334.16
R27 - R28	1856.20	1856.20	1856.22	1856.00	1852.99
R28 - R29	849.35	849.35	849.35	849.23	847.86
R30 - R31	1703.54	1703.53	1703.55	1703.46	1700.50
R32 - R01	1875.72	1875.71	1875.71	1875.51	1872.30
R01 - R02	1241.06	1241.05	1241.04	1240.89	1238.76
T O T A L	31162.30	31162.33	31162.29	31163.01	31114.80

C6, SON CHANG-WOO

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3086.12	3086.12	3086.08	3086.00	3082.75
R06 - R07	1431.11	1431.11	1431.18	1430.99	1429.47
R08 - R09	1454.28	1454.28	1454.37	1454.13	1452.59
R09 - R10	1786.84	1786.84	1786.96	1786.61	1784.72
R10 - R11	1273.69	1273.69	1273.78	1273.50	1272.15
R12 - R13	1642.13	1642.13	1642.23	1641.91	1640.10
R14 - R15	2453.24	2453.24	2453.37	2453.54	2450.13
R16 - R17	397.93	397.93	397.94	398.04	397.41
R18 - R18A	2351.17	2351.16	2351.20	2351.52	2348.05
R18A- R19	567.84	567.84	567.84	567.91	567.07
R19 - R20	2905.41	2905.41	2905.37	2905.72	2901.43
R21 - R22	2102.44	2102.44	2102.36	2102.38	2099.47
R23 - R24	848.58	848.58	848.54	848.44	847.36
R25 - R26	1336.22	1336.22	1336.15	1336.19	1334.26
R27 - R28	1856.58	1856.58	1856.48	1856.55	1853.80
R28 - R29	849.53	849.53	849.49	849.50	848.24
R30 - R31	1704.00	1704.00	1703.94	1703.72	1701.38
R32 - R01	1875.64	1875.64	1875.64	1875.76	1872.70
R01 - R02	1241.28	1241.28	1241.31	1241.33	1239.31
T O T A L	31164.02	31164.02	31164.22	31163.73	31122.41

C7, CHA JOO-MIN

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3085.85	3086.19	3086.21	3086.32	3094.33
R06 - R07	1431.16	1431.22	1431.19	1431.12	1435.00
R08 - R09	1454.09	1454.11	1454.08	1454.01	1457.95
R09 - R10	1786.77	1786.75	1786.71	1786.62	1791.46
R10 - R11	1273.81	1273.77	1273.74	1273.67	1277.11
R12 - R13	1641.91	1641.83	1641.79	1641.39	1646.11
R14 - R15	2453.40	2453.23	2453.18	2453..12	2459.57
R16 - R17	397.94	397.90	397.90	398.01	398.92
R18 - R18A	2352.17	2351.96	2351.94	2352.47	2357.89
R18A- R19	568.08	568.03	568.03	568.14	569.45
R19 - R20	2906.39	2906.14	2906.15	2906.59	2913.29
R21 - R22	2102.67	2102.52	2102.55	2102.31	2107.53
R23 - R24	848.79	848.74	848.76	848.65	850.72
R25 - R26	1336.36	1336.30	1336.33	1336.37	1339.35
R27 - R28	1857.15	1857.13	1857.16	1857.39	1861.24
R28 - R29	849.59	849.60	849.61	849.68	851.44
R30 - R31	1704.18	1704.23	1704.25	1704.25	1707.83
R32 - R01	1875.56	1875.70	1875.71	1875.62	1879.50
R01 - R02	1241.08	1241.21	1241.20	1241.08	1243.65
T O T A L	31166.96	31166.57	31166.50	31166.81	31242.36

C8, KIM DONG-WON

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3086.32	3086.43	3086.44	3086.43	3084.75
R06 - R07	1431.25	1431.27	1431.26	1430.90	1430.43
R08 - R09	1454.25	1454.25	1454.24	1453.86	1453.38
R09 - R10	1786.85	1786.84	1786.83	1786.32	1785.73
R10 - R11	1273.93	1273.91	1273.90	1273.52	1273.10
R12 - R13	1642.38	1642.35	1642.34	1642.33	1641.26
R14 - R15	2454.45	2454.39	2454.37	2454.93	2452.67
R16 - R17	398.07	398.06	398.06	398.07	397.77
R18 - R18A	2352.59	2352.53	2352.52	2352.83	2350.72
R18A- R19	567.95	567.94	567.94	568.00	567.49
R19 - R20	2906.47	2906.39	2906.39	2906.60	2904.00
R21 - R22	2103.02	2102.97	2102.98	2103.04	2101.12
R23 - R24	848.70	848.68	848.69	848.65	847.90
R25 - R26	1336.53	1336.52	1336.53	1336.47	1335.24
R27 - R28	1857.23	1857.22	1857.24	1857.03	1855.37
R28 - R29	849.40	849.40	849.40	849.28	848.52
R30 - R31	1704.10	1704.12	1704.13	1704.09	1702.31
R32 - R01	1875.84	1875.88	1875.88	1876.08	1873.79
R01 - R02	1241.39	1241.43	1241.42	1241.51	1240.00
T O T A L	31170.70	31170.58	31170.56	31169.94	31145.54

C9. CHO HEE-GON

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3086.15	3086.34	3086.35	3086.42	3094.19
R06 - R07	1430.93	1430.96	1430.94	1430.79	1434.55
R08 - R09	1454.01	1454.02	1454.00	1453.83	1457.65
R09 - R10	1786.53	1786.52	1786.50	1786.25	1790.95
R10 - R11	1273.74	1273.71	1273.70	1273.50	1276.85
R12 - R13	1642.04	1642.00	1641.97	1641.68	1646.00
R14 - R15	2453.72	2453.63	2453.60	2453.72	2459.53
R16 - R17	397.93	397.91	397.91	398.00	398.86
R18 - R18A	2351.14	2351.03	2351.02	2351.46	2356.51
R18A- R19	567.92	567.89	567.89	567.98	569.20
R19 - R20	2906.09	2905.95	2905.96	2906.31	2912.55
R21 - R22	2102.07	2101.99	2102.00	2101.67	2106.62
R23 - R24	848.67	848.65	848.65	848.63	850.47
R25 - R26	1335.76	1335.74	1335.75	1335.93	1338.56
R27 - R28	1856.81	1856.80	1856.82	1856.63	1860.62
R28 - R29	849.11	849.12	849.13	849.01	850.84
R30 - R31	1703.84	1703.87	1703.88	1703.79	1707.24
R32 - R01	1875.64	1875.71	1875.72	1875.90	1879.30
R01 - R02	1241.06	1241.13	1241.13	1241.20	1243.45
T O T A L	31163.18	31162.97	31162.93	31162.69	31233.94

C10, KIM KEE-SOO

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3086.79	3087.19	3087.15	3087.14	3103.33
R06 - R07	1431.07	1431.13	1431.19	1431.04	1438.64
R08 - R09	1454.17	1454.19	1454.27	1454.11	1461.83
R09 - R10	1786.62	1786.60	1786.71	1786.49	1795.99
R10 - R11	1273.61	1273.56	1273.64	1273.48	1280.25
R12 - R13	1641.62	1641.52	1641.62	1641.34	1650.13
R14 - R15	2453.96	2453.76	2453.88	2454.08	2466.58
R16 - R17	397.90	397.86	397.88	397.96	399.93
R18 - R18A	2351.71	2351.46	2351.50	2351.85	2363.62
R18A- R19	567.89	567.83	567.84	567.91	570.76
R19 - R20	2905.46	2905.17	2905.13	2905.49	2920.03
R21 - R22	2102.61	2102.43	2102.36	2102.43	2113.03
R23 - R24	848.68	848.63	848.59	848.42	852.86
R25 - R26	1336.11	1336.05	1335.98	1335.88	1342.65
R27 - R28	1856.65	1856.62	1856.53	1856.77	1865.67
R28 - R29	849.43	849.43	849.40	849.46	853.53
R30 - R31	1703.82	1703.89	1703.83	1703.83	1712.01
R32 - R01	1874.83	1875.00	1874.99	1875.14	1883.76
R01 - R02	1240.67	1240.83	1240.86	1240.84	1246.55
T O T A L	31163.63	31163.17	31163.35	31163.66	31321.17

C11. YUN SUN-HO

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3086.20	3086.47	3086.51	3086.55	3085.26
R06 - R07	1430.95	1430.99	1430.93	1430.96	1430.38
R08 - R09	1454.26	1454.27	1454.19	1454.22	1453.63
R09 - R10	1786.78	1786.76	1786.66	1786.66	1785.94
R10 - R11	1273.72	1273.69	1273.61	1273.59	1273.07
R12 - R13	1641.86	1641.79	1641.70	1641.49	1640.95
R14 - R15	2453.47	2453.33	2453.21	2452.84	2451.96
R16 - R17	397.94	397.92	397.90	397.98	397.68
R18 - R18A	2350.85	2350.69	2350.65	2351.28	2349.14
R18A- R19	568.01	567.97	567.97	568.09	567.58
R19 - R20	2906.47	2906.27	2906.30	2906.78	2904.13
R21 - R22	2102.22	2102.10	2102.17	2101.96	2100.35
R23 - R24	848.47	848.43	848.47	848.36	847.67
R25 - R26	1335.64	1335.60	1335.66	1335.75	1334.33
R27 - R28	1856.71	1856.69	1856.78	1856.99	1854.79
R28 - R29	849.10	849.10	849.14	849.20	848.19
R30 - R31	1703.89	1703.93	1703.99	1703.92	1702.00
R32 - R01	1875.49	1875.60	1875.61	1875.59	1873.30
R01 - R02	1241.12	1241.23	1241.20	1241.14	1239.63
T O T A L	31163.14	31162.84	31162.65	31163.34	31139.97

C12, SONG JUNG-YUEL

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3086.69	3086.82	3086.86	3087.47	3094.69
R06 - R07	1430.73	1430.75	1430.70	1430.69	1434.28
R08 - R09	1453.72	1453.73	1453.66	1453.62	1457.27
R09 - R10	1786.18	1786.17	1786.07	1785.97	1790.45
R10 - R11	1273.80	1273.78	1273.71	1273.60	1276.79
R12 - R13	1640.94	1640.91	1640.82	1640.01	1644.71
R14 - R15	2454.84	2454.77	2454.67	2454.33	2460.30
R16 - R17	398.25	398.24	398.23	398.32	399.11
R18 - R18A	2351.75	2351.67	2351.64	2353.17	2356.68
R18A- R19	568.08	568.06	568.05	568.40	569.24
R19 - R20	2906.52	2906.43	2906.46	2908.02	2912.35
R21 - R22	2102.57	2102.51	2102.58	2102.98	2106.58
R23 - R24	848.35	848.33	848.36	848.21	849.91
R25 - R26	1336.57	1336.55	1336.61	1336.35	1338.98
R27 - R28	1856.49	1856.48	1856.56	1856.26	1859.71
R28 - R29	849.67	849.67	849.70	849.53	851.11
R30 - R31	1704.40	1704.42	1704.47	1704.54	1707.21
R32 - R01	1876.29	1876.35	1876.35	1876.43	1879.26
R01 - R02	1241.87	1241.92	1241.89	1241.91	1243.77
T O T A L	31167.70	31167.56	31167.40	31169.81	31232.39

C13, MUN HEE-BOK

COMPUTED DISTANCE OF EACH INTERVALS

INTERVAL	LINEAR	2ND-ORDER	3RD-ORDER	TWO BASE	WGT-MEAN
R03 - R04	3086.08	3086.31	3086.27	3086.26	3084.90
R06 - R07	1430.75	1430.79	1430.85	1430.88	1430.11
R08 - R09	1453.89	1453.90	1453.98	1453.98	1453.19
R09 - R10	1786.58	1786.56	1786.67	1786.64	1785.67
R10 - R11	1273.75	1273.73	1273.80	1273.76	1273.07
R12 - R13	1641.58	1641.52	1641.62	1641.39	1640.65
R14 - R15	2455.35	2455.23	2455.35	2455.13	2453.85
R16 - R17	397.89	397.87	397.88	397.96	397.63
R18 - R18A	2351.85	2351.70	2351.74	2352.05	2350.22
R18A- R19	568.28	568.25	568.25	568.32	567.87
R19 - R20	2906.65	2906.47	2906.44	2906.73	2904.47
R21 - R22	2103.01	2102.90	2102.83	2102.54	2101.30
R23 - R24	848.71	848.68	848.64	848.62	847.99
R25 - R26	1336.28	1336.25	1336.18	1336.19	1335.11
R27 - R28	1857.06	1857.04	1856.95	1857.06	1855.35
R28 - R29	849.41	849.42	849.38	849.40	848.61
R30 - R31	1704.34	1704.38	1704.33	1704.45	1702.68
R32 - R01	1876.96	1877.06	1877.06	1877.14	1875.06
R01 - R02	1241.25	1241.34	1241.37	1241.33	1239.95
T O T A L	31169.67	31169.40	31169.58	31169.81	31147.67

TABLES OF GROUP IV

COMPUTED DISTANCE
OF
EACH RIDER FOR EACH INTERVAL

INTERVAL : R1—R2

COMPUTED DISTANCES OF EACH RIDERS

RIDER		LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C	1	1241.30	1241.42	1241.44	1241.29	1240.93
C	2	1241.18	1241.33	1241.32	1241.31	1240.29
C	3	1241.14	1241.23	1241.20	1241.20	1236.32
C	4	1241.14	1241.29	1241.25	1241.22	1239.05
C	5	1241.06	1241.05	1241.04	1240.89	1238.76
C	6	1241.28	1241.28	1241.31	1241.33	1239.31
C	7	1241.08	1241.21	1241.20	1241.08	1243.65
C	8	1241.39	1241.43	1241.42	1241.51	1240.00
C	9	1241.06	1241.13	1241.13	1241.20	1243.45
C	10	1240.67	1240.83	1240.86	1240.84	1246.55
C	11	1241.12	1241.23	1241.20	1241.14	1239.63
C	12	1241.87	1241.92	1241.89	1241.91	1243.77
C	13	1241.25	1241.34	1241.37	1241.33	1239.95
MEDIAN		1241.14	1241.28	1241.25	1241.22	1240.00
MEAN		1241.20	1241.28	1241.28	1241.25	1240.90
ST.DEV		0.26	0.25	0.24	0.27	2.73
99%CON		1240.46	1240.59	1240.61	1240.51	1233.31
0.999M		1239.90	1240.04	1240.01	1239.98	1238.76

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL : R3—R4

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	3087.03	3087.36	3087.34	3087.21	3087.96
C 2	3086.04	3086.41	3086.43	3086.51	3085.71
C 3	3086.26	3086.48	3086.52	3086.79	3076.51
C 4	3086.84	3087.21	3087.26	3087.41	3083.46
C 5	3086.74	3086.72	3086.73	3087.00	3083.01
C 6	3086.12	3086.12	3086.08	3086.00	3082.75
C 7	3085.85	3086.19	3086.21	3086.32	3094.33
C 8	3086.32	3086.43	3086.44	3086.43	3084.75
C 9	3086.15	3086.34	3086.35	3086.42	3094.19
C 10	3086.79	3087.19	3087.15	3087.14	3103.33
C 11	3086.20	3086.47	3086.51	3086.55	3085.26
C 12	3086.69	3086.82	3086.86	3087.47	3094.69
C 13	3086.08	3086.31	3086.27	3086.26	3084.90
MEDIAN	3086.26	3086.47	3086.51	3086.55	3085.27
MEAN	3086.39	3086.62	3086.63	3086.73	3087.76
ST.DEV	0.38	0.41	0.41	0.47	7.04
99%CON	3085.35	3085.49	3085.48	3085.42	3068.17
0.999M	3083.17	3083.38	3083.43	3083.46	3082.18

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL : R6—R7

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	1431.47	1431.52	1431.54	1431.46	1431.81
C 2	1431.03	1431.09	1431.06	1430.82	1430.79
C 3	1430.96	1430.99	1430.93	1430.83	1426.33
C 4	1431.17	1431.22	1431.15	1431.00	1429.51
C 5	1431.18	1431.17	1431.16	1431.19	1429.35
C 6	1431.11	1431.11	1431.18	1430.99	1429.47
C 7	1431.16	1431.22	1431.19	1431.12	1435.00
C 8	1431.25	1431.27	1431.26	1430.90	1430.43
C 9	1430.93	1430.96	1430.94	1430.79	1434.55
C 10	1431.07	1431.13	1431.19	1431.04	1438.64
C 11	1430.95	1430.99	1430.93	1430.96	1430.38
C 12	1430.73	1430.75	1430.70	1430.69	1434.28
C 13	1430.75	1430.79	1430.85	1430.88	1430.11
MEDIAN	1431.07	1431.11	1431.15	1430.96	1430.43
MEAN	1431.06	1431.09	1431.08	1430.98	1431.59
ST.DEV	0.20	0.20	0.21	0.20	3.22
99%CON	1430.50	1430.53	1430.49	1430.42	1422.63
0.999M	1429.64	1429.68	1429.72	1429.53	1429.00

