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# Physical Fitness Training Reference Manual for Security Force Personnel at Fuel Cycle Facilities Possessing Formula Quantities of Special Nuclear Materials

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Prepared by  
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Foundation, Inc.  
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Prepared for  
U.S. Nuclear Regulatory Commission

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## **ABSTRACT**

The recommendations contained throughout this NUREG are being provided to the Nuclear Regulatory Commission (NRC) as a reference manual which can be used by licensee management as they develop a program plan for the safe participation of guards, Tactical Response Team members (TRTs), and all other armed response personnel in physical fitness training and in physical performance standards testing. The information provided in this NUREG will help licensees to determine if guards, TRTs, and other armed response personnel can effectively perform their normal and emergency duties without undue hazard to themselves, to fellow employees, to the plant site, and to the general public. The recommendations in this NUREG are similar in part to those contained within the Department of Energy (DOE) Medical and Fitness Implementation Guide which was published in March, 1991. The guidelines contained in this NUREG are not requirements, and compliance is not required.

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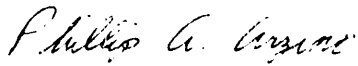
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Respectfully submitted,



Phillip A. Arzino  
Principal Investigator

# **1 INTRODUCTIONS**

## **1.1 Background**

**1.1.1** The United States Nuclear Regulatory Commission (NRC) is amending 10 CFR Part 73 to include 10 CFR Part 73.46(b)(10 and 11) which specifies requirements for a physical fitness training program as well as for objectively measurable physical performance standards for guards, Tactical Response Team members (TRTs), and all other armed response personnel at NRC-licensed Category I fuel facilities. (Hereafter, the inclusive terms of "security force personnel" or "security force person" will be used to reference all three personnel classifications.) This NUREG will serve as a reference manual for licensees as they develop physical fitness training programs in keeping with these new requirements.

**1.1.2** Current regulations specify that armed security force personnel should have no physical weaknesses or abnormalities that would adversely affect their performance of assigned security job duties. No standards exist, however, for assuring that security force personnel are sufficiently physically fit to perform their regular or potential duties. Additionally, there are no criteria for an ongoing physical fitness training program which will reasonably assure fitness maintenance without unduly endangering the health of those participating in it.

**1.1.3** The United States Department of Energy (DOE) has already adopted regulations which set forth medical and physical performance qualification standards for their protective force personnel. The purpose of the standards is to ensure that protective force personnel at DOE facilities can effectively perform their normal and emergency duties without undue hazard to themselves, to fellow employees, to the plant site, or to the general public. The DOE rules require incumbent and applicant protective force personnel at government-owned facilities to meet certain medical and physical fitness qualification standards which were professionally developed and validated to reasonably assure that they can physically respond in emergency situations. Additionally, 10 CFR Part 1046 requires incumbent DOE protective force personnel to participate in an ongoing physical fitness training program.

## **1.2 Purpose and Scope**

This NUREG provides information that can be used by licensees to develop sound criteria which reasonably assure

- that TRT personnel are physically fit to engage those adversaries who might be encountered in an emergency response situation, and
- that all security force personnel can attain physiological changes which increase the capacities of the various systems of the human body, resulting in greater protection against undue injuries and degenerative diseases.

## **1.3 Organization of the Report**

**1.3.1** Section 1 provides the background, the purpose and scope, and the organization of this NUREG.

**1.3.2** Section 2 offers considerations for selecting personnel, developing a program plan, and assessing the costs of setting up an ongoing physical fitness program.



- 1.3.3** Section 3 outlines the recommended qualifications of the fitness staff.
- 1.3.4** Section 4 recommends procedures for testing against the physical performance standards.
- 1.3.5** Section 5 furnishes information useful in setting up a quarterly assessment program.
- 1.3.6** Section 6 offers suggested parameters for the ongoing physical fitness training program.
- 1.3.7** Section 7 provides general information for developing a physical fitness program plan to be approved by NRC.

## **2 GETTING STARTED**

### **2.1 Selecting Personnel**

**2.1.1** Selecting the proper personnel to set up and maintain a physical fitness program is the first important step in this process. A decision should be made early on as to whether existing personnel will absorb most of the fitness program support responsibilities with technical support staff only retained as needed or whether a staff dedicated to supporting the fitness program will be employed. If the existing staff option is selected, a number of incumbent employees will be needed to accomplish this mission, and they should be able to assume the additional responsibilities. Specific knowledge in the area of physical fitness may not be required for the following responsibilities:

- Scheduling and tracking fitness and medical appointments
- Maintaining a database
- Billing and fiscal management
- Maintaining facilities and equipment as needed
- Maintaining compliance and inspection status
- Performance standards testing

**2.1.2** Fitness-related technical responsibilities include:

- Writing and justifying a program plan
- Recommending facility and equipment needs
- Assessing the population each quarter
- Developing exercise prescriptions from assessments and medical evaluations
- Providing counseling
- Supervising, leading, and monitoring exercise as needed

**2.1.3** The following questions should first be answered in order to assess personnel needs:

**2.1.3.1** *How many security force personnel will be participating in the ongoing physical fitness training program and do they have special concerns relating to training?*

**2.1.3.2** *Are there individuals within your employment who have the capabilities to assume either the technical or the non-technical responsibilities outlined above?*

**2.1.3.3** *Will you have an on-site fitness program or will you contract with an off-site agency and facility?*

**2.1.3.4** *What are your projected manpower needs for maintaining the fitness program based upon the considerations just mentioned?*

## **2.2 Developing a Program Plan**

It is prudent to use the resources of a technical advisor in developing a fitness program plan for licensing approval. This individual may be someone who has had experience in setting up similar programs, or it may be the key individual who will be employed or contracted with to operate and maintain the fitness program. There are advantages to both. In either case, the following policy and procedure considerations should be addressed in the program plan:

- **Medical Standards:** evaluations, certifications, waivers, and appeals
- **Physical Performance Standards:** testing, certifications, and time extensions
- **Physical Fitness Assessments:** selection and application
- **Physical Fitness Training and Maintenance:** injury prevention and safety, environmental concerns, fitness staffing and supervision, record keeping, and physiological training
- **Personnel Responsibilities and Requirements of:** manager, supervisor, physician, fitness staff, TRT, guard, and armed response person

## **2.3 Assessing Costs**

Ideally, the costs of setting up, implementing, and maintaining a fitness program should be assessed by means of a zero-based budget approach. This approach necessitates a quantifiable and qualifiable justification for each cost item. The individual(s) who develop this budget should be prepared to defend each line item by assessing alternative means and costs and by predicting the consequences of using those alternatives. Once approved, this pro-forma budget should be tracked against actual costs in order to adjust, request, and approve subsequent budgets.

