(1) Physical Fitness in the Army

by

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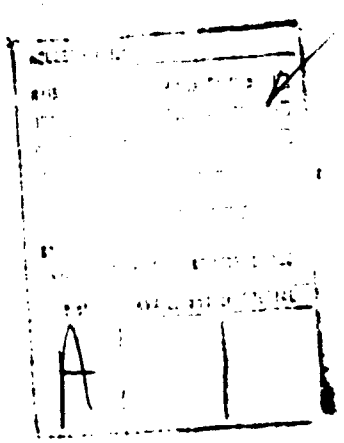
*The views of the author do not purport to reflect the positions of the Department of the Army or the Department of Defense.

Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.



Have you noticed that physical fitness training in the Army is changing? Maybe you have not if you are new, but if you have been in for 3 or more years you probably realize that there are fewer jumping jacks, or horizontal ladders and more 2-4 mile runs being done during unit training. Why? Mostly because of science. Yes, new scientific knowledge is changing Army physical training - showing which methods are the most likely to provide soldiers with the greatest gain in stamina and work capacity for the least training time. Unfortunately, most of this knowledge has come to the Army from the civilian scientific community - designed for the fitness goals of business men, workers, and executives. It wasn't difficult for alert commanders to see the advantages of these physical fitness programs and to incorporate them into their own units. General Emerson's "Pro-Life" program is a good example of this. But the Army no longer has to borrow ideas from the civilian community. The Army Medical Department has established its own scientific research team for the study of fitness training and development of programs specifically designed for the soldier.

Located at the US Army Research Institute of Environmental Medicine (USARIEM), Natick, MA, this team of 20 scientists and technicians are working full time on applying the scientific principles of exercise to your training program. What does

this really mean to you and your unit commander?

It means the Army is increasingly concerned about fitness standards for many of the same reasons as the civilian world is - greater work capacity - better job performance - improved health and better morale and sense of physical well-being.

Therefore the Army has directed the Exercise Physiology Division of USARIEM to (1) assist in the development of fitness standards to better match personal fitness to MOS or unit assignments and (2) develop training programs to achieve these fitness goals for everyone from cooks to the infantry man, 18 year old privates to 40 year old colonels. Since studies have suggested that fit soldiers are more efficient and productive than their sedentary counterparts, the relationship between fitness and the capacity for work, any kind of work, would appear to be clearly established. Additional support for this can be found in the number of large business corporations that have instituted fitness programs for their employees because they realize that a fit employee is a good investment. However, in the Army, besides the concern for the young male soldier, physical fitness in females and middle-aged officers and NCOs has become increasingly important as these populations have increased.

So if your job requires you to work in the field, the

maintenance shop, or the kitchen, or you are concerned about good health, you owe it to yourself and your fellow soldier to get and stay in shape. The purpose of this article is to give you an understanding of what fitness is, how you can achieve fitness, and an idea of some of the research that is being done by the Medical Research and Development Command to assist you and your commander in achieving your unit's fitness goals.

But let us clarify what we mean by fitness or, as we call it, work capacity: Fitness is the ability to perform your job with vigor and alertness, and with sufficient energy to meet unforseen emergencies. Work capacity is the capability to accomplish the mission requirements with safety and without undue fatigue. But fitness is more than an increased capacity for work. It means better health, a decreased risk of heart disease, a trim military appearance, and an energy reserve to meet emergency situations. Fitness programs are the best possible investment of time that a commander or the Army can make in you. However, my purpose is not only to have you understand fitness but to assist you in achieving it as well. We will talk about what types of fitness there are, how to assess your current level of fitness, and suggest specific steps that you can take to achieve the fitness goals or standards that are best for you.

Aerobic Fitness and Work Capacity. Fitness means many things to

many people. The physician is interested in fitness as the absence of disease or injury. The coach defines fitness as those factors responsible for success in a sport. The leader is interested in the ability of his troops to complete the mission. We at the Research Institute of Environmental Medicine at Natick are interested in all factors that constitute fitness, whether it be endurance, muscular strength, flexibility, speed, agility or, of course, motivation:

CHART 1 (SLIDE)

For our purposes, fitness for sustained work or stamina involves primarily a well developed oxygen delivery system - strong heart and lungs that deliver oxygen to the working muscles. Your ability to take in, transport, and use oxygen (aerobic fitness) is the best single measure of your work capacity. The connection between aerobic fitness and work capacity is a direct one. The tougher the job, the more energy or oxygen required. In the research laboratory we typically measure aerobic capacity with a laboratory treadmill test. It is the most objective and precise technique for measuring your overall work capacity. Test results are standardized in milliliters (ml) of oxygen (O_2) consumed per kilogram (kg) of body weight per minute (min), and this is the standard measure of aerobic fitness. In several studies with basic trainees at Ft.