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL : R8—R9

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	1454.32	1454.34	1454.37	1454.28	1454.64
C 2	1454.17	1454.19	1454.16	1453.92	1453.89
C 3	1454.00	1454.02	1453.94	1453.84	1449.26
C 4	1453.91	1453.93	1453.84	1453.70	1452.19
C 5	1454.04	1454.04	1454.02	1454.02	1452.14
C 6	1454.28	1454.28	1454.37	1454.13	1452.59
C 7	1454.09	1454.11	1454.08	1454.01	1457.95
C 8	1454.25	1454.25	1454.24	1453.86	1453.38
C 9	1454.01	1454.02	1454.00	1453.83	1457.65
C 10	1454.17	1454.19	1454.27	1454.11	1461.83
C 11	1454.26	1454.27	1454.19	1454.22	1453.63
C 12	1453.72	1453.73	1453.66	1453.62	1457.27
C 13	1453.89	1453.90	1453.98	1453.98	1453.19
MEDIAN	1454.09	1454.11	1454.08	1453.98	1453.63
MEAN	1454.09	1454.10	1454.09	1453.96	1454.59
ST. DEV	0.18	0.18	0.21	0.19	3.28
99%CON	1453.59	1453.60	1453.50	1453.42	1445.46
0.999M	1452.64	1452.65	1452.62	1452.53	1452.17

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13

U N I T .... METER

99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL: R9—R10

COMPUTED DISTANCES OF EACH RIDERS

RIDER		LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C	1	1786.87	1786.85	1786.89	1786.77	1787.21
C	2	1786.69	1786.67	1786.62	1786.33	1786.29
C	3	1786.53	1786.52	1786.42	1786.27	1780.65
C	4	1786.68	1786.66	1786.53	1786.38	1784.52
C	5	1786.15	1786.15	1786.13	1786.07	1783.77
C	6	1786.84	1786.84	1786.96	1786.61	1784.72
C	7	1786.77	1786.75	1786.71	1786.62	1791.46
C	8	1786.85	1786.84	1786.83	1786.32	1785.73
C	9	1786.53	1786.52	1786.50	1786.25	1790.95
C	10	1786.62	1786.60	1786.71	1786.49	1795.99
C	11	1786.78	1786.76	1786.66	1786.66	1785.94
C	12	1786.18	1786.17	1786.07	1785.97	1790.45
C	13	1786.58	1786.56	1786.67	1786.64	1785.67
MEDIAN		1786.68	1786.66	1786.66	1786.38	1785.94
MEAN		1786.62	1786.61	1786.59	1786.41	1787.18
ST. DEV		0.23	0.23	0.27	0.24	4.03
99%CON		1785.97	1785.97	1785.85	1785.74	1775.98
0.999M		1784.89	1784.87	1784.87	1784.59	1784.15

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13

U N I T .... METER

99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL: R10-R11

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	1273.98	1273.94	1273.97	1273.88	1274.19
C 2	1273.67	1273.63	1273.60	1273.39	1273.36
C 3	1273.79	1273.76	1273.68	1273.56	1269.55
C 4	1274.23	1274.19	1274.09	1273.98	1272.66
C 5	1273.28	1273.28	1273.26	1273.19	1271.55
C 6	1273.69	1273.69	1273.78	1273.50	1272.15
C 7	1273.81	1273.77	1273.74	1273.67	1277.11
C 8	1273.93	1273.91	1273.90	1273.52	1273.10
C 9	1273.74	1273.71	1273.70	1273.50	1276.85
C 10	1273.61	1273.56	1273.64	1273.48	1280.25
C 11	1273.72	1273.69	1273.61	1273.59	1273.07
C 12	1273.80	1273.78	1273.71	1273.60	1276.79
C 13	1273.75	1273.73	1273.80	1273.76	1273.07
MEDIAN	1273.75	1273.73	1273.71	1273.56	1273.10
MEAN	1273.77	1273.74	1273.73	1273.59	1274.13
ST.DEV	0.22	0.21	0.20	0.21	2.86
99%CON	1273.16	1273.16	1273.17	1273.02	1266.17
0.999M	1272.48	1272.45	1272.44	1272.29	1271.83

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL: R12-R13

COMPUTED DISTANCES OF EACH RIDERS

RIDER		LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C	1	1642.60	1642.52	1642.56	1642.59	1642.82
C	2	1642.14	1642.05	1642.01	1641.69	1641.68
C	3	1642.34	1642.29	1642.19	1641.67	1636.82
C	4	1642.28	1642.19	1642.07	1641.62	1640.21
C	5	1641.89	1641.90	1641.88	1641.44	1639.61
C	6	1642.13	1642.13	1642.23	1641.91	1640.10
C	7	1641.91	1641.83	1641.79	1641.39	1646.11
C	8	1642.38	1642.35	1642.34	1642.33	1641.26
C	9	1642.04	1642.00	1641.97	1641.68	1646.00
C	10	1641.62	1641.52	1641.62	1641.34	1650.13
C	11	1641.86	1641.79	1641.70	1641.49	1640.95
C	12	1640.94	1640.91	1640.82	1640.01	1644.71
C	13	1641.58	1641.52	1641.62	1641.39	1640.65
MEDIAN		1642.04	1642.00	1641.97	1641.62	1641.26
MEAN		1641.98	1641.92	1641.91	1641.58	1642.39
ST.DEV		0.43	0.43	0.43	0.60	3.51
99%CON		1640.79	1640.74	1640.71	1639.91	1632.62
0.999M		1640.40	1640.35	1640.33	1639.98	1639.62

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL: R14—R15

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	2454.34	2454.17	2454.22	2454.22	2454.58
C 2	2453.50	2453.31	2453.26	2453.50	2452.71
C 3	2453.82	2453.71	2453.59	2453.48	2445.45
C 4	2453.31	2453.12	2452.98	2452.88	2450.12
C 5	2453.56	2453.57	2453.55	2453.23	2450.04
C 6	2453.24	2453.24	2453.37	2453.54	2450.13
C 7	2453.40	2453.23	2453.18	2453.12	2459.57
C 8	2454.45	2454.39	2454.37	2454.93	2452.67
C 9	2453.72	2453.63	2453.60	2453.72	2459.53
C 10	2453.96	2453.76	2453.88	2454.08	2466.58
C 11	2453.47	2453.33	2453.21	2452.84	2451.96
C 12	2454.84	2454.77	2454.67	2454.33	2460.30
C 13	2455.35	2455.23	2455.35	2455.13	2453.85
MEDIAN	2453.72	2453.63	2453.59	2453.54	2452.71
MEAN	2453.92	2453.81	2453.79	2453.77	2454.42
ST.DEV	0.65	0.65	0.69	0.73	5.66
99%CON	2452.12	2451.98	2451.87	2451.74	2438.70
0.999M	2451.27	2451.18	2451.14	2451.08	2450.26

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL : R16—R17

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	397.97	397.94	397.94	397.96	397.99
C 2	397.95	397.91	397.91	397.99	397.81
C 3	397.92	397.89	397.88	397.98	396.54
C 4	398.10	398.06	398.04	398.15	397.57
C 5	398.05	398.05	398.05	398.08	397.46
C 6	397.93	397.93	397.94	398.04	397.41
C 7	397.94	397.90	397.90	398.01	398.92
C 8	398.07	398.06	398.06	398.07	397.77
C 9	397.93	397.91	397.91	398.00	398.86
C 10	397.90	397.86	397.88	397.96	399.93
C 11	397.94	397.92	397.90	397.98	397.68
C 12	398.25	398.24	398.23	398.32	399.11
C 13	397.89	397.87	397.88	397.96	397.63
MEDIAN	397.94	397.92	397.91	398.00	397.77
MEAN	397.99	397.97	397.96	398.04	398.05
ST.DEV	0.10	0.11	0.10	0.10	0.90
99%CON	397.70	397.67	397.68	397.75	395.54
0.999M	397.54	397.52	397.51	397.60	397.37

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL : R18—R18A

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	2351.28	2351.08	2351.09	2351.53	2351.33
C 2	2351.90	2351.68	2351.66	2352.11	2350.98
C 3	2350.98	2350.85	2350.81	2351.37	2342.75
C 4	2351.53	2351.31	2351.26	2351.86	2348.31
C 5	2350.86	2350.88	2350.87	2351.62	2347.31
C 6	2351.17	2351.16	2351.20	2351.52	2348.05
C 7	2352.17	2351.96	2351.94	2352.47	2357.89
C 8	2352.59	2352.53	2352.52	2352.83	2350.72
C 9	2351.14	2351.03	2351.02	2351.46	2356.51
C 10	2351.71	2351.46	2351.50	2351.85	2363.62
C 11	2350.85	2350.69	2350.65	2351.28	2349.14
C 12	2351.75	2351.67	2351.64	2353.17	2356.68
C 13	2351.85	2351.70	2351.74	2352.05	2350.22
MEDIAN	2351.53	2351.31	2351.26	2351.85	2350.72
MEAN	2351.52	2351.38	2351.38	2351.93	2351.81
ST.DEV	0.53	0.52	0.52	0.58	5.50
99%CON	2350.04	2349.94	2349.92	2350.31	2336.52
0.999M	2349.18	2348.96	2348.91	2349.50	2348.37

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL: R18A—R19

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	568.07	568.02	568.02	568.11	568.06
C 2	568.04	567.98	567.98	568.07	567.80
C 3	567.80	567.77	567.77	567.88	565.80
C 4	567.80	567.75	567.74	567.87	567.01
C 5	567.48	567.48	567.48	567.65	566.61
C 6	567.84	567.84	567.84	567.91	567.07
C 7	568.08	568.03	568.03	568.14	569.45
C 8	567.95	567.94	567.94	568.00	567.49
C 9	567.92	567.89	567.89	567.98	569.20
C 10	567.89	567.83	567.84	567.91	570.76
C 11	568.01	567.97	567.97	568.09	567.58
C 12	568.08	568.06	568.05	568.40	569.24
C 13	568.28	568.25	568.25	568.32	567.87
MEDIAN	567.95	567.94	567.94	568.00	567.80
MEAN	567.94	567.91	567.91	568.03	568.00
ST.DEV	0.19	0.18	0.19	0.20	1.35
99%CON	567.40	567.39	567.39	567.48	564.25
0.999M	567.38	567.37	567.37	567.43	567.23

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL: R19-R20

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	2906.14	2905.90	2905.89	2906.31	2906.06
C 2	2906.42	2906.15	2906.16	2906.53	2905.13
C 3	2905.75	2905.58	2905.61	2906.04	2895.40
C 4	2906.24	2905.96	2906.00	2906.50	2902.10
C 5	2906.03	2906.05	2906.06	2906.80	2901.48
C 6	2905.41	2905.41	2905.37	2905.72	2901.43
C 7	2906.39	2906.14	2906.15	2906.59	2913.29
C 8	2906.47	2906.39	2906.39	2906.60	2904.00
C 9	2906.09	2905.95	2905.96	2906.31	2912.55
C 10	2905.46	2905.17	2905.13	2905.49	2920.03
C 11	2906.47	2906.27	2906.30	2906.78	2904.13
C 12	2906.52	2906.43	2906.46	2908.02	2912.35
C 13	2906.65	2906.47	2906.44	2906.73	2904.47
MEDIAN	2906.24	2906.05	2906.06	2906.53	2904.47
MEAN	2906.16	2905.99	2905.99	2906.49	2906.34
ST.DEV	0.40	0.40	0.41	0.61	6.53
99%CON	2905.04	2904.88	2904.86	2904.80	2888.19
0.999M	2903.33	2903.15	2903.15	2903.62	2901.56

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13

U N I T .... METER

99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL : R21-R22

COMPUTED DISTANCES OF EACH RIDERS

RIDER		LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C	1	2102.88	2102.73	2102.70	2102.52	2102.71
C	2	2102.73	2102.56	2102.60	2102.40	2101.67
C	3	2102.56	2102.46	2102.53	2102.57	2094.93
C	4	2102.58	2102.42	2102.50	2102.76	2099.48
C	5	2102.00	2102.02	2102.03	2102.61	2098.59
C	6	2102.44	2102.44	2102.36	2102.38	2099.47
C	7	2102.67	2102.52	2102.55	2102.31	2107.53
C	8	2103.02	2102.97	2102.98	2103.04	2101.12
C	9	2102.07	2101.99	2102.00	2101.67	2106.62
C	10	2102.61	2102.43	2102.36	2102.43	2113.03
C	11	2102.22	2102.10	2102.17	2101.96	2100.35
C	12	2102.57	2102.51	2102.58	2102.98	2106.58
C	13	2103.01	2102.90	2102.83	2102.54	2101.30
MEDIAN		2102.58	2102.46	2102.53	2102.52	2101.30
MEAN		2102.57	2102.47	2102.48	2102.47	2102.57
ST.DEV		0.32	0.30	0.29	0.37	4.74
99%CON		2101.67	2101.62	2101.67	2101.44	2089.39
0.999M		2100.48	2100.36	2100.43	2100.42	2099.20

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13

U N I T .... METER

99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL: R23—R24

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	848.54	848.50	848.48	848.29	848.44
C 2	848.86	848.81	848.83	848.74	848.40
C 3	848.62	848.59	848.62	848.72	845.50
C 4	848.49	848.44	848.49	848.47	847.21
C 5	848.75	848.75	848.76	848.86	847.33
C 6	848.58	848.58	848.54	848.44	847.36
C 7	848.79	848.74	848.76	848.65	850.72
C 8	848.70	848.68	848.69	848.65	847.90
C 9	848.67	848.65	848.65	848.63	850.47
C 10	848.68	848.63	848.59	848.42	852.86
C 11	848.47	848.43	848.47	848.36	847.67
C 12	848.35	848.33	848.36	848.21	849.91
C 13	848.71	848.68	848.64	848.62	847.99
MEDIAN	848.67	848.63	848.62	848.62	847.99
MEAN	848.63	848.60	848.61	848.54	848.60
ST. DEV	0.14	0.14	0.13	0.19	1.92
99%CON	848.24	848.21	848.23	848.00	843.26
0.999M	847.82	847.78	847.78	847.77	847.14

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL : R25—R26

COMPUTED DISTANCES OF EACH RIDERS

RIDER		LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C	1	1336.23	1336.18	1336.15	1336.22	1336.03
C	2	1336.40	1336.34	1336.37	1336.62	1335.65
C	3	1335.96	1335.93	1335.99	1336.13	1331.01
C	4	1336.21	1336.15	1336.23	1336.27	1334.15
C	5	1336.42	1336.43	1336.44	1336.15	1334.16
C	6	1336.22	1336.22	1336.15	1336.19	1334.26
C	7	1336.36	1336.30	1336.33	1336.37	1339.35
C	8	1336.53	1336.52	1336.53	1336.47	1335.24
C	9	1335.76	1335.74	1335.75	1335.93	1338.56
C	10	1336.11	1336.05	1335.98	1335.88	1342.65
C	11	1335.64	1335.60	1335.66	1335.75	1334.33
C	12	1336.57	1336.55	1336.61	1336.35	1338.98
C	13	1336.28	1336.25	1336.18	1336.19	1335.11
MEDIAN		1336.23	1336.22	1336.18	1336.19	1335.24
MEAN		1336.21	1336.17	1336.18	1336.19	1336.11
ST.DEV		0.28	0.29	0.28	0.24	3.02
99%CON		1335.43	1335.38	1335.40	1335.52	1327.71
0.999M		1334.89	1334.88	1334.85	1334.85	1333.90

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL : R27–R28

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	1856.86	1856.83	1856.80	1857.24	1856.52
C 2	1857.02	1856.99	1857.03	1857.05	1855.90
C 3	1856.71	1856.69	1856.78	1856.47	1849.75
C 4	1857.31	1857.29	1857.39	1857.30	1854.39
C 5	1856.20	1856.20	1856.22	1856.00	1852.99
C 6	1856.58	1856.58	1856.48	1856.55	1853.80
C 7	1857.15	1857.13	1857.16	1857.39	1861.24
C 8	1857.23	1857.22	1857.24	1857.03	1855.37
C 9	1856.81	1856.80	1856.82	1856.63	1860.62
C 10	1856.65	1856.62	1856.53	1856.77	1865.67
C 11	1856.71	1856.69	1856.78	1856.99	1854.79
C 12	1856.49	1856.48	1856.56	1856.26	1859.71
C 13	1857.06	1857.04	1856.95	1857.06	1855.35
MEDIAN	1856.81	1856.80	1856.80	1856.99	1855.37
MEAN	1856.83	1856.81	1856.83	1856.83	1856.62
ST.DEV	0.32	0.31	0.33	0.42	4.17
99%CON	1855.94	1855.94	1855.91	1855.65	1845.02
0.999M	1854.96	1854.94	1854.94	1855.13	1853.51

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL : R28-R29

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	849.29	849.29	849.27	849.44	849.11
C 2	849.40	849.41	849.42	849.40	848.87
C 3	849.38	849.39	849.42	849.25	846.18
C 4	849.76	849.77	849.81	849.74	848.41
C 5	849.35	849.35	849.35	849.23	847.86
C 6	849.53	849.53	849.49	849.50	848.24
C 7	849.59	849.60	849.61	849.68	851.44
C 8	849.40	849.40	849.40	849.28	848.52
C 9	849.11	849.12	849.13	849.01	850.84
C 10	849.43	849.43	849.40	849.46	853.53
C 11	849.10	849.10	849.14	849.20	848.19
C 12	849.67	849.67	849.70	849.53	851.11
C 13	849.41	849.42	849.38	849.40	848.61
MEDIAN	849.40	849.41	849.40	849.40	848.61
MEAN	849.42	849.42	849.43	849.39	849.30
ST.DEV	0.19	0.19	0.20	0.20	1.92
99%CON	848.88	848.89	848.88	848.84	843.95
0.999M	848.55	848.56	848.55	848.55	847.76

