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ANALYSES OF THE ENERGY SOURCES
USED BY TURKISH REFEREES DURING NINETY MINUTES
SOCCER MATCH

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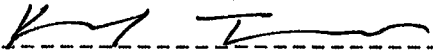
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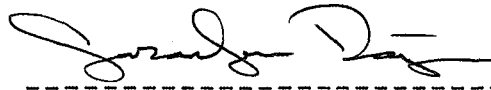
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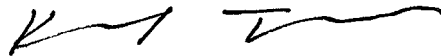
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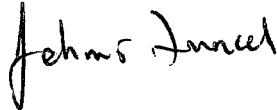


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ABSTRACT

ANALYSES OF ENERGY EXPENDITURE OF TURKISH REFEREES DURING MINETY MINUTES SOCCER MATCH

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M.S. Physical Education and Sports

Supervisor: Assist.Prof.Dr.Gazanfer DOGU

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Scope and Method of Study: The purpose of this study was to predict the percentages of various energy sources used by volunteer Turkish Refees (N=5) and to analyze the locomotor motions during 90min soccer match.

Each subjects pulse rate listing was taken through PE 3000 sport tester computer program file output in numerical form while officiating ametuer league matches in Ankara. Percentages of heart rate in different zones were defined by maximum heart rate (x:181.8 beats/min) and estimated anaerobic threshold level (x: 171.2 beats/min). Each subjects locomotor movements was recorded on the field by using observation sheet for whole match period. Data reduction and descriptive analysis was conducted.

Finding and Conclusions: The mean work ratio below A.T.L. was 77.04% (1. half = 73.46%; 2. half = 80.62%) and

the mean value of total distance covered was 6166 meter (1.half = 3298 m; 2. half = 2868m) The mean value of walking was 1858 m (1.half = 766 m; 2.half = 1093 m). The mean value of jogging was 3534 m (1.half = 2059 m; 2. half = 1470 m). The mean value of fast running was 414 m (1. half = 233 m; 2. half = 181 m). The mean value of backward running was 323 m (1. half = 219 m; 2. half = 104 m). The mean value of side way running was 43 m (1. half = 21 m; 2. half = 22 m).

According the results of this study referees doesn't need vigorous training for officiating a match. But they should participate in aerobic conditioning programs on regular basis and also should be abrupt acceleration and deceleration, charges of direction and angles runs. Additionally, muscle glycogen levels should not be lowered by strenous activities the day before or the morning of soccer match to be officiated.

Science code: 224.19.01

ÖZ

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Ocak, 1992, 63 sayfa

Çalışmanın Amacı ve Metodu: Bu çalışmanın amacı 90 dakikalık bir futbol müsabakasında Türk futbol hakemlerinin kullandıkları enerji çeşitlerinin tespiti ve hakemlerin saha içinde yaptıkları hareketlerin sıklığını belirtmektir.

Her hakemin kalp atım sayılarını Ankara'da Amatör maç idare ederken PE 3000 computer programla hakemlerin verileri sırayla tespit edildi. Kalp atım sayı yüzdeleri ile farklı bölgeler tanımlandı. Maximum kalp atım sayısı 181.8 atım/dak., tahmini anaerobik eşik noktası, 171.2 atım/dak. Her deneğin 90 dakika oyun boyunca yaptığı hareketleri özel izleme formuna kayıt edildi. Descriptif analiz yapıldı.

Bulgular ve Sonuçlandırma: Ortalama A.T.L. altında yapılan işin yüzdesi 77.04% (1.Devre = 73,46%; 2.Devre = 80.62%), Ortalama kat edilen mesafe 6166 metre. (1.Devre = 3298 m; 2 Devre = 2868 m). Ortalama yürünen mesafe 1858 m (1.Devre = 766 m; 2 .Devre = 1093 m), Ortalama yapılan jog 3534 m (1.Devre = 2059 m; 2.Devre = 1470 m), Ortalama yapılan hızlı koşu 414 m (1.Devre = 233 m; 2.Devre = 181 m).

Ortalama yapılan geri geri kořu 323 m (1.Devre = 219 m; 2.Devre = 104 m). Ortalama yapılan yan yan kořu 43 m (1.Devre = 21 m; 2.Devre = 22 m).

Sonuřlarında gsterdięi gibi futbol hakeminin bir futbol karřılařmasını idare edebilmek iřin řok yoęun bir antreman programına ihtiyacı yoktur. Fakat řeřitli ařılarda yn deęiřtirerek yapılacak hızlı, yavař kořularla dzenli aerobik kapasiteyi geliřtirici antremanlara katılmalıdır. İlave olarak hakem mař idare etmeye řıkmadan bir gn veya mař gn sabahı kas glikojen seviyesini dřrmemelidir.

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CHAPTER 1

INTRODUCTION

Soccer is a dynamic game. It is a ninety minutes paced activity, and it is played with a ball by two sides, each trying to kick it over the others goal line. These and other definitions describe soccer as an object or basic mechanism of playing the game. (Stanley, 1986)

Soccer was a game played in gentlemanly fashion that was in the disciplinary environment of schools and colleges or by the old boy's clubs of soccer playing establishments. Differences of opinion were settled in a sporting manner between two captains, although it was recorded that sometimes blows were struck in the process. Therefore, some institutions required umpires to be appointed by the teams. Each umpire was stationed in the half of the field defended by own teams. Only when an appeal was made by a player, umpire was required to make a decision.

After a while in the historical development of the game, when one could not decide the right course of action, the umpires conferred with a third man who appeared on the scene as a referee stationed at the halfway line outside the field of the play. When the umpires could not get agreement up on the problem, it was taken to the referee. When the problems became acute, a new arrangement was made. The

referee went in to the middle and the umpires went to the side lines. Thus, the diagonal system started so the referee had become essential in maintaining the principles of enjoyment in soccer.

Over the years the referee has been given greater authority and responsibility. It has never been more vital than it is today for match officials to be fully aware of their role in the game.

There was a time when the soccer referee needed only a sound knowledge of laws, strong lungs to blow a whistle and a pair of reasonably active legs to control a soccer match. Someone who lacked one or more of these essentials, were able to get by with the reason why he wants to be referee, needs deep knowledge of the game, its player, their skills, the styles and tactics of team play, and the physical and mental pressure which arise during competitive situations. He needs to develop good technique in management, to know gamesmanship plays, the latest thinking in law changes and problems which have give rise to changes. He needs to study the influences of various factors on match control which, in past, have tended to be only of passing interest.

Demands on fitness and mobility have increased with changing tempo of modern soccer. Demands on personal time and dedication have increased with the need to assimilate an accelerating flow of information and instruction. The modern

referee needs much more helps and quaidance than his precedessors and he needs both earlier in his carrier.

Refereeing is an athletic activity. It is a common sense that any athlete who wishes to perform his activity well should begin by assessing his basic health and then take positive action to improve deficiencies and develop whatever physical and mental requirements are necessary for his task.

The referee is not required, as player is, to develop the ability to head a ball powerfully or kick to it. But he is required to accelarate quickly from a standing start, to have speed of movements and ability to manoeuvre over heavy grounds to turn and change direction while in motion and possess sufficient reserves of stamina to last more than two hours. To determine what improvements to his health may be required, the referee should know, by analysing each game, how efficient he has been in keeping up with the play, in moving to the position selected after reading situations and what degree of fatigue he has experienced during the later stages of a hard game.

Very few people refer to a soccer referee as an athlete. Although many people take it for granted that referees must under go adequate physical fitness training in order to be able to keep up with modern soccer requirements of the 90's. Like a top class player that must gain his

physical fitness though hard work, the same applies to a top class referee.

Today's fast action of the game with every changing direction and speed, requires referee to be close to the ball which means, he must be all over the field and be able to keep up with the pace of the game.

In a seminar for international soccer referees held at the University of Nottingham England in 1979, the participants were ask to consider ten factors they believed to be the most important in order of priority for "A Good Referee" and similar factors that produce "Good Match Control". The aggregate scores were recorded in the order of priorities. Knowledge of the laws of the game, physical fitness, personality was listed as the most important factors.

Physiological fitness levels required for match-play depend on the work-rate demands of the game which vary with the level of competition. Specific positional roles of referee may demand unique physiological attributes. These are reflected in the anthropometric and physiological fitness profiles of referee.

Heart rate measurements of the referee is one way of the prediction various energy sources used by a referee.

Heart rate is one index of physiological strain incurred by the referee during match-play. It is relatively

unobtrusive as it can be monitored continuously by radio telemeter.

Use of heart rate in such field contexts have been defended on the grounds that is at once an indicator of the total circulatory load imposed on the body. The heart rate accelerates with increasing exercises intensity to raise cardiac output so that circulatory system can meet the needs of the active muscle for oxygen. Increased blood flow to the skin resulting from a heat load will be reflected in increased heart rate as will an emotional consequence of executing skills. Because of the relatively short recovery periods in soccer the heart rate stays at an elevated level and fluctuations during play are not very large.

Soccer matches last 90 min and patterns of activity in this time can be expressed as work rate profiles, these may be determined by methods of motion analysis which give useful pointers to the physiological stresses imposed by match-play. Although the physiological demands of soccer may vary according to the system of play.

In normal locomotion the energy expenditure is a direct function of the distance travelled so the distance covered in a game may be a crude guide to the work rate of individual.

At the end of this research results can help to the referee, trainer or coaches to prepare good physical

conditioning program and therefore referee can progressively increase the level of performance by a daily personal physical routine until a satisfactory standart has been achieved.

PURPOSE OF THE STUDY

The purpose of this study was to analyse energy expenditure of Turkish referees during ninety minutes soccer match.

PROBLEM OF THE STUDY

The problem of this study was to predict the percentages of various energy sources used by a referee during a 90 minutes soccer match.

SUB PROBLEM

Determining the type of locomotor movements and their frequencies during a 90 minutes soccer match.

LIMITATIONS

1. All subjects were volunteers.
2. Measurements were taken while the referees were calling official league games.

ASSUMPTIONS

1. Maximum heart rate (MHR) estimated through Karvoniön formüle (220-Age) was assumed to be subjects true MHR.

2. %90 percent level of estimated MHR were assumed to be subjects true anaerobic threshold level (A.T.L.)

3. Subjects' performances during testing were same in all other matches.

4. Distance marked on the observation form reflected the true distance covered by the movement of the referees.

SIGNIFICANCE OF THE STUDY

Today's fast action of the game with every changing direction and speed requires the referee to be closed to the ball which means referee must be all over the field and be able to keep up with the pace of the game. Therefore, referee has to have significantly high physical fitness because the performance of the referee effect decisions and fluidity of the game. Measuring of referee's energy expenditures and analysis of the movements can give results and helpful to decide what type of training program needs to be selected.

DEFINITION OF TERMS

Aerobic : The process of using energy in the presence of oxygen.

Anaerobic : The process of using energy in the absence of oxygen.

Anaerobic Threshold : That intensity of work load or oxygen consumption in which anaerobic metabolism is accelerated.

Heart Rate : The numbers of ventricular beats in one minute.

Walking : It is accomplished by the alternative action of two lower extremities at slow pace. When one foot is always in contact with the ground.

Fast running (Sprint) : The motion of the lower extremities at high pace when both feet loses contact with the ground.

Backward running : During this type of run one faces the opposite direction of the running pathway.

Sideway running : In this run one is moving while facing side way.

Slow running (Jogging) : The motion of the lower extremities at slow pace.

DESCRIPTION OF INSTRUMENTS:

The sport tester telemetry : It is a versatile heart rate meter designed to measure and register the heart beat frequency of the user. It consist of electrode belt, transmitter and receiver.



CHAPTER II

REVIEW OF LITERATURE

A review of the literature shows few studies of the heart rate responses and locomotor motions or patterns of activities of officials during athletic events. Heart rate is one index of physiological strain incurred by referee during match play. It is relatively unobtrusive as it can be monitored continuously by radio telemeter. The subject wears chest electrodes attached to a light weight radio transmitter, the signal being picked up by a receiver. Alternatively short range telemeter may be used, the receiver being worn like a watch on the wrist of a subject; the signal is retained in the memory of the receiver and played back for analysis after the game.

The anaerobic threshold (AT) described by Wasserman et al., (1979) and Davis et al., (1979) has many potential uses in exercise physiology. The AT, characterized by an accumulation of lactate in the blood above resting levels. It may also be a major determinant of exercises capacity. The AT is potentially useful in identifying an appropriate and optimal training intensity depending upon the objectives of the exercise programs.

Katch et al., (1978) based partially on their observation that at a specific percent of HRmax subject may exercise above or below their AT. During work at 80% HRmax

forexample, half of their subjects remained below their AT. All subjects were below AT at 70% HRmax. AT roughly 75-80% HRmax a zone of non uniform exercises stress, with respect to AT, was encountered that extended beyond 90% HRmax. Within this zone a highly variable number of subjects exercised above their AT at any specific percent HRmax.