Jackson and the 2nd Infantry Division in Korea, we have found that the average young male soldier's aerobic capacity was about 50 ml/kg·min. Therefore, if you have an aerobic capacity of 50 or better, you are in good shape by Army standards. But this is a rather complex and expensive procedure for use in the field or with large numbers of troops. Let me tell you about several ways in which you or your commander can assess your aerobic capacity. These tests and standards have been developed by scientists and physicians and are good indicators of your aerobic fitness.

Tests of Aerobic Fitness. If you have been inactive or doing a desk job or are over 35 years of age you might try the 12 minute run-walk test. See how far you can comfortably run/walk or jog in 12 minutes. The distance covered can be entered into the table along with your age and gives you a good estimate of your aerobic capacity.

Table 1 & Fitness Category Charts

Remember that 50 ml/kg·min is a representative value for young male troops. If you have been exercising regularly, try the 1½ mile run test. This test requires a maximal effort on your part and should not be undertaken if you have not been on some form of training to build yourself up. Take your time in minutes and seconds for the run and use the chart to predict your level of fitness or work capacity.

Chart 2 (Cont'd)

Another simple test that estimates your aerobic capacity and that you can do right in your own room involves stepping on and off a bench (16 inches high for men and 13 inches high for women) so that you go up and down 22 times in a minute. (That works out to be about 5½ trips every 15 seconds.) Try it several times to get the proper rhythm. It is also most important that the bench be the correct height. After 5 minutes of stepping, take your pulse at your wrist for 30 seconds, beginning exactly 15 seconds after you have stopped exercising. Multiply it by 2 and find your fitness index using the nomogram below. Use your pulse rate per minute, after exercise, and body weight to calculate your fitness index, then enter this value into the table to find your fitness category for your age group.

Nomogram 2

Once you have established your level of fitness we can begin to decide upon an exercise program designed to achieve the fitness goals you have established for yourself or your unit.

It must be kept in mind that a total fitness program consists of not only a self directed exercise program to develop the heart and respiratory system but also a program for the reduction in food or caloric intake. A combined program will not only insure that excess body fat is lost but that your overall

weight remains stable. This regimen will insure adequate stamina to meet emergency situations, deal with the day to day duty demands, and maintain a trim physical appearance.

But if it has been years since you exercised, do not run right out and begin to violently exercise. Start slowly and go at a level you can maintain; long, slow, distance runs, also called LSD. You are not competing with anyone! The principle purpose should be to gradually increase what you are doing. As your body becomes accustomed to the work, it becomes easier; then you can increase your work out time, and continue this way until you have developed the aerobic fitness you may need to do your job or meet your units standards.

As a commander with a population of middle aged, overweight, sedentary types this kind of gradual approach is probably best suited for you. However, if you have a group of "young legs" or "airborne types" you can probably skip the preliminaries. The question still remains how much exercise is required to achieve and maintain a fit unit and secondly, how is this fitness requirement modified by age and sex.

The Training Program. The amount of exercise that is necessary to experience a training effect is based upon the concept of progressive resistance. In other words, as the activity in which you are involved becomes easier, increase the amount. You can do

this by varying the intensity (how hard you exercise as measured by your heart rate) or the duration (how long you exercise) or the number of times you do it each week.

Intensity. The exercise heart rate is the best indicator or the intensity at which you are working because it is directly related to the oxygen you consume. As exercise intensity increases, more oxygen is required and heart rate increases. Research by Dr. Kenneth Cooper has shown that when you exercise at a given percentage of your maximum heart rate a training effect is achieved. The chart illustrates the heart rate training zone for different levels of fitness. The training zone is determined by your age and fitness level and gives the minimum heart rate you should attain when exercising to achieve a training effect.

However, maximum heart rate decreases with age so adjust your workouts accordingly. If you are young and highly fit, your HR during training may be as high as 180 BPM. If you are 40, your heart rate need only be about 160 BPM to be working at the same intensity.

