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THE EFFECT OF WEARING CBRN INDIVIDUAL PROTECTION EQUIPMENT ON INDIVIDUAL AND UNIT PERFORMANCE DURING MILITARY OPERATIONS

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NATO LETTER OF PROMULGATION

29 January 2021

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CHAPTER 1 FACTORS AFFECTING PERFORMANCE DEGRADATION – GENERAL CONCEPTS

1.1 Purpose of ATP-65

This publication provides Commanders with commander's guidance on the individual and unit performance degradation, due to CBRN Individual Protection Equipment (IPE) being worn, during military operations. Unless otherwise specified, the information provided relates to the wear of a negative pressure air-purifying respirator (APR), with a moderate burden IPE design (typically an air-permeable activated carbon based suit).

1.2 Aim

The aim of Chapter 1 is to provide general concepts regarding Dress Category, performance degradation, Performance Degradation Factor (PDF), physiological and psychological factors coupled to wearing CBRN IPE affecting individual and unit performance.

1.3 Definitions

The following is a list of all the relevant definitions, in addition to those in AAP-6 that apply to this publication.

a. NATO Dress State; state in IPE dressing that indicate how much of the protective ensemble is being worn by an individual or individuals in a unit. Table 1-1 is the NATO Dress States Zero to Four.

DRESS STATE	Suit	Boots	Gloves	Respirator/Mask
ZERO	Immediately Available	Immediately Available	Immediately Available	Carried*
ONE	Worn	Carried	Carried	Carried*
TWO	Worn	Worn	Carried	Carried*
THREE	Worn	Worn	Worn	Carried*
FOUR	Worn	Worn	Worn	Worn

***Respirator may be worn in any Dress State**

Note: Dress States are set against the expected threat/risk to Force and the required time to react to that threat.

Table 1-1 Graduated Personal Protective Regimes

Note 1: Commanders may order the level of protection to be:

a. Reduced, if warranted by special conditions e.g. if personnel are inside COLPRO or it is judged that the risk of casualties is outweighed by the need to pursue the mission unencumbered by the use of some or all items of IPE.

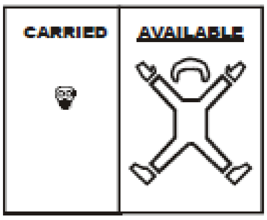
b. Increased, if local conditions demand a higher degree of protection.

Note 2: The additional description Respirator Worn may be added to any of the Dress States; this may denote any nationally recognized form of respiratory protection.

Note 3: To enhance risk management, 'Jacket/Suit Open' or 'Jacket/Suit Off' may be suffixed to any of NATO Dress States 1, 2, 3 and 4.

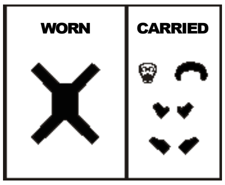
b. Dress Category: A combination of one or more Dress States that facilitates the establishment of work/rest/water tables contained in this publication.

(1) Dress Category "LOW": individual is in fighting order (wearing battledress uniform - BDU) with the IPE immediately available and respirator carried.

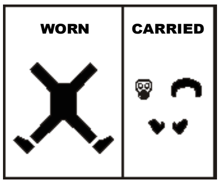


(Dress State 0)

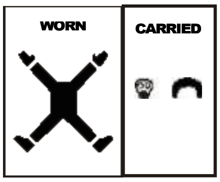
(2) Dress Category "MEDIUM": individual is wearing CBRN protective equipment NATO Dress States one to Three:



(Dress State 1)



(Dress State 2)



(Dress State 3)

(3) Dress Category "HIGH": individual is wearing all CBRN protective equipment including protective suit, foot coverings, gloves and respirator (with hood if applicable) and the ensemble is worn closed.

(Dress State 4)

c. Performance Degradation: The impact of wearing IPE which results in impeded physiological functions such as vision, hearing, speaking, manual dexterity and others and the psychological effects from encapsulation, such as isolation and claustrophobia. The result of these impediments usually takes the form of increased time to complete tasks and reduced accuracy, and might include the need for increased requirement for rest and fluid replacement.

d. Performance Degradation Factor (PDF): For each Dress Category, a single average PDF is given. The PDF is a factor that either increases the time or decreases performance of a task. Multiplying the normal task completion time by the PDF for the IPE worn gives a new task completion time ("correct" time) for that dress. Dividing 100% performance (assuming normal performance = 100%) by the appropriate PDF gives the degraded performance as a percentage for that dress category. The value of PDF is an average number, that does not take in to account the difference in the material and design of various IPE used by different countries.