## **3 QUALIFICATIONS OF THE FITNESS STAFF**

Education, certification, experience, and program needs are all important considerations when selecting a qualified fitness staff. To date, there is no governing legislative organization that licenses personnel to run fitness programs. Fitness-concerned professionals from the fields of academia, medicine, and program application recognize the American College of Sports Medicine (ACSM) as the industry standard for certifying individuals as competent in specific areas of both preventive and rehabilitative exercise programs. Recommended qualifications for the following positions are based upon the ACSM industry standard of care. It should be noted that the following positions are based upon functional need; some individuals may have the qualifications to assume more than one of these functions.

## **3.1 Fitness Coordinator**

**3.1.1** The fitness program should have at least one individual to oversee exercise prescription for and the counseling of apparently healthy personnel. Depending upon the size of the security force, it may be more economical to use the services of a consultant or of a part-time employee. This individual should meet at least one of the following minimum qualifications:

- A bachelor's degree in physical education, exercise science, or other equivalent discipline and certification as a Health/Fitness Instructor from ACSM, or
- A master's degree in physical education, exercise science, or an equivalent discipline

**3.1.2** The Health/Fitness Instructor Certification is awarded to individuals who demonstrate the capacity to administer and interpret basic physical fitness assessments, prescribe exercise, and counsel apparently healthy persons.

## **3.2 Exercise Leader**

**3.2.1** All personnel involved in direct exercise leadership positions should have a cardiopulmonary resuscitation (CPR) certification and one of the following:

- An ACSM certification as an Exercise Leader, or
- A bachelor's degree in physical education, exercise science, or an equivalent discipline

**3.2.2** The Exercise Leader Certification is awarded to individuals who are involved in direct exercise leadership roles and who demonstrate the capacity to assure proper warm-up and cool-down, safe and effective stretching, adequate cardiovascular and musculoskeletal training, proper addressment of safety concerns, safe practices, recognition of signs and symptoms of intolerance to exercise, and limit-setting in exercise leadership.

## **3.3 Exercise Test Technologist**

**3.3.1** If symptom-limited graded exercise evaluations (see Section 5) are utilized to assess any of the security force personnel, the fitness staff should have at least one individual with both of the following qualifications:

- A bachelor's degree in physical education, exercise science, or other equivalent discipline, and
- Certification as an Exercise Test Technologist from ACSM

**3.3.2** The Exercise Test Technologist Certification is awarded to individuals who demonstrate the capacity to administer graded exercise evaluations and to interpret physiological responses to exercise including heart rate, blood pressure, electrocardiogram, perceived exertion, and signs and symptoms of intolerance.

### **3.4 Exercise Specialist**

**3.4.1** If any segment of the security force personnel suffers from chronic cardiovascular, pulmonary, or metabolic diseases (i.e. hypertension, chronic obstructive pulmonary disease, diabetes), the fitness staff should include at least one individual with both of the following minimal qualifications:

- A bachelor's degree in physical education, exercise science, or other equivalent discipline, and
- Certification as an Exercise Specialist from ACSM

**3.4.2** The Exercise Specialist Certification is awarded to individuals who demonstrate the capacity to understand the special concerns and adaptations necessary in testing and training individuals with chronic diseases as well as individuals on chronic medications.

### **3.5 Health/Fitness Director**

**3.5.1** If the decision is made to employ a fitness professional with most of the skills listed above and to utilize this individual in the development of a program plan and budget as well as in health-related programming (i.e. nutrition, smoking cessation, etc.), the following qualifications are recommended:

- A master's degree in physical education, exercise science, or an equivalent discipline, and
- An ACSM certification as a Health/Fitness Director

**3.5.2** The Health/Fitness Director Certification is awarded to individuals who demonstrate the capacity to design and administer health and fitness promotion programs, educate and direct staff and community, evaluate program effectiveness, and redirect efforts as needed.

## **4 PHYSICAL PERFORMANCE STANDARDS TESTING**

The physical performance qualification standards specify distinctive requirements for TRTs, guards, and armed response personnel. This section gives procedural direction for implementing these standards.

### **4.1 The Physical Performance Standard for TRTs (10 CFR Part 73.46(b)(11))**

For TRT members, the standard is a one-mile run with a maximum qualifying time of eight minutes and thirty seconds and a forty-yard dash, starting from a prone position, with a maximum qualifying time of eight seconds.

### **4.2 The Physical Performance Standard for Guards and Armed Response Personnel (10 CFR Part 73.46(b)(11))**

For guards and armed response personnel who are not members of the TRT, the standard is a one-half mile run with a maximum qualifying time of four minutes and forty seconds and a forty-yard dash, starting from a prone position, with a maximum qualifying time of eight and one-half seconds.

## **4.3 Personnel and Emergency Procedures**

### **4.3.1 Personnel**

Personnel directly administering the physical fitness qualification standards testing should have a current Red Cross or American Heart Association CPR certification in addition to either one of the following qualifications:

- An ACSM certification as a Fitness Leader, or
- A bachelor's degree in physical education, exercise science, or an equivalent discipline

### **4.3.2 Emergency Procedures**

There should be a written standard operating procedure for emergencies. As a minimum, the standard operating procedure should include notifying the appropriate individuals of the testing date, time, and location. The procedure should also identify the provisions for immediate first aid and CPR as well as the measures taken to ensure the effective dispatching of emergency assistance to the testing site if necessary.

### **4.3.3 Field Test Procedure**

**4.3.3.1** Attention to safety is the most important aspect of qualification testing. Special consideration should be given to the running surface used for qualification testing and to environmental conditions (see Section 6).

**4.3.3.2** The recommended course is a regulation track. If other courses are used, the following conditions should be considered:

- The course should be as level as possible
- The distance should be determined as accurately as possible

**4.3.3.3** The timing device should have a start and a stop mechanism. A timing device which also provides a printed copy of each time is recommended.