Duration. Along with the intensity of your exercise, duration is another aspect of your workout. Exercising very intensely for a short period is the same as exercising for a longer period at a relatively comfortable level. If you are in the low fitness category you should probably start out with long, slow, workouts

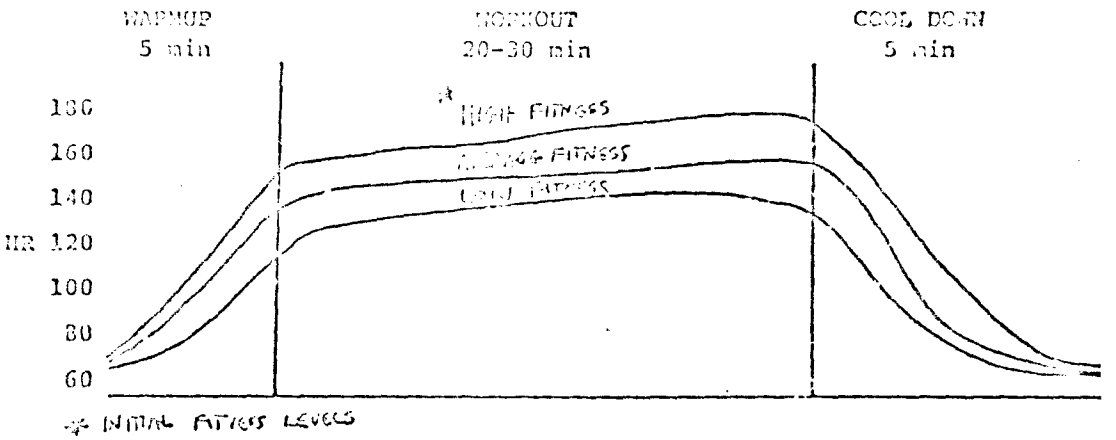
(LSD). As your fitness level improves, workouts can become more intense. It is usually figured that a 20-30 minute workout at moderate levels of intensity is sufficient to achieve an aerobic training effect. Now, if you are overweight and want to lose some of those excess pounds you will want to exercise at low intensities and increase the duration up to 40-50 minutes.

Frequency. Three training sessions a week seems to be enough for those beginning an exercise program or those in the low fitness category. As training progresses you can comfortably exercise more frequently.

A note of caution before you start your training program. Each exercise session should include a 5 minute warmup and a cool down period. The warmup may include stretching the muscles of the lower back and legs to gradually increase your body's level of activity. This will reduce the risk of injury and prevent unnecessary soreness. Also, a gradual cooling down period after exercise is recommended. Continue to walk or jog for a few minutes after your workout - this assists the body in getting rid of the metabolic by-products of exercise, and prevents cramps and muscle soreness. You may even want to do some stretching exercises to keep those leg muscles loose.

Chart 3

Essential Elements of a Training Session



What exercise should you be doing? Once you have decided on your fitness goal or that of your unit, the next decision is to determine the activity or activities in which you will participate. Your choice depends on what you want to be fit for! If your goal is to improve your ability to march long distances with a pack - endurance type activities - you will want to train at closely related activities (jogging or walking uphill with a load etc.). This concept is called training specificity and essentially means that in order to improve your work capacity for a particular task or job you must do that task or a closely related activity. So the type of training you do should relate to the desired results. If you trained by swimming, don't expect your ability to run or march long distances to be greatly improved. The training effect tends to be limited to those

muscles and systems that are exercised in training.

However, if the task or job you are training for involves sustained periods of work, where your legs must move your body weight from place to place, then your program should include aerobic training. Running seems to provide one of the best exercises for general conditioning and it has the advantage that it can be done alone or in a group, in any weather, as some of you know when you see joggers out in the snow or rain, and it provides a moderate and sustained workout of the oxygen delivery system and the lower body muscles. Walking, jogging, cycling, swimming, cross-country skiing are all good. They can be maintained at moderate levels for long periods and provide a workout for the oxygen delivery system.