At 70% HRmax none of the subjects would work above their AT. A transitional point was indicated between 80-85% HRmax where approximately 25% of the subject would work above AT. Even 90% HRmax exceeding upper limit in exercises prescription, more than 25% of the subjects were below their AT. (Dwyer, Jeffrey and Ronald Bybee 1981). As shown in Table I.

Table 1. Number of subjects (N=20) above and below AT at 70-90% HRmax

%HR max	70	75	80	85	90
Mean HR	128	137	146	155	164
Subject above AT	0	1	4	5	14
Subject below AT	20	19	16	15	6

Davis et al., (1976) found that AT occurred at approximately 65% HRmax in untrained middle aged man.

Dressendorfer et al., (1981) found the AT at 88% HRmax.

Seliger (1986) Studied players during a 10 min model game and found mean heart rates of 160 beats/min and peak values that were 166 beat 6 min on average. The standard deviation for both mean and peak measures 14 beats/min. Mean values for Czechoslovak soccer players were reported in other publication (Seliger 1968b) to be about 165 beats/min. These values were equivalent to sport such as ski padding which had a mean heart rate of 166 beats/min.

Holland and Cherry (1971) studied the response of official during an intrasquad soccer game and concluded that officiating cause marked sinus tachycardia and there was not much difference in the heart rate responses of the referee, head linesman, umpire and field judge.

Schulze and Morehouse (1972) found that average energy expenditure of intercollegiate soccer officials was about 6 mets, the equivalent of jogging at 4 mph.

Holland (1971) found marked sinus tachycardia associated with anaerobic running in high basketball officials. He also noted that heart rate increased during coach official confortations.

Soccer matches last 90 min and the pattern of activities in this time can be expressed as work rate profiles. These may be determined by methods of motion analysis. Although physiological demands of soccer may vary according to the system of play or tactic employed, there

are some consistencies in the movement profiles displayed during the course of a match. In English League First Division matches player change activity every 5-6 sec on average, have brief rest pauses averaging only 3sec every 2min, although rest breaks tend to be longer and more frequent at lower levels of competition. Sprints average about 15meter and occur every 90sec or so while player run at a cruise or sprint once every 30 sec.

Abraham Klein (1980-1981) studied 17 referee locomotor motion during the game and found out the overall distance covered by the referee during match consists of 26% walking, 52% jogging, 8% sprinting, 12% backward running and 2% sideway running. Total distance covered by referee varies between 6km and 7km oproximately.

Mean heart rate of players in a Belgian University team during a friendly match were 169 beats/min in the first half and 165 beats/min in the second half. These coresponded respectively to 86,7% and 84,4% of maximal heart rate. During the game the distance covered was 10225m; the slightly lower heart rate in the second half are likely to have been due to a reduced work rate since players covered 444m less in the second half than in the first half. (Van Gool, Van Gerwen and Boutmans, 1988).

At high standards of play a fatigue effect is noticeable in the second half as drop in the work rate (Reilly and Thomas, 1979). This has been shown to be

related to reduction in energy stores within the active muscle.

In one study the top rated soccer officials exhibited a significant higher level of physical fitness than lesser rated officials. The American Heart Association Committee on Exercises states taht men 40 to 49 years old in a good condition have a maximum oxgen uptake (AHAC 1980).



CHAPTER III

METHODS AND PROCEDURE

The purpose of this study was to predict the percentages of various energy sources used by a referee and to analyse of locomotor motions during 90 min soccer match.

Selection of Subjects

The subjects of this study were 5 volunteer A Meteur Turkish Referees who calls game in Ankara, 1992 soccer season.

Collection of Personal Data

Each referee's personal information was collected and recorded before the matchs. (see Appendix A)

Test Administration

Heart Rate : At the beging of the game, the subject worn chest electrode belt attached to short range telemetry and the recevier being worn like a watch on the wrist of the subject in the dressing room. During the game recevier recorded heart beats at 5 sec. intervals in the memory of the watch. The signals of each subject's were transffered to the computer during the half time periods and at the end of each game.

Motion Analysis : The method was to record the locomotor movement of the referee on the field from the minute subject started the game. Motion form was worked by the observers each time the referee has changed activities and direction in both halves

Statistical Analysis

Each subject's pulse rate listing was taken through PE 3000 computer programs file out put in numerical form. Pulse rate values in selected intervals were listed in the table form.

Pulse rate curve of each subject was printed having the pulse on the vertical axis and time on the horizontal axis. To the right of the curve, percentages of heart rate in different zones were defined by the maximum, anaerobic and aerobic heart rate values that were calculated.

Each subject's values were listed. All subject's means were calculated and the distribution was shown on the graph.

Descriptive statistics were conducted after recording the activities of 5 referees shown in table.

CHAPTER IV

RESULTS AND DISCUSSIONS

Total of five referees were used as subject in this study.

Subject 1 was 36 years old non smoker. His resting heart rate was 72 beats/min. In the first half of the game his average heart rate was 169 beats/min. But, in the second half of the game his average heart rate decreased by 4 beats/min to 165 beats/min. In the first half subject worked with the heart rate ranged from 114 to 184 beats/min. But in the second half subject's heart rate range changed to 114-188 beats/min as shown in table II.

Table II. First Subject's Heart Rate Measurements

Subject 1 (36 years old)	Estim M.H.R. Beat/min	R.H.R.	Estim A.T.L.	True H.R Reached			Period Worked X Below A.T.L.
				Min.H.R.	Max.H.R.	X	
1. Half				114	184	169	44.1
	184	72	172				
2. Half				114	188	165	65.2
Total Period				114	188	167	54.6

Subject's estimated maximum heart rate was 184 beat/min. and his estimated A.T.L. was 172 beats/min.

Subject worked below estimated A.T.L. for 44.1% of the first half and 65.2% of the second half.

Through the analysis of the subject's locomotor motions, it was obtained that he covered a total distance of 7018 m during the whole match. 3769 m of this distance (53.7%) was covered in the first half and 3249 m (46.3%) was covered in the second half.

Out of the total distance, 1570 m (22.3%) was walked by the subject, 720 m (10.2%) was walked in the first half and 850 m (12.1%) was walked in the second half.

4447 m of the total distance (63.4%) was jogged of which 2442 m (34.8%) during the first half and 2005 m (28.6%) during the second half.

596 m (8.5%) was run in fast pace by the subject during the whole match 316 m (4.6%) was run in the first half and 280 m (3.9%) was run in the second half.

367 m (5.3%) was run backward by the subject 265 m (3.8%) was run in the first half and 102 m (1.5%) was run in the second half.

38 m (0.5%) was run sideways by the subject 26 m (0.3%) was run in the first half and 12 m (0.2%) was run in the second half. All datas of subject were shown in table III.

Table III. First Subject's Locomotor Motions

Item	Task/ Activity	First Half Dist.% of Dist.	Second Half Dist.% of Dist.	Total Dist. % of Dist.
1	Walking	720m % 10.2	850m % 12.1	1570m % 22.3
2	Jogging	2442m % 34.8	2005m % 20.6	4447m % 63.4
3	Fast Running	316m % 4.6	280m % 3.9	596m % 8.5
4	Backward Run.	265m % 3.8	102m % 1.5	367m % 5.3
5	Sideway Run.	26m % 0.3	12m % 0.2	38m % 0.5
6	Total	3769m % 53.7	3249m % 46.3	7018m % 100

Subject II was 48 years old and non smoker. His resting heart rate was 80 beats/min. his average heart rate was 160 beats/min in both halves. In the first half subject worked with the heart rate ranged from 123-173 beats/min. But in the second half subject's heart rate range changed to 94-180 beats/min.

Table IV. Second Subject's Heart Rate Measurements

Subject 1 (48 years old)	Estim M.H.R. Beat/min	R.H.R.	Estim A.T.L.	True H.R Min.H.R.	Reached Max.H.R.	X	Period Worked Below A.T.L.
1. Half	172	80	163	123	173	160	26.2
2. Half				94	180	160	46.4
Total Period				94	180	160	36.3

Table V. Second Subject's Locomotor Motions

Item	Task/ Activity	First Half Dist.% of Dist.	Second Half Dist.% of Dist.	Total Dist. % of Dist.
1	Walking	985m % 12.5	1283m % 16.3	2268m % 28.8
2	Jogging	2558m % 32.4	1726m % 22.8	4308m % 55.2
3	Fast Running	432m % 5.4	358m % 4.6	789m % 10
4	Backward Run.	295m % 3.8	198m % 1.6	419m % 5.4
5	Sideway Run.	14m % 0.2	35m % 0.4	49m % 0.6
6	Total	4283m % 54.3	3600m % 45.7	7883m % 100

Subject III was 36 years old non smoker. His resting heart rate was 68 beats/min. In the first half of the game his average heart rate was 142 beats/min. but in the second half of the game his average heart rate increased by 5 beats/min. to 147 beats/min. In the first half subject worked with the heart rate ranged from 76-176 beats/min. But in the second half subject's heart rate range changed to 99-187 beats/min.

Table VI. Third Subject's Heart Rate Measurements

Subject 1 (36 years old)	Estim M.H.R. Beat/min	R.H.R.	Estim A.T.L.	True H.R Min.H.R.	Reached Max.H.R.	X	Period Worked Below A.T.L.
1. Half	184	68	175	76	176	142	99.3
2. Half				99	187	147	92.7
Total Period				76	187	145	96

Subject's estimated maximum heart rate was 184 beats/min and his estimated A.T.L. was 175 beats/min. Subject worked below estimated A.T.L. for 99.3% of the first half and 92.7% of the second half.

Through analysis of the third subject's locomotor motion, it was obtained that he covered a total distance of 4922 m during the whole match. 2738 m of this distance (55.5%) was covered in the first half and 2184 m (44.5%) was covered in the second half.

Out of the total distance, 1600 m (32.4%) was walked by the subject 680 m (13.7%) was walked in the first half and 920 m (18.7%) was walked in the second half.

3013 m of the total distance (61.2%) was jogged of which 1860 m (37.7%) during the first half and 1153 m (23.5%) during the second half.

265 m (5.3%) was run in fast pace by the subject during the whole match. 185 m (3.8%) was run in the first

half and 80 m (1.5%) was run in the second half.

10 m (0.2%) was run backward by the subject. 3 m (0.06%) was run in the first half and 7 m (0.14%) was run in the second half.

34 m (0.8%) was run sideways by the subject 10 m (0.2%) was run in the first half and 24 m (0.6%) was run in the second half.

Table VII. Third Subject's Locomotor Motion

Item	Task/ Activity	First Half Dist.% of Dist.	Second Half Dist.% of Dist.	Total Dist.% of Dist.
1	Walking	80m % 13.7	920m % 18.7	1600m % 32.4
2	Jogging	1860m % 37.7	1153m % 23.5	3013m % 61.2
3	Fast Running	185m % 3.8	80m % 1.5	265m % 5.3
4	Backward Run.	3m % 0.06	7m % 0.14	10m % 0.2
5	Sideway Run.	10m % 0.2	24m % 0.6	34m % 0.8
6	Total	2736m % 55.5	2184m % 44.5	4922m % 100

Subject IV was 35 years old and smoker. His resting heart rate was 62 beats/min. His average heart rate was 121 beats/min. in both halves. In the first half subject worked with the heart rate ranged from 78-145 beats/min. but in the

second half subject's heart rate range changed to 95-144 beats/min.

Table VIII. Fourth Subject's Heart Rate Measurement

Subject 1 (36 years old)	Estim M.H.R. Beat/min	R.H.R.	Estim A.T.L.	True H.R Min.H.R.	Reached Max.H.R.	X	Period Worked Below A.T.L.
1. Half	185	62	173	78	176	145	100
2. Half				95	187	144	99.3
Total Period				78	187	145	99.6

Subject's estimated maximum heart rate was 185 beats/min. and his estimated A.T.L. was 173 beats/min. Subject worked below estimated A.T.L. for 100% of the first half and 99.3% of the second half. These are given in Table VIII.

Through the analysis of the fourth subject's locomotor motions, it was obtained that he covered a total distance of 4226 m during the whole match. 2123 m of the total distance (50.2%) was covered in the first half and 2103 m (49.8%) was covered in the second half.

Out of the total distance 1849 m (43.6%) was walked by the subject. 599 m (14.3%) was walked in the first half and 1250 m (29.3%) was walked in the second half.

2086 m (49.3%) of the total distance was jogged of which 1367 m (32.3%) during the first half and 719 m (17%) during the second half.

Table IX. Fourth Subject's Locomotor Motion

Item	Task/ Activity	First Half Dist.% of Dist.	Second Half Dist.% of Dist.	Total Dist.% of Dist.
1	Walking	599m % 14.3	1250m % 29.3	1849m % 43.6
2	Jogging	367m % 32.3	719m % 17	2086m % 49.3
3	Fast Running	114m % 2.6	85m % 2.2	199m % 4.7
4	Backward Run.	12m % 0.3	24m % 0.5	36m % 0.8
5	Sideway Run.	31m % 0.7	25m % 0.9	56m % 1.6
6	Total	2123m % 50.2	2103m % 49.8	4226m % 100

199 m (4.7%) was run in fast pace by the subject during the whole match. 114 m (2.6%) was run in the first half and 85 m (2.1%) was run in the second half.