**4.3.3.4** Each participant should complete a form which contains qualification standard test information (see example in Appendix A). It should be completed on the date of the qualification testing and before any physical participation. This form should include the participant's current health status and a certification that the individual has adequately participated in an approved physical fitness training program and is prepared to take the test. The participant should then sign and date the form.

**4.3.3.5** This form should also include a written copy of testing instructions for the participant. These instructions should then be repeated verbally to the participant immediately before the qualification test. The following information should be included on the form:

- The participant (and the official time) should start after a verbal command is given to the participant and a concurrent visual command is given to the timekeeper. The official qualification run time is the time elapsed from the visual command, at the starting line, to the participant's crossing of the finish line.

- The course should be described including the distance, the starting and finishing locations, and the number of laps or the course route.
- Abnormal signs and symptoms which call for the cessation of the testing should be described to the participant. These signs might include, but are not limited to, abnormal chest pain, arm pain, other muscle pain, or shortness of breath.
- No testing should be permitted during extreme weather conditions (i.e. heat, humidity, cold, snow, wind, icy track, smog alert).
- After the test, the participant should cool down by walking for five minutes.
- The forty-yard dash is a prone-to-running qualification. The participant should be instructed to lie in a prone position with his or her head behind the starting line. The body position for a prone posture is the chest and pelvis on the ground and at least one leg fully extended.
- Starting blocks should not be used for any qualification run.
- The participants should be cautioned that all qualifications are individual efforts. The participant should not be assisted by physical touching unless an emergency develops or the test has been completed.
- The physical performance qualification standard consists of two elements: the one-half or one-mile run and the forty-yard prone-to-running dash. Both elements should be tested on the same day. The preferred order of testing is the distance run followed by the dash. Failure of either element should constitute a failure of the standard and requires the retesting of both elements at another time.
- The testing period is within thirty days from the date on which the medical certification is issued. Failure to qualify during that time should result in the individual being placed into a directly supervised training program (see Section 6).

**4.3.3.6** Smoking should be discouraged for a minimum of one hour before qualification testing since it may adversely impair the participant's safety.

**4.3.3.7** Each participant should warm up before testing begins. The warm-up should include walking, jogging, and/or other movements that use large muscle groups. The warm-up should be a minimum of five minutes long.

**4.3.3.8** Following the warm-up, each participant should stretch for five minutes. The stretching should be sustained with no bouncing. It should emphasize the legs, trunk, and shoulders.

**4.3.3.9** The annual requalification date should be established by security force management. Testing should occur within thirty days of the annual requalification date. Once the date has been established, it should not change without licensure approval. An extension does not change the annual requalification date. If it is necessary to extend an individual beyond his or her annual requalification date either for medical reasons or because the individual attempts but fails the standard, the test should be taken as soon as the medical or physical condition or the time extension ceases to exist. Failure to qualify for any reason beyond the maximum three month extension should result in the removal of the individual from an armed response position. The originally established annual requalification date should continue to be used as the date for future requalification testing.

## 5 PHYSICAL FITNESS ASSESSMENTS

### 5.1 Physical Fitness Assessment Battery Requirements

**5.1.1** Each quarter, security force personnel are required to participate in a battery of physical fitness assessments. The assessments serve several purposes:

- To provide valuable functional information related to the maintenance of minimal expectations for fitness
- To identify fitness concerns which might lead to undue injury
- To assess the effectiveness of the ongoing training program
- To modify the individual's training regime as necessary

**5.1.2** These periodic assessments should address:

- **cardiovascular endurance**, since security force personnel may have to exhibit endurance in tactical training and in emergencies
- **upper-body strength and endurance**, since they may have to grapple, handcuff individuals, climb, and carry wounded to cover
- **abdominal strength and endurance**, since abdominal muscles play a large role in maintaining the integrity of the spine. Weak abdominals permit the pelvis to tilt anteriorly which puts pressure on the lower back
- **body composition**, since it is a factor in endurance-related activities. Obesity is also a health risk
- **hamstring flexibility**, since tight hamstrings place more strain on the lower back and are more susceptible to injury

**5.1.3** The suggested measurement methods for the physical fitness assessments are those which can be readily used in the field and for which many norms are currently established. Examples of well established physical fitness assessment programs used in North America include the Canadian Standardized Test of Fitness (CSTF), the Young Men's Christian Association (YMCA) fitness tests, and the Institute of Aerobics Research (IAR) fitness tests. Each security force person should, as a minimum, achieve the fiftieth percentile scores as identified by healthy adult population age- and sex-adjusted norms. Additional assessments may also be indicated by the responsible physician in order to clear up a medical concern. The specific battery of tests to be employed for any given security force person should be left to the discretion of the health/fitness coordinator in consultation with the responsible physician.

### 5.2 Justification

**5.2.1** A significant reduction in cardiorespiratory fitness occurs after two weeks of detraining.<sup>1,2</sup> A return to near pretraining levels has been shown to occur in as little as ten weeks<sup>3</sup> and in as long as eight months after the cessation of training.<sup>4</sup> The time course varies with the degree of detraining or of

reduced training (i.e. reduced combination of the intensity, duration, and frequency of exercise). Strength training, if reduced from three to two times per week, will show significant reductions in about twelve weeks.<sup>5</sup> It would therefore be prudent to have regular fitness assessments at a much shorter interval than one year in order to ensure that all security force personnel are fit enough to maintain their requisite capabilities throughout the year.

**5.2.2** General fitness assessments are designed to give a gross estimate of strengths and weaknesses in the areas of aerobic power, muscular strength and endurance, flexibility, and body composition. They are usually based on age and sex norms and rank individuals according to percentiles. In addition to giving information on the individual, gross fitness assessments can reveal trends in large group demographics. This is useful in evaluating a group risk profile, the continuing need for fitness, and the need for fine-tuning health and fitness programs.