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL : R30—R31

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	1704.33	1704.38	1704.36	1704.35	1703.94
C 2	1704.51	1704.57	1704.59	1704.28	1703.40
C 3	1704.09	1704.13	1704.18	1703.83	1697.60
C 4	1704.36	1704.42	1704.49	1704.06	1701.60
C 5	1703.54	1703.53	1703.55	1703.46	1700.50
C 6	1704.00	1704.00	1703.94	1703.72	1701.38
C 7	1704.18	1704.23	1704.25	1704.25	1707.83
C 8	1704.10	1704.12	1704.13	1704.09	1702.31
C 9	1703.84	1703.87	1703.88	1703.79	1707.24
C 10	1703.82	1703.89	1703.83	1703.83	1712.01
C 11	1703.89	1703.93	1703.99	1703.92	1702.00
C 12	1704.40	1704.42	1704.47	1704.54	1707.21
C 13	1704.34	1704.38	1704.33	1704.45	1702.68
MEDIAN	1704.10	1704.13	1704.18	1704.06	1702.68
MEAN	1704.11	1704.14	1704.15	1704.04	1703.82
ST.DEV	0.28	0.29	0.30	0.32	3.81
99%CON	1703.32	1703.33	1703.31	1703.15	1693.24
0.999M	1702.40	1702.43	1702.48	1702.36	1700.98

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

INTERVAL : R32—R1

COMPUTED DISTANCES OF EACH RIDERS

RIDER	LINEAR	2ND-ORDER	3RD-ORDER	TWO-BASE	WGT MEAN
C 1	1876.07	1876.20	1876.20	1876.11	1875.56
C 2	1875.83	1875.98	1875.98	1876.07	1874.53
C 3	1875.60	1875.69	1875.70	1875.75	1868.37
C 4	1875.61	1875.76	1875.77	1875.77	1872.50
C 5	1875.72	1875.71	1875.71	1875.51	1872.30
C 6	1875.64	1875.64	1875.64	1875.76	1872.70
C 7	1875.56	1875.70	1875.71	1875.62	1879.50
C 8	1875.84	1875.88	1875.88	1876.08	1873.79
C 9	1875.64	1875.71	1875.72	1875.90	1879.30
C 10	1874.83	1875.00	1874.99	1875.14	1883.76
C 11	1875.49	1875.60	1875.61	1875.59	1873.30
C 12	1876.29	1876.35	1876.35	1876.43	1879.26
C 13	1876.96	1877.06	1877.06	1877.14	1875.06
MEDIAN	1875.64	1875.71	1875.72	1875.77	1874.53
MEAN	1875.77	1875.87	1875.87	1875.91	1875.38
ST.DEV	0.49	0.48	0.48	0.49	4.08
99%CON	1874.41	1874.53	1874.53	1874.55	1864.04
0.999M	1873.77	1873.84	1873.84	1873.89	1872.66

* R E M A R K S *

TOTAL NR OF MEASUREMENTS 13
U N I T .... METER
99% OF CONFIDENCE LEVEL .... 2.78 * ST. DEV.

TABLES OF GROUP V

COMPUTED DISTANCE OF BASELINES FOR EACH REGRESSION METHOD PER EACH CYCLIST

BASELINE: 1

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	2361.820	2362.217	2362.139	2362.639
CYCLIST 2	2361.609	2362.056	2362.133	2361.464
CYCLIST 3	2361.839	2362.107	2362.295	2354.506
CYCLIST 4	2361.456	2361.901	2362.132	2358.972
CYCLIST 5	2362.390	2362.358	2362.399	2359.641
CYCLIST 6	2362.254	2362.258	2362.052	2359.761
CYCLIST 7	2361.737	2362.155	2362.228	2368.349
CYCLIST 8	2361.969	2362.098	2362.129	2360.869
CYCLIST 9	2361.953	2362.178	2362.222	2368.220
CYCLIST 10	2361.885	2362.366	2362.175	2374.648
CYCLIST 11	2361.712	2362.038	2362.231	2361.156
CYCLIST 12	2362.326	2362.482	2362.652	2368.635
CYCLIST 13	2362.180	2362.468	2362.283	2361.396
MEAN DIST.	2361.933	2362.206	2362.236	2363.096
STD. DEVIAT.	0.285	0.174	0.154	5.372
ERROR 1 =	-0.895	-0.622	-0.592	0.269
ERROR(m/km)	-0.379	-0.263	-0.250	0.114

BASELINE: 2

1628.700

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	1628.845	1628.944	1628.962	1629.276
CYCLIST 2	1628.685	1628.796	1628.779	1628.447
CYCLIST 3	1628.466	1628.533	1628.493	1623.247
CYCLIST 4	1628.685	1628.796	1628.747	1626.839
CYCLIST 5	1628.374	1628.366	1628.358	1626.336
CYCLIST 6	1628.868	1628.869	1628.913	1627.037
CYCLIST 7	1628.594	1628.698	1628.683	1633.001
CYCLIST 8	1628.829	1628.861	1628.855	1627.934
CYCLIST 9	1628.668	1628.725	1628.715	1632.837
CYCLIST 10	1628.622	1628.742	1628.783	1637.283
CYCLIST 11	1628.740	1628.822	1628.781	1628.154
CYCLIST 12	1627.859	1627.898	1627.861	1631.969
CYCLIST 13	1628.599	1628.671	1628.710	1627.909
MEAN DIST.	1628.602	1628.671	1628.665	1629.251
STD. DEVIAT.	0.265	0.277	0.290	3.646
ERROR 1 =	-0.098	-0.029	-0.035	0.551
ERROR (m/km)	-0.060	-0.018	-0.022	0.339

BASELINE: 3

[illegible]9.595

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	439.588	439.571	439.583	439.655
CYCLIST 2	439.759	439.740	439.729	439.644
CYCLIST 3	439.768	439.756	439.730	438.298
CYCLIST 4	439.733	439.714	439.681	439.186
CYCLIST 5	439.703	439.704	439.698	439.099
CYCLIST 6	439.649	439.649	439.678	439.114
CYCLIST 7	439.679	439.662	439.651	440.813
CYCLIST 8	439.803	439.798	439.794	439.511
CYCLIST 9	439.724	439.714	439.708	440.793
CYCLIST 10	439.664	439.644	439.671	441.951
CYCLIST 11	439.619	439.605	439.577	439.385
CYCLIST 12	439.896	439.889	439.865	440.918
CYCLIST 13	439.575	439.562	439.588	439.333
MEAN DIST.	439.705	439.693	439.689	439.823
STD. DEVIAT.	0.090	0.092	0.082	1.000
ERROR 1 =	0.110	0.098	0.094	0.228
ERROR (m/km)	0.249	0.223	0.213	0.519

BASELINE: 4

370.802

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	370.814	370.793	370.802	370.858
CYCLIST 2	370.874	370.850	370.842	370.765
CYCLIST 3	370.966	370.952	370.932	369.711
CYCLIST 4	370.988	370.964	370.939	370.514
CYCLIST 5	370.923	370.924	370.920	370.400
CYCLIST 6	370.859	370.858	370.881	370.396
CYCLIST 7	370.972	370.950	370.942	371.915
CYCLIST 8	370.656	370.649	370.645	370.397
CYCLIST 9	370.862	370.850	370.845	371.750
CYCLIST 10	370.874	370.848	370.869	372.791
CYCLIST 11	370.955	370.937	370.917	370.739
CYCLIST 12	370.976	370.968	370.949	371.817
CYCLIST 13	370.913	370.898	370.917	370.695
MEAN DIST.	370.895	370.880	370.877	370.981
STD. DEVIAT.	0.090	0.089	0.083	0.841
ERROR 1 =	0.087	0.072	0.069	0.173
ERROR (m/km)	0.234	0.194	0.186	0.466

BASELINE: 5

600.096

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	600.086	600.040	600.050	600.128
CYCLIST 2	599.928	599.877	599.867	599.722
CYCLIST 3	599.947	599.916	599.893	597.882
CYCLIST 4	599.954	599.902	599.874	599.159
CYCLIST 5	600.011	600.015	600.010	599.135
CYCLIST 6	599.809	599.808	599.833	599.037
CYCLIST 7	599.910	599.862	599.853	601.402
CYCLIST 8	600.046	600.031	600.028	599.598
CYCLIST 9	599.952	599.926	599.921	601.355
CYCLIST 10	599.874	599.819	599.842	602.944
CYCLIST 11	600.107	600.069	600.046	599.715
CYCLIST 12	600.014	599.996	599.975	601.323
CYCLIST 13	599.975	599.942	599.965	599.592
MEAN DIST.	599.970	599.939	599.935	600.076
STD. DEVIAT.	0.083	0.086	0.081	1.339
ERROR 1 =	-0.066	-0.097	-0.101	0.040
ERROR (m/km)	-0.110	-0.162	-0.168	0.067

BASELINE: 6

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	1114.646	1114.555	1114.569	1114.702
CYCLIST 2	1114.621	1114.519	1114.506	1114.214
CYCLIST 3	1114.453	1114.391	1114.359	1110.591
CYCLIST 4	1114.549	1114.448	1114.408	1113.051
CYCLIST 5	1114.517	1114.525	1114.518	1112.866
CYCLIST 6	1114.463	1114.462	1114.498	1113.011
CYCLIST 7	1114.508	1114.413	1114.400	1117.254
CYCLIST 8	1114.648	1114.618	1114.613	1113.792
CYCLIST 9	1114.438	1114.387	1114.379	1117.018
CYCLIST 10	1114.667	1114.557	1114.591	1120.348
CYCLIST 11	1114.332	1114.258	1114.225	1113.570
CYCLIST 12	1114.307	1114.272	1114.243	1116.698
CYCLIST 13	1114.384	1114.319	1114.350	1113.646
MEAN DIST.	1114.502	1114.440	1114.435	1114.674
STD. DEVIAT.	0.121	0.114	0.125	2.534
ERROR 1 =	−0.163	−0.225	−0.230	0.009
ERROR (m/km)	−0.146	−0.202	−0.206	0.008

BASELINE: 7

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	839.098	839.034	839.024	839.049
CYCLIST 2	839.150	839.077	839.086	838.749
CYCLIST 3	839.161	839.117	839.138	836.141
CYCLIST 4	839.116	839.043	839.069	837.897
CYCLIST 5	838.841	838.846	838.851	837.499
CYCLIST 6	839.156	839.156	839.133	837.986
CYCLIST 7	839.178	839.110	839.118	841.141
CYCLIST 8	839.114	839.093	839.096	838.376
CYCLIST 9	839.217	839.180	839.185	841.054
CYCLIST 10	839.161	839.082	839.061	843.342
CYCLIST 11	839.233	839.179	839.201	838.519
CYCLIST 12	838.553	838.527	838.547	840.188
CYCLIST 13	839.338	839.291	839.271	838.680
MEAN DIST.	839.101	839.057	839.060	839.124
STD. DEVIAT.	0.199	0.189	0.184	1.878
ERROR 1 =	-0.119	-0.163	-0.160	-0.096
ERROR (m/km)	-0.142	-0.195	-0.191	-0.114

BASELINE: 8

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	761.305	761.260	761.246	761.225
CYCLIST 2	761.238	761.187	761.200	760.838
CYCLIST 3	760.977	760.946	760.978	758.195
CYCLIST 4	760.897	760.847	760.886	759.757
CYCLIST 5	760.844	760.848	760.855	759.588
CYCLIST 6	761.041	761.041	761.006	759.950
CYCLIST 7	761.240	761.192	761.204	762.980
CYCLIST 8	761.016	761.001	761.006	760.310
CYCLIST 9	761.228	761.202	761.210	762.854
CYCLIST 10	761.119	761.063	761.031	764.873
CYCLIST 11	761.110	761.072	761.105	760.408
CYCLIST 12	761.242	761.225	761.254	762.664
CYCLIST 13	761.163	761.130	761.099	760.526
MEAN DIST.	761.109	761.078	761.083	761.090
STD. DEVIAT.	0.145	0.138	0.135	1.795
ERROR 1 =	0.173	0.142	0.147	0.154
ERROR (m/km)	0.228	0.187	0.193	0.202

BASELINE: 9

529.061

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	529.118	529.093	529.082	529.049
CYCLIST 2	529.006	528.978	528.988	528.715
CYCLIST 3	528.905	528.889	528.913	526.956
CYCLIST 4	529.108	529.080	529.111	528.303
CYCLIST 5	528.982	528.984	528.989	528.095
CYCLIST 6	529.163	529.163	529.136	528.394
CYCLIST 7	529.020	528.993	529.003	530.214
CYCLIST 8	529.062	529.054	529.058	528.558
CYCLIST 9	528.908	528.893	528.899	530.023
CYCLIST 10	529.262	529.232	529.206	531.860
CYCLIST 11	529.080	529.059	529.085	528.573
CYCLIST 12	529.021	529.011	529.034	529.986
CYCLIST 13	529.019	529.001	528.977	528.562
MEAN DIST.	529.050	529.033	529.037	529.022
STD. DEVIAT.	0.099	0.097	0.088	1.230
ERROR 1 =	-0.011	-0.028	-0.024	-0.039
ERROR (m/km)	-0.020	-0.053	-0.045	-0.074

BASELINE: 10

568.674

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	568.623	568.608	568.595	568.532
CYCLIST 2	568.546	568.528	568.540	568.215
CYCLIST 3	568.696	568.686	568.714	566.579
CYCLIST 4	568.568	568.550	568.585	567.685
CYCLIST 5	568.986	568.987	568.993	568.013
CYCLIST 6	568.591	568.591	568.560	567.750
CYCLIST 7	568.707	568.690	568.701	569.971
CYCLIST 8	568.723	568.718	568.722	568.164
CYCLIST 9	568.698	568.689	568.696	569.877
CYCLIST 10	568.659	568.640	568.611	571.432
CYCLIST 11	568.563	568.550	568.579	567.992
CYCLIST 12	568.911	568.905	568.931	569.918
CYCLIST 13	568.799	568.788	568.760	568.289
MEAN DIST.	568.698	568.687	568.691	568.647
STD. DEVIAT.	0.134	0.138	0.140	1.292
ERROR 1 =	0.025	0.014	0.018	-0.026
ERROR (m/km)	0.043	0.024	0.032	-0.045

BASELINE: 11

434.33?

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	434.196	434.202	434.195	434.103
CYCLIST 2	434.417	434.425	434.432	434.142
CYCLIST 3	434.431	434.435	434.452	432.786
CYCLIST 4	434.420	434.427	434.448	433.723
CYCLIST 5	434.192	434.192	434.196	433.426
CYCLIST 6	434.413	434.413	434.394	433.752
CYCLIST 7	434.201	434.208	434.215	435.141
CYCLIST 8	434.392	434.395	434.397	433.942
CYCLIST 9	434.402	434.406	434.410	435.278
CYCLIST 10	434.293	434.301	434.283	436.387
CYCLIST 11	434.291	434.296	434.314	433.821
CYCLIST 12	434.262	434.265	434.280	434.991
CYCLIST 13	434.236	434.241	434.224	433.821
MEAN DIST.	434.319	434.324	434.326	434.255
STD.DEVIAT.	0.096	0.096	0.100	0.949
ERROR 1 =	-0.011	-0.006	-0.004	-0.075
ERROR(m/km)	-0.025	-0.015	-0.009	-0.173

BASELINE: 12

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	527.104	527.131	527.127	526.974
CYCLIST 2	526.992	527.022	527.026	526.638
CYCLIST 3	526.998	527.016	527.027	524.980
CYCLIST 4	527.033	527.063	527.076	526.170
CYCLIST 5	527.172	527.170	527.172	526.221
CYCLIST 6	527.026	527.026	527.014	526.208
CYCLIST 7	527.065	527.093	527.097	528.185
CYCLIST 8	526.885	526.894	526.896	526.320
CYCLIST 9	526.901	526.916	526.919	527.942
CYCLIST 10	526.998	527.030	527.020	529.520
CYCLIST 11	526.988	527.009	527.020	526.389
CYCLIST 12	526.951	526.961	526.971	527.802
CYCLIST 13	527.007	527.026	527.016	526.482
MEAN DIST.	527.009	527.028	527.029	526.910
STD. DEVIAT.	0.077	0.077	0.077	1.170
ERROR 1 =	0.053	0.072	0.073	-0.046
ERROR (m/km)	0.101	0.136	0.139	-0.087

BASELINE: 13

412.853

COMPUTED DISTANCES OF BASELINES

CYCLIST	LINEAR	2ND-ORDER	3RD-ORDER	WGT MEAN
CYCLIST 1	4723.361	4724.165	4724.360	4721.751
CYCLIST 2	4723.377	4724.282	4724.092	4719.761
CYCLIST 3	4723.840	4724.385	4723.944	4705.216
CYCLIST 4	4723.411	4724.312	4723.764	4715.238
CYCLIST 5	4724.059	4723.993	4723.898	4715.067
CYCLIST 6	4723.679	4723.687	4724.176	4715.981
CYCLIST 7	4723.672	4724.519	4724.344	4733.211
CYCLIST 8	4724.335	4724.598	4724.526	4718.824
CYCLIST 9	4724.126	4724.580	4724.475	4732.953
CYCLIST 10	4722.991	4723.968	4724.425	4745.136
CYCLIST 11	4724.237	4724.898	4724.442	4718.203
CYCLIST 12	4724.439	4724.754	4724.345	4731.290
CYCLIST 13	4723.614	4724.196	4724.634	4718.424
MEAN DIST.	4723.780	4724.333	4724.263	4722.389
STD. DEVIAT.	0.438	0.339	0.267	10.486
ERROR 1 =	-0.976	-0.423	-0.493	-2.367
ERROR (m/km)	-0.206	-0.089	-0.104	-0.501

5. GOODNESS OF FIT

Let us observe how well the various regression methods of computed counts/km fit the actual recorded counts/km for each baseline.