36 m (0.8%) was run backward by the subject. 12 m (0.3%) was run in the first half and 24 m (0.5%) was run in the second half.

56 m (1.6%) was run sideway by the subject. 31 m (0.7%) was run in the first half and 25 m (0.9%) was run in the second.

Subject V was 36 years old and smoker. His resting heart rate was 70 beats/min. In the first half of the game his average heart rate was 145 beats/min. but in the second half of the game his average heart rate decreased by 10 beats/min. to 135 beats/min. In the first half subject worked with the heart rate ranged from 91-183 beats/min. but in the second half subject's heart range changed to 90-171 beats/min.

Table X. Fifth Subject's Heart Rate Measurements.

Subject 1 (36 years old)	Estim M.H.R. Beat/min	R.H.R.	Estim A.T.L.	True H.R Reached			Period Worked Below A.T.L.
				Min.H.R.	Max.H.R.	X	
1. Half	184	70	173	91	183	145	97.7
2. Half				90	171	135	99.5
Total Period				90	183	140	98.6

Subject's estimated maximum heart rate was 184 beats/min and his estimated A.T.L. was 173 beats/min. Subject worked below estimated A.T.L. for 97.7 % of the first half and 99.5% of the second half.

Through the analysis of the subject's locomotor motion, it was obtained that he covered a total distance of 6783 m during the whole match period. 3577 m of this distance (52.7%) was covered in the first half and 3206 m (47.3%) was covered in the second half.

Out of the total distance, 2004 m (29.5%) was

walked by the subject 844 m (12.4%) was walked in the first half and 1160 m (17.1%) was walked in the second half.

3814 m of the total distance (56.2%) was jogged of which 2069 m (30.5%) during the first half and 1745 m (25.7%) during the second half.

220 m (3.2%) was run in fast pace by the subject during the whole match 120 m (1.7%) was run in the first half and 100 m (1.5%) was run in the second half.

709 m (10.4%) was run backward by the subject 520 m (7.6%) was run in the first half and 189 m (2.8%) was run in the second half.

36 m (0.7%) was run sideways by the subject 24 m (0.5%) was run in the first half and 12 m (0.2%) was run in the second half. These data are given in Table XI.

Table XI. Fifth Subject's Locomotor Motion

Item	Task/ Activity	First Half Dist.% of Dist.	Second Half Dist.% of Dist.	Total Dist.% of Dist.
1	Walking	680m % 13.7	920m % 18.7	1600m % 32.4
2	Jogging	11860m % 37.7	1153m % 23.5	3013m % 61.2
3	Fast Running	185m % 3.8	80m % 1.5	265m % 5.3
4	Backward Run.	3m % 0.06	7m % 0.14	10m % 0.2
5	Sideway Run	10m % 0.2	24m % 0.6	34m % 0.8
6	Total	2736m % 55.5	2184m % 44.5	4922m % 100

All five subject's heart rate measurements were shown in table XII.

Table XII. HeartRate Measurement of all subjects

Sub	Esti mated MHR	RHR	Esti mated ATL	Average HR		Period Worked Total	Worked Below ATL		
				First	Second		First	Second	Total
1	184	72	172	169	165	167	%44.1 22.4Min	%65.2 34Min	%54.6 56.4Min
2	172	80	163	160	160	160	%26.2 14Min	%46.4 23.3Min	%36.3 37.3min
3	184	68	175	147	147	144.5	%99.3 48.6Min	%92.7 46Min	%96 94.6Min
4	185	62	173	121	121	121	%100 50.5Min	%99.3 42.7Min	%99.6 98.9Min
5	184	70	173	145	135	140	%97.7 49.2Min	%99.5 49.1Min	%98.6 98.3Min
X	181.8	70.4	171.2	147.4	145.5	146.5	%73.46 36.94Min	%80.62 40.16	%77.04 77.1Min

Subject's mean maximum heart rate was 181.8 beats/min. The Mean, values of resting heart rate was 70.4 beats min. The mean, value of ATL was 171.2 beats/min. The mean value of average heart rate was 147.4 beats/min in the first half of the game. But, in the second half. The Mean value of average heart rate decreased by 2 beats min to 145.5 beats min. The mean value of average heart rate was 146 beats/min for whole match period. The mean value of ratio of work below anaerobic threshold level was 73.46% (36.94 min) in the first half but in the second half the

mean, value of ratio of work below anaerobic threshold level was 80.62% (40.16 min).

The mean, value of ratio of work below anaerobic threshold level was 77.04% (77.1 min) for whole game.

Physiological fitness levels required for match play depend on the work rate demands of the game which vary with the level of competition. Use of the heart rate in such field has been defended on the grounds that it was at once indicator of the total circulatory load imposed on the body. During the game many exercises or activities require a blend of both anaerobic and aerobic metabolism.

One way to facilitate exercises prescription was to estimate exercise intensity in relation to subject's heart rate. Activities were based on the heart rate response during the work interval. Exercise heart rate was determined by karvonen formula. Intensity of exercises at or slightly above the anaerobic threshold of subject represented anaerobic work.

Heart rate below anaerobic threshold level of subject represented aerobic work.

First and second subject's maximum heart rates reached were above the estimated maximum heart rates at times during the matches. Therefore, it can be said that these subject's estimated max. H.Rates were underestimated. When this was true, the lowest percents that were obtained

by these two, subjects (54.6% and 35.8% respectively) showed as the percent of period worked below ATL would have been increased.

Fourth subject worked 100% of the time at below ATL. This subjects worked not too intense during the match and this could be seen at his average heart rate obtained (121 beats/min.).

The high heart rates of first and second subject could have been also due to emotional factor and some degree of nervousness during the game. Shepherd (1968) concluded that the stresses on the heart from anxiety reactions may be more intense than that from maximum exercises, Johnson's (1980) study of boat racers and Porter and Allsen's (1978) study of basketball coaches support the role of psychological stress increasing heart rate.

Subjects' heart rates during the match varied considerably and in some cases their heart rate was maintained close the maximal level. Holland and Cherry (1971) reported the highest heart rate after the officials sprinted 20 to 25 yards to cover a play (182 beats/min 91% maximum).

Except of the third subjects the average heart rates of all subjects decreased in second half this was due to the fact that the tempo of the games dropped down when loosing teams appeared to have lost interest in the game.

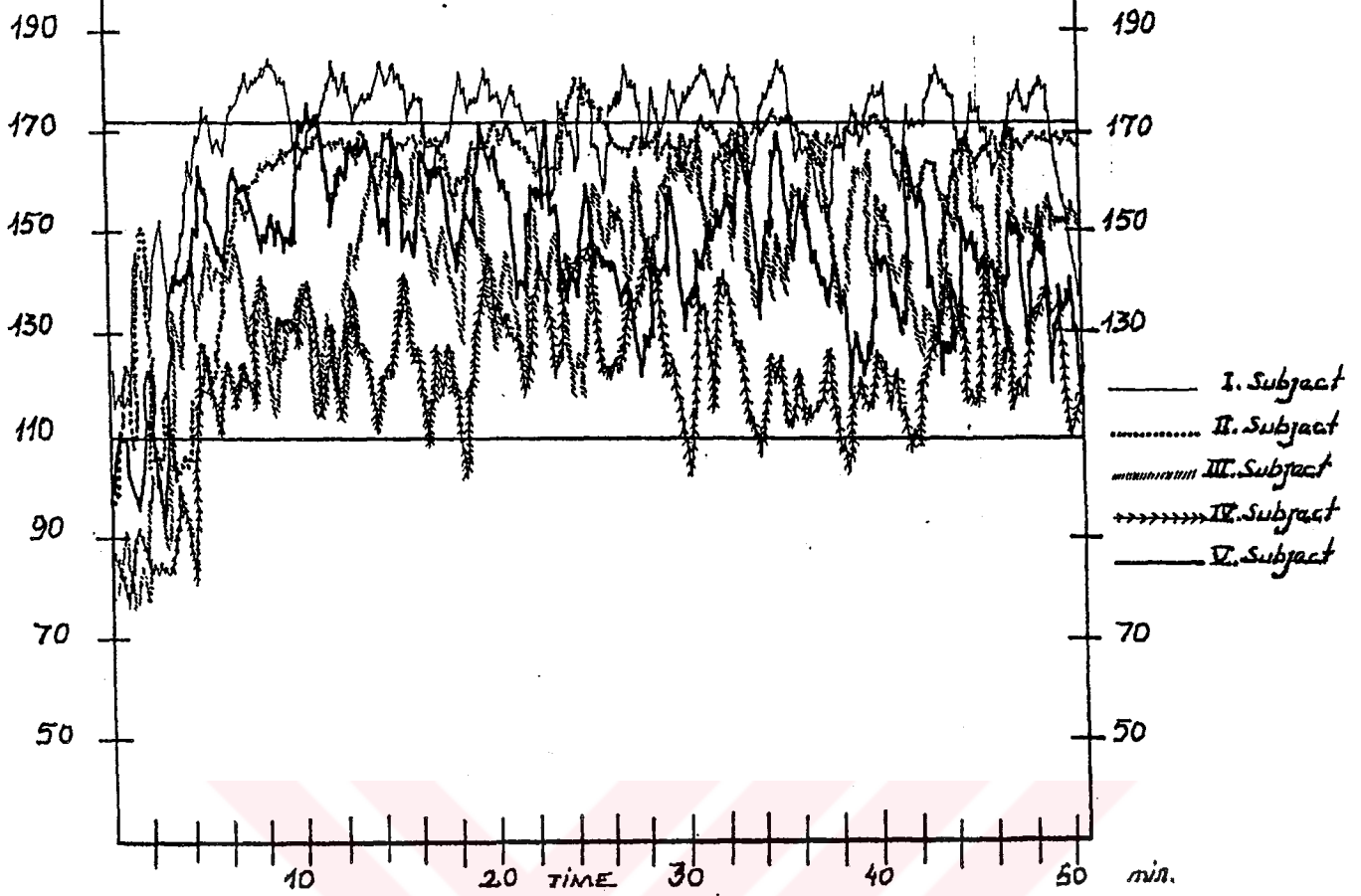
In general the heart rate of subjects during the matches were, 20 to 30 beats/min below maximal level. (GRAPH I and II).

During the exercises below anaerobic threshold level, subjects, required energy may be produced almost exclusively by aerobic processes. During less intermitted work subjects used aerobic system predominantly by ATP production from breakdown mainly of carbohydrates and fats and sometimes of protein, to carbondioxide and water. But during the short burst of physical effort, subjects' heart rates reached above anaerobic threshold using anaerobic energy source. At the begining of activities, subjects used high energy phoshates and followed through the partial breakdown of carbohydrates to lactic acid.

In sum, most types of ball games officiating represent more or less intermittent work with frequent interchanges of short burst of physical effort interspaced with biref pauses. For this reason, refereeing required physical endurance or dominantly aerobic power. Then referee should participate in aerobic conditioning program on regular basis and the activities during the course of training should be include accelaration and deceleration, changes of direction and angled runs.

Averages of all five subjects' Locomotor motions (walking, jogging, fast running, backward running, sideway running) were shown in Table XIII.

c GRAPH I: Heart Rates Distributions of all subjects during the first halves of the matches.



GRAPH II: Heart Rates Distributions of all subjects during the second halves of the matches.

