Peculiarities of a mobile workout training facility for rescuer's practical training

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Abstract. One of the most important factors in the success of an intervention/rescue operation in toxic/ flammable / explosive environments is appropriate training process for rescue personnel taking part in these interventions. Intervention can take place in small (confined) spaces, in high temperature / humidity areas, with low visibility conditions, which would make rescuer's activity even more difficult, during interventions. Training is a process of psychophysiological preparation, which produces a high (maximum) return in professional activity of rescuers. The maximum yield is obtained by increasing the body's functional capacity to highest degree. For this purpose, it is necessary to use systematic and methodical exercise according to pedagogical rules. The current paper presents a mobile workout training facility equipped with an area of enclosed spaces with different training routes, on various degrees of difficulty, allowing for simulation of some interventions in such spaces, having the possibility of creating high temperature and humidity, low visibility, etc. environments within the training facility, with the purpose of preparing intervention and rescue teams for situations close to real ones.

1 Introduction

Intervention and rescue in flammable toxic / explosive environments may only be carried out by personnel trained and authorized in this respect, by personnel using individual breathing equipment [1]. The decisive factor in ensuring the success of an intervention and rescue operation in toxic or chemically aggressive environments resides in the optimal and efficient design of rescue personnel's training process including interventions in confined spaces [2].

Training is a process of psychophysiological preparation that maximizes the efficiency of rescue work. The maximum yield is obtained by increasing the body's functional capacity to highest degree. For this purpose, it is necessary to use systematic and methodical exercise [3]. The intensity of workout put into training is conditioned by:

- individual possibilities of rescuers;

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- degree of training;
- type of exercises;
- external operation conditions.

Their sequence and grading are rigorously planned, providing a scientific character to training.

During training, the following psychophysiological objectives are pursued: learning motor skills, developing psychological and physical qualities of motor activity: speed, strength, skill, will, perseverance, self-confidence, courage, determination, initiative.

Learning and development of motor skills is achieved with participation of the central nervous system that ensures efficiency of body functions and through it a high level of activity of the locomotor apparatus. It also represents a "training of the internal organs" that precedes exercise.

2 Presentation of the mobile workout facility

For safety and health at work of intervention and rescue personnel in toxic/ explosive/ flammable environments and for efficiency of actions undertaken, it is necessary that rescuers are physically and psychologically prepared and trained. Such training can be achieved by using a modern training facility (mobile facility) that can be made available to any economic agent regardless of place and nature of activity carried out [4].

Practical training in the process of training / re-training of rescuers at economic agent's locations, is performed at present within their own installations, under normal conditions of activity, without being able to simulate difficult conditions encountered in a real intervention situation such as: low visibility, high temperature and humidity, closed spaces, conditions that can be encountered in a real intervention situation [5].

The mobile training facility (fig.1) will have a complex character, this characteristic being due to the fact that it will contain tanks, piping, niches, gas channel, etc. The facility will be designed to allow rescue from confined spaces [6].

Fig. 1. Mobile training facility

Also, areas with high temperature and humidity and low visibility will be created in some areas of the mobile workout facility, allowing for training of intervention and rescue teams in difficult conditions.

The mobile workout facility will consist of:

a. Computer interface stair climber (fig. 2).

Rescuers will practice climbing on an endless stair having the possibility to electronically measure speed of movement. It has automatic safety systems, photoelectric sensors, special braking circuit and automatic electronic start. A free wheel on the transmission shaft drives the endless chain, by means of body weight only. If the nominal value is reached by the person under training, the device automatically stops. Without readjustment of the counter or climb speed, several people can train successively under exactly the same conditions. The climb speed can be set between 3 and 25 meters / minute according to climbing distance.

Fig. 2. Stair climber

b. Computer interface bicycle - ergometer (fig. 3).

Training programs work on the principle of independent speed resistance so that the pedalling frequency can be arbitrarily chosen without thereby influencing the power. The device has two manual and two programmable training programs as well as an automatic pulse power adjustment program. Pulse adjusting power is guided by pre-set pulses for the training time.

Fig. 3. Bicycle – ergometer
c. Treadmill (fig. 4)

It is a device for testing the load condition with an adjustable travel speed between 0.1 and 25 km / h and with a variable inclination between 0 and 30%. Oxygen consumption per body Kg, depends in this case, on the speed and angle of inclination. The device is effectively used for bloodstream training, lung function testing, stress tests and orthopaedic performance testing.

Fig. 4. Treadmill

d. Impact device with computer interface (fig. 5).

A 22 kg weight on the bearings, sliding on a steel frame. The weight drop is attenuated by a system fitted at the lower end point. The 1-meter-long cable is routed over a roll. The ergometer is used for training rescuers, the amount of work performed allowing a correct analysis of physical capacity of the trainee.

Fig. 5. Impact device

e. Confined space track (fig. 6)

The training area is made of a metallic structure, on several levels in the form of interconnected cells, so that training tracks with varying degrees of difficulty can be created.