## **5.3 Methods of Measuring General Fitness**

### **5.3.1 Measuring Cardiorespiratory Fitness**

**5.3.1.1** Cardiorespiratory fitness, also known as aerobic power, is the body's ability to use oxygen for energy production and is expressed as oxygen uptake ( $VO_2$ ). Cardiorespiratory fitness can be measured either maximally or submaximally. Submaximal assessments can give important physiological information regarding most people's safe parameters for moderate exercise. ACSM further recommends a maximal graded exercise evaluation (GXE) for individuals about to start an exercise program if they meet the following criteria:<sup>6</sup>

- Apparently healthy males forty-five years of age or older and apparently healthy females fifty years of age or older
- Individuals thirty-five years of age or older with one or more cardiovascular risk factors
- Individuals who are symptomatic of chronic disease at any age

**5.3.1.2** Since the population under consideration is being mandated, rather than volunteering, to participate in an ongoing physical fitness training program, an entry level symptom-limited GXE is suggested for all armed personnel with periodic repeat GXEs as indicated by the responsible physician, paying particular attention to the combination of age, gender, and risk factors. GXEs are most often preferred on a treadmill where an electrocardiogram and blood pressure measurements can be obtained in a continuous fashion during sequentially increasing exercise intensities. Bicycle tests, although acceptable, tend to underestimate cardiorespiratory fitness in smaller individuals and overestimate it in muscle-bound individuals, both due to the utilization of an increasing external work force.

**5.3.1.3** Submaximal tests, although not as diagnostic in nature as are symptom-limited tests, can be safely applied in a field test environment and are excellent indicators of improvements, maintenance, or decrements in fitness. The most common means of submaximal assessment include walking and/or running a specified distance, stationary bicycle ergometry, stepping up and down steps, and walking on a treadmill. Run/walk field tests have been developed to estimate  $VO_2$  max in large groups of healthy young men and women. Bruno Balke, one of the most influential and prolific researchers in the field of physiological response to exercise in various environments, first noted the correlation between  $VO_2$  max and distance run times.<sup>7</sup> Other tests which have been developed include the twelve-minute run and the one and one-half mile run.<sup>8,9</sup> Gregory Kline of the University of Massachusetts at Amherst validated a one-mile walk with  $VO_2$  max estimation using time, heart rate, age, sex, and body weight.<sup>10</sup> It must be



pointed out that any estimate of  $VO_2$  max must consider that the normative group used justifies the comparison.

**5.3.1.4** In conjunction with periodic graded exercise evaluations, submaximal tests can assist in identifying the effectiveness of and the compliance with the aerobic element of an ongoing fitness program by quantifying changes in fitness due to training or the lack of it.

## **5.3.2 Measuring Muscular Strength and Local Endurance**

**5.3.2.1** Muscular strength is the maximum force that a muscle group can exert over a short period of time.<sup>11</sup> Strength can be measured as a maximum static contraction, known as isometric strength, or as a maximal dynamic contraction, known as isotonic or isokinetic strength.

**5.3.2.2** Muscular endurance is the ability to resist local muscular fatigue<sup>12</sup> and is measured by the ability to continue a physical activity for periods up to two to three minutes. Both absolute and relative local muscular endurance can be measured.

**5.3.2.3** Absolute endurance measures the ability to move a specific weight until exhaustion. All persons of the same sex are measured against the same weight load, regardless of their own size. Herbert DeVries, a professor at the University of Southern California who has done extensive work in measuring the physiological responses of humans to exercise, states that there is a high ( $r=.90$ ) correlation between absolute endurance measures and strength.<sup>13</sup> This makes sense since stronger individuals are lifting a lower percentage of their maximum than are weaker individuals, thus making the lift easier for the stronger individual.

**5.3.2.4** Relative local muscle endurance measures the ability of individuals to manipulate their own body against the pull of gravity to exhaustion. Another method is to have individuals manipulate a weight that is a percentage of their own body weight. According to Ted Baumgartner of Indiana University and Andrew Jackson of the University of Houston,<sup>14</sup> two basic muscular endurance abilities have been identified:

- muscular endurance of the arms and shoulder girdle
- muscular endurance of the abdominal muscles

**5.3.2.5** Additionally, they state that there is a negative correlation between body weight and the number of repetitions completed and an even higher negative correlation between the amount of body fat and the number of repetitions completed. Push-ups, pull-ups, and sit-ups are all easily administered relative endurance field tests.

## **5.3.3 Measuring Flexibility**

**5.3.3.1** Evidence suggests that persons who tend to be "tight" in a given region are more prone to muscle and tendon pulls than are people who are not. Persons who are "loose" or more flexible in a particular region, although not prone to muscle and tendon pulls, are more likely to experience ligament injury in the same area.<sup>15</sup> Flexibility is measured by the range of motion of a joint or a series of joints.

**5.3.3.2** For field testing, the most commonly used test of flexibility is the sit-and-reach test. It is an easily administered field test, and large population norms exist for its use. Historically, sit-and-reach has been purported to measure the flexibility of the lower back, hips, and hamstrings, all of which have been implicated in lower back problems.<sup>16,17,18</sup> There has been recent evidence, however, which questions

its validity in measuring lower back flexibility.<sup>19,20,21</sup> These studies have found that it is a valid measure of hamstring flexibility but not of lower back flexibility. Other flexibility tests which have been used include trunk extension, shoulder elevation, and ankle flexibility.<sup>22</sup>

### **5.3.4 Measuring Body Composition**

**5.3.4.1** Body composition refers to the relative contributions of lean body weight and fat weight to the body. It is expressed as a percentage of body fat. The two most common methods used for assessing body fat are hydrostatic weighing and skinfolds. Using the hydrostatic method requires a trained administrator, the training of the individual being tested, expensive equipment, and time. This makes it most difficult to use as a field test.

**5.3.4.2** Skinfold calipers are used more often for fat estimation than is hydrostatic weighing, and testers can be trained relatively easily. This method is easy to use in the field since it requires only the calipers and the appropriate population formula for the sample being measured. Correlations show that the use of skinfold calipers is a valid method of estimating body fat.<sup>23</sup> Another advantage to using skinfold calipers is that the specific distribution of fat and how that distribution changes over time can be assessed. Evaluating body composition is needed since excessive body fat is implicated in cardiovascular disease<sup>24</sup> and since heavier individuals require more work to complete tasks.<sup>25</sup>

## **6 THE PHYSICAL FITNESS TRAINING PROGRAM**

### **6.1 Injury Prevention and Safety**

**6.1.1** All exercise sessions should consist of a warm-up and a cool-down period. Movements for the warm-up period should use large muscle groups and should be similar to the activities used in the main portion of the workout. The warm-up should be a minimum of five minutes long, and it should be followed by stretching. After exercise, there should be a gradual reduction in intensity commonly referred to as cool-down. Individuals should not stop suddenly at peak intensity or shortly after peak intensity. A minimum of five minutes should be used for the cool-down period. Higher intensity workouts merit longer cool-down periods.