1.4 Factors Affecting Performance Degradation

The key to selecting appropriate Dress Categories lies in understanding factors contributing to performance degradation and heat casualties on one hand and protection of individuals against the CBRN threat and its effects on the other hand. It is to be stressed that Dress Category HIGH protects individuals by isolating them from the CBRN environment. However, this encapsulation imposes both physiological and psychological stresses upon the wearer and interacts to degrade individual performance. On the other hand, lower Dress Category reduces the stress associated with encapsulation but increases the risk of exposure to threat agents. Exposure to low levels of some agents can also lead to performance degradation.

In order to counter the problems associated with increased levels of protection, performance problems and casualties can be minimized through informed planning and thorough preparation. The wearing of IPE can influence the outcome of a battle by degrading performance, altering projected force ratios, and creating additional confusion on an already complex battlefield. A knowledge of the impact that wearing IPE may have on the integrated battlefield could be the margin required for victory. As a result, commanders need to make sound judgements with regards to balance between all factors involved in order to be able to select an appropriate category, avoiding unnecessary burden upon the individuals.

a. Physiological Factors. Adding layers of clothing (for example protective ensemble over uniform) increases the risk of heat stress, even at moderate environmental temperatures and work intensities. This increases the possibility of heat casualties and degrades performance. Hunger, thirst, and discomfort during sustained periods of IPE wear can also seriously degrade performance.

(1) Heat Stress in IPE.
Body temperature must be maintained within narrow limits for optimum physical and mental performance. The body produces more heat during work than rest. Normally, the body cools itself by evaporation of sweat, convection and radiation of heat at the skin's surface. The wearing of IPE restricts these heat loss mechanisms because of its high insulation and low permeability to water vapor. In addition, physical work tasks require more effort when soldiers wear IPE because of added weight and

restricted movement. This results in more body heat to be dissipated than normal, and body temperature tends to rise quickly. The amount of heat accumulation depends upon the amount of physical activity, the level of hydration, the clothing worn, the load carried, the state of heat acclimatization, physical fitness, and fatigue, as well as terrain and climatic conditions. Adjusting Dress Categories by opening the protective ensemble top, unblousing boots, rolling up hood and so forth will reduce barriers to body cooling. The decision process for selecting appropriate adjustments is covered in the Dress Category analyses section.

(2) Dehydration.
Because of higher body temperatures, soldiers wearing IPE sweat considerably more than usual, often losing more than 1 liter of water every hour during work. Water must be consumed to replace lost fluids and avoid dehydration. Even a slight degree of dehydration impairs the body's ability to regulate its temperature, and reduces the benefits of heat acclimatization and physical fitness. It also increases susceptibility to heat injury and reduces work capacity, appetite, and alertness. Even in individuals who are not heat casualties, the combined effects of dehydration, restricted heat loss from the body, and increased work effort place a severe strain on the body's functions, and soldiers suffer a decrease in mental and physical performance. The difficulty of drinking in IPE increases the likelihood of dehydration. Further, often rates of fluid loss through sweating exceed the body's maximal rate of fluid absorption. Thus, some degree of dehydration is inevitable. In this situation, therefore, individuals are encouraged to continue to drink during rest periods or when meals are provided. Thirst is not an adequate indicator of dehydration. However, if members "drink to thirst" and continue to consume fluids during recovery and during meals there will be no risk of hyperhydration. It is also important to adjust the fluid replacement guidelines to differences in members' body mass since the guidelines refer to rates of absolute volume replacement guidelines. Commanders at all levels must take responsibility for enforcing regular and timely fluid replacement in personnel under their command.

(3) Respiration difficulties.
When a negative pressure air-purifying respirator is being worn, respiration becomes more difficult owing to the resistances imposed by the filter and the inlet and outlet valves. This leads not only to an increase in respiration frequency, but also to an increase in the depth of respiration. More importantly, it also leads to a decrease in exercise endurance. Positive pressure systems, such as self-contained breathing apparatus and powered-air purifying respirators, generally reduce this breathing resistance but increase other forms of burden.