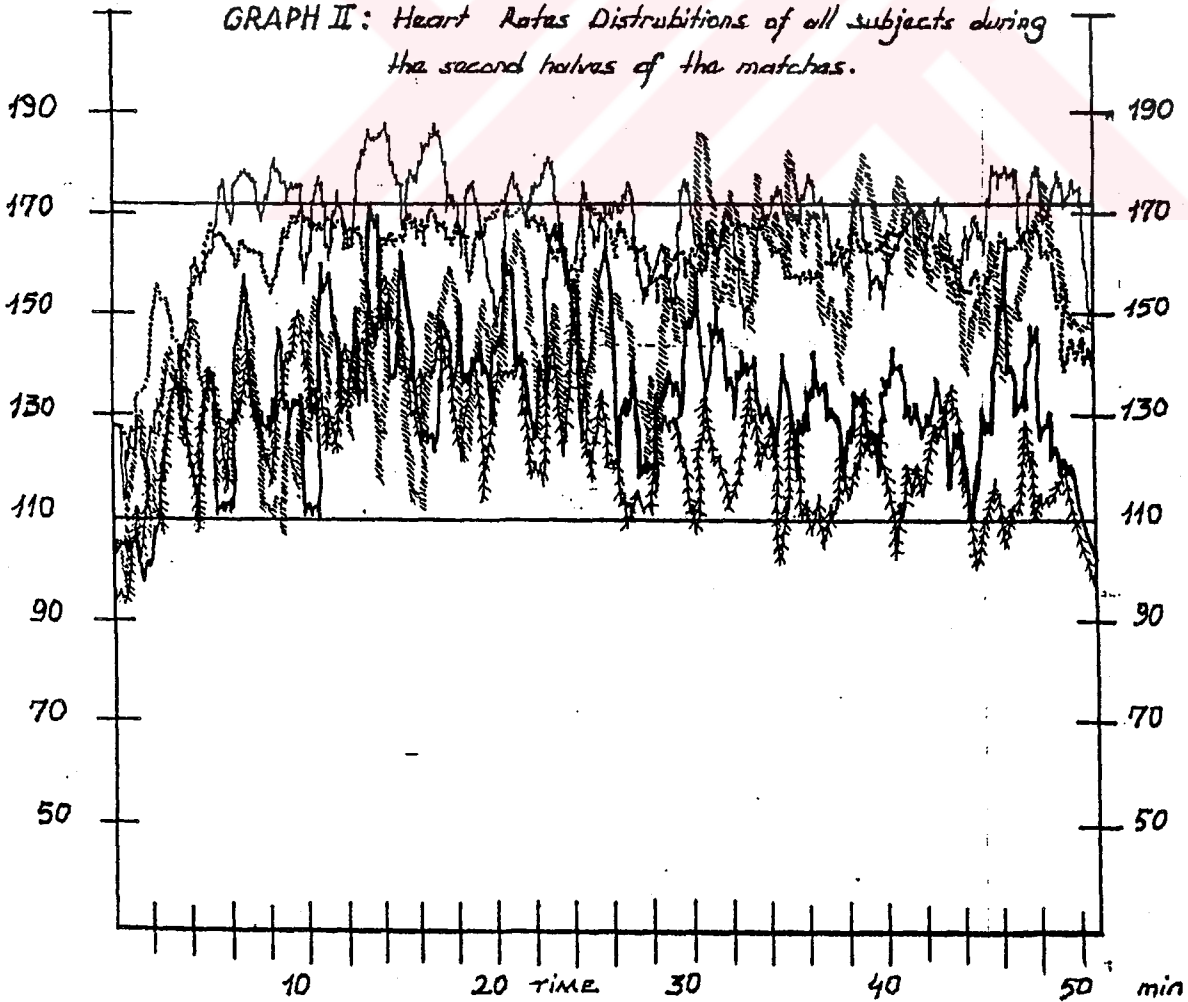


Table XIII. Averages of all five Subjects' Locomotor Motions

Item	Task/ Activity	First Half Dist.% of Dist.	Second Half Dist.% of Dist.	Total Dist.% of Dist.
1	Walking	66m % 12	1093m % 18	1858m % 30
2	Jogging	2059m % 33	1470m % 24	3534m % 57
3	Fast Running	233m % 3.7	181m % 3	414m % 6.7
4	Backward Run.	219m % 3.5	104m % 1.7	323m % 5.2
5	Sideway Run.	21m % 0.55	22m % 0.55	43m % 1.1
6	Total	3298m % 53.4	2868m % 46.5	6166m % 100

The mean, vaule of total distance covered by referees was 6166 m. The mean, vaule of distance covered in the first half was 3298 m (53.4%) and the mean value of distance covered in the second half was decreased to 2868 m (46.5%).

The mean, value of walking in the first half was 766 m (12%) and 1093 m (18%) in the second half. The mean, value o walking was 1858 m (30%) for whole game.

The mean, value of jogging in the first half was 2059 m (33%) and 1470 m (24%) in the second half. The mean, value of jogging was 3534 m (57%) for whole game.

The mean, value of fast running in the first half was 233 m (3.7%) and 181 m (3%) in the second half. The mean, value of fast running was 414 m (6.7%) for whole game.

The mean value of backward running in the first half was 219 m (3.5%) and 104 m (1.7%) in the second half. The mean, value of backward running was 323 meter (5.2%) for whole match.

The mean value of sideway running in the first half was 21 m (0.55%) and 22 m (0.55%) in the second half. The mean, value of sideway running was 43 m (1.1%) for whole match.

So, the mean value of walking in the second half increased (765.6 m 1092.6 m): At the other side the mean values of jogging and fast running in the second half decreased. The mean heart rate of referees during the match were 147.4 beats/min in the first half and 145.5 beats/min in the second half. These coressponded to 81.1% and 79.7% of the maximal heart rate. During the game distance covered was 6166 m. The slightly lower heart rates in the second half were likely to have been due to reduced work rate since referees covered 430 meter less in the second half than in the first half. First and second subjects covered more distance than others and this might have been the reflection of their higher physical capacity.

As the results shown, referee covered distance aproximately 6166 meter distance during the 90 min soccer match. But in general all subject's work rate decreased at the second halves. This decrease might have been due to fatigue, importance of game, surface of the field, weather.

CHAPTER V

Conclusion And Recommendation

Today's fast action of the game with every changing direction and speed, requires the referee to be close to the ball which means, referee must be all over the field and be able to keep up with the pace of the game.

Based on above facts, the purpose of this study was to predict the percentage of various energy sources used by the referee and determining the type of locomotor movements and their frequencies during the 90 min soccer match.

Within the limits of this study, the following conclusion were made.

1. The subjects' had mean estimated maximum heart rate of 181.8 beats/min.
2. The subjects' had mean resting heart rate of 70.4 beats/min.
3. The subjects' had mean estimated A.T.L. of 171.4 beats/min.
4. The subjects' had mean average heart rate of 146.5 beats/min for whole match period.
5. The subject's had mean period worked below A.T.L. of 76.56%.

6. The subject's had mean walking of 1858.2 m (30%).

7. The subject's had mean jogging activity of 3533.6 m (57%).

8. The subject's had mean fast running of 413.8 m (6.7%).

9. The subject's had mean backward running of 323 m (5.2%).

10. The subject's had mean sideways running of 42.6m (1.1%).

11. The subject's had mean total distance covered of 6166 m

Referees worked below ATL 76.56% of the time. This means, refereeing activities need energy from aerobic metabolism in this proportion. Energy for the short sprints done by the referees is obtained from anaerobic breakdown of glycogen. Since subjects of this study performed 5.2% of their locomotor motions in fast run and in short sprints form, it is important for the referees not to get involved with vigorous activities the day before and/or the morning of the match day they are assigned to officiate. So they could store enough glycogen.

Analysis of the referees locomotor motions reflect

knowledge in preparation individualized training program. Their training intensity and load can be arranged by looking at results of their locomotor motions analysis.

Recommendations:

In order to obtain valid results several recommendations could have been made. These recommendations were as follows.

1. Knowing referees' true max. H.R. and A.T.L. is significant to further studies and/or prepare individualized training programs. Therefore, referees should go through stress testing regularly on yearly base.

2. Multiple game measurements for each referee should be used for further studies.

3. Cinemografik method should be used to analyses the referees' locomotor motions.

4. More subject's should be used for further studies.

5. A.T.L. should be determined.

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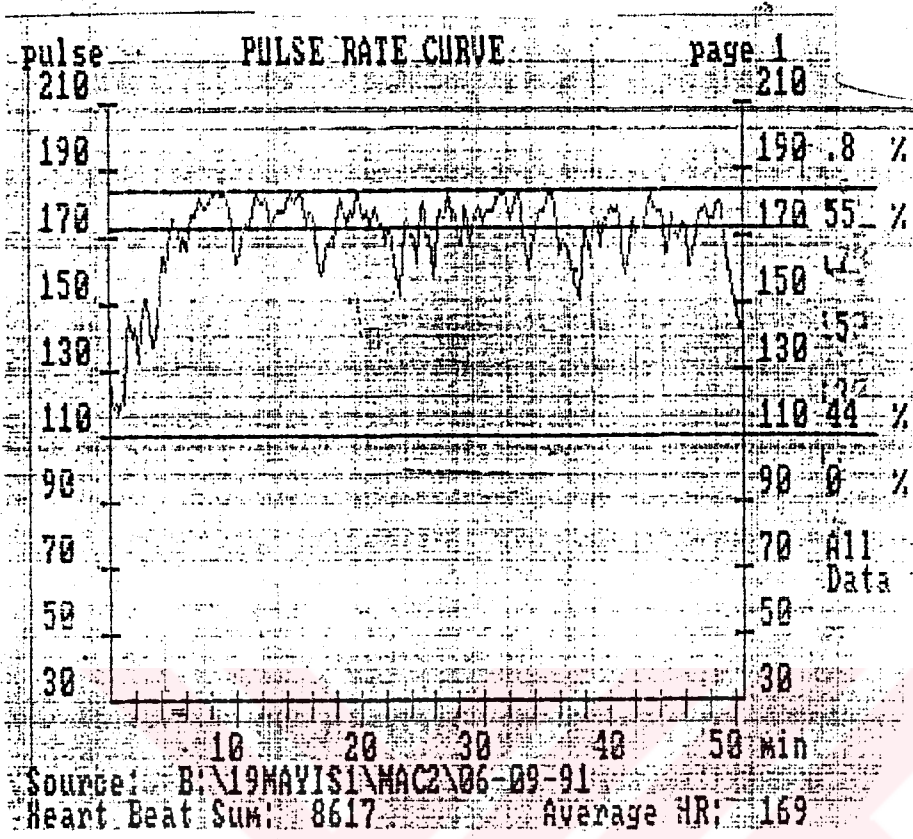
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Physiological Load Imposed on Soccer Players During
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APPENDIX A
PERSONAL FORM

Name of Referee :
Age :
Game Location :
Weather :
Field Condition :
Date :
Cup/ league/international game :
Other Remarks :



APPENDIX B



SUMMARY

Identifier (Level 2): MAC2

Time min.

Totals:

Source : B:\19MAYIS1\MAC2
Date : 06-09-91

Total time : 50.8 min

Over Anaer. limit: 28.4 min = 55.9 %
Between Anaer.-Aerob. limit: 22.4 min = 44.1 %
Below Aerob. limit: 0 min = 0 %

Anaer. limit : 173
Aerob. limit : 110



SUBJECT I

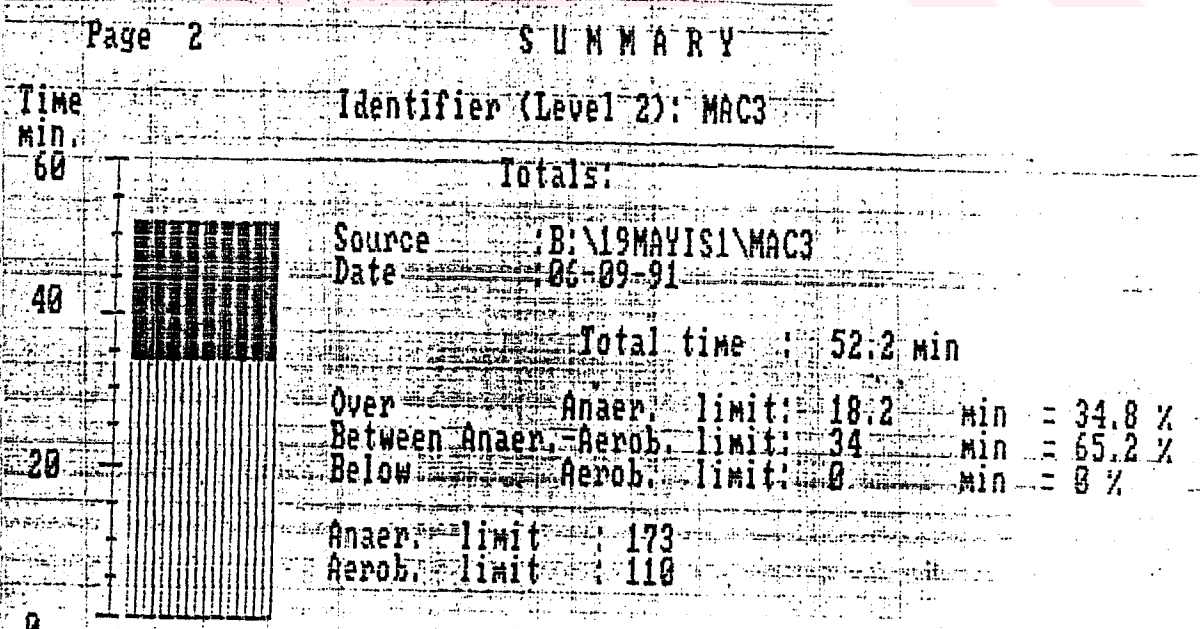
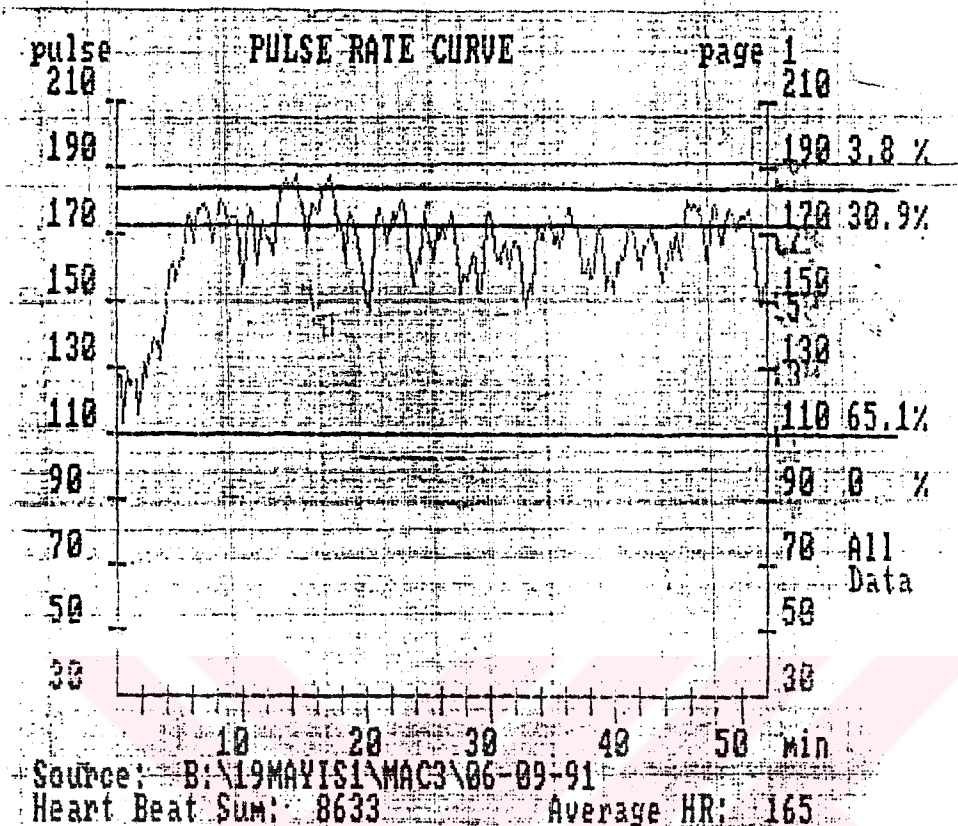
FIRST HALF

page 1 PULSE RATE LISTING Copyright by Polar Electro

Time (min.)