**6.1.2** Each training program should assess musculoskeletal risk according to the security force population, the facilities, the equipment, and other variables. The responsible physician may determine training restrictions on a case-by-case basis. Musculoskeletal injuries should be assessed according to intrinsic and extrinsic risk factors. Intrinsic risk factors which have been shown to increase musculoskeletal injuries include:

- Low fitness level (aerobic and/or strength)
- Anatomical problems (i.e. flat feet, high arches, bowed legs)
- Obesity
- Prior injury
- Musculoskeletal disease

**6.1.3** Extrinsic risk factors for musculoskeletal injuries during weight-bearing activities include:

- Improper or poor quality footwear
- An inadequate training surface
- Inappropriate training parameters with regard to intensity, duration, and frequency

## **6.2 Environment**

### **6.2.1 Heat Stress Index**

If hot or humid conditions exist, a wet bulb globe temperature (WBGT) index can be used to determine if training should occur. Index values may be determined directly from a commercially available WBGT instrument. There should be no training at an WBGT index above 82 °F. Training may occur with an WBGT index between 73° to 82 °F if proper acclimatization has occurred. If a WBGT instrument is not available, a heat-stress index is provided in Appendix B.

### **6.2.2 Temperature, Air Quality, and Other Factors Affecting Performance**

**6.2.2.1** When individuals exercise in high temperatures, they should drink water before, during, and after exercising in order to prevent dehydration. Fluids should be made available to security force personnel who are exercising under these conditions. Breathable clothing should also be worn.

**6.2.2.2** For low ambient temperatures, outdoor training should not occur when the wind chill index reaches the increasing risk category described in Appendix B.

**6.2.2.3** If a training facility is located in a geographical area with high air pollution, activity should be restricted when pollution levels are at the alert level. Exercising indoors in such conditions may be appropriate.

**6.2.2.4** For every 1,000-foot increase in elevation above 5,000 feet, there is an approximate 3.2 percent decrease in VO<sub>2</sub> max. Decrements in aerobic performance are questionable up to elevations of 5,000 feet.

**6.2.2.5** Individuals should report all abnormal responses to exercise to the fitness coordinator. If the fitness coordinator or someone from the fitness staff is not immediately available, then their immediate supervisor should be sought out. Abnormal symptoms may include chest discomfort or pain, arm pain, shortness of breath, or fainting.

## **6.3 Fitness Program Supervision**

**6.3.1** Supervision through direct or indirect monitoring should be conducted by qualified fitness staff members as is discussed in Section 3. The responsible physician should determine the medical status of participants before engaging in training and testing.

**6.3.1.1 Minimally Supervised Training:** This is suggested for healthy individuals. Supervision should consist of quarterly reviews by the fitness staff for fitness evaluation and direction. General guidelines for exercise should be provided by the exercise staff as needed. Parameters should be set for the frequency, duration, mode, and intensity of exercise.

**6.3.1.2 Directly Supervised Training:** This is suggested for those individuals who may have had a recent illness or injury, or those with a substandard fitness level. Each session should be directed through an individualized training program which specifies the mode, frequency, duration, and intensity of exercise or through a controlled group exercise setting. Although training sessions would be directed, individual observation by fitness personnel may not be necessary.

**6.3.1.3 Individually Monitored Training:** If it is warranted, qualified personnel should provide individually monitored training (i.e. blood pressure, pulse) for some participants. Individually monitored training should be specified by the responsible physician.

## **6.4 Record Keeping System**

A tracking system of workout sessions should be maintained in order to document physical training. Records may be kept in exercise logs. Records may also be created and maintained by developing a computer database or by purchasing commercially available software. As a minimum, the frequency and duration of training should be documented in order to keep track of individual training performance.

## **6.5 Physiological Training**

The recommended quality and quantity of exercise needed for developing and maintaining cardiorespiratory and muscular fitness in healthy adults is found in the ACSM Position Stand dated April, 1990. The exercise portion of each training session should last at least thirty-five minutes; this is exclusive of time for preparation, warm-up, cool-down, clean up, dressing, and travel.

### **6.5.1 Aerobic Training**

It is recognized that a generalized training adaptation is complex and includes many variables. Specific and generalized exercise prescriptions and adaptations are based upon the frequency, intensity, and duration of training, the mode of activity, and the current or initial level of fitness.

**6.5.1.1 Frequency:** Aerobic training should occur on a minimum of three days per week. Preferably, the training sessions should be on nonconsecutive days. Specific shift schedules (i.e. four days on and three days off) may make three nonconsecutive days per week impractical. Once the desired fitness level is achieved, most individuals can maintain that fitness level for many months by exercising on two nonconsecutive days per week, provided that the appropriate duration and the intensity of exercise are carefully adhered to.

**6.5.1.2 Intensity:** Depending upon the duration, level of fitness, motivation, adherence, and other factors, intensity levels should range from 60 to 90 percent of maximum heart rate (HR max) or from 50 to 85 percent of  $VO_2$  max or HR max reserve.

**6.5.1.3 Duration:** Aerobic training should consist of from twenty to sixty minutes of continuous aerobic activity. The duration is dependent upon the intensity of the activity; lower intensity activity should be conducted over a longer period of time. A lower-to-moderate intensity of exercise over a longer duration is recommended for security force personnel since fitness is more readily attained in longer duration programs and because the potential hazards and compliance problems associated with high intensity activity are lessened.

**6.5.1.4 Mode:** The mode is any activity which uses large muscle groups and which can be maintained continuously. It is rhythmical and aerobic in nature such as running/jogging, brisk walking/hiking,

cycling/bicycling, swimming, rowing, rope skipping, stair climbing, and other approved endurance game activities. The mode should be enjoyable to the participant in order to maintain a consistent adherence level.

## **6.5.2 Muscular Strength and Endurance Training**

Since aerobic training will generally result in an acceptable level of leg strength and local muscular endurance, most resistance training should concentrate on the upper body.

**6.5.2.1 Frequency:** Strength training should occur on a minimum of two days per week and should be concurrent with aerobic training. Preferably, training sessions should be on nonconsecutive days.

**6.5.2.2 Duration and Intensity:** A minimum of one set of eight to twelve repetitions of the major muscle groups should be performed.

### **6.5.2.3 Mode**

**6.5.2.3.1** Dynamic exercises using weight machines, free weights, or body weight are recommended. Circuit weight training with or without an interspersed form of aerobic exercise is also appropriate.