Fig. 3-2 shows the counts/km against baselines for each cyclist. The average error from each method on each baseline is listed in Table 3-1 and Figure 3-1.

The table and figure indicate that all the methods used have fallen into within 1/1000 of the actual counts/km, and the three regression methods excluding "weighted mean" have produced the same average mean error. The mean error of "weighted mean method" appears to be more than triple as inaccurate as others. Thus, the weighted mean baseline method has not been included in this study due to its large deviation from the other methods.

Table 3-1. Average Error For Each Method

	Linear	2nd-order	3rd-order	WGT mean
B1	−0.379	−0.263	−0.250	0.114
B2	−0.060	−0.018	−0.022	0.339
B3	0.249	0.223	0.213	0.519
B4	0.234	0.194	0.186	0.466
B5	−0.110	−0.162	−0.168	0.067
B6	−0.146	−0.202	−0.206	0.008
B7	−0.142	−0.195	−0.191	−0.114
B8	0.228	0.187	0.193	0.202
B9	−0.020	−0.053	−0.045	−0.074
B10	0.043	0.024	0.032	−0.045
B11	−0.025	−0.015	−0.009	−0.173
B12	0.101	0.136	0.139	−0.087
B1	−0.206	−0.089	−0.104	−0.501
mean	−0.018	−0.018	−0.018	0.055
S.D.	0.187	0.164	0.162	0.278

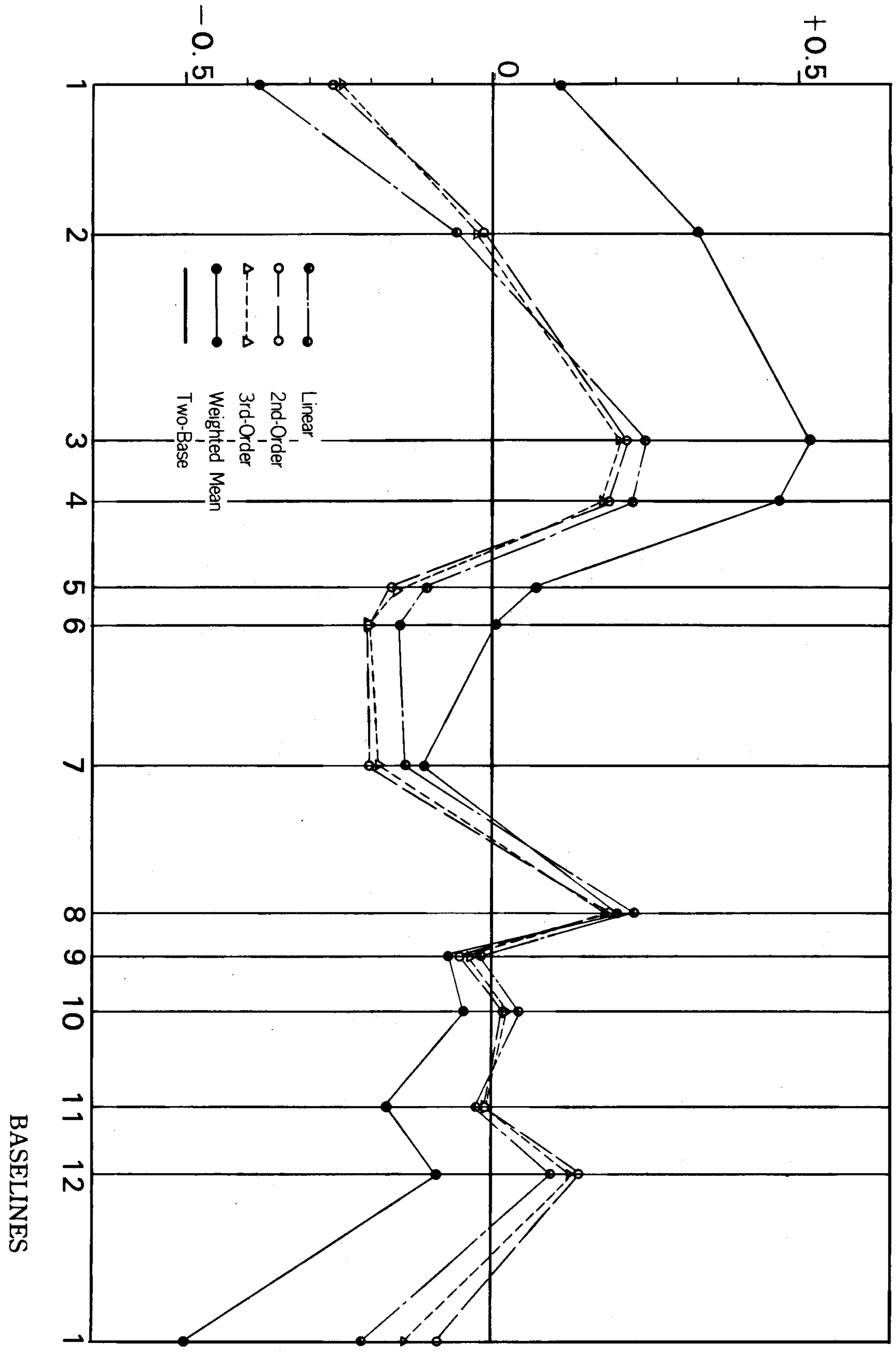
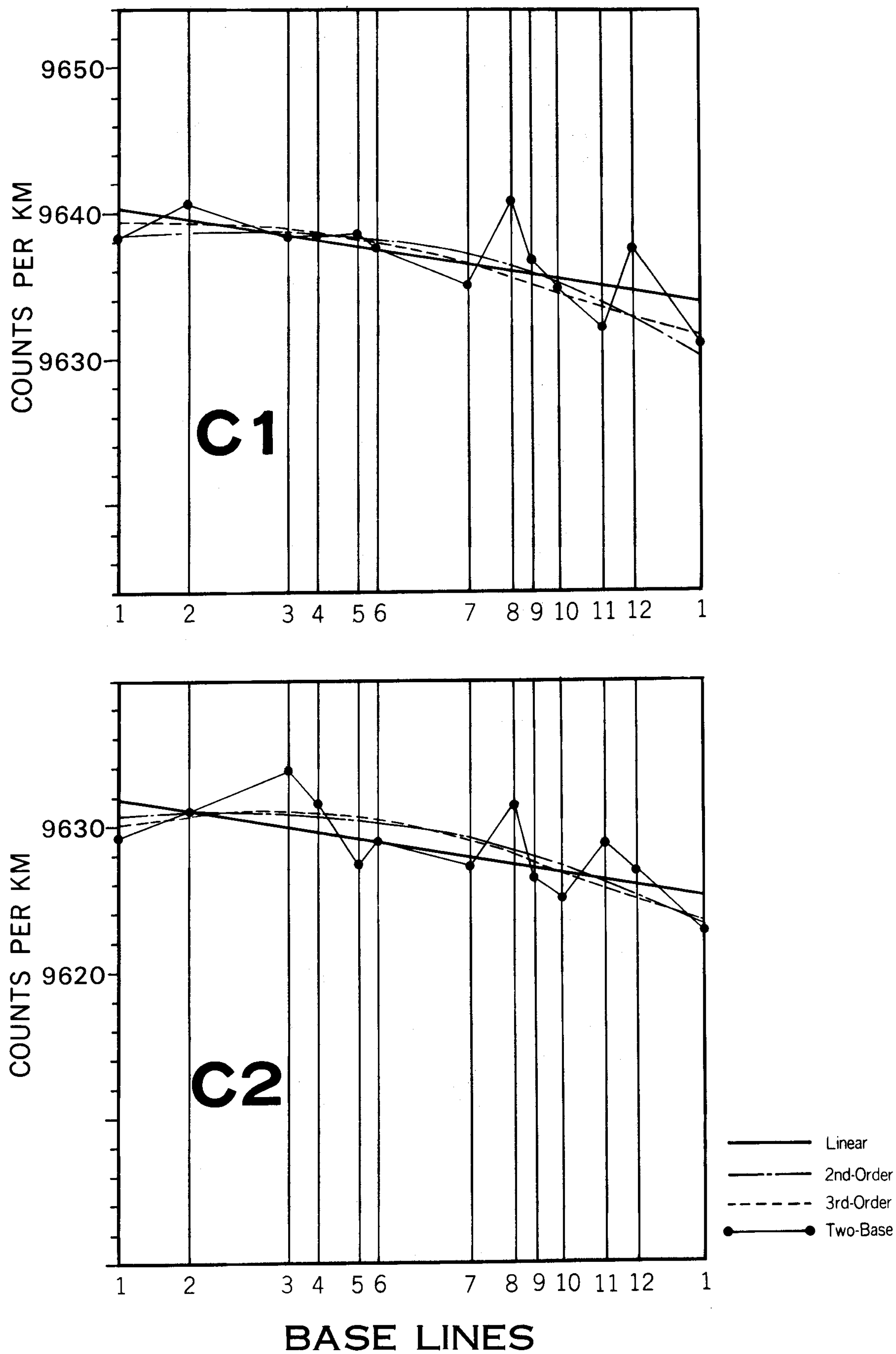
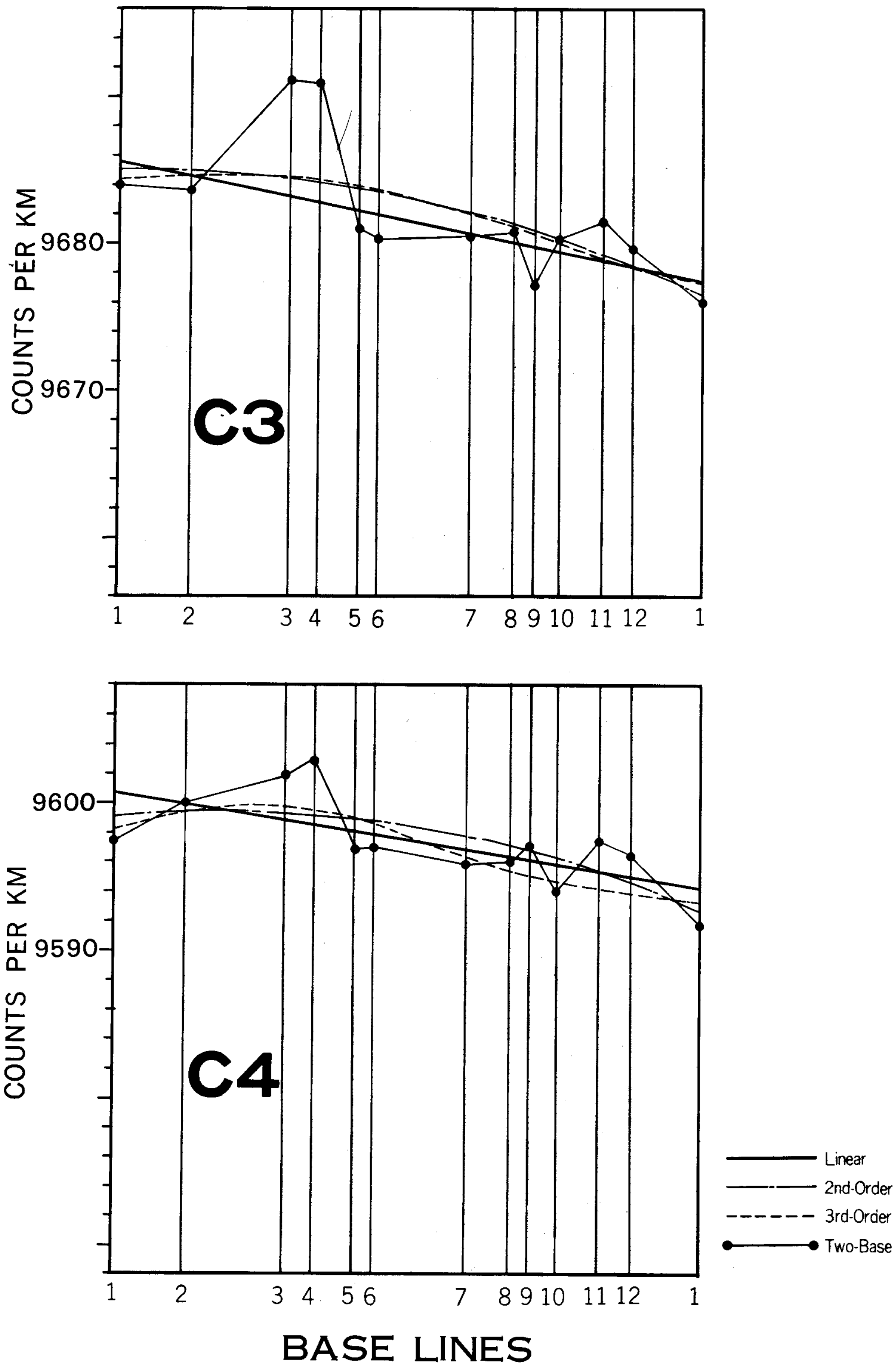