(4) Inadequate Nutrition.

In addition to bodily requirements for electrolyte replacement caused by sustained and excessive sweating, the higher work intensities typical of operations in IPE lead to an increased demand for calories. Lack of adequate energy supplies can lead to decrements in both physical and mental performance.

(5) Identification difficulties.
Easy identification of key personnel is hindered by the wearing of IPE. The wearing of a full-face respirator and chemical protective suit hides all of the features normally used in identifying personnel. This aspect of increased levels of protection, and the possible confusion that may result, needs to be taken into account in all operations in a CBRN environment.

b. Psychological Factors. The threat of CBRN warfare adds to an already stressful situation because it creates unique fears in soldiers. This fear may reduce a soldier’s ability to perform their mission.

(1) Isolation from the Environment.
IPE reduces the ability to see and hear clearly which makes it more difficult to recognize and communicate with others. This creates or increases feelings of isolation and confusion. The awkwardness of wearing bulky, impermeable or semi-permeable garments, gloves, and boots on top of the field uniform can cause frustration in many soldiers and claustrophobia in some. Long periods of reduced mobility and sensory awareness degrade attention and alertness and create or increase feelings of alienation. Protective filters in the respirators make breathing more difficult; this too may create feelings of claustrophobia or panic.

(2) Combat Stress.
The threat of CBRN warfare increases the overall psychological and physiological stress that is an integral part of combat. Because the highest CBRN protective posture is adopted when the threat of an attack is imminent, the encapsulation can increase generalized fears and anxiety associated with combat. Combat stress or battlefield fatigue can cause significant numbers of psychological casualties, depending on the duration and intensity of battle. Psychological stress results not only from the death and destruction that characterize combat, but also from the challenging operational conditions (noise, confusion, and loss of sleep). Challenging operational conditions that create fatigue and cause changes in diet and personal hygiene cause physiological stress as well.

(3) Minimizing Psychological Factors.
The adverse impact of psychological stress during IPE operations can be minimized by the experience and confidence that realistic training in

IPE provides. Wearing IPE causes physical and emotional stress. Tough, realistic, mission essential task driven training using IPE creates a stressful environment for soldiers and units. Successful training helps support units preparation for battle stress encountered during operations.

1.5 Military Task Performance Problems in IPE

a. Adding layers to the uniform reduces mobility, agility, coordination, and dexterity. Units operating in Dress Category MEDIUM generally do not experience significant time increases to perform a given task except when travelling by foot. Extensive foot travel is slowed due to the effects of the foot covering.

b. Leaders must plan for a slower pace of operations in IPE if accuracy is to be maintained. Practicing critical tasks offers improvements, but this may or may not be sufficient, depending on mission requirements. Tasks that require manual dexterity and unrestricted hearing and vision should be simplified or modified.

c. Command, control and communications are difficult in a CBRN environment. Wearing the respirator degrades hearing, vision, and speech; all are important to effective communication. Individuals are difficult to identify by name or rank, leading to confusion as well as contributing to failures in effective communication. Performance of command functions while in IPE presents a problem all commanders must consider. A few of these challenges include:

(1) Heat stress causes personnel in leadership positions to tire rapidly and affects mental and physical capability.

(2) The respirator voice emitter makes speech difficult to understand.

(3) Eye lens of the respirator narrows the field of view.

(4) The hood impairs hearing and may narrow the field of view.

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CHAPTER 2 RECOMMENDATIONS TO COUNTER THE HEAT STRESS OF WEARING CBRN PROTECTIVE CLOTHING

2.1 Aim

The aim of this chapter is to focus attention to the problem of the heat stress associated with wearing CBRN protective clothing in hot environments and to clarify which, if any, physiological countermeasures can be adopted in order to maximize soldier's performance.
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2.2. Introduction

Man functions effectively only when his body temperature is maintained within fairly narrow limits. An increase in body temperature above these limits will lead to decrements in cognitive and physical performance, fatigue, illness, incapacity, and in extreme cases, death.