**6.5.2.3.2** Muscular endurance is best developed by using lighter weights with a greater number of repetitions. Muscular strength is best developed by using heavier weights. The intensity may be manipulated by varying the weight load, the number of repetitions, and the rest interval between exercises. For maximum benefits, all resistance training should be performed through a full range of motion.

## **6.5.3 Flexibility**

**6.5.3.1** To maintain flexibility and prevent injury, stretching should be performed following the warm-up before each workout and also at the end of every workout if possible. All stretches should reach a level where the individual feels the stretch. Care should be taken to not overstretch the muscle(s). A minimum of fifteen to twenty seconds per stretch is recommended, while twenty to thirty seconds is encouraged.

**6.5.3.2** All stretches should be static (held) versus bouncing. Major muscle groups which are specific to the activity being engaged in should be stretched after warm-up.

## **6.6 Physiological Detraining (Cessation of Training)**

### **6.6.1 Aerobic**

**6.6.1.1** Exercise should be continued on a regular basis in order to maintain the training effect. A significant reduction in aerobic fitness occurs within two weeks of detraining. Individuals can return to near pre-training levels in a minimum of ten weeks. While dramatic reductions in aerobic fitness occur from the cessation of training, reduced training shows modest-to-no reductions for periods of five to fifteen weeks. When reducing training, intensity is the most influential variable in maintaining a degree of original fitness.

**6.6.1.2** Maximal  $VO_2$  does show a steady decline with age, although the amount of exercise and activity influences this decline significantly. As an individual ages, therefore, he or she will continue to be able to pass the qualification standard if proper training levels have been maintained.

## **6.6.2 Muscular Strength and Endurance**

Muscular strength and endurance detraining is somewhat similar to aerobic detraining although not as dramatic in nature. Healthy adults can maintain a larger percentage of strength for longer periods as compared to cardiorespiratory detraining. If an individual has been out of training, the initiation of his or her exercise program should concentrate on aerobic improvements.

## **6.7 Other Factors Affecting Training**

**6.7.1** During program development, special emphasis should be placed on the attainment of acceptable training adherence. Because adherence is influenced by many variables, each specific training program should address all of the known variables.

**6.7.2** Boredom is a major cause of poor exercise adherence. To counteract boredom, provisions should be made for as much aerobic variety and as many diverse settings as possible.

**6.7.3** The physical discomfort from exertion, particularly at low fitness levels or in the early stages of increased activity, should be minimized or offset by positive factors in order for the individual to train at appropriate levels. Enjoyment is also increased by allowing choices and some degree of autonomy. Program administrators and fitness staff members should provide a positive atmosphere with strong support and encouragement for the security force personnel.

**6.7.4** The individual should be educated on the positive health benefits to be derived from exercising. Increased education correlates well with changing health behavior.

## **7 WRITING A PROGRAM PLAN**

This NUREG, as well as 10 CFR Part 73, can be used in developing a program plan. The program plan should consist of written licensee-specific standard operating procedures which are approved by NRC. The program plan should be designed to ensure that security force personnel safely maintain a suitable level of fitness and are able to perform all assigned routine and emergency duties. The program plan format may be at the discretion of the originator or as required by management or contract. In any event, main topical areas of the program plan should include:

- NRC standards
- Personnel responsibilities and requirements
- The physical fitness training program
- Medical extensions, waivers, and appeals
- Safety
- Documents, reports, and forms

### **7.1 NRC Standards**

The program plan should describe the procedures to be used for new security force personnel including their initial medical examination, certification, and qualification for an armed position. A medical examination, certification, and performance requalification for incumbent security force personnel should be established annually. Site-specific annual requalification dates should also be established.

## **7.2 Personnel Responsibilities and Requirements**

**7.2.1** Program plans should establish minimum requirements and responsibilities related to the fitness program. The personnel involved should include as a minimum:

- Program manager
- Evaluating physician
- Fitness staff
- Security force personnel

**7.2.2** This section of the program plan should include the requirement that security force personnel immediately report to their superior any known or suspected change in their health that might impair their capacity for duty or for the safe and effective performance of their assigned job duties.

## **7.3 The Physical Fitness Training Program**

**7.3.1** A detailed description of all major components of fitness training and maintenance, assessments, and qualification testing should be described in this section of the program plan.

**7.3.2** The fitness training and maintenance portion of the program plan should describe, but not be limited to, the following:

- Frequency
- Intensity
- Duration
- Mode
- Exercise prescription, as needed
- Detraining
- Training adherence
- Supervision

**7.3.3** The fitness assessments section should describe as a minimum:

- Initial tests and protocols to be used
- Quarterly tests and protocols to be used

**7.3.4** The program plan's annual physical fitness qualification standards section should describe as a minimum:

- Testing procedures
- Qualification of test administrators
- Testing of high-risk persons

## **7.4 Medical Extensions, Waivers, and Appeals**

Medical extensions, waivers, and appeals should be handled by the licensee management with information and counsel received from the responsible physician.

## **7.5 Safety**

**7.5.1** Program plans should describe safety orientations for participants on the use of facilities and equipment and should also include safety briefings describing the danger signals associated with exercise.

**7.5.2** Even with the best of planning and precautions, there exists the possibility of injury occurring during the course of an exercise or testing session. Depending on the nature and the severity of the injury, varying degrees of first aid and medical attention may be required. Standard operating procedures for medical emergency responses to exercise-related injuries should be documented, updated, and on file as required by the Licensee personnel who are assigned to said tasks. The methods by which the fitness staff and the security force personnel maintain familiarity with the medical emergency procedures should be described in the program plan.

## **7.6 Documents, Reports, and Forms**

Documentation and record maintenance are vital for assessing the effectiveness of the program on all levels. This section of the program plan should describe the licensee-specific system for documenting participation in the physical fitness program as well as the reports and forms used for such documentation. The forms in the program plan should include, but not necessarily be limited to, those listed below.

### **7.6.1 Forms**

#### **7.6.1.1 Certification of Fitness for Duty**

**7.6.1.1.1** This is a certification that the security force person is medically qualified for that position based on meeting the medical standards of 10 CFR 73 as well as any additional ones established in the NRC-approved Physical Protection Plan (refer to NUREG 5689 for guidance). This certification should be issued by the responsible physician when any of the following conditions apply:

- At the time of employment
- After each annually required physical examination
- Whenever there is a significant change in personal health
- Whenever the individual has been away from work for health reasons for five or more working days
- Whenever there is an occupationally-related illness or injury

**7.6.1.1.2** A record of the certification should be kept by the licensee fitness coordinator. An example of this certification is provided as Appendix C.