Another exercise for building up your heart and lungs is jumping rope. That's right, the same fun thing we used to do as kids. But it is an excellent aerobic exercise and develops coordination and agility as well. The same progressive approach used for jogging should be used: Start gradually and increase your exercise time from 3-15 minutes daily at 60-70 jumps per minute. After several weeks you will begin to enjoy the same training effects as found with running, swimming or cycling. Another benefit or asset is that if it is raining or snowing outside you can do it in your bedroom at night or in front of the

TV if you are a little self-conscious about exercising publically. It will be a little frustrating at first, but you will be surprised how easy it becomes. You might even try some rhymes to help you keep pace. If you men are concerned about masculinity, remember that boxers and other athletes spend many hours doing this excellent training. For the women, it is a natural and as good an aerobic activity as there is. For further information about aerobic activities such as jumping rope, see Ken Cooper's book, The New Aerobics, 1970 or Aerobics for Women, 1973.

What About Muscular Strength and Fitness? We have related aerobic fitness to work capacity and have provided a prescription for improving and maintaining it. But what about muscular strength which is also an essential part of your total work capacity. If your job involves lifting, carrying equipment, or working with hand tools, you need muscular strength, endurance, and flexibility. Let's discuss the importance of muscular fitness and how we can achieve this kind of fitness through weightlifting or calisthenics. Remember our discussion on specificity of training - if you want to improve the work capacity of your arms and shoulder muscles you should work with those muscles. The effects of any strength training will be limited to those muscles. The experience and training of an individual also influence his ability to use his strength.

Learning occurs as you do a particular task and your muscles become more coordinated with practice. But most sustained work involves something more than muscular strength or coordination, and we refer to this as muscular endurance. A minimum level of strength is necessary for any job. To further increase work capacity once that level is attained, endurance and aerobic capacity have to be increased. So you can see that an ideal fitness program for the Army would involve a combination of muscular endurance, and aerobic capacity training to achieve total body fitness.

We haven't talked too much about women and fitness, but it certainly deserves comment. In a study we did with men and women entering the Army we found that the average woman has about half the arm and shoulder strength and about 3/4 the leg strength of the average male recruit entering the service.

However, when women engage in comparable strength or aerobic training programs, we have found they increase their work capacity in amounts similar to that found in men, and this increase did not result in any unpleasant changes in the women's appearance. From our research we have concluded that, given the appropriate training program, women should be able to achieve the aerobic fitness and muscular strength and endurance necessary to carry out most of the strenuous military occupations.

Staying Fit. Now, in order to keep the fitness level you have worked so hard to attain, you can switch to a maintenance program. We at the Exercise Physiology Division of USARIEM have found that you can maintain your level of fitness with a program of 2-3 days of activity per week. However, you must be working out at the same intensity and duration that you used to achieve that level. The Army PT test will provide you with a periodic check telling you if you are, in fact, maintaining the total fitness you have achieved. But this maintenance program does not mean that you should only run or do calesthenics. Basketball, tennis, racketball, handball are all excellent for helping to maintain fitness. But they are not an adequate substitute for aerobic fitness training since they don't provide a sustained level of exertion over a 20 or 30 minute period. They often involve brief bursts of exertion but not for sustained periods. In selecting a maintenance program, try to seek activities you enjoy - fitness should be fun -but don't be fooled into thinking that these activities develop adequate fitness.

Unit Training for the Commander. So far our discussion of fitness has emphasized individual programs. But the unit commander has an obligation to insure that his men and women are fit and maintain a trim military appearance. Besides, unit exercise and fitness programs can build unit spirit and morale as well as

helping the individual achieve and maintain the necessary work capacity to do his job.

The development of a successful unit training program is an old story for the Army. It depends in large part on the quality of the leadership. The effective leader provides the opportunity for unit training as well as time for individuals to train. He sets a good example for his personnel and demonstrates that he feels fitness is an important part of a soldiers job. But besides many of the techniques that the Army already uses in its unit training, the commander might consider these: breaking up his unit into smaller groups to help individualize programs - the older or overweight individuals in one group and another group for the airborne type, active young troops. Develop competitions between these groups to increase motivation and participation. Organize 100 mile a month clubs or as they have done at Ft. Benning, a "run for your life" program. If a circuit training facility exists, use it as a means of introducing variety into the program. The possibilities are endless, and the rewards in terms of teamwork, improved unit efficiency and total fitness of the individual are worth the effort.

In 1974 the US Army Research Institute of Environmental Medicine was asked to (1) evaluate the effectiveness of a "pro-life" physical training program in 350 men of the 2d Infantry

Division and (2) to determine the impact of such a program on the incidence and risk of heart disease in 200 officers and NCOs between the ages of 35-50.