Starting Time: 0 : 0 : 0

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49	178	175	170	165	166	164	160	158	158	156	153	150
50	151	150	147	144	143	143	143	145	146			
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SUBJECT II
SECOND HALF

page 1

PULSE RATE LISTING

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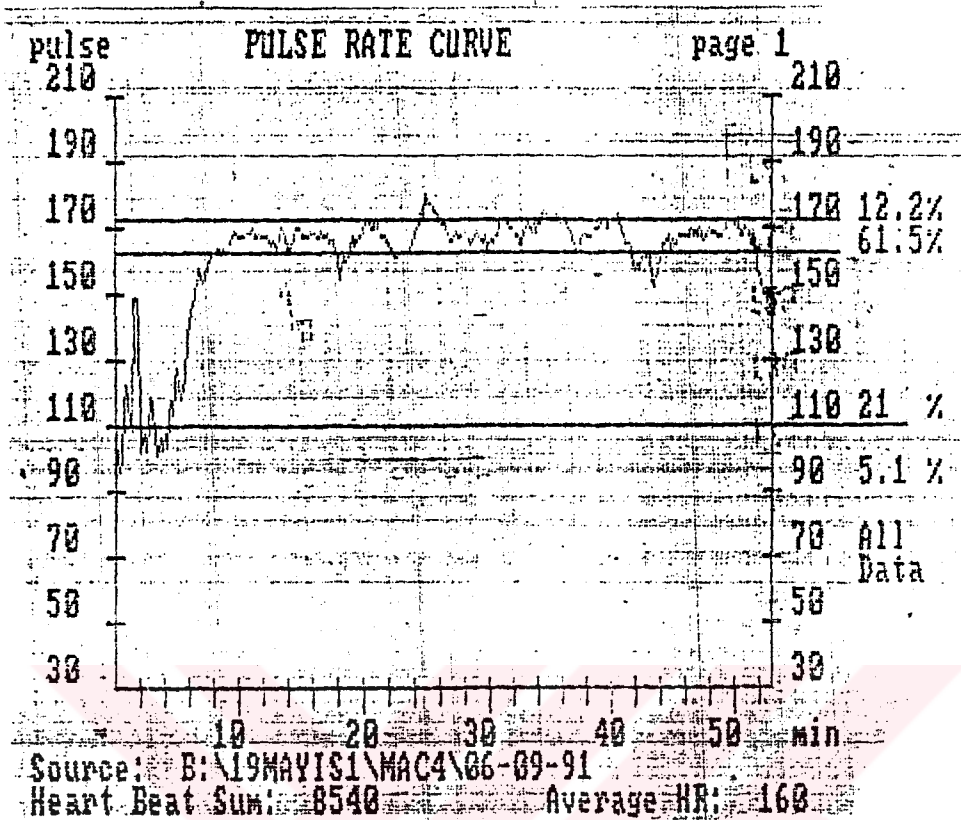
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17	188	188	184	182	181	182	179	175	171	172	174	174
18	172	170	168	160	161	167	173	175	176	176	175	174
19	174	173	171	169	168	165	163	162	160	158	155	152
20	150	151	149	152	148	150	157	164	169	173	174	176
21	178	178	177	176	174	172	170	168	168	170	171	170
22	171	174	176	175	174	173	175	178	178	180	180	180
23	179	176	175	172	168	165	161	160	159	158	155	157
24	161	163	162	159	161	165	170	174	176	175	173	169
25	168	167	167	164	162	160	164	169	172	172	169	167
26	170	172	172	171	169	171	172	172	173	175	176	176
27	175	173	170	168	164	162	158	152	152	154	158	157
28	157	157	156	155	159	162	163	164	164	163	162	159
29	154	155	152	153	154	157	163	169	174	176	176	176
30	176	175	172	168	166	164	163	163	163	162	161	163
31	166	168	168	167	162	160	160	159	162	167	168	167
32	167	165	166	165	166	164	157	155	152	151	149	151
33	151	154	155	152	153	158	163	169	172	174	173	172
34	169	169	169	171	173	175	174	174	175	174	172	170
35	168	165	167	170	170	169	166	166	169	171	170	171
36	174	176	177	178	178	175	174	172	172	173	173	172
37	171	168	167	166	159	159	159	155	159	163	163	162
38	157	157	157	156	159	165	169	170	171	172	171	169
39	166	163	161	155	154	155	156	159	159	158	156	152
40	152	158	161	160	159	162	164	164	162	162	164	166
41	169	172	173	173	173	172	170	169	168	165	162	162
42	162	159	160	164	166	165	166	167	167	169	171	171
43	169	168	168	168	167	163	160	159	159	155	156	158
44	161	162	163	166	167	165	162	166	167	168	170	169
45	166	163	163	165	169	173	174	178	180	180	179	178
46	178	178	179	179	179	178	178	178	179	177	172	170
47	170	168	162	164	163	165	171	176	177	179	179	179
48	177	174	171	167	168	165	168	170	173	175	176	177
49	177	177	176	176	174	170	171	173	174	175	175	175
50	175	175	175	176	176	178	178	178	174	171	168	165
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52	153											

Final Time: 52 : 4 : 2

SUBJECT II
FIRST HALF



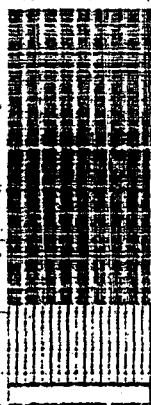
Page 2

SUMMARY

Time
min.
60

Identifier (Level 2): MAC4

Totals:



Source : B:\19MAYIS1\MAC4

Date : 06-09-91

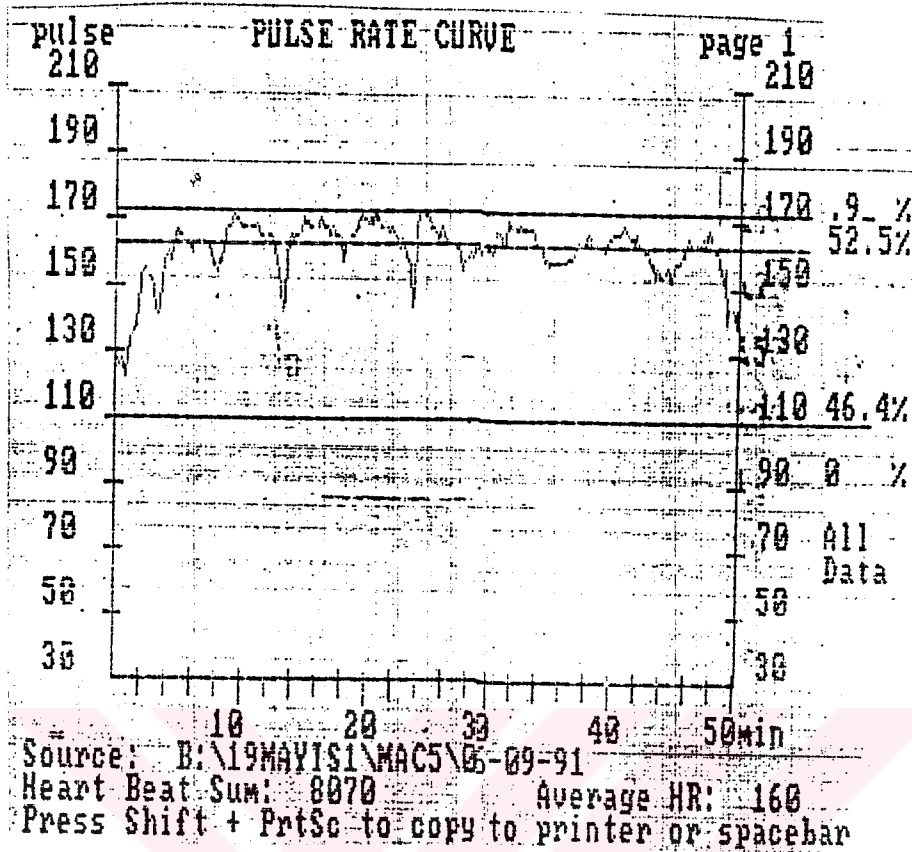
Total time : 53.2 min

Over	Anaer. limit:	39.3	min =	73.8 %
Between	Anaer. Aerob. limit:	11.2	min =	21 %
Below	Aerob. limit:	2.8	min =	5.2 %

Anaer. limit : 163
Aerob. limit : 110

SUBJECT II
FIRST HALF

page	PULSE RATE LISTING												Copyright by Polar E
Time (min.)													
Starting Time: 0 : 0 : 0													
0	106	103	99	94	96	99	100	108	116	121	122	124	
1	118	115	110	109	109	109	149	149	149	149	149	149	
2	102	104	106	108	107	104	103	108	110	114	119	121	
3	116	110	106	105	101	102	102	103	106	102	102	102	
4	107	105	104	109	112	114	118	117	114	118	122	127	
5	128	125	123	126	119	120	122	122	124	128	136	138	
6	141	143	145	146	146	146	150	153	154	155	157	156	
7	155	154	154	155	155	155	158	160	160	161	161	162	
8	162	162	163	164	164	164	164	163	163	163	164	164	
9	163	163	163	164	165	167	167	168	169	169	169	168	
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11	169	169	170	168	168	167	168	168	169	169	168	169	
12	168	167	167	167	167	168	166	165	165	168	166	165	
13	165	164	164	166	167	169	170	171	169	169	166	165	
14	164	164	164	164	164	166	168	170	170	170	170	169	
15	170	169	168	167	168	168	168	168	168	168	169	169	
16	169	168	169	168	168	167	168	168	169	168	167	168	
17	168	168	169	167	165	166	166	166	166	164	163	161	
18	160	158	155	158	158	159	161	160	160	160	161	164	
19	164	166	167	165	165	164	166	166	167	167	167	168	
20	169	170	172	172	173	171	171	170	170	171	170	171	
21	172	170	170	170	168	167	168	168	167	167	166	166	
22	165	164	163	164	164	162	161	161	161	161	162	163	
23	162	162	162	161	162	162	163	163	163	164	166	168	
24	167	167	170	170	171	172	173	172	172	178	180	179	
25	179	178	178	177	177	177	175	175	175	173	173	173	
26	173	172	171	171	171	171	171	169	168	166	166	166	
27	166	166	168	170	169	169	167	167	167	168	168	169	
28	169	168	167	166	166	165	165	166	166	167	168	170	
29	169	169	168	167	166	165	165	167	167	165	164	164	
30	165	166	166	165	165	166	167	166	167	170	170	171	
31	172	172	173	172	172	172	171	169	170	169	170	170	
32	170	170	168	169	168	166	165	165	165	168	169	170	
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36	172	172	172	172	171	170	170	170	169	167	166	165	
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39	170	170	171	173	172	172	172	170	170	169	170	172	
40	172	172	172	172	172	173	174	173	172	171	169	168	
41	168	166	165	166	165	165	165	163	162	161	159	157	
42	157	159	159	159	158	159	160	161	162	162	161	161	
43	162	162	162	161	154	154	153	155	155	154	156	158	
44	161	164	165	165	165	166	166	166	167	166	164	165	
45	166	165	164	165	165	166	167	167	168	168	168	168	
46	167	167	168	167	167	169	170	169	168	169	169	169	
47	168	168	170	169	168	167	166	166	167	168	168	169	
48	170	169	169	169	169	169	169	168	168	167	167	168	
49	167	169	169	168	170	171	172	172	173	174	173	172	
50	171	171	173	172	171	169	168	167	168	169	170	170	
51	170	169	167	166	165	165	165	165	166	163	159	157	
52	155	155	153	151	150	150	150	150	147	147	146	147	
53													
Final Time: 53 : 0 : 3													



S U M M A R Y

Time
min.