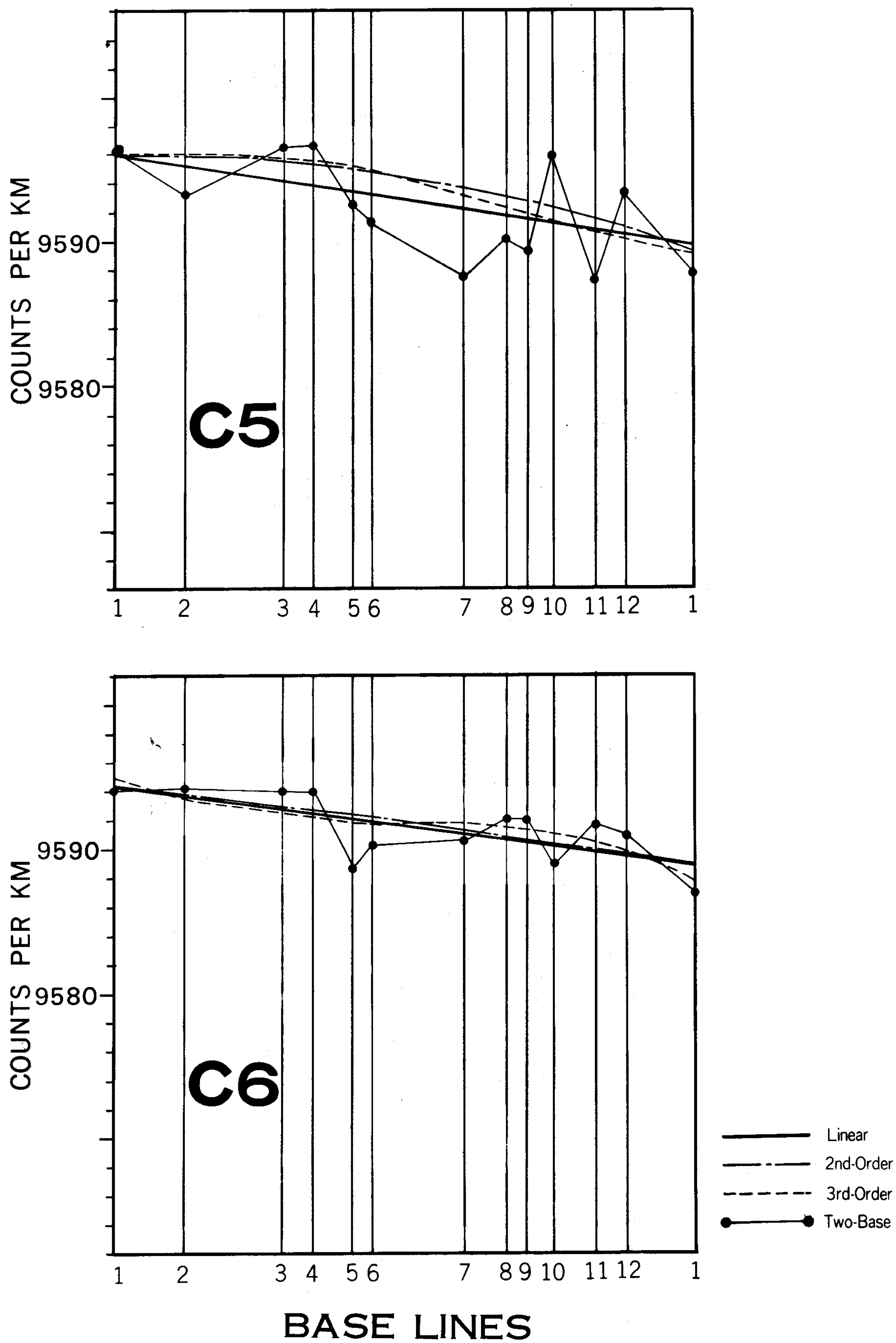
Fig. 3-1. Goodness of fit

FIG. 3-2. COUNTS / KM AGAINST BASELINES FOR EACH CYCLIST

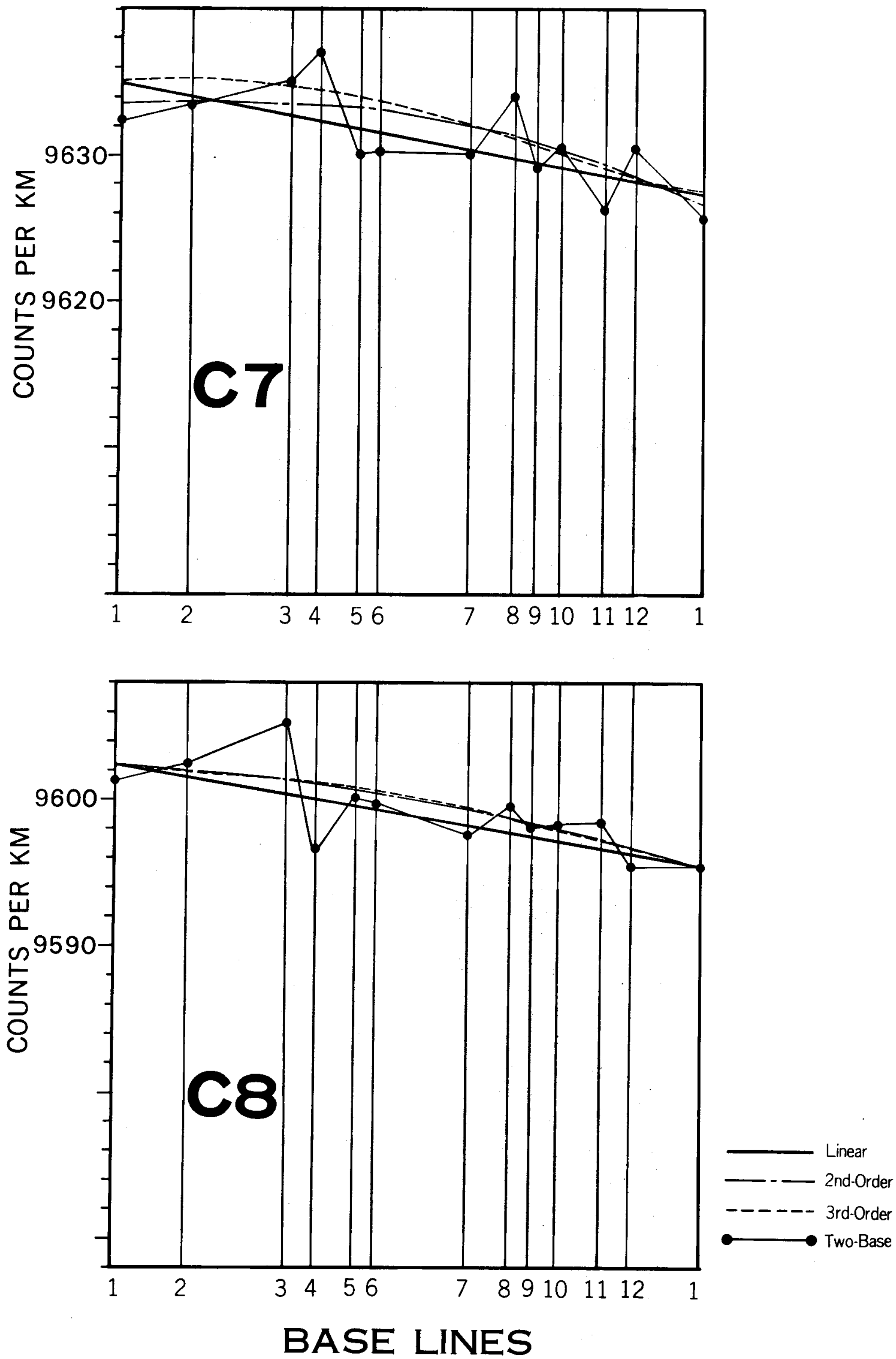


9650
9640
9630
COUNTS PER KM
C1
1 2 3 4 5 6 7 8 9 10 11 12 1
9630
9620
COUNTS PER KM
C2
Linear
2nd-Order
3rd-Order
Two-Base
1 2 3 4 5 6 7 8 9 10 11 12 1
BASE LINES

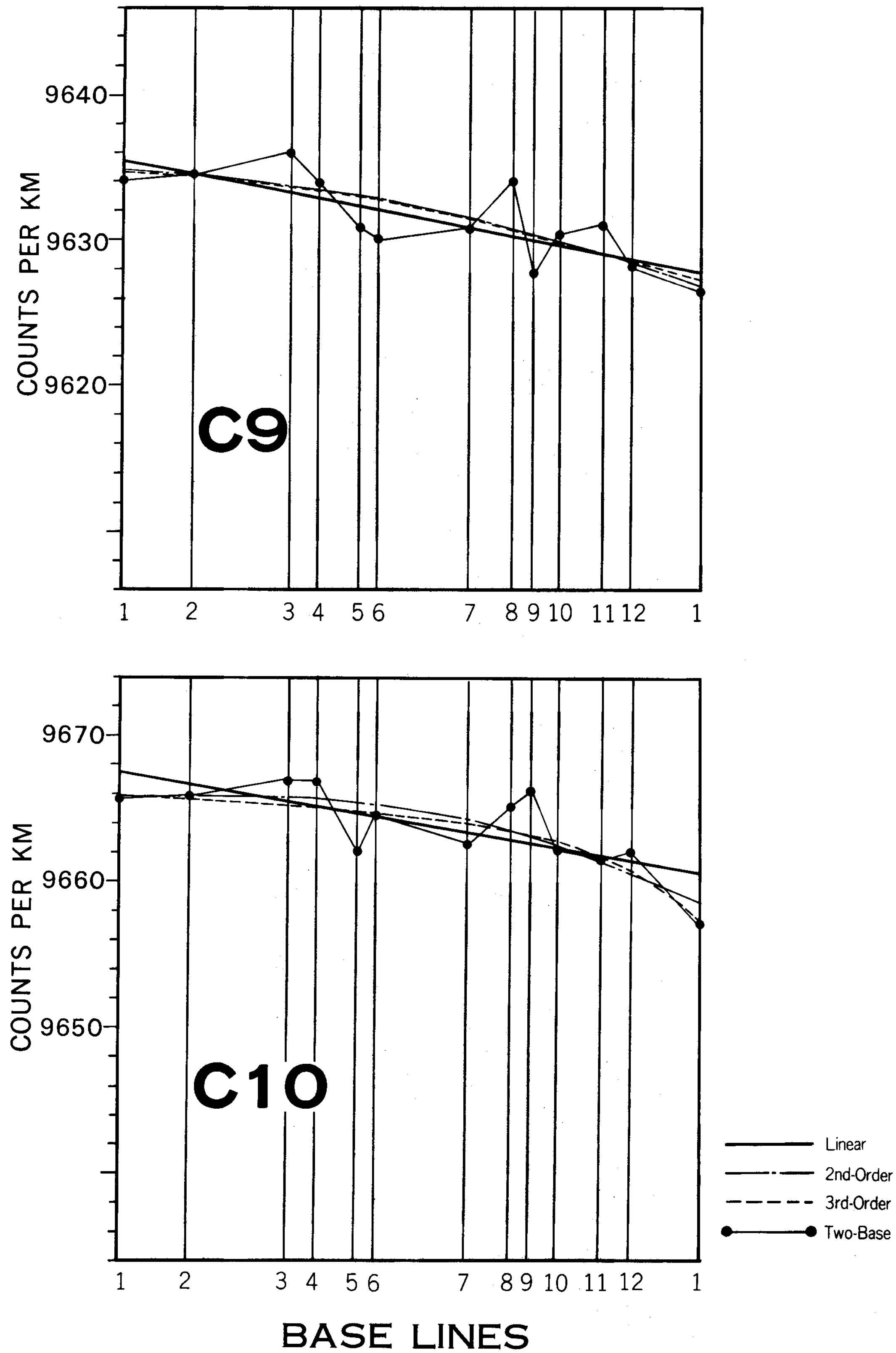

COUNTS PER KM
9680
9670
C3
1 2 3 4 5 6 7 8 9 10 11 12 1
COUNTS PER KM
9600
9590
C4
Linear
2nd-Order
3rd-Order
Two-Base
1 2 3 4 5 6 7 8 9 10 11 12 1
BASE LINES

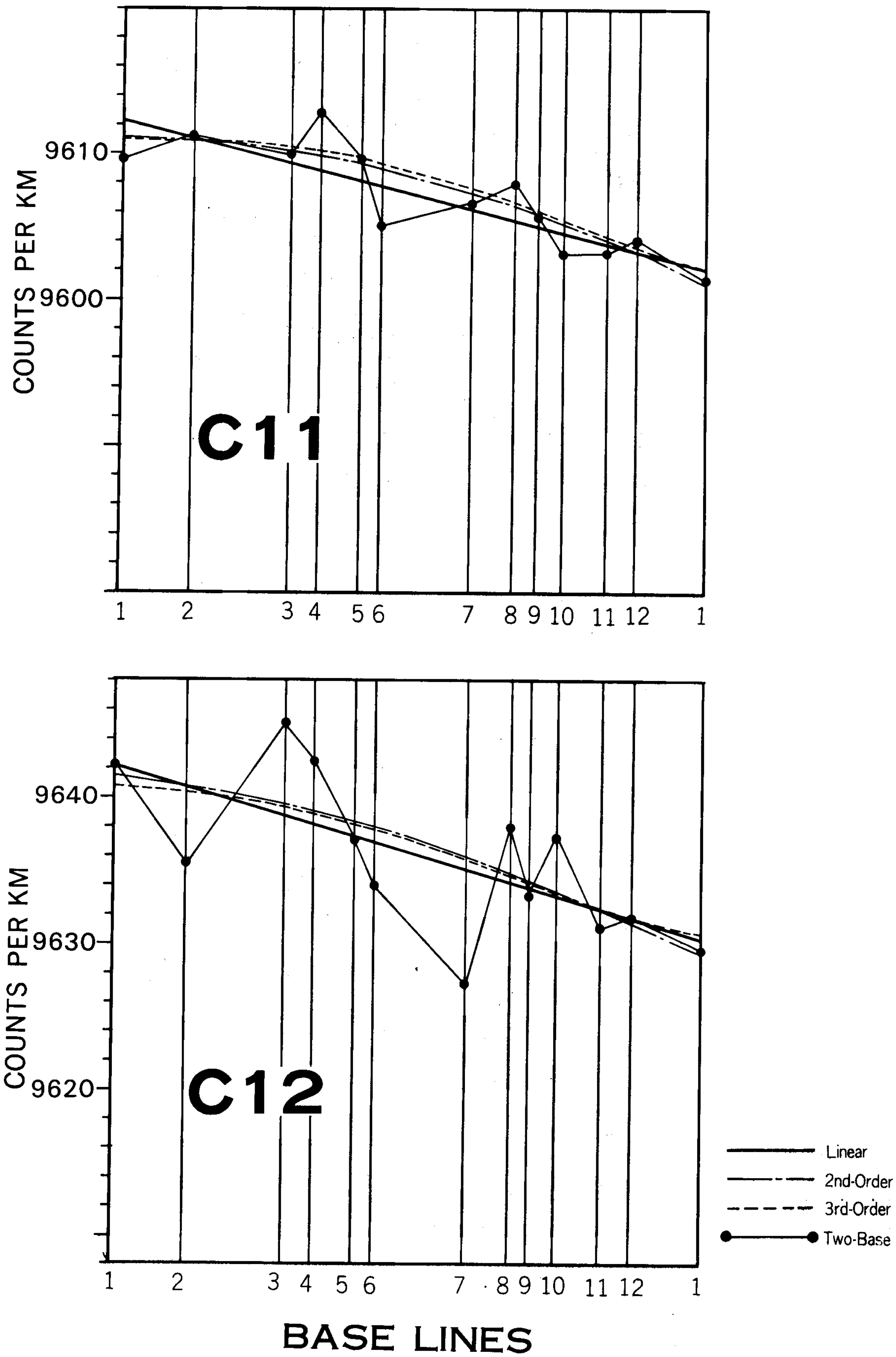


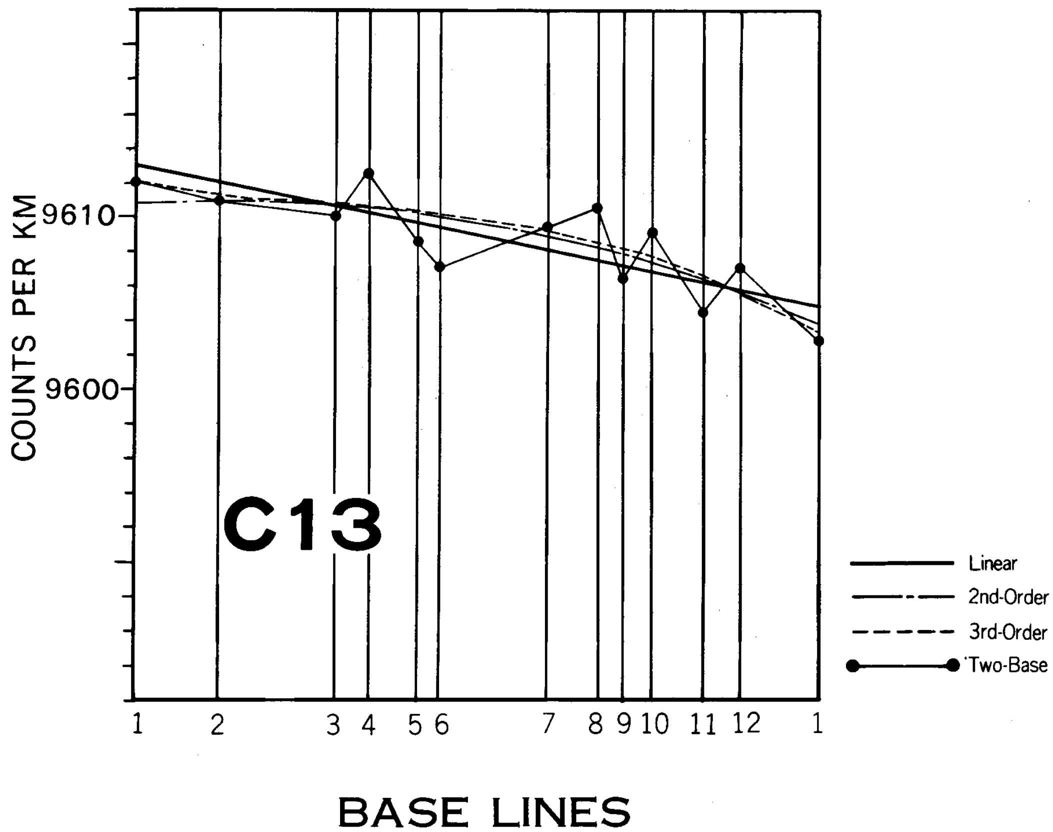
COUNTS PER KM
9590
9580
C5
1 2 3 4 5 6 7 8 9 10 11 12 1
COUNTS PER KM
9590
9580
C6
1 2 3 4 5 6 7 8 9 10 11 12 1
BASE LINES
Linear
2nd-Order
3rd-Order
Two-Base



9630
9620
COUNTS PER KM
C7
1
2
3 4 5 6
7 8 9 10 11 12 1
9600
9590
COUNTS PER KM
C8
1
2
3 4 5 6
7 8 9 10 11 12 1
Linear
2nd-Order
3rd-Order
Two-Base
BASE LINES


9640
9630
9620
COUNTS PER KM
C9
1 2 3 4 5 6 7 8 9 10 11 12 1
9670
9660
9650
COUNTS PER KM
C10
1 2 3 4 5 6 7 8 9 10 11 12 1
Linear
2nd-Order
3rd-Order
Two-Base
BASE LINES


9610
9600
COUNTS PER KM
C11
1 2 3 4 5 6 7 8 9 10 11 12 1
9640
9630
9620
COUNTS PER KM
C12
1 2 3 4 5 6 7 8 9 10 11 12 1
BASE LINES
Linear
2nd-Order
3rd-Order
Two-Base


COUNTS PER KM
9610
9600
C13
Linear
2nd-Order
3rd-Order
Two-Base
1
2
3
4
5
6
7
8
9
10
11
12
1
BASE LINES

6. SAFETY FACTOR AGAINST SHORT COURSE

According to the IAAF Rules, we can set forth necessary requirements of a marathon course as mentioned below:

1) A marathon course must be somewhere between 42,195 and 42,237 meters.

2) A course is said to be satisfactory if it is with an accuracy of better than one part in one thousand (1/1000).