2.3. Heat production

Heat production within the body is governed by the amount of physical activity or work that is performed. If body temperature is to remain at a controlled level, the increased heat production associated with increased work efforts must be removed. Dry heat exchange through convection and radiation, and evaporation of sweat are the major avenues for heat loss from the body. Dry heat exchange is dependent on the temperature gradient between the skin and the environment. Thus, this mechanism is very effective for heat loss in cool environments but as ambient temperature increases above 36˚C and exceeds skin temperature, this method of heat transfer will become a source of heat gain for the body. Therefore, as environmental temperature increases, evaporation of sweat becomes the predominant mechanism for body heat loss. Sweat evaporation is dependent primarily on the vapor pressure gradient between the skin surface and the environment. The relative humidity and the temperature together determine the vapor pressure. Thus, desert environments that are hot and dry can still promote effective heat loss through evaporation of sweat because a substantial vapor pressure gradient can be established between the skin and the environment. Conversely, in tropical environments that are warm and very humid, evaporative heat loss is restricted because of the small vapor pressure gradient that is developed. Similar constraints develop if typical protective clothing is worn (due to low or no air or moisture vapor permeability).

2.4. Hypo-hydration

Hypo-hydration is a state of decreased body water content. This occurs when body fluid losses are not fully replaced. It is a danger in military operations, where adequate re-hydration and recovery may not be possible prior to a subsequent work session. This is the case while wearing either combat or CBRN clothing. Even minor hypo-hydration of only 1% body mass can significantly impair heart rate and temperature responses to exercise, with the intensity of the impairment increasing with greater levels of hypo-hydration. When the CBRN clothing is worn, hypo-hydration and the restriction of fluid exert a greater negative effect on heat tolerance when work efforts exceed 60 min. Hypo-hydration impairs tolerance regardless of an individual's level of physical fitness or heat acclimation.

2.5. Physiological and psychological strain

Physiological and Psychological strain and a decrease in exercise performance and tolerance are well-documented phenomena with the wearing of protective clothing in hot environments. The wearing of CBRN clothing produces a thermal microenvironment within the clothing ensemble, which is potentially much more hazardous than exercise in the heat while wearing combat clothing. Even very light exercise in a hot environment can produce a situation where the individual is unable to maintain a controlled body temperature when protective clothing is worn. This continued rise in body temperature while wearing the CBRN clothing occurs due to a number of contributing factors:

a. Weight and stiffness. CBRN clothing increases the physical load on the individual because of the extra weight of the clothing, and decreases movement efficiency because of the hobbling effect from the additional bulk and stiffness of the clothing. These factors lead to an increase in heat production compared with the situation when the same work is performed while wearing combat clothing;

b. Skin temperature. In a hot environment, the skin temperature while wearing CBRN clothing is very close to or below the temperature of the ambient environment. This decreases the effectiveness of dry heat loss from the skin, and increases the reliance upon evaporative heat loss for regulation of body temperature;

c. Evaporative heat loss. Due to this increased reliance on evaporative heat loss, the rate of sweat production is greater while wearing CBRN clothing than while performing the same exercise in combat clothing; further, because evaporation is relatively ineffective in this context, the body continues to sweat at a high rate to attempt to compensate. This increases the rate of dehydration, or the loss of water from the body which increases the importance of fluid replacement strategies during exercise (see countermeasure dealing with hydration); and

d. Permeability. The reduced water vapour permeability of the CBRN clothing, severely limits the dissipation of body heat through the evaporation of secreted sweat.

2.6. Countermeasures

a. Implementing Work and Rest Schedules. Interjecting scheduled rest periods throughout a work activity will decrease the amount of heat produced for any given amount of time that the protective clothing is worn. If the individual is able to lose body heat during this rest period, then the implementation of scheduled rest breaks will be beneficial and more total work can be accomplished. If the protective clothing can be removed or unbuttoned to promote heat loss, then greater benefits will be found by using rest periods. However, if personnel must remain in the CBRN protective ensemble and exposed to ambient temperatures in excess of 40˚C, then implementing scheduled rest periods will not extend work performance unless some additional intentional cooling mechanisms are provided that may require the IPE to be opened. In very hot environments, individuals will continue to increase body temperature even under resting conditions when the protective clothing is worn.