Identifier (Level-2): MAC5

Totals:

Source : B:\19MAYIS1\MAC5
 Date : 06-09-91

Total time : 50.3 min

Over Anaer. limit: 26.9 min = 53.6 %
 Between Anaer.-Aerob. limit: 23.3 min = 46.4 %
 Below Aerob. limit: 0 min = 0 %

Anaer. limit : 163
 Aerob. limit : 110



SUBJECT II

SECOND HALF

page 2

PULSE RATE LISTING

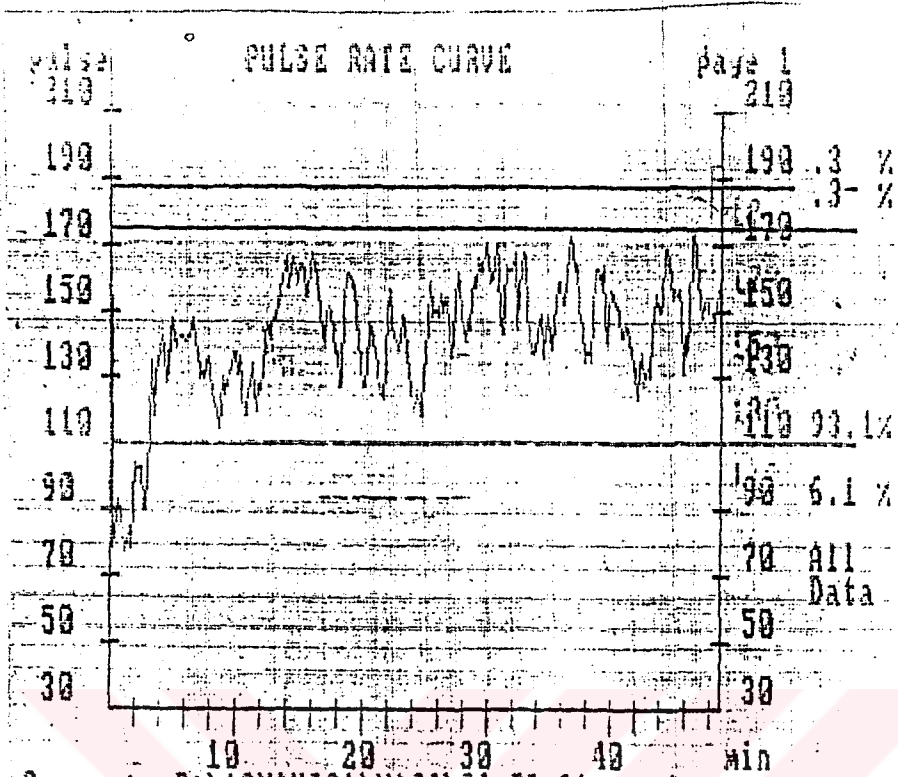
Copyright by Polar Electro

Starting Time: 0 : 0 : 0

0	128	128	128	126	126	127	128	128	125	124	123	123
1	127	129	134	134	135	135	136	137	137	137	142	147
2	151	152	154	154	155	154	154	153	153	152	151	152
3	149	147	142	141	141	142	143	147	151	155	158	159
4	159	159	160	160	158	159	160	163	165	166	166	165
5	165	166	165	164	164	164	162	162	162	162	161	160
6	160	161	162	162	163	164	164	164	163	162	164	163
7	163	163	162	160	161	160	159	157	156	157	156	154
8	154	156	157	156	158	159	161	163	165	168	168	168
9	168	167	169	168	171	169	170	170	170	170	169	168
10	168	168	168	167	167	169	169	171	167	168	168	168
11	168	168	169	168	166	165	165	164	165	163	163	162
12	163	164	165	166	165	164	164	164	161	157	156	155
13	155	152	148	146	143	145	146	152	156	161	164	164
14	165	163	163	164	165	165	165	164	165	165	165	166
15	170	170	169	169	169	169	168	168	167	167	168	166
16	165	166	168	169	170	168	169	167	168	168	167	165
17	165	166	165	167	167	166	165	164	165	164	165	165
18	162	159	158	158	161	162	162	162	162	164	165	165
19	165	165	166	166	167	168	170	170	171	170	170	171
20	170	169	169	170	170	169	169	171	172	171	170	170
21	170	169	168	168	167	169	169	168	167	167	166	166
22	167	166	166	164	165	164	164	161	161	163	164	164
23	163	160	159	159	157	157	155	150	144	145	147	147
24	166	169	171	173	172	173	172	171	171	171	171	170
25	170	167	168	168	167	166	166	164	164	165	165	165
26	167	166	165	165	164	163	164	164	164	162	162	163
27	163	163	161	161	161	160	159	157	155	156	158	159
28	158	158	159	160	160	159	159	159	160	161	162	161
29	161	159	160	162	160	162	162	162	163	162	161	161
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31	164	164	163	163	164	169	170	170	169	168	168	168
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33	168	168	167	166	167	166	167	168	166	164	163	164
34	163	163	163	161	161	159	158	158	159	158	156	156
35	157	157	157	157	157	157	158	159	158	157	158	157
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37	161	162	164	164	163	163	163	164	164	163	164	165
38	166	165	164	163	162	163	162	164	164	164	162	162
39	162	164	162	161	161	162	163	165	165	166	165	165
40	166	165	166	166	166	166	166	167	168	169	169	168
41	167	167	166	164	165	166	165	165	164	164	166	165
42	163	162	162	162	162	160	161	161	161	161	159	157
43	157	157	157	155	154	156	156	154	154	154	154	154
44	154	154	155	155	156	155	154	152	153	156	156	156
45	157	159	158	156	157	158	160	161	160	161	163	165
46	165	164	163	162	162	162	163	162	164	164	163	163
47	164	164	165	164	164	164	165	166	167	167	165	162
48	162	161	161	161	162	159	157	158	156	153	152	153
49	156	144	140	140	143	145	145	144	144	146	142	139
50	139	144										

Final Time: 50 : 8 : 6

SUBJECT III
FIRST HALF



Source: B:\19MAYIS1\MAC6\06-09-91
Heart Beat Sum: 6971 Average HR: 142

Page 1

SUMMARY

Time
min.

Identifier (Level 2): MAC6

Totals:

Source: B:\19MAYIS1\MAC6
Data: 06-09-91

Total time: 48.9 min

Over Anaer. limit: 3 min = .7 %
Between Anaer.-Aerob. limit: 45.6 min = 93.2 %
Below Aerob. limit: 3 min = 6.1 %

Anaer. Limit : 175
Aerob. Limit : 110

SUBJECT III

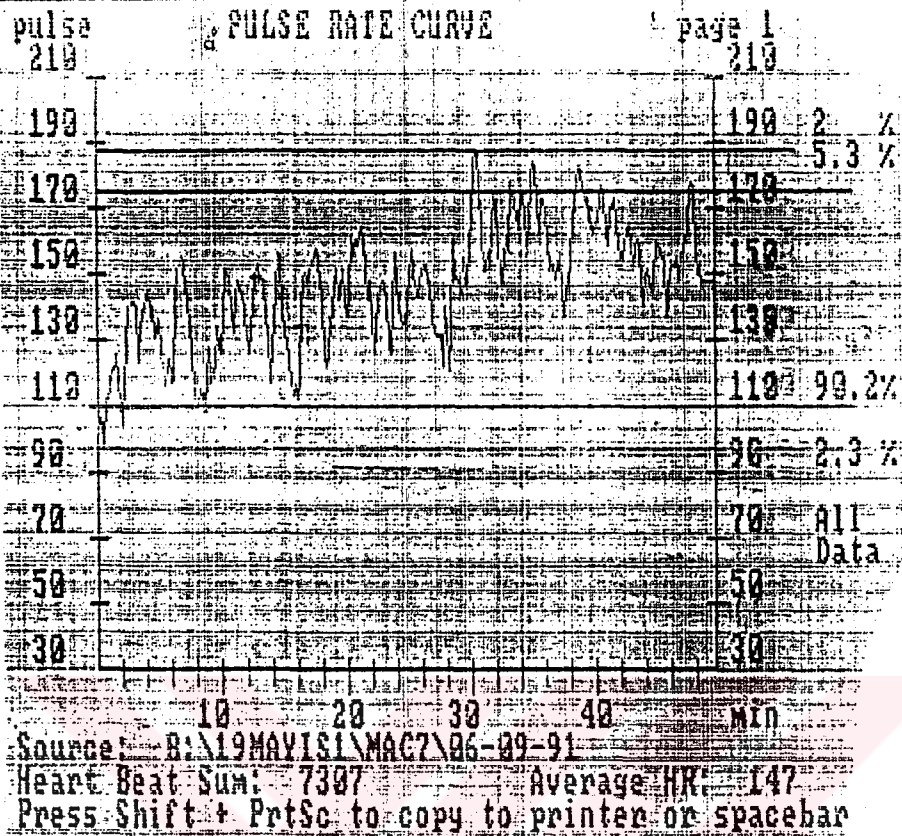
FIRST HALF

page 1 PULSE RATE LISTING Copyright by Polar Elect

Time (min:)

Starting Time: 0 : 0 : 0

0		79	84	83	88	89	90	92	92	87	85	
1	83	79	77	76	81	90	85	79	79	87	92	99
2	104	105	102	103	103	104	102	97	90	95	90	92
3	100	109	114	125	135	134	119	124	130	135	136	139
4	138	140	143	143	138	132	129	129	132	137	142	145
5	147	145	141	139	140	143	143	144	142	143	142	141
6	141	140	142	142	143	145	146	148	148	143	140	139
7	137	136	130	130	131	129	130	131	134	134	136	134
8	133	125	123	125	124	120	117	116	115	117	120	121
9	130	130	125	126	128	129	133	133	132	133	137	139
10	138	131	131	135	136	131	128	126	116	117	120	128
11	126	129	128	133	134	128	125	122	120	125	128	130
12	126	128	131	136	141	145	146	144	144	143	146	147
13	147	146	148	150	152	152	156	159	160	162	164	166
14	166	164	158	158	162	168	168	163	161	159	159	159
15	164	165	164	162	161	158	155	153	156	157	162	163
16	168	167	164	161	160	159	156	152	150	147	142	141
17	141	145	149	151	151	152	150	146	143	138	138	138
18	138	130	127	129	129	129	153	158	161	163	161	160
19	160	160	158	157	157	154	148	144	141	141	134	134
20	127	122	127	130	133	140	146	147	145	145	141	138
21	137	134	132	130	125	124	125	120	124	125	133	145
22	153	158	156	150	146	144	142	142	141	138	139	140
23	142	145	149	146	146	138	137	132	130	129	127	122
24	120	122	122	119	126	122	119	118	119	127	132	133
25	135	138	147	155	159	154	149	144	150	151	150	149
26	149	153	155	151	150	151	153	153	155	149	144	140
27	136	139	141	145	151	159	161	161	158	153	147	144
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29	158	162	166	165	162	162	163	165	167	171	170	166
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31	147	147	144	147	153	160	164	162	163	164	162	161
32	164	166	167	160	145	146	155	162	162	164	168	168
33	165	160	151	146	142	137	137	138	138	135	139	142
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35	141	138	139	142	146	149	152	155	159	162	159	154
36	152	151	153	157	159	165	170	172	172	171	169	164
37	162	164	164	160	151	146	147	149	146	144	135	135
38	138	138	138	135	135	141	147	151	162	164	163	166
39	160	156	159	163	164	156	148	141	141	143	149	154
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41	143	147	146	146	145	141	140	141	138	135	132	134
42	133	129	124	128	133	138	138	136	127	128	131	133
43	132	132	130	137	144	147	149	153	155	153	151	150
44	150	150	153	163	169	171	169	167	164	161	159	153
45	154	156	156	154	155	157	156	149	149	133	131	135
46	142	145	139	140	149	161	170	176	175	170	165	161
47	160	159	153	149	149	148	153	157	154	152	151	150
48	147	145	149	149	148	152	154	154	155	156		
	Final Time:		48	:	46	:	7					



Page 1 SUMMARY

Time min. Identifier (Level 2): MAC7

Totals:

Source	B:\19MAYIS1\MAC7		
Date	06-09-91		
Total time	49.6 min		
Over	Anaer. limit: 3.7	min = 7.4 %	
Between	Anaer. limit: 44.8	min = 90.3 %	
Below	Aerob. limit: 1.2	min = 2.4 %	
Anaer. limit	175		
Aerob. limit	110		