In an effort to evaluate the complete spectrum of fitness, aerobic power, muscle strength, body composition and psychological aspects of physical activity were assessed.

The results demonstrated that the "Pro-Life" program which consisted of daily runs of 3-5 miles and other activities had the effect of increasing endurance by 10% and in decreasing obesity in the troops. However, there was no change in muscle strength of upper arms or legs, but this was not necessarily to be expected in training that emphasized aerobic or endurance training since, as we know, training is specific to the muscles involved in the activity. However, the forced nature of the program or the fact that the personnel were on a hardship tour led to an increase in things like anger and fatigue, which could indicate a drop in morale. Nonetheless, there appeared to be an improvement in such things as physical self-esteem, or measures of physical ability, and perception of effort. This would certainly coincide with the physiological findings of improved endurance capacity and stamina. A second area of interest was the incidence of risk factor for coronary heart disease in a population of 35-50 year old officers and NCOs. The evaluation

included a complete medical exam, pulmonary function test, resting 12 lead electrocardiogram (EKG), blood lipid profile and a progressive cardiac stress test. The results demonstrated that the prevalence of risk factor for coronary heart disease (such as abnormal pulmonary function, hypertension, elevated blood cholesterol, obesity, smoking and abnormal EKG) tended to be greater in the NCOs and lower in the officers than in a comparable civilian population prior to training.

Subsequent to the "Pro-Life" evaluation, we became concerned with the levels of fitness of both male and female personnel entering active duty and the effect of basic training on various aspects of fitness, mental health, and self-esteem. The approach was to evaluate the effect of basic training on the muscular strength and aerobic fitness of men and women entering service. The testing was performed at Ft. Jackson during Oct and Nov of 1975. Approximately 200 males and 200 females were tested either before or after a 6 week basic training cycle. The subjects were randomly selected from various companies in the training brigade.

For the male recruits, six weeks of basic training resulted in a loss of body weight; something most of us can probably tolerate and appreciate. There was also an 8.5% increase in aerobic capacity (from 50 ml/kg·min to 55 ml/kg·min) and an

increase in the strength of both their arms and legs. As you may remember with a bit of pain, both of these muscle groups are thoroughly exercised during basic.

Basic training also, and, most significantly, resulted in a substantial improvement in the mental health, morale, and psychological well being of the male trainees. This was most evident in the area of physical self-esteem, mental health, and positive attitudes toward physical activity - a most important thing for a young infantry soldier. However, the results for females during basic training were not as encouraging. They demonstrated no appreciable changes in muscular strength, aerobic capacity, psychological well being or mental health. However, they evidenced a small increase in body weight, mostly fat. This suggested that the basic training program for females at Ft. Jackson during Oct of 1975 was not a very challenging experience either physically or psychologically. Subsequently, introduction of an integrated training program has apparently resulted in improving women's strength and aerobic fitness (since the challenge is certainly there now, by all reports!) A research study to determine the response of young women to a strenuous training program was conducted at West Point in 1976. We demonstrated that an 8-week training program increased their aerobic fitness and muscular strength and endurance to a level

comparable to the improvements we have found in men, lending strong support for the position that, with proper training, women can perform many of the strenuous jobs in the military.

These studies gave some idea of the endurance, muscular strength, mental health and well being of the every day troop in the field and of those entering service. Since then, we have been looking at factors that place limits on the physical work capacity of the soldier, whether these are physiological or psychological is still being evaluated. We hope to expand our research to evaluate fitness and its impact on performance in environmental extremes, whether it be high altitude, heat, or freezing cold conditions. Some findings are already available from other divisions in our lab.

For example, at high altitude a person's work capacity and endurance is low, compared to the same individual's work capacity at sea level. Obviously, if you are highly fit, you will have less difficulty at altitudes than an unfit individual will have - a plus for you!

In the cold, the high energy needed to do just about any job, whether it be skiing, walking or carrying equipment, requires a high level of fitness. In addition, evidence suggests that being physically fit helps prevent cold injuries such as frostbite or trenchfoot by increasing the blood circulation to

the extremities. It is a part of doctrine in the Northern European and Canadian Armies that the deciding factor in a combat operation in Arctic or Subarctic conditions is the level of fitness of the combat troops and their leaders. Fitness is an equally important factor in hot environments. But in order to get acclimated, or adjusted to the heat, you must train in it - or there will be very little benefit from fitness training.