In the training area, a thermal imaging camera for keeping track of rescuer's movement through low visibility environments will be used.

Within the confined space training facility, high temperature and humidity and low-visibility environments will be created by using high-powered air heaters and water vaporizers, respectively a smoke machine.

Fig. 6. Confined space track

3 Rescue training and its effects on physiological parameters

While working with the insulating apparatus, there are a number of factors that make work become stressful. As a rule, those who work under the protection of insulating apparatuses, besides carrying a device weighing 14-18 kg on their back, are subject to great difficulty, in terms of securing their own safety, saving lives, carrying out urgent and highly skilled works (restoring damaged areas, work in water areas, transport of materials etc.) in tough microclimate (high heat and humidity), toxic environment, smoke. It follows that the physical effort put in by rescuers is intense because of the above-mentioned conditions.

Normal activity is defined as the performance of a worker with average performance capacity, trained, accustomed to his work, working at a moderate pace, taking his rest periods according to his needs.

During effort, body adaptation is ensured on one hand by nervous regulation and on the other by neuro-hormonal regulation. During effort, a number of changes in body's apparatuses and systems are produced, as an expression of functional adaptation trend, changes that most outwardly appear in the cardiovascular system. The most noticeable manner of adaptation of this apparatus is acceleration of heart rate, the increased heart rate reflecting the increased heart rhythm. Heart rhythm can reach a level from 60-70 beats per minute, to 120-150 or even 200 beats per minute in exceptional cases, at great efforts.

The heart rate adaptation begins immediately after initiation of effort, first with an increase over need and then a stabilization at a constant level, if effort is constant. Once effort is over, the return to normal takes place in two steps: first by a sudden drop, then by a slow and progressive, sometimes wave-like, decline.

Another manifestation of circulatory changes during exercise is the increase in blood pressure, which is proportional to effort intensity, in this situation, both maximum and minimum being of interest. Once the work is finished, blood pressure returns to normal, a return that depends on intensity of effort that has been made and individual training degree. In the first few minutes, pressure values fall below the rest value, then rise to normal. In the event of an inappropriate adaptation of the cardio vascular system, the maximum pressure

decreases abruptly before the end of the stress test, so the heart is at the limit of its resources.

Once the effort has ceased, the muscles that were in full activity need a certain amount of time to eliminate wear, a period that depends on the mechanical work performed.

Repeated physical activity leads to adaptation of the circulatory system to increased demands, the heart increases its volume, increases its circulation force and reduces its frequency. As the training progresses, blood pressure is set at increasingly lower values.

The phenomenon of fatigue that occurs during training represents the totality of subjective and objective phenomena that arise from a physical effort and involves the accompanying sensations of effort as well as consecutive repair phenomena. It is characterized by more or less prolonged reduction of labour capacity, induced by effort duration and intensity, and represents a decrease of work capacity, being a signal that drives a complex of functional processes. The emergence of fatigue presents great differences from individual to individual. In the case of fatigue, there is a favourable situation, obtained through training and life style, so there's the possibility of positive influence.

Practical training exercises for ergometer and ergometer-bicycle have been performed within the training facility of INCD-INSEMEX, to establish how pulse, blood pressure and critical fusion frequency progresses in rescuers putting in high-effort (about 20,000 kgm), which is considered to be very high and requiring the body to make a great effort to achieve it whilst wearing insulating apparatuses. The effort is intense in these cases and the pulse changes must be set to maximum values between 150-175 pulses per minute.

From keeping track of physiological changes to effort it was established that:

- pulse and blood pressure changes are easily accessible to medical observation, being illustrative for assessing the degree of body stress;
- when putting in effort whilst wearing insulating apparatuses, it is estimated that the body is subjected to a 30% extra load, a figure that is taken into account as reference when appraising rescuer's effort.

To cope with such overload, proper training of rescuers is required, as well as periodic testing for establishing the degree and ability of effort, constantly monitoring physiological parameters by means of mobile training facility's equipment or by rescue station's physician.

4 Conclusions

1. Development of a mobile training facility will lead to development of the practical training infrastructure for intervention and rescue personnel in toxic/ explosive/ flammable environments, allowing for research studies with the final objective of elaborating and implementing selection and training procedures for intervention and rescue teams working in confined spaces, both within INCD INSEMEX as well as at economic agent's rescue stations.

2. Various training scenarios with various degrees of difficulty can be created within the mobile facility, allowing simulation of intervention activities in confined, horizontal and vertical spaces, environment with low visibility, high temperature and humidity, etc., aiming at training intervention and rescue teams for situations close to real ones.

3. Benefits for economic agents, beneficiaries of the training - authorization activity of intervention and rescue personnel in toxic / explosive / flammable environments which, by using the mobile facility, will ensure an increase in health and safety at work, accident prevention capabilities, and more effective protection of patrimony susceptible of being destroyed or disabled by accidents or break-downs.

4. The possibility of constant monitoring of rescuer's physiological parameters (heart rhythm, blood pressure, blood oxygen, etc.) during training, with the help of equipment provided by the mobile training facility.

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