3) The course shall be measured along an ideal line of running: i.e. the shortest possible path in that section of the road permitted for the runners. The course must not measure less than the official distance for the event (i.e. for the marathon race 42,195 meters).

Ideally, the distance should be as close to standard (i.e. 42, 195 meters for marathon) as possible without being short.

If we are to create the most accurate course possible for the 1988 Seoul Olympic Marathon, then a "Safety Factor" must be addressed. If the Safety Factor (SF) is too small, remeasurement may find the course to be unacceptably short. However, if the SF is too large, the course will be unnecessarily oversized.

The requirement of the SF, 1/1000, under the IAAF rule, hereinafter called "Standard Method", is based on the personal experience of several seasoned certifiers. We have learned that inexperienced measurers create courses that are short by approximately as much as 1/100. However, we have also learned that experienced measurers can always create courses that are within 1/1000 of remeasurements performed by highly skilled certifiers. The size of the SF therefore depends on the experience and skill of the measurer.

It has been fortunate that our measurement implemented on May 18, 1986, was endowed with numerous quality performances by many experienced cyclists. This leads us to believe that, for intervals repeatedly measured (e.g. 13 measurements/interval), statistics can safely be used to calculate the size of an SF that is good enough to provide a reasonable assurance against shortness. Moreover, considering the fact that the course has been measured independently by separating the judgment of the shortest path and the cycling itself, confidence for our measurement will be increased. Please refer to Chapter 2-2 and 2-5 for details.

In determining the safety factor (SF), three simple approaches can be considered by:

- Taking 0.999 × Median Value
- Taking the probability with 99% confidence level
- Taking the lowest actual measurement

SELECTION OF CONFIDENCE LIMIT:

The question is what confidence limit should be adequate for "short course prevention". We have learned that most of practical users use a confidence limit in the range of 95% to 99% for their industrial purposes. We assume that a 99% confidence limit is the upper limit, and that therefore a confidence limit larger than 99% is unrequired.

FINDING CONFIDENCE COEFFICIENT:

For the simplicity of study, we assume that our measurements are normally distributed. If our assumption is perfectly true, then since the sampling distribution of the means and of the standard deviations are also normal, it is possible to predict the probability of sampling statistics lying in the intervals:

Mean ± standard deviation with 68.26% probability,
Mean ± standard deviation with 95.44% probability,
or, Mean ± standard deviation with 99.74% probability

However, these methods rely on a relatively large sample size, usually taken as many as 30 or more. This is because when a sample size is large the sampling distribution of a parameter is about normal. When a sample size is small, usually taken less than 30, the techniques used for estimating population parameters become increasingly inaccurate as the sample size becomes smaller, since the sampling distribution no longer approximates to a normal one.

Since our sample size is relatively too small, i.e. 13 measurements for each interval, it is unreasonable to apply the standard normal distribution. Therefore, it should be more reliable to find the confidence coefficient by Student T-Distribution.

The followings are the derivation of confidence coefficient.

Let's consider the probability of a short course in a validation measurement. Suppose that the "official length" is set as L in a validation measurement and then a remeasurement is made of the course with the result of V. What is the probability that V will be less than the official length L?

Let A_1, A_2...A_N be the given sets of independent random variables, which have mean μ_0 and standard deviation σ_0. We assume further that the remeasurement V is also a Gaussian random variable, but with mean μ and standard deviation σ. We also assume that the random variable V is independent of the random variable A_1, A_2, ... A_N.

Let L be set at:

$$L = \frac{A_1 + A_2 + A_3 + \cdots + A_N}{N} - S \quad \cdots (1)$$

where S is some "Safety Factor."

It is clear that we want the probability that:

$$\mathrm{Prob}\{V\} < \mathrm{Prob}(L) \quad \text{or}$$

$$\mathrm{Prob}\{V\} < \mathrm{Prob}\left\{\frac{A_1 + A_2 + \cdots + A_N}{N} - S\right\} \quad \text{or}$$

$$\mathrm{Prob}\left\{V - \frac{A_1 + A_2 + \cdots + A_N}{N}\right\} < \mathrm{Prob}(-S) \quad \cdots (2)$$

Let us therefore define the new random variable:

$$X = V - \frac{A_1 + A_2 + \cdots\cdots + A_N}{N} \qquad (3)$$

Since X is a linear combination of independent Gaussian random variables, it is itself a Gaussian random variable. Therefore, the probability distribution of X has the following mean and standard deviation:

$$\mu_X = \mu - \mu_0$$
$$\sigma_X = \sqrt{\sigma^2 + \frac{\sigma_0^2}{N}} \qquad (4)$$

Suppose that the mean and standard deviation of L and V are the same, then we obtain,

$$\mu = \mu_0$$
$$\sigma = \sigma_0 .$$

Hence,

$$\mu_X = 0, \quad \sigma_X = \sqrt{\frac{N+1}{N}}\,\sigma_0 \qquad (5)$$

Let $\overline{A}$ and $\hat{\sigma}$ denote the sample mean and sample standard deviation of the A's:

$$\overline{A} = \frac{A_1 + A_2 + \cdots\cdots + A_N}{N}$$
$$\hat{\sigma} = \sqrt{\frac{(A_1 - \overline{A})^2 + (A_2 - \overline{A})^2 + \cdots + (A_N - \overline{A})^2}{N-1}} \qquad (6)$$

If we define the "official length" L by the formula,

$$L = \overline{A} - S = \overline{A} - K \cdot \hat{\sigma} . \qquad (7)$$

Now, what value of K must be chosen in order to attain a given probability p that V is not less than L?

From (3) and (6), a new random variable X is,

$$X = V - A,$$

'and then we have,

$$\mathcal{T}=\frac{X-\mu_x}{\sigma_x} \quad \cdots\cdots (8)$$

From (5) and (8), we have,

$$\mathcal{T}=\frac{V-\bar{A}}{\sqrt{\frac{N+1}{N}}\hat{\sigma}}=\sqrt{\frac{N}{N+1}}\left(\frac{V-\bar{A}}{\hat{\sigma}}\right)$$

This is the standard T-distribution with N-1 degree of freedom.

Finding the proper value of K in equation (7)

$$F(t)=\text{Prob}(X<-S)=\mathcal{T}\left[\sqrt{\frac{N}{N+1}}\left(\frac{-S}{\hat{\sigma}}\right)\right].$$

Then, the confidence interval,

$$1-C=\mathcal{T}\left[\sqrt{\frac{N}{N+1}}\left(\frac{-S}{\hat{\sigma}}\right)\right]$$

$$C=\mathcal{T}\left[\sqrt{\frac{N}{N+1}}\left(\frac{S}{\hat{\sigma}}\right)\right]. \quad \cdots\cdots (9)$$

Taking the inverse, then we obtain,

$$S=\mathcal{T}_{(C)}^{-1}\sqrt{\frac{N+1}{N}}\hat{\sigma}. \quad \cdots\cdots (10)$$

Finally, we obtain the correct K-value to be used in equation (7) as follows:

$$K=\sqrt{\frac{N+1}{N}}\,t_p^{(N-1)} \quad \cdots\cdots (11)$$

where $t_p^{(N-1)}$ denotes the p^{th} percentile of the T-distribution with N-1 degree of freedom.

Now, we want to compute K-value for use in our case: i.e. N=13 with 99% of confidence, then we obtain,

$$K = \sqrt{\frac{14}{13}} \times t_{0.99}^{(12)} = \sqrt{\frac{14}{13}} \times 2.68 = 2.78.$$

This means that the "safety factor" needed for 99% confidence when we have 13 measurers is 2.78 $\hat{\sigma}$.

7. SELECTION OF SAFETY FACTOR AGAINST SHORT COURSE

FOR 99% CONFIDENCE:

The total length, represented by the **sum** of the 19 intervals, is shown in Table 3-2, and has the following mean ($\overline{X}_{13}$), standard sample deviation (S.D.), and 99%-99.999% of confidence length for each method of analysis. The lowest value is thickened by Gothic (meters).

Table 3-2. Various Confidence Levels for Each Method of Analysis

Method		Linear	2nd-order	3rd-order	Two-Base	Remarks
$\overline{X}_{13}$		31166.16	31165.90	31165.88	31166.14	
$t_p^{(12)}$	K \ S.D.	2.87	2.83	2.85	2.94	
p = 99%	2.78	31158.18	31158.03	**31157.96**	31157.97	99%(SUM)
p = 99.5%	3.18	31157.03	31156.90	31156.82	31156.79	99.5(SUM)
p = 99.9%	4.08	31154.45	31154.35	31154.25	31154.15	
p = 99.95%	4.48	31153.30	31153.22	31153.11	31152.97	
p = 99.99%	5.50	31150.38	31150.33	31150.21	31149.97	
p = 99.995%	5.92	31149.17	31149.15	31149.01	31148.74	
p = 99.999%	6.85	31146.50	31146.51	31146.36	31146.00	

*t_p : 1-side interference

*The computed example of the 99% confidence length in 3rd-order method:

$$99\%\ (SUM) = \overline{X}_{13} - 2.78SD = 31165.88 - 2.78 \times 2.85 = 31157.96$$

Table 3-3 shows the 99% of confidence length for EACH of the 19 intervals according to respective methods of analysis. The table also shows the sum of these 99% lengths, SUM (99%). The lowest SUM(99%) is thickened by Gothic (meters).

Table 3-3. 99% Confidence of Each Interval ($\overline{X}_{13}$ – 2.78 S.D.)

Terminus	Linear	2nd-order	3rd-order	Two-Base
R1-R2	1240.46	1240.56	1240.61	1240.51
R3 -R4	3085.35	3085.49	3085.48	3085.42
R6 -R7	1430.50	1430.53	1430.49	1430.42
R8 -R9	1453.59	1453.60	1453.50	1453.42
R9 -R10	1785.97	1785.97	1785.85	1785.74
R10-R11	1273.16	1273.16	1273.17	1273.02
R12-R13	1640.79	1640.74	1640.71	1639.91
R14-R15	2452.12	2451.98	2451.87	2451.74
R16-R17	397.70	397.67	397.68	397.75
R18-R18A	2350.04	2349.94	2349.92	2350.31
R18-R19	567.40	567.39	567.39	567.48
R19-R20	2905.04	2904.88	2904.86	2904.80
R21-R22	2101.67	2101.62	2101.67	2101.44
R23-R24	848.24	848.21	848.23	848.00
R25-R26	1335.43	1335.38	1335.40	1335.52
R27-R28	1855.94	1855.94	1855.91	1855.65
R28-R29	848.88	848.89	848.89	848.84
R30-R31	1703.32	1703.33	1703.31	1703.15
R32-R1	1874.41	1874.53	1874.53	1874.55
SUM(99%)	31150.01	31149.81	31149.47	**31147.67**

NOTE: The lowest value of SUM (99%) is 10.29 meters below the lowest of 99% (SUM), and provides about 99.997% assurance against shortness for the total length (Refer to Table 3-2).

LOWEST ACTUAL MEASUREMENTS:

Another approach to estimating a length that has a high probability of being adequate is to use only the "best" (lowest) actual measurements for each interval.

Table 3-4 shows the "best" (lowest) actual measurements for each interval. The lowest value is thickened by Gothic (meters).

The lowest value of SUM (BEST)[1] (Two-Base Method) is 2.85 meters lower than 99% (SUM) value, and therefore provides more than 99.7% confidence against shortness.

The SUM (**BEST**)[2] provides about 99.95% confidence against shortness.

Table 3-4. Lowest Actual Measurements

Terminus	Linear	2nd-order	3rd-order	Two-Base
R1-R2	**1240.67**	1240.83	1240.86	1240.84
R3-R4	**3085.85**	3086.12	3086.08	3086.00
R6-R7	1430.73	1430.75	1430.70	**1430.69**
R8-R9	1453.72	1453.73	1453.66	**1453.62**
R9-R10	1786.15	1786.15	1786.07	**1785.97**
R10-R11	1273.28	1273.28	1273.60	**1273.19**
R12-R13	1640.94	1640.91	1640.82	**1640.01**
R14-R15	2453.24	2453.23	2452.98	**2452.84**
R16-R17	397.89	**397.87**	397.88	397.96
R18-R18A	2350.85	2350.69	**2350.65**	2351.37
R18-R19	**567.48**	567.48	567.48	567.65
R19-R20	2905.41	2905.17	**2905.13**	2905.72
R21-R22	2102.00	2101.99	2102.00	**2101.67**
R23-R24	848.35	848.33	848.36	**848.21**
R25-R26	1335.64	**1335.60**	1335.66	1335.75
R27-R28	1856.20	1856.20	1856.22	**1856.00**
R28-R29	849.10	849.10	849.13	**849.01**
R30-R31	1703.54	1703.53	1703.55	**1703.46**
R32-R1	1875.49	1875.00	**1875.99**	1875.14
SUM(BEST)[1]	31156.53	31156.53	31155.82	31155.10

SUM(**BEST**)[2]=31152.92

SUMMARY OF TWO METHODS:

Fig. 3-2 shows the relative positions of 0.999 $\overline{Md}$, 99% (SUM), SUM (99%), SUM (BEST)[1], SUM (**BEST**)[2] and actual measured lengths. All values below the 99% (SUM) provide more than 99.7% confidence against shortness, and specially, attention must be given to the 0.999 Md providing 99.999% confidence against shortness. In conclusion, we choose the SUM (**BEST**)[2], i.e. the lowest actual measurement, providing 99.95% confidence against shortness.

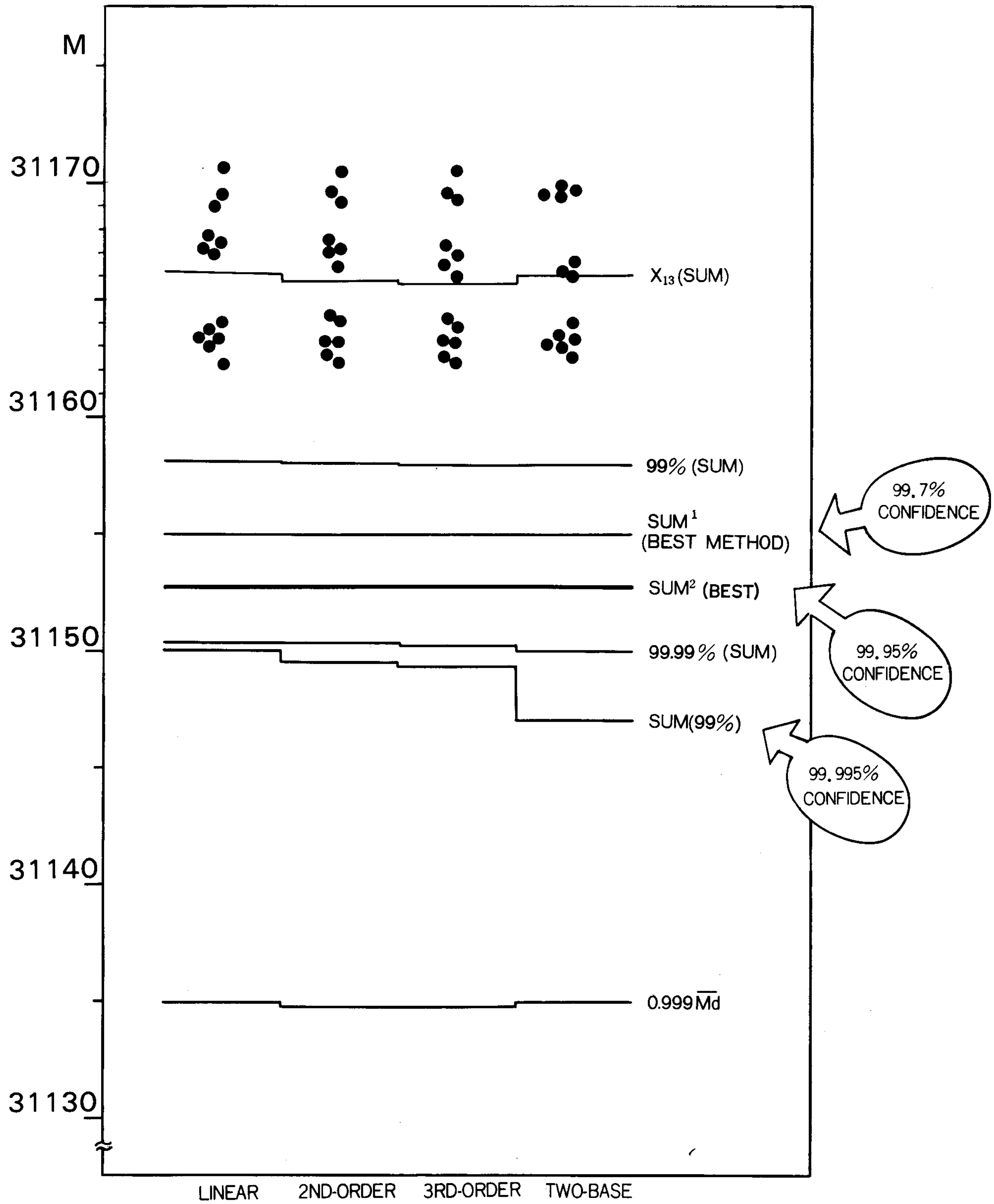
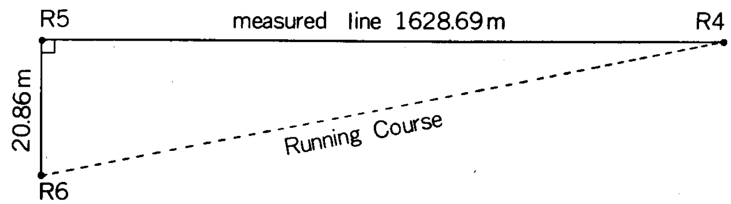


Fig. 3-2. Relation between different confidence length

8. CORRECTION ON SOME INTERVALS:

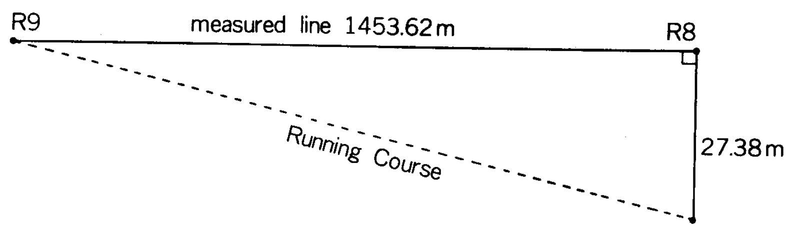
The following corrections should be made on interval R4-R5 and R8-R9.