#### **7.6.1.2 Supervision Concerns for the Physical Fitness Program**

**7.6.1.2.1** This is a certification of readiness to participate in an ongoing physical fitness training program. This certification should be forwarded to the licensee fitness coordinator after each quarterly physical



fitness assessment or subsequent to a change in the individual's health status. An example of this certification is provided as Appendix D.

**7.6.1.2.2** This certification defines the parameters of supervision for the security force person. He/she should be placed into one of three levels of care:

- Cleared for minimally supervised training
- Cleared for directly supervised training
- Cleared for monitored training

### **7.6.1.3 Clearance for the Physical Performance Standard Attempt**

**7.6.1.3.1** This is a certification of readiness to attempt the physical performance qualification test. This certification should be based upon the results of the annual physical examination and should be submitted to the fitness coordinator. The physical performance qualification test should be conducted within thirty days of the issuance of this certification. If this certification is not issued at the same time as the annual physical examination, an additional medical examination should be made prior to certification for performance testing.

**7.6.1.3.2** The additional medical examination, if needed, should be conducted based upon a review of medical records, a review of statements reflecting the training and the appropriateness of testing by both the individual being tested and by the fitness coordinator, and the results of any special evaluations that are determined to be necessary by the responsible evaluating physician. The following guidance is provided for the medical evaluation, and an example of the resultant certification is presented as Appendix E:

- The medical record should be reviewed for any previous physical examination finding and any subsequent illness, injury, or examination data.
- The fitness coordinator should provide a report to the responsible examining physician stating whether or not the individual has participated in an approved physical fitness training program as well as stating any fitness concerns that the coordinator may have for the individual.
- The security force person should identify any medical concerns or limitations and any use of prescribed or over-the-counter medications.

**7.6.1.3.3** Based upon the information that has developed, the responsible examining physician may insist upon other tests or examinations in order to verify health status for certification.

## **7.6.2 Reports**

**7.6.2.1 Fitness Training Attendance:** Each Licensee should develop a method for verifying and recording training session attendance.

**7.6.2.2 The Fitness Assessment Report:** Each Licensee should develop a method for verifying and recording fitness assessments as identified in this guide.

### **7.6.2.3 The Annual Physical Performance Qualification Standard Report**

**7.6.2.3.1** The Physical Fitness Qualification Standard report should be filled out annually for each security force person and should be kept on file for evaluations of program effectiveness. The following information should be included:

- Calendar year
- Site
- Security force person identifier
- Gender
- Age
- Medical certification that the security force person may attempt the standard
- Whether the individual was tested on a track or on a treadmill
- Whether the individual passed the standard
- Date of passing the standard
- Passed 1 mile time, or
- Passed 1/2 mile time
- Passed 40-yard prone-to-running dash time
- Fastest failed 1 mile time, or
- Fastest failed 1/2 mile time
- Fastest failed 40-yard time
- Ethnicity

**7.6.2.3.1.1** Although there may be legal problems in getting ethnicity information on all individuals, it remains a suggested component of data collection because some of the first court challenges to the physical fitness performance standards may be contended on the basis of adverse impact to certain segments of the population.

**7.6.2.3.2** Additional data may be requested by NRC concerning training parameters (i.e. training days per week) as well as physiological characteristics of security force personnel who have failed the standard (i.e. smoking status, body composition).

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## APPENDIX A

### VERIFICATION OF PERFORMANCE STANDARD ATTEMPT

*This section is to be completed on the day of testing immediately prior to attempting the physical performance qualification standard which is mandated in 10 CFR 73.46(b)(10).*

Name of guard, TRT member, or armed response person \_\_\_\_\_

I certify that I have not had any health concerns and/or changes in my medications since I was medically cleared to attempt the standard. I have been continuing to exercise in accordance with 10 CFR 73.46(b)10, and I feel prepared to safely attempt the standard at this time.

Signature \_\_\_\_\_ Date \_\_\_\_\_

***Please read the following test instructions.***

You (and the official time) will start after hearing a verbal command; a concurrent visual command will be given to the timekeeper. The official qualification run time is the time elapsed from the visual command at the starting line to your crossing of the finish line.

*\* Describe the course here including the distance, the starting and finishing locations, and the number of laps or the course route.*

Abnormal signs and symptoms may call for you to stop the testing. These signs might include, but are not limited to, abnormal chest pain, arm pain, or shortness of breath.

After completing the test, you should cool down by walking for five minutes.

The 40-yard dash is a prone-to-running qualification. You will be instructed to lie in a prone position with your head behind the starting line. The body position for a prone posture is the chest and pelvis on the ground and at least one leg fully extended.

Starting blocks will not be used for any qualification run.

You are cautioned that all qualifications are individual efforts. You may not be assisted by physical touching unless an emergency develops or the test has been completed.

The physical performance qualification standard consists of two elements: the 1/2 or 1 mile run and the 40-yard prone-to-running dash. Both elements must be tested on the same day. The preferred order of testing is the distance run followed by the dash. Failure of either element should constitute a failure of the standard and requires the retesting of both elements at another time.