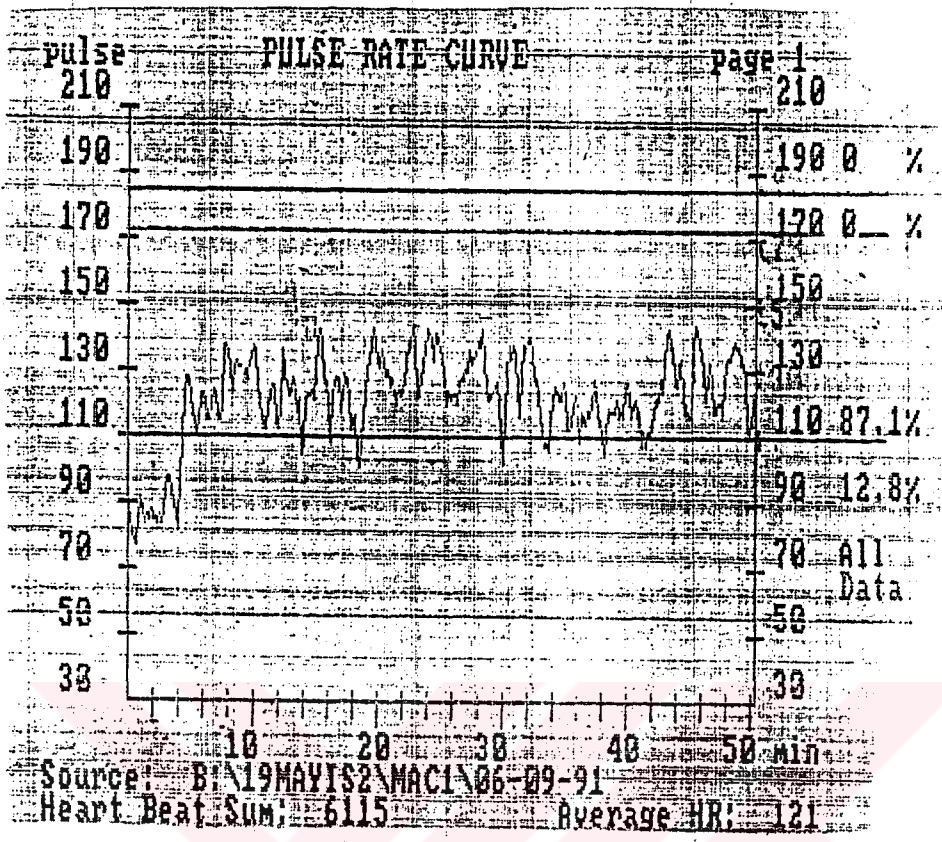
SUB
SECOND HALF

page 2 PULSE RATE LISTING Copyright by Polar Electro

Starting Time: 0 : 0 : 0

0	103	105	106	105	105	108	99	106	112	112	112	112
1	115	122	122	122	121	123	125	121	117	117	111	107
2	105	113	117	122	129	131	139	139	141	142	141	139
3	141	143	139	128	124	124	134	134	137	139	140	139
4	144	146	145	140	138	139	140	137	131	133	132	133
5	136	131	126	125	121	121	116	120	122	124	125	120
6	118	115	119	133	143	142	150	149	153	156	155	152
7	152	149	146	146	142	137	134	129	127	122	113	107
8	110	111	110	113	115	110	114	109	109	115	119	129
9	128	124	118	118	120	120	122	129	134	131	128	129
10	126	127	137	147	151	149	150	150	148	145	138	136
11	132	133	143	147	148	148	146	144	143	141	140	138
12	129	126	126	129	132	134	141	145	149	153	152	149
13	147	147	149	148	146	145	138	132	131	124	118	122
14	129	134	135	139	145	154	156	156	154	151	139	132
15	132	131	129	125	124	120	116	117	114	116	116	108
16	113	110	118	130	140	144	149	152	150	146	147	149
17	151	152	153	154	155	156	157	156	154	150	147	145
18	143	129	124	119	123	127	126	124	134	139	140	143
19	146	151	151	149	143	141	144	149	151	150	141	141
20	137	139	144	152	161	161	156	159	160	159	159	160
21	163	165	164	162	159	157	151	145	143	145	147	139
22	136	130	126	130	132	135	142	145	146	146	147	146
23	145	144	142	135	127	131	128	131	140	155	156	152
24	148	144	140	138	136	133	135	134	135	140	141	143
25	149	156	158	155	150	146	146	144	144	144	147	148
26	151	152	153	156	153	149	147	146	148	137	136	136
27	133	131	131	133	131	130	131	117	123	134	140	139
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29	148	141	145	151	155	152	146	146	148	152	159	167
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32	173	169	159	154	150	147	148	150	155	160	161	157
33	157	171	178	177	174	171	171	167	166	164	164	170
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35	184	185	183	177	170	166	163	166	173	176	173	168
36	168	168	160	153	151	151	152	152	152	153	149	150
37	152	156	156	157	145	135	137	143	146	146	146	150
38	155	161	166	171	172	175	178	181	183	183	181	179
39	175	173	173	172	172	170	168	166	164	160	163	164
40	165	165	166	169	171	173	176	176	175	169	161	158
41	159	165	170	173	170	170	173	171	165	159	159	157
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43	154	159	158	157	160	160	158	152	145	142	141	144
44	149	149	151	148	146	144	146	144	147	153	160	159
45	159	159	156	155	155	155	153	149	138	138	141	148
46	154	154	153	150	153	157	155	153	149	152	156	158
47	158	160	160	163	164	170	176	178	178	175	176	167
48	155	135	150	153	152	149	146	149	148			
49												

Final Time: 49 : 28 : 8



Page 1

S U M M A R Y

Time
min

Identifier (Level 2): MAC1

Totals:

Source: B:\19MAYIS2\MAC1
Date: 06-09-91

Total time: 50.5 min

Over Anaer. limit: 0 min = 0 %
Between Anaer.-Aerob. limit: 44 min = 87.1 %
Below Aerob. limit: 6.5 min = 12.9 %

Anaer. limit : 173
Aerob. limit : 110

SUBJECT LV
FIRST HALF

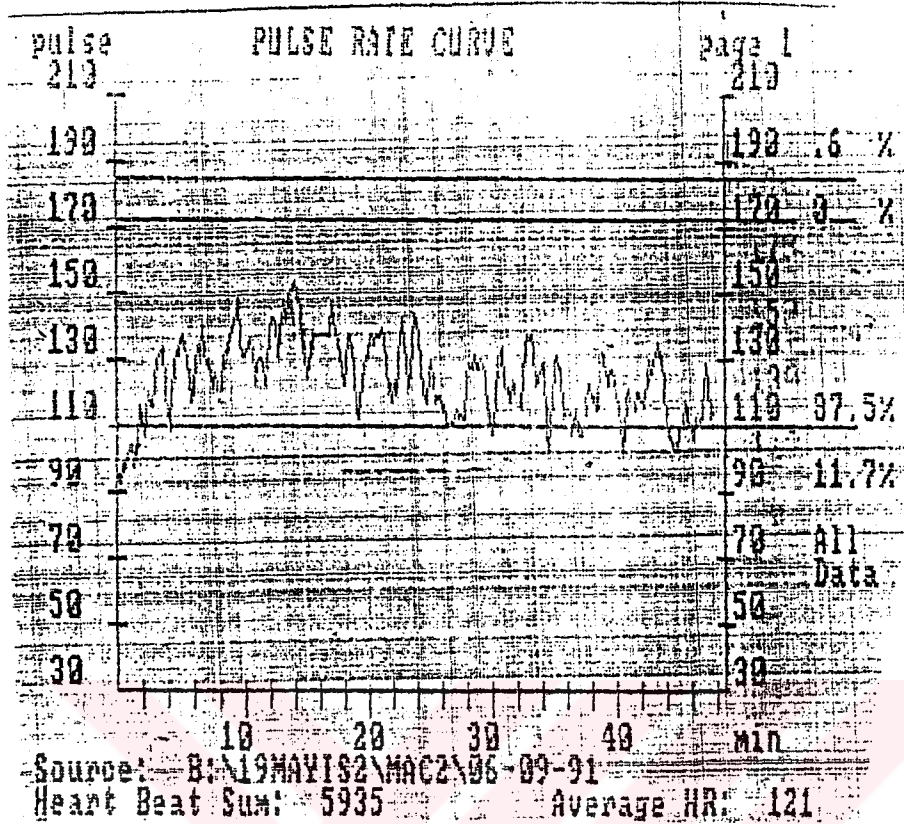
Time (min.)

Starting Time: 0 : 0 : 0

0			102	98	103	108	111	110	109	110	104	
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2	120	113	117	117	110	99	93	91	98	98	98	129
3	129	129	129	129	141	140	140	140	140	140	140	140
4	140	140	140	140	140	161	161	161	161	161	161	161
5	153	153	153	153	153	147	147	147	147	145	145	145
6	145	145	145	145	145	161	161	161	161	158	158	158
7	158	158	157	157	157	157	157	157	147	147	147	147
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10	169	169	173	174	174	173	171	171	171	183	174	174
11	167	167	165	159	159	151	151	155	156	157	158	158
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13	166	166	166	166	166	166	166	162	162	162	158	158
14	155	155	150	151	151	148	149	149	149	149	165	164
15	164	158	160	156	156	147	147	147	147	147	147	147
16	147	156	156	156	156	161	161	163	163	163	163	163
17	161	161	161	161	161	161	161	160	159	159	159	143
18	142	144	145	145	145	145	153	157	160	158	151	149
19	149	166	168	168	168	168	172	172	166	167	163	164
20	166	166	166	166	166	166	163	163	158	158	158	148
21	147	147	127	127	127	145	151	151	151	151	151	157
22	157	157	157	154	154	154	154	154	173	173	172	169
23	169	169	169	161	154	147	146	146	145	143	145	139
24	138	138	137	137	137	137	137	160	156	154	156	156
25	155	148	144	144	144	138	138	140	145	145	144	144
26	144	144	142	141	141	141	136	137	137	143	141	141
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29	142	156	155	155	156	156	155	148	142	133	130	131
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32	152	152	157	154	152	149	148	148	148	170	170	171
33	171	168	160	155	155	155	132	131	133	133	139	140
34	143	143	143	144	145	153	155	155	166	166	170	168
35	164	163	164	164	158	158	155	152	146	146	146	153
36	158	155	153	152	152	144	145	145	145	141	141	141
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38	133	134	132	129	126	113	114	121	130	126	126	126
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42	156	154	154	155	154	142	139	139	140	141	137	134
43	128	126	121	120	130	133	135	135	133	132	130	130
44	139	141	149	149	150	151	151	150	149	147	147	147
45	147	144	142	140	140	140	140	140	142	140	140	139
46	138	139	141	140	140	128	127	127	150	150	150	155
47	152	152	142	145	145	140	133	133	131	133	133	148
48	133	152	152	153	152	150	147	144	144	119	120	123
49	123	123	138	138	137	132	133	134	137	141	140	133
50	128	120										

Final Time: 50 : 14 : 2

SUBJECT IV
SECOND HALF



Page 1

S U M M A R Y

Time Identifier (Level 2): MAC2
min.

Totals:

Source: B:\19MAYIS2\MAC2
Date: 06-09-91

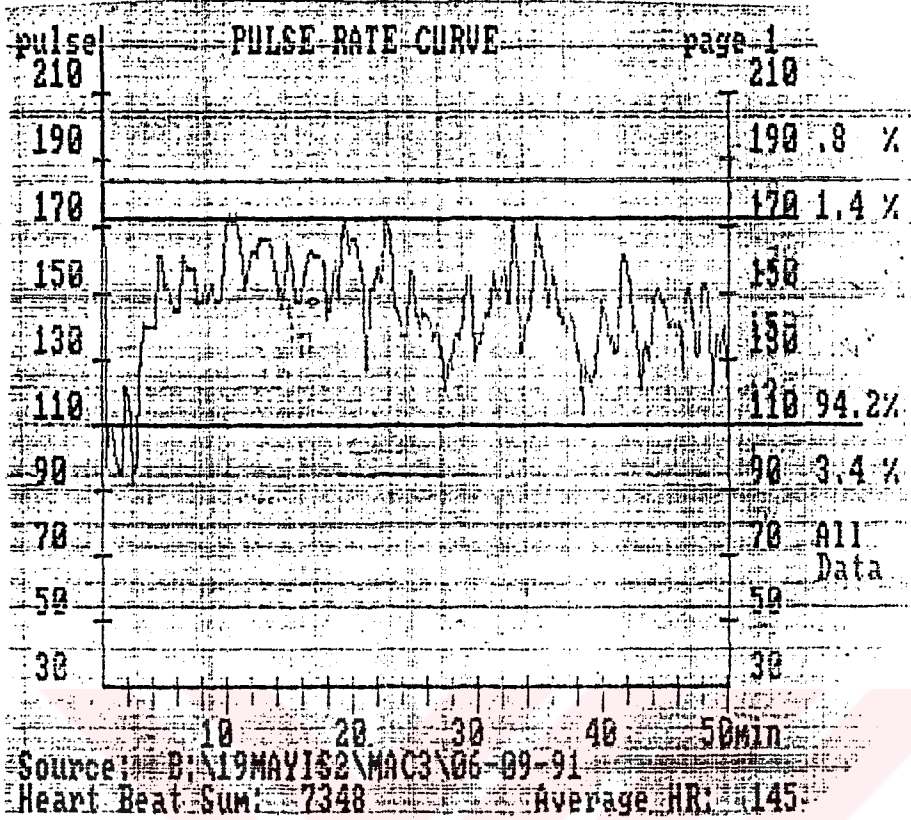
Total time: 48.8 min

Over Anaer. limit: 3 min = 7 %
Between Anaer.-Aerob. limit: 42.7 min = 87.5 %
Below Aerob. limit: 5.7 min = 11.8 %