INTERVAL R4 - R5



DTSTANCE (R4 – R6) = $(1628.69^2 + 20.86^2)^{1/2}$ = 1628.82 m.

INTERVAL R8 - R9



DISTANCE (R7 – R9) = $(1453.62^2 + 27.38^2)^{1/2}$ = 1453.88 m

***Consideration of error propagation**

$$S=(x^2+y^2)^{\frac{1}{2}}$$
$$\Delta S=(x^2+y^2)^{-\frac{1}{2}}(x\cdot \Delta x+y\cdot \Delta y)$$

Where ΔS is the total error which is propagated from two independent variables X and Y. By computation of ΔS using above numerical data, it is clear that ΔS is insignificant ($\approx$ 0.0001 meter only).

9. PROPOSED LENGTHS

INTERVAL		MEDIAN ($\overline{Md}$)	S.F.	PROPOSED LENGTHS
R1 -R2		1241.22	0.55	1240.67
R2 -R3	B1	1181.16	0.01	1181.15
R3 -R4		3086.45	0.60	3085.85
R4 -R5	B2	1628.70	0.01	1628.69
R6 -R7		1431.07	0.38	1430.69
R8 -R9		1454.07	0.45	1453.62
R9 -R10		1786.60	0.63	1785.97
R10-R11		1723.69	0.50	1273.19
R11-R12	B3	439.60	0.01	439.59
R12-R13		1641.91	1.90	1640.01
R13-R14	B4	370.81	0.01	370.80
R14-R15		2453.62	0.78	2452.84
R15-R16	B5	600.04	0.01	600.03
R16-R17		397.94	0.06	397.88
R17-R18	B6	1114.67	0.01	1114.66
R18-R18A		2351.49	0.84	2350.65
R18A-R19		567.96	0.48	567.48
R19-R20		2906.22	1.09	2905.13
R20-R21	B7	839.22	0.01	839.21
R21-R22		2102.52	0.85	2101.67
R22-R23	B8	760.94	0.01	760.93
R23-R24		848.64	0.43	848.21
R24-R25	B9	529.06	0.01	529.05
R25-R26		1336.21	0.61	1335.60
R26-R27	B10	568.67	0.01	568.66
R27-R28		1856.85	0.85	1856.00
R28-R29		849.40	0.39	849.01
R29-R30	B11	434.33	0.01	434.32
R30-R31		1704.12	0.66	1703.46
R31-R32	B12	526.96	0.01	526.95
R32-R1		1875.71	0.72	1874.99
Sub-Total		40159.85	12.89	40146.96
R4 -R5(Correction)		0.13	—	0.13
R8 -R9(Correction)		0.26	—	0.26
TOTAL		**40160.24**	**12.89**	**40147.35**

CHAPTER 4 – LAYOUT AND MAPPING FOR MARATHON /RACE WALKS COURSES

1. General
2. Additional Measurement
3. Distance Marking
4. Race Walk Measurement
5. Layout and Setting up the Marathon and Race Walks Courses
6. Mapping
7. Delivery Items

1. GENERAL

In this chapter, the following items are described:

— Additional measurement

— Distance marking

— Racewalks measurement

— Final layout of marathon/racewalks courses

— Mapping

2. ADDITIONAL MEASUREMENT

An additional measurement was implemented from R1 point to the main stadium. The course between the R1 point and the Stadium consisted of straight and curved lines. The straight stretch was measured with EDM systems, and the curved portions with a 50 meter-long steel tape. The steel tapes were officially standardized by the Korean Standards Research Institute. All required correction, such as for tension, temperature, sag, etc. were made after measurements.

Please refer to the final layout of marathon and racewalks courses for details.

3. DISTANCE MARKING

Along the whole marathon course, four different types of distance marking were used with bronze and plastic monuments and they were differentiated by colors.

Type I: 40 points in total:

The bronze monuments were marked at each interval of 1 Km from the starting point throughout the whole course.

Type II: 7 points in total:

Plastic monuments colored yellow were marked at each 5 Km. The first position to be marked was located 7.5 Km away from the starting point of the marathon race course.

Type III: 5 points in total:

White colored plastic monuments were marked every 1 km interval from the finish point of the marathon race course.

Type IV: 1 point in total:

One bronze monument was marked at the mid-point of the marathon race course; i.e. 21,097.5 meters.

These points were protected with three to six auxiliary marks in order to make remarking possible when they were found destroyed.

For the race walks course, three red plastic monuments were marked at the points of 1.25 km, 2.5 km, and 3.75 km from the start line of the race walks.

The distance was measured with EDMs and steel tapes starting from the nearest reference point.

Please refer to the tables 4-1 and 4-2 for details.

Table 4-1. Distance marks for Marathon Course

No.	Station (km)	Interval	Distance (m)	Remarks
1	1	Stadium	—	—
2	2	R2 -R1	667.34	EDM
3	3	R2 -R3	332.66	EDM
4	4	R3 -R4	151.51	EDM
5	5	〃	1151.51	EDM, steel tape
6	6	R4 -R3	934.34	EDM, steel tape
7	7	R4 -R6	65.66	EDM
8	7.5	〃	565.66	steel tape
9	8	R6 -R4	563.16	EDM
10	9	R6 -R7	436.84	EDM, steel tape
11	10	R7 -R9	6.15	steel tape
12	11	R9 -R7	447.73	EDM
13	12	R9 -R10	552.27	EDM, steel tape
14	12.5	〃	1052.27	EDM
15	13	R10-R9	233.70	steel tape
16	14	R11-R10	506.89	steel tape
17	15	R12-R13	53.52	steel tape
18	16	R13-R14	586.49	steel tape
19	17	R14-R15	42.71	steel tape
20	17.5	〃	542.71	EDM, steel tape
21	18	〃	1042.71	EDM, steel tape
22	19	R15-R14	410.13	EDM, steel tape
23	20	R16-R15	10.16	steel tape
24	21	R18-R17	522.70	EDM
25	21.0975 (turning point)	21^{K}-R18	97.50	steel tape

No.	Station (km)	Interval	Distance (m)	Remarks
26	22	R18-R19A	447.30	EDM, steel tape
27	22.5	〃	947.30	EDM, steel tape
28	23	〃	1447.30	EDM, steel tape
29	24	R18A-R19	126.65	EDM
30	25	R19-R20	559.17	EDM, steel tape
31	26	〃	1559.17	EDM, steel tape
32	27	R20-R19	345.96	steel tape
33	27.5	R20-R21	154.04	EDM
34	28	R21-R20	185.17	EDM
35	29	R21-R22	814.83	EDM, steel tape
36	30	R22-R21	286.84	EDM, steel tape
37	31	R23-R22	47.77	steel tape
38	32	R24-R25	104.02	EDM
39	32.5	R25-R26	74.97	EDM
40	33	〃	574.97	EDM, steel tape
41	34	R26-R27	239.37	EDM
42	35	R27-R28	670.71	EDM
43	36	R28-R27	185.29	EDM
44	37	R29-R28	34.30	steel tape
45	37.5	R30-R31	31.38	steel tape
46	38	〃	531.38	EDM, steel tape
47	39	R31-R30	172.08	EDM, steel tape
48	40	R32-R1	300.97	EDM, steel tape
49	41	R1 -R32	574.02	EDM, steel tape
50	42	stadium	—	—

No.	Station (km)	Interval	Distance (m)	Remarks
51	−5	37^K-37.5^K	195.00	EDM
52	−4	38^K-39^K	195.00	EDM
53	−3	39^K-40^K	195.00	steel tape
54	−2	40^K-39^K	195.00	EDM, steel tape
55	−1	41^K-finish	195.00	EDM

Table 4-2. Distance Marks for Race Walks Course

No.	Station (km)	Interval	Distance (m)	Remarks
1	1.25	Entrance pt. to R1	32.27	steel tape
2	2.50	Circuit (East Circle)	3.75	steel tape, (anti-clockwise)
3	3.75	Circuit (West Circle)	5.39	steel tape, (from exit pt.)

4. RACE WALKS MEASUREMENTS

Our task involved one additional mission, that was to measure and set up the Race Walks Course.

The requirements are specified below:

— The total length of the course shall be 5,000 meters.

— The allowable error shall be within 1/1000, same as in the case of the marathon course.

— The course shall be a combination of two different shapes; one is a point to point course starting from the main stadium and ending to the single loop track course, the other is a single loop track course connected to the point to point course. Each of them should be 2,500 meters long.

— A single loop track course should be designed in such a way that the loop consists of two straight lines and a half of circle at each end. The radius of the circle should be 12 meters each at both ends.

In the course measurements, a steel tape and EDM system were employed. EDM was used for the measurement of the straight lines and the steel tape to measure curved lines. All measurements were preformed under the same circumstances as in the Marathon Course Measurement.

The measurement was performed on May 28 through June 15, 1986 under the direction of Prof. Suck-Chan Lee and Chief assistants, Young-Ho Cheon and Ki-Won Ahn.

Three distance markers were established at the interval of 1.25 km starting from the main stadium.

5. LAYOUT & SETTING UP THE MARTHON/RACE WALKS COURSE

a. Marathon Course

The final task of our mission was to fix the start and finish points of marathon and race walks races.

The finish point was already fixed in accordance with SLOOC's request and could not be changed.

For the marathon course, we proceeded with the following steps:

1. Measuring of distance from R1 to the Entrance Point to track lines in the stadium.

2. Measuring of distance from the Entrance Point to the Finish Point, and the distance from the Exit Point to R1.

3. Finding the total length by adding bicycle-measured lengths and lengths decided in items 1 and 2 above.

4. Finding differnce between the total length obtained in item 3 and the official length of the marathon course, 42,195 meters.

5. Deciding how many times the runner should turn the track until the total length come near to 42,195 metres.

6. Deciding the starting point in such a way that the total lengths should be identical to 42,195 metres.

7. Finally, to decide and fix the starting point so that the total length of the marathon course become exactly 42,195 metres.

The number of turns inside the track contains some restrictions in that runners are not allowed to take more than one turn when arriving.

The length of the main track is fixed as 400 metres and has been already approved by KAAF.

The final proposed lengths and course layout are listed below:
(Please refer to Fig. 4-1 and 4-4 for details.)

Interval	Measured Length	S.F.	Proposed Length
(I) R 1 to Entrance	96.58	0.01	96.57
	87.97	0.01	87.96
	96.55(*)	0.10	96.45
	281.10	0.12	280.98
(II) Entrance to Finish	340.00(**)	—	340.00
(III) Exit to R1	43.96(*)	0.05	43.91
	130.09	0.01	130.08
	87.97	0.01	87.96
	96.59	0.01	96.57
	358.60	0.08	358.52
Sub-total(I)+(II)+(III)	979.70	0.20	979.50
Bicycle Measurement (R1 to R1)	40,160.24	12.89	40,147.35
TOTAL	41,139.94	13.09	41,126.85
			−42,195.00
			1,068.15
Number of track turn	2 times × 400 m =		800.00
DIFFERENCE			**(***) 268.15 meters**

NOTES:

1) (*) : steel tape measurement applying 1/1000 SF to total length.

2) (**) : lengths computed from the main track.

i.e. 1/2 × 120 m + 2 × 80 m + 120 m = 340 m

length of half circle track .... 120 m

length of straight course track ..... 80 m

3) 0.01 m of S.F. given to each EDM measurements.

4) (***) : the location of the start point should be 268.15 meters apart from "EXIT POINT".

5) some intervals were sub-devided into many sections for the sake of convenience in measuring

6) The start point has been fixed with stainless steel monument as in the case of FINISH POINT.

b. Race Walks Course

Layout of the race walks course was performed according to the following procedures:

1. Setting up a single loop track course.
2. Measuring the distance between the ENTRANCE and EXIT points of the track and R1 Point. (Please refer to diagram for details.)
3. Finding a start point in the main stadium in the same manner that we used in the marathon course.

In setting up a single loop track, the trial and error method was used till the total length of the track measured up to 2,500 metres. For this purpose, two basic reference points, ENTRANCE and EXIT points for the track, were pre-selected, and the distance between these two points was 24 metres as requested by the client.

In actual measurements, all intervals were sub-devided into many sections for measuring conveniences.

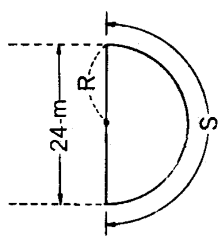
The details of computation and proposed length of the track are indicated as follows (please refer to Fig. 4-2, 4-3, and 4-5 for details):

(1) 2,500m circuit course

measured length	S.F.	proposed length
836.10	0.01	836.09
91.71 (*)	0.09	91.62
286.28	0.01	286.27
37.70 (**)	0.04	37.66
293.30	0.01	293.29
41.28 (*)	0.04	41.24
60.29	0.01	60.28
815.90	0.01	815.89
37.70 (**)	0.04	37.66
2500.26	0.26	2500.00

NOTES: (*) : measured by steel tape

(**): distance of the arc of half-circle and S.F.



$$S=\pi\times R=\pi\times 12=37.70\text{m}$$

$$\Delta S=\pi\cdot\Delta R$$

$$\Delta S\fallingdotseq\pi\times 12^{m}\times 0.001=0.04^{m}$$

(2) Distance from Exit Point to R1 Point

Measured	S.F.	Proposed
396.22	0.01	396.21
48.34	0.05	48.29
188.68	0.01	188.67
1.24	—	1.24
634.48	0.07	634.41

(3) **Distance from R1 to the ENTRANCE Point**

Measured	S.F.	Proposed
188.68	0.01	188.67
310.71	0.01	310.70
81.19	0.01	81.18
49.58	0.05	49.53 (steel tape)
630.16	0.08	630.08

(4) **Distance between R1 and the FINISH Point**
(same as in the marathon course measurement)

621.10	0.12	620.98

SUB-TOTAL (1) — (4)

4386.00	**0.53**	**4385.47**
		−5000.00
		−37.66 (*)
		652.19 (**)

NOTES: (*) The total length of the race walks course does not include the half-circle arc length starting from ENTRANCE point and ending at the EXIT point of the race walks track, corresponding to $\pi \times 24$ meters = 37.66 meters.

(**) Start point should be fixed at a distance of 652.19 meters from R1 point.