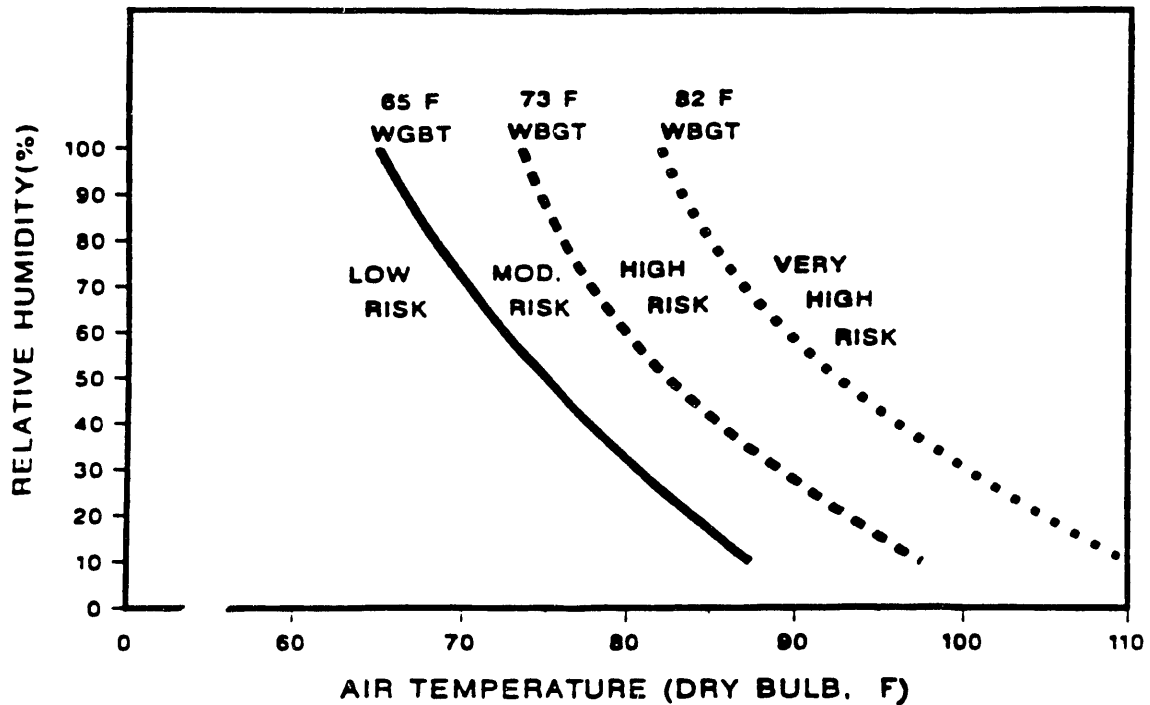
The testing period is within thirty days from the date on which the medical certification is issued.

I have read the instructions as listed above. \_\_\_\_\_  
Signature of officer to be tested

## APPENDIX B

### HEAT-STRESS INDEX

Risk of Injury During Exercise in High Environmental Temperature and Humidity



Adapted from Armstrong, L.E. and R.W. Hubbard, "High and dry", *Runners World*, June 1985, p.13.

### WIND-CHILL INDEX

Wind speed (mph)	Thermometer reading (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	
	(Equivalent temperature [°F])											
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	
40	26	10	-6	-21	-37	-53	-69	-85	-100	-115	-132	
	<i>Minimal Risk</i>				<i>Increasing Risk</i>				<i>Great Risk</i>			

Adapted from Blair, S.N. et al., *Resource Manual for Exercise Testing and Prescription*, Lea and Febiger, Philadelphia, Pennsylvania, 1990.

**APPENDIX C**  
**CERTIFICATION OF PHYSICAL FITNESS FOR DUTY**

I, (name of physician) \_\_\_\_\_, certify that (name of individual) \_\_\_\_\_ is medically qualified for the position of (guard, TRT, or other armed response person) \_\_\_\_\_ and meets the medical standards contained within 10 CFR 73 as well as within the NRC-approved Physical Protection Plan. This certification is valid for up to one year from the date of my signature. It must, however, be renewed within one year if there is a significant change in health status.

Signature \_\_\_\_\_ Date \_\_\_\_\_

Limitations to duty:

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## APPENDIX D

### SUPERVISION CONCERNS FOR THE PHYSICAL FITNESS PROGRAM

Name of Individual \_\_\_\_\_

The following parameters for training are to be updated after each periodic physical fitness assessment, annual physical examination, or significant change in health status.

#### TRAINING CLEARANCE

- Cleared for minimally supervised training
- Cleared for directly supervised training
- Cleared for monitored training

#### MONITORING OR DIRECT SUPERVISION

- Blood pressure
- Orthopedic
- Fitness Progress
- Other \_\_\_\_\_

#### FREQUENCY OF MONITORING OR DIRECT SUPERVISION

- Three times per week
- One time per week
- One time every two weeks
- One time per month

Name of Physician \_\_\_\_\_

and

Signature \_\_\_\_\_ Date \_\_\_\_\_

Comments:



**APPENDIX E**  
**CLEARANCE FOR THE PHYSICAL PERFORMANCE**  
**STANDARD ATTEMPT**  
**10 CFR 73**

Name of Individual \_\_\_\_\_

I certify that I have not had any health concerns and/or changes in medications which have occurred since my last NRC-required physical exam except for those noted below. These changes do not pose a concern to me in attempting the standard safely. I also certify that I have been exercising consistently as described in the NRC-approved Physical Protection Plan.

Concerns/Medications \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Signature of Individual \_\_\_\_\_ Date \_\_\_\_\_

I certify that this individual's training records have been reviewed and that this individual has trained in accordance with 10 CFR 73.46 (b)(10); he/she demonstrates no apparent fitness-related concerns to prevent him/her from attempting the standard.

Signature of Fitness Coordinator \_\_\_\_\_ Date \_\_\_\_\_

I certify that the individual's health records have been reviewed to determine if any contraindications for attempting the standard exist. I certify that the current health and fitness status of this individual appears sufficient to attempt the standard. This certification is good for up to thirty days as long as there is no negative change in the individual's health status and if at least two training sessions per week are maintained during this period.

Name of Authorized Physician \_\_\_\_\_

and

Signature \_\_\_\_\_ Date \_\_\_\_\_

**BIBLIOGRAPHIC DATA SHEET**

*(See instructions on the reverse)*

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*(Assigned by NRC. Add Vol., Supp., Rev.,  
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Office of Nuclear Material Safety and Safeguards  
U.S. Nuclear Regulatory Commission  
Washington D.C. 20555

10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

The recommendations contained throughout this NUREG are being provided to the Nuclear Regulatory Commission (NRC) as a reference manual which can be used by licensee management as they develop a program plan for the safe participation of guards, Tactical Response Team members (TRTs), and all other armed response personnel in physical fitness training and in physical performance standards testing. The information provided in this NUREG will help licensees determine if guards, TRTs, and other armed response personnel can effectively perform their normal and emergency duties without undue hazard to themselves, to fellow employees, to the plant site, and to the general public. The recommendations in this NUREG are similar in part to those contained within the Department of Energy (DOE) Medical and Fitness Implementation Guide which was published in March, 1991. The guidelines contained in this NUREG are not requirements, and compliance is not required.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

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14. SECURITY CLASSIFICATION

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