It is obvious that the study of fitness and development of fitness programs is not a haphazard process in the Army any longer. The scientific resources of the Medical Research and Development Command and The Surgeon General are being utilized to make physical training in the Army more effective and to insure that our Army is brought to a high level of fitness and maintained at a ready-to-go level to meet any mission or emergency.

But we, at the Exercise Physiology Division, not only do this sort or research, we live it. Any time of the day you will find one of our staff running on the treadmill, evaluating a new piece of equipment or a different type of physical fitness test. This allows us to not only do research but also to determine the meaningfulness and feasibility of the test for the soldier.

Table 1
Fitness Category for Men*

AGE (yrs)	POOR	FAIR	AVERAGE	GOOD	EXCELLENT
17-19	<39	40-44	45-49	50-53	54+
20-24	<35	36-39	40-45	46-52	53+
25-29	<34	35-38	39-44	45-50	51+
30-34	<33	34-37	38-43	44-48	49+
35-39	<32	33-35	36-41	42-46	47+
40-44	<30	31-34	35-38	39-44	45+
45-49	<28	29-32	33-35	36-43	44+
50-54	<26	27-30	31-32	34-42	43+

Fitness Category for Women*
(ml/kg/min)

AGE (yrs)	POOR	FAIR	AVERAGE	GOOD	EXCELLENT
17-19	<33	34-38	39-42	43-47	48+
20-24	<32	33-36	37-40	41-45	46+
25-29	<30	31-34	35-39	39-43	44+
30-34	<28	29-32	33-37	38-41	42+
35-39	<26	27-30	31-35	36-39	40+
40-44	<24	25-28	29-33	34-37	38+
45-49	<22	23-26	27-31	32-35	36+
50-54	<20	21-24	25-29	30-33	34+

<means less than
*Based on data from military personnel tested by the Exercise Physiology Division, USARIEM, Natick, MA

Table 1A

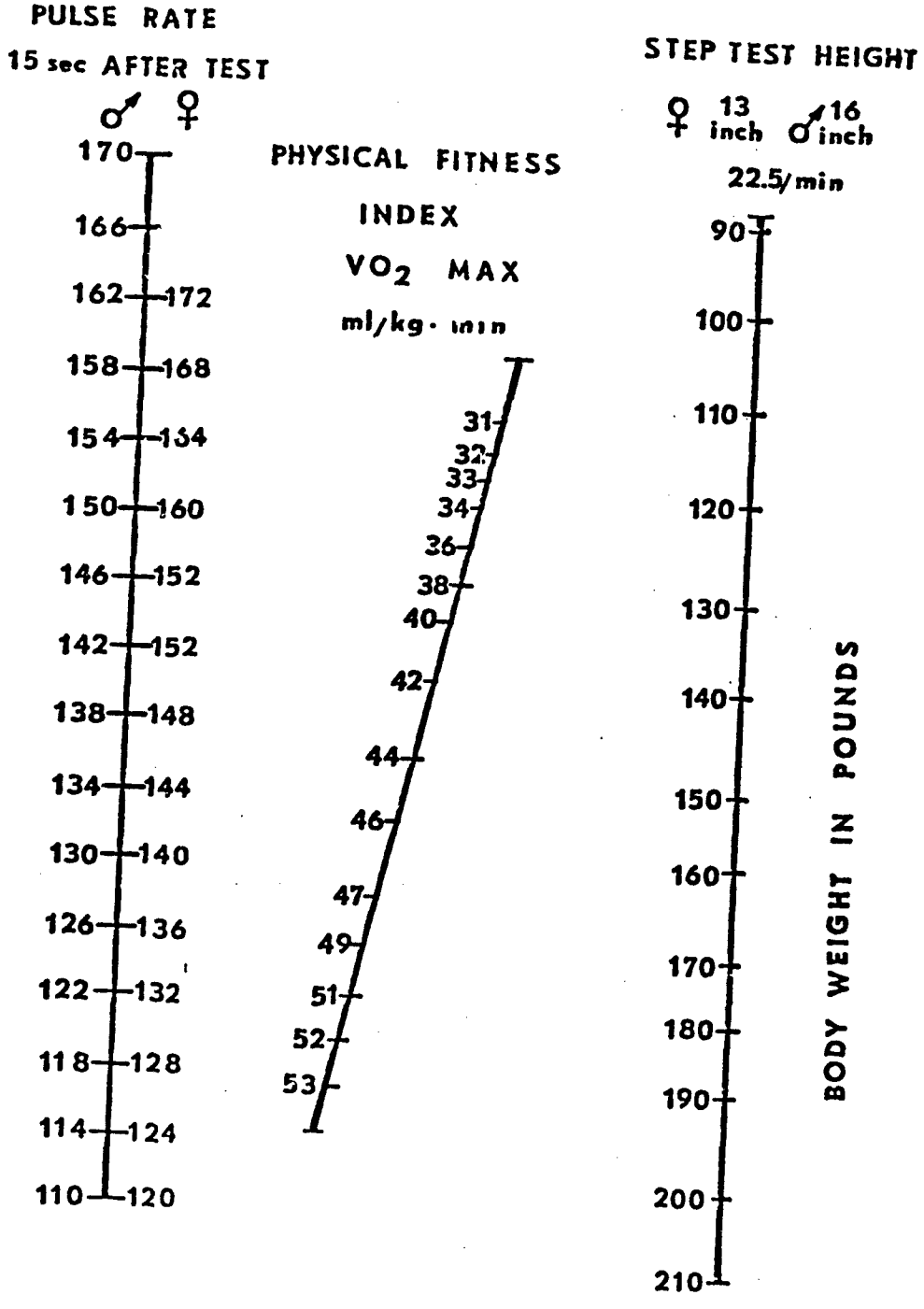
Physical Fitness Test and Standard - Male Personnel Aerobic Test
Distance (Males) Walked and Run in 12 Minutes by Age