Fig. 4-1. STADIUM↔R1 POINT

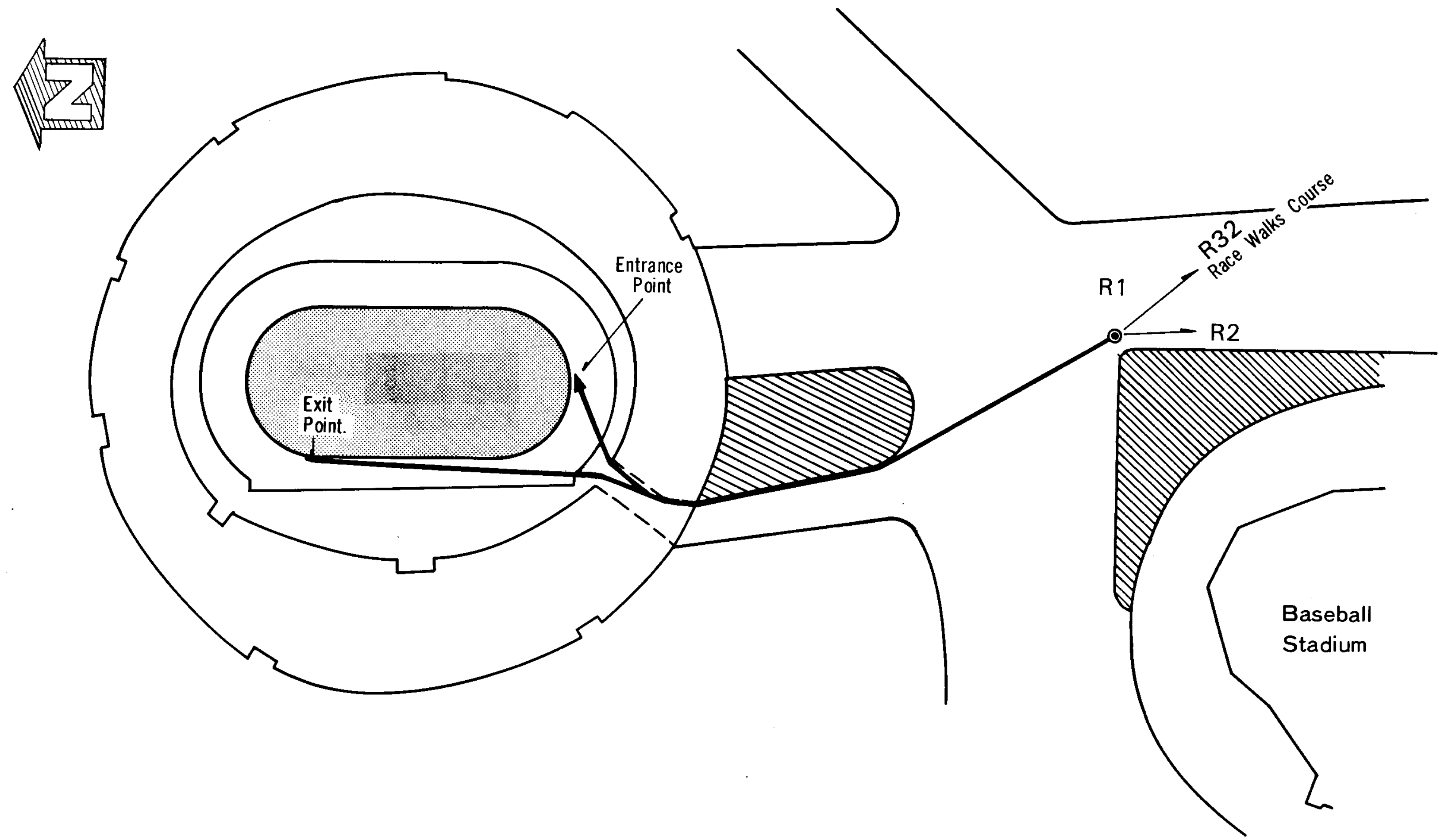


Fig. 4-2. R1 ↔ RACE WALKS COURSE(1)

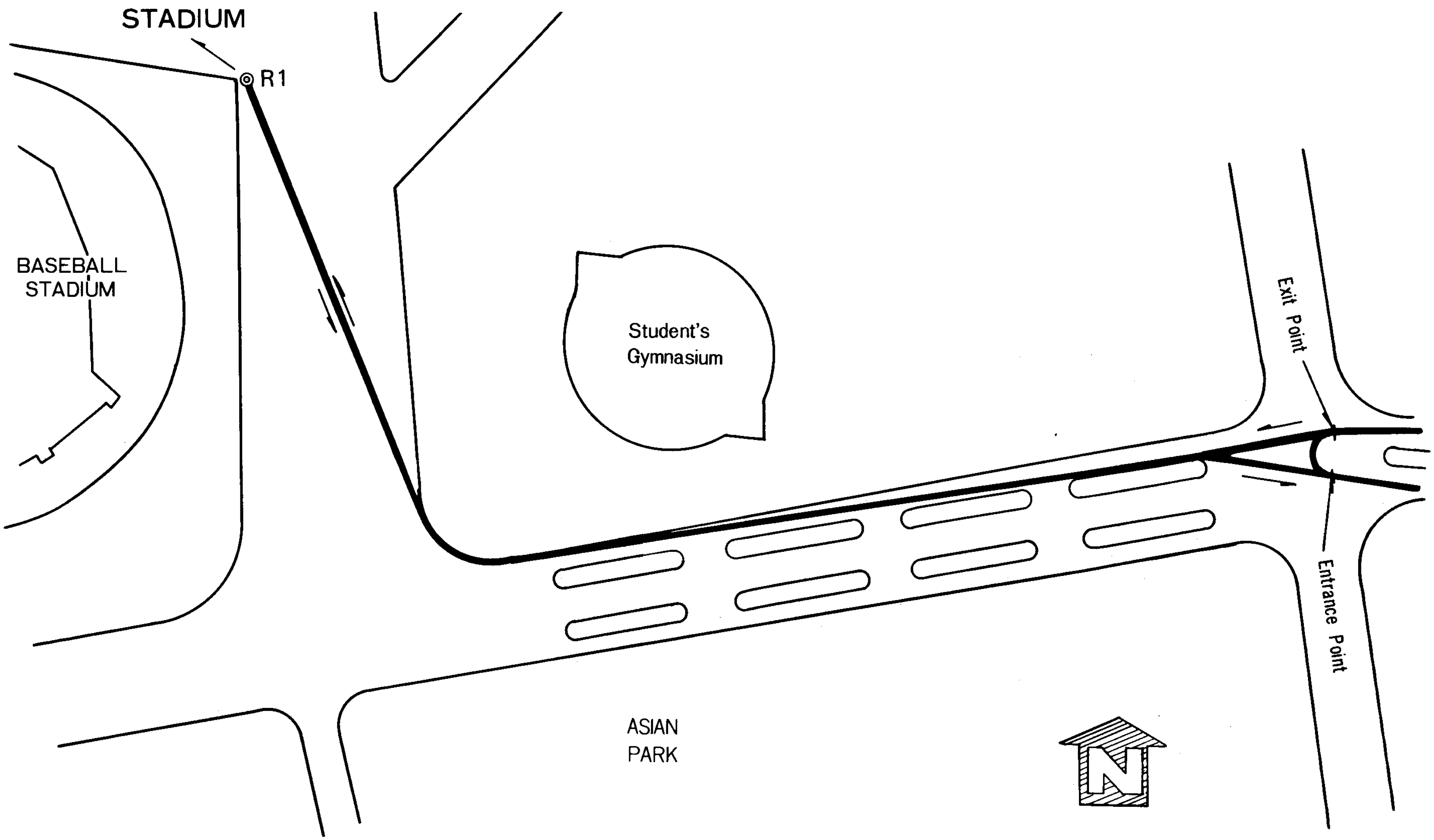


Fig. 4-3 R1 ↔ RACE WALKS COURSE(2)

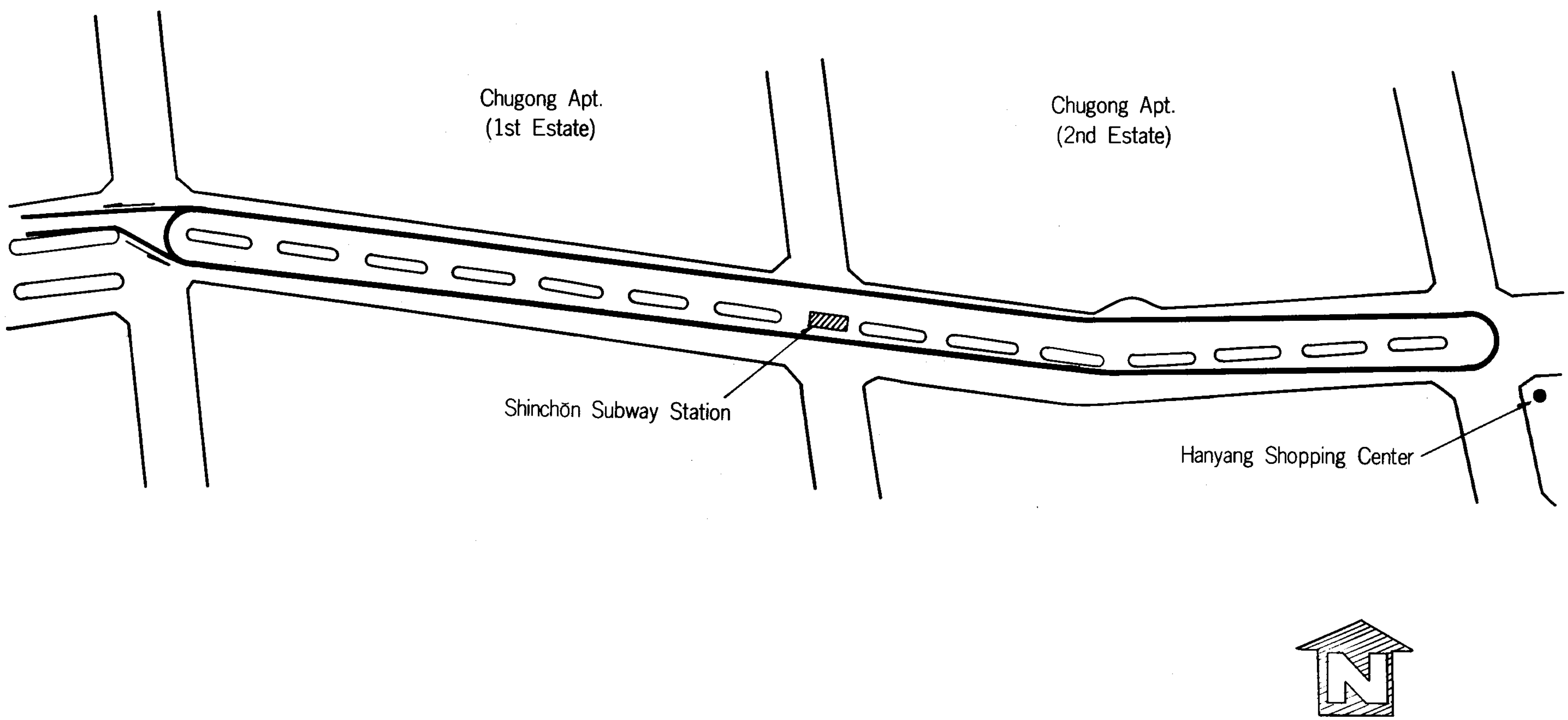
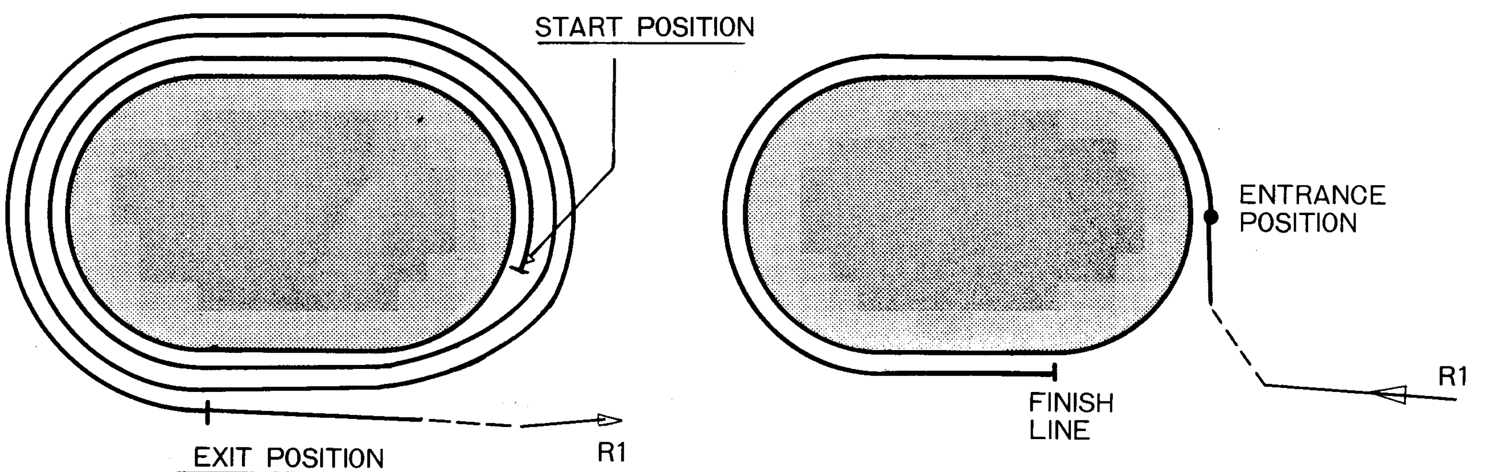


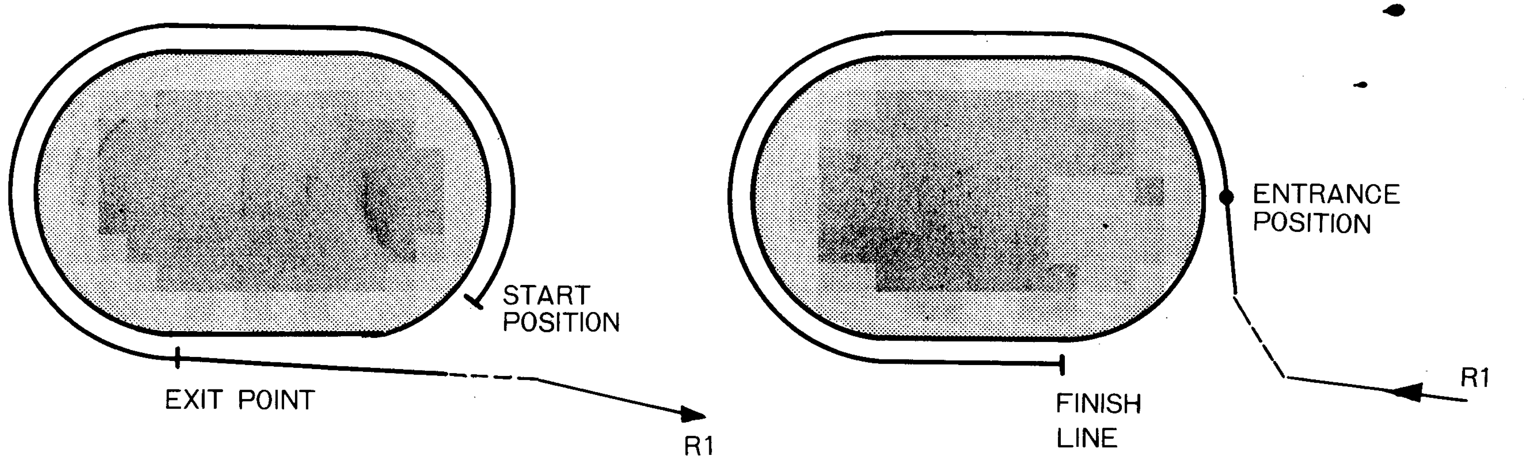
Fig. 4-4. LAYOUT OF MARATHON RACE START AND FINISH



DISTANCE BETWEEN START POSITION AND EXIT POSITION IS 268.15 METRES

DISTANCE BETWEEN ENTRANCE POSITION AND FINISH LINE IS 340.00 METRES

Fig. 4-5. LAYOUT OF RACE WALKS START AND FINISH



DISTANCE BETWEEN START POSITION AND EXIT POINT IS 293. 67 METRES

DISTANCE BETWEEN ENTRANCE POSITION AND FINISH LINE IS 340. 00 METRES

6. MAPPING

Detailed Marathon and Race Walks Courses were presented on the colour map at scales of 1/20,000 and 1/8,000 respectively.

Both courses were edited on one sheet. A line of marathon and race walks courses edited in different colours.

All distance markers and other reference informations, such as drinking station and sponging point, were presented on the map.

Fair drawing was made by scribing method on the stable polyester scribe base, and the final printing was done using different colors. A total of 1000 copies was printed and submitted to SLOOC.

The course map was edited and printed by Chung-Ang Atlas Co., Ltd, Seoul Korea, under the direction of Prof. Chan Lee.

7. DELIVERY ITEMS

The following items have separately been delivered to the Seoul Olympic Organization Committee:

1. 200 copies of the final report

2. 1000 copies of the final map

3. Field books of Jones Counts Reading

4. Field books for base line measurement

5. Field book for Levelling and profiling

6. Computer Output

7. Detailed diagrams and descriptions of all distance markers and reference points used in Jones Count Reading

8. Detailed diagrams and descriptions of auxiliary reference points of Item 7 above

9. Painting Plan of the marathon and race walks courses for runners.

CHAPTER 5 – CONCLUSIONS

CONCLUSIONS

From the results of measurements and analyses, the following conclusions are summarized as below:

1. The following safety factor against short course provide more than 99 percent confidence that any remeasurement will result in combined larger than 42,195 meters for marathon and 5,000 meters for race walks course.

   a. For the interval measured via EDM, an adequate "Safety Factor Against Short Course" is 0.01 meter for each measurement.

   b. For each interval measured with steel tape, an adequate "Safety Factor Against Short Course" is 1/1,000.

   c. For each interval measured by bicycles, the "BEST" (lowest) actual measurement for all methods provides about 99.95% confidence that the combined length of all such intervals will not be found short upon an equally accurate remeasurement.

2. Using above "Safety Factor Against Short Course", the PROPOSED LENGTHS for all measurements list as follows: (unit: meter)

Item	Measured Length	S.F.	Proposed Length
Marathon Course	42,208.16	13.16	42,195.00
Race Walks Course	5,000.71	0.71	5,000.00

3. If the proposed length is used, this will results in an average median length of about 42,195 + 13.16 meters for marathon and 5,000 + 0.71 meters for race walks course.

4. If the remeasurement is as accurate as this proposed length, the risk of its being less than 42,195 meters is about 1/2000.


마 라 톤 코 스
MARATHON COURSE
Scale 1/20,000
경 보 코 스
RACE WALK COURSE