Anaer. limit: 173
Aerob. limit: 110

SUBJECT IV
SECOND HALF

page	PULSE RATE LISTING											Copyright by Polar file
Time (min.)												
	Starting Time: 0 : 0 : 0											
0	90	93	95	89	92	97	99	100	98	101	100	100
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3	123	126	130	130	131	133	133	132	134	129	121	115
4	112	105	109	115	121	126	128	132	133	132	131	132
5	136	137	137	136	134	133	129	126	124	120	118	118
6	120	125	130	132	134	131	130	134	140	136	131	130
7	129	131	130	128	124	122	122	126	126	126	122	121
8	117	121	124	127	130	134	132	132	132	134	138	140
9	139	141	141	142	145	148	149	140	134	134	131	129
10	131	134	132	132	134	134	136	133	132	125	123	125
11	127	126	130	131	130	132	129	124	122	124	127	131
12	137	140	142	141	145	144	141	133	131	132	136	140
13	144	146	145	141	142	146	149	151	151	148	151	153
14	154	151	149	150	147	148	145	141	134	129	130	126
15	125	125	127	130	132	134	137	139	137	138	137	
16												147
17	147	144	141	139	139	138	134	132	132	129	126	122
18	122	124	128	134	137	140	138	136	133	131	127	117
19	114	112	113	114	117	119	123	126	127	132	131	130
20	131	134	137	135	137	139	135	137	138	135	137	137
21	137	139	140	138	135	130	128	122	120	120	123	122
22	118	124	124	121	120	119	129	133	139	142	142	137
23	134	134	129	124	122	124	125	132	136	141	144	140
24	141	139	136	134	129	120	120	117	119	118	118	124
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32	116	116	116	112	116	120	125	130	133	135	137	137
33	136	138	138	137	133	132	122	119	124	127	128	129
34	127	129	130	119	108	107	102	103	110	113	118	124
35	129	131	131	128	127	128	128	122	113	110	114	114
36	115	113	112	112	107	107	110	112	115	113	109	113
37	108	108	108	109	111	111	115	118	122	125	122	124
38	119	120	119	121	115	112	116	127	130	132	133	132
39	130	127	126	121	122	125	127	129	128	125	123	121
40	121	117	114	115	111	98	103	106	108	118	119	121
41	121	116	116	114	116	114	115	117	121	120	119	118
42	118	118	116	116	119	122	125	128	130	125	126	129
43	130	129	131	133	135	134	131	132	131	129	122	116
44	111	110	107	107	106	105	104	104	102	106	104	102
45	107	111	111	110	110	116	117	114	113	113	111	112
46	110	110	106	106	111	114	114	114	111	109	113	116
47	122	124	129	130	122	118	112	113	114	115	115	113
48	115	117	119	119	116							
	Final Time: 48 : 36 : 0											



Page 1 SUMMARY

Time Identifier (Level 2): MAC3
min.

Totals:

Source: D:\19MAYIS2\MAC3
Date: 06-09-91

Total time: 50.3 min

Over Anaer. limit: 1.2 min = 2.3 %
Between Anaer.-Aerob. limit: 47.4 min = 94.2 %
Below Aerob. limit: 1.8 min = 3.5 %

Anaer. limit: 173
Aerob. limit: 110

SUBJECT V

FIRST HALF

page 1 PULSE RATE LISTING Copyright by Polar Elect

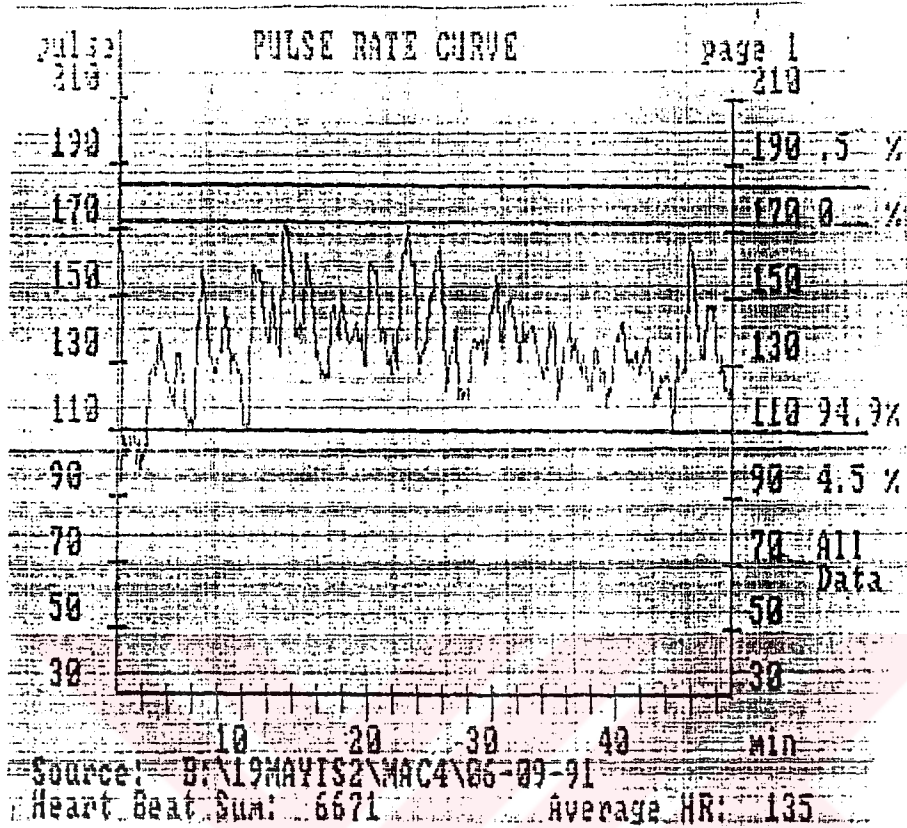
Time (min.)

Starting Time: 0 : 0 : 0

0	B2	81	86	85	80	80	79	80	78	79	85	86
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2	85	84	85	87	84	87	86	82	84	84	87	90
3	93	97	97	96	97	99	94	93	90	89	85	83
4	82	84	98	104	109	115	122	126	128	128	127	124
5	121	120	116	114	114	112	111	112	114	117	122	125
6	122	122	120	114	115	112	115	117	119	123	124	125
7	123	123	116	118	115	117	117	137	138	137	137	136
8	136	134	130	128	124	126	131	133	133	131	131	131
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10	137	138	135	131	125	122	121	118	115	115	114	111
11	112	112	117	122	123	125	125	124	125	121	114	112
12	112	117	117	127	136	132	129	126	125	123	122	123
13	124	128	127	125	123	118	118	118	121	113	105	107
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15	129	134	139	140	142	141	139	137	128	125	125	120
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17	118	119	123	126	129	129	126	123	121	119	113	113
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19	123	127	131	131	132	134	137	140	142	143	139	134
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21	125	126	128	126	124	120	120	124	125	123	122	123
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26	122	123	122	117	120	123	126	126	128	127	127	129
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35	122	120	112	114	113	112	114	114	119	124	123	122
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41	117	108	108	111	111	106	108	107	111	116	111	113
42	112	113	117	122	121	125	121	122	127	125	124	125
43	131	136	141	142	143	138	138	139	137	134	127	122
44	124	126	132	134	134	128	122	125	118	118	117	114
45	116	116	116	132	137	140	144	145	142	140	137	135
46	135	135	130	125	121	124	126	129	133	132	126	121
47	118	120	118	120	120	123	120	119	117	120	126	129
48	133	135	134	134	134	134	137	137	139	137	137	135
49	137	136	133	130	133	127	127	120	112	111	111	112
50	114	117	119	121	124							

Final Time: 50 : 23 : 5

SUBJECT V
SECOND HALF



Page 1

SUMMARY

Time
min

Identifier (Level 2): MAC4

Totals:

Source: B:\19MAYIS2\MAC4

Date: 06-09-91

Total time: 49.3 min

Over Anaer. limit: 3 min = 5 %
Between Anaer. Aerob. limit: 46.8 min = 94.9 %
Below Aerob. limit: 2.3 min = 4.6 %

Anaer. limit: 173

Aerob. limit: 110

SUBJECT V
SECOND HALF

Time (min.)	Starting Time: 0 0 0											
0			90	95	103	108	104	103	107	104	102	
1	105	109	110	108	110	104	100	105	106	109	99	102
2	101	103	105	105	105	124	127	127	127	127	130	127
3	126	129	133	137	139	137	133	130	129	125	127	121
4	120	119	122	116	118	118	118	133	135	135	135	134
5	133	129	124	124	123	114	109	108	111	115	114	108
6	110	114	115	115	143	141	141	154	158	157	153	155
7	148	148	141	139	133	130	130	129	127	126	127	131
8	131	134	134	134	134	134	146	141	141	139	140	140
9	128	130	133	137	132	128	127	128	128	127	125	126
10	110	111	111	111	111	111	111	162	160	158	158	158
11	155	158	158	158	158	157	151	149	142	141	140	136
12	136	138	138	152	152	147	144	141	136	135	135	132
13	132	132	168	170	171	171	169	169	169	169	158	158
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15	163	163	159	159	158	147	148	146	145	146	132	131
16	134	135	126	130	127	126	126	126	126	148	126	144
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18	145	145	140	140	138	135	136	137	138	138	139	143
19	143	141	137	135	138	139	139	131	130	130	130	130
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21	138	138	141	141	139	131	130	129	131	127	127	138
22	139	139	133	129	129	129	152	152	163	164	164	164
23	164	172	172	161	160	160	160	160	160	160	141	131
24	128	135	133	131	134	135	135	137	138	138	150	150
25	150	152	152	152	163	163	164	165	165	165	150	148
26	146	129	123	122	126	130	133	135	134	137	140	142
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32	131	131	131	145	142	141	138	137	139	139	140	141
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45	130	129	127	129	129	129	129	160	161	164	166	162
46	162	157	156	146	142	140	140	132	133	133	132	128
47	133	145	147	147	147	147	148	147	148	141	139	135
48	128	126	128	129	132	132	123	121	122	119	120	120
49	122	120										
	Final Time: 49 7 2											

Table XIII All five Subjects' Locomotor motion during the game.

S U B J E C T	WALKING meter / %			JOGGING meter / %			FAST RUNNING meter / %			BACKWARD RUNNING meter / %			SIDEWAY RUNNING meter / %			TOTAL meter / %		
	1st HALF	2nd HALF	TOTAL	1st HALF	2nd HALF	TOTAL	1st HALF	2nd HALF	TOTAL	1st HALF	2nd HALF	TOTAL	1st HALF	2nd HALF	TOTAL	1st HALF	2nd HALF	TOTAL
1	720	850	1570	2442	2005	4447	316	280	596	265	102	367	26	12	38	3769	3249	7018
	10.2	12.1	22.3	34.6	28.6	63.4	4.6	3.9	8.5	3.8	1.5	5.3	0.3	0.2	0.5	53.7	46.3	100
2	985	1283	2268	2558	1726	4308	431	358	789	295	198	419	14	35	49	4283	3600	7883
	12.5	16.3	28.8	32.4	22.8	55.2	5.4	4.6	10	3.8	1.6	5.4	0.2	0.4	0.6	54.3	45.7	100
3	680	920	1600	1860	1153	3013	185	80	265	3	7	10	10	24	34	2736	2184	4922
	13.7	18.7	32.4	37.7	23.5	61.2	3.8	1.5	5.3	0.06	0.14	0.2	0.2	0.6	0.8	55.5	44.5	100
4	599	1250	1849	1367	719	2086	114	85	199	12	24	36	31	25	56	2123	2103	4226
	14.3	29.3	43.6	32.3	17	49.3	2.6	2.1	4.7	0.3	0.5	0.8	0.7	0.9	1.6	50.2	49.8	100
5	844	1160	2004	2069	1745	3814	120	100	220	520	189	709	24	12	36	3577	3206	6783
	12.4	17.1	29.5	30.5	25.7	56.2	1.7	1.5	3.2	7.6	2.8	10.4	0.5	0.2	0.7	52.7	47.3	100
X	766	1093	1858	2059	1470	3534	233	181	414	219	104	323	21	22	43	3298	2868	6166
	12	18	30	33	24	57	3.7	3	6.7	3.5	1.7	5.2	0.55	0.55	1.1	53.4	46.5	100