FITNESS CATEGORY	A <30	B 30-39	C 40-49	D 50-59
POOR	<1.0	<.95	<.85	<.80
FAIR	1.0 -1.24	.95-1.14	.85-1.04	.80- .99
AVERAGE	1.25-1.49	1.15-1.39	1.05-1.29	1.0 -1.24
GOOD	1.50-1.74	1.40-1.64	1.30-1.54	1.25-1.49
EXCELLENT	1.75+	1.65+	1.55+	1.50+

< means less than

*Adapted from Cooper, 1975

NOMOGRAM FOR ESTIMATING AEROBIC CAPACITY WITH A STEP TEST+

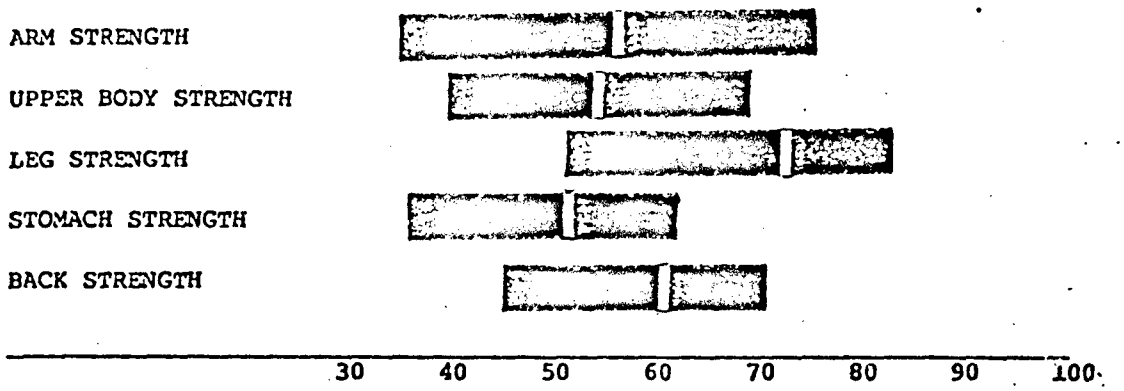


HOW TO USE THE NOMOGRAM TO ESTIMATE YOUR AEROBIC CAPACITY

PFI can be estimated from the chart by finding your pulse rate (beats per minute) and using a ruler to line up with your work load/body weight in lbs. Where it crosses the Physical Fitness Index line is an estimate of your aerobic capacity in ml/kg·min. In order to adjust your Fitness Index for your age, enter this value into the Age-Fitness Chart to get your fitness category.

CHART 4

Comparison of the Muscle Strength of Men and Women
For Selected Muscle Groups



Bars represent the range of muscle strength of women (%) when compared to men. The (I) represent the average of women compared to men at entry into service through the Boston AFEES July 1976.

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