b. Physical Fitness. Increasing cardiovascular fitness level through regular aerobic exercise will increase sweat rates at a given body temperature; this will allow for greater evaporative cooling during physical activity if the clothing that is being worn or the environmental conditions do not restrict the sweat evaporation. When the CBRN clothing is worn, however, increased sweat loss does not equate to increased evaporative cooling. Findings have shown that regular aerobic exercise programs of less than 10 weeks duration will provide little benefit for less fit individuals when the protective clothing is worn. It would appear that a longer commitment to regular exercise is required before improvements in heat tolerance are observed. Individuals with high levels of cardiovascular fitness have lower core temperatures at rest throughout the day and are able to tolerate higher body temperatures during the heat stress of wearing the CBRN clothing. For example, individuals with high levels of aerobic fitness attained through regular endurance exercise can tolerate increases in body core temperatures close to or even above 40°C, whereas their untrained or less fit counterpart may become exhausted and collapse at core temperatures below 39°C. These differences in the core temperature that can be tolerated can translate into substantial differences in work times among personnel when the IPE is worn.

c. Heat Acclimatization. Regular daily exposure to hot environments while performing light exercise for 2-3 hours promotes acclimatization to the heat. Once again, the major adaptive response involves an increased sweat rate but, as emphasized above, this change does not necessarily increase heat tolerance when the CBRN clothing is worn. A lowered body temperature at rest throughout the day is also found following the acclimatization. The acclimatization process requires a minimum of 4 days, before some benefits are observed, and a maximum of 10-14 days before it is complete. Heat acclimatization will improve heat tolerance for unfit individuals by as much as 100% when combat clothing is worn. However, for all personnel, heat acclimatization will not enhance heat tolerance by more than 25% when the CBRN clothing is worn. The data supporting this latter statement were recorded when fluid replacement was restricted during the exercise period (see below). If fluid losses are replenished during work periods in IPE, heat acclimatization confers no further benefit

d. Hydration. Sweat rates exceeding 1 liter per hour are typical during moderate exercise in the heat. Even with an adequate fluid supply, the rate of voluntary fluid intake rarely matches the rate at which fluid is lost through sweating, and an individual will become dehydrated before a strong behavioral drinking response is observed. In addition, high rates of fluid loss often exceed the maximal rate of fluid absorption through the small intestine, which approximates one litre per hour. If sweat rates exceed these maximal rates of fluid absorption, personnel will become progressively dehydrated regardless of the volume of fluid consumed. However, even minor levels of fluid loss can impair exercise performance, with both heart rate and body temperature at a given work intensity progressively increasing with increasing levels of dehydration. Two separate factors are involved in determining an individual's hydration status:

(1) The individual's hydration status prior to beginning exercise, and whether the individual is euhydrated (i.e. at normal body weight and hydration) or hypo-hydrated (decreased body weight due to sweating and inadequate recovery from a previous bout of exercise).

(2) The availability of fluid during exercise. Without adequate fluid replacement or with excessive rates of fluid loss, the individual will become dehydrated, due to the amount of water loss being greater than the amount of water intake and absorption.

2.7. Recommendations

It is possible to design IPE to increase the ease of transitioning between open and closed states, or to assist with mitigation measures. For example, a protective combat uniform-style of IPE that includes vents can permit easier transition to evaporative cooling loss by opening vents without having to defeat other closures.

Hydration status is one of the most important, and easily manipulated, physiological variables that determines heat tolerance while wearing CBRN clothing. Personnel should always be well hydrated before performing exercise in the heat. Whenever possible, adequate recovery time and fluid must be provided to allow personnel to regain normal body weight and to restore body temperature to normal levels before initiating a second bout of exercise. Hypo-hydration prior to exercise will result in significant impairment regardless of any other countermeasures employed. Even highly fit and heat acclimated individuals provided with fluid during exercise will have reduced tolerance if they are hypo-hydrated prior to exercise.

Fluid replacement during exercise is another critical factor in maximizing exercise heat tolerance while wearing CBRN clothing. Adequate fluid is a more effective countermeasure in reducing heat stress in IPE than heat acclimation. A liberal supply of water should be available throughout exercise. However, personnel should be aware that prolonged hyperhydration can lead to a critical dilution of blood electrolytes that can lead to death. In addition, since individual sweat rates vary considerably, soldiers in CBRN clothing are encouraged to “drink to thirst” during and following conditions that require the use of IPE. Also, monitoring body weight in the morning each day will help ensure that adequate rehydration from the previous day’s activity and not hypohydration prior to beginning additional scenarios that may require the use of IPE. Examples of regulated drinking regimens that can be followed are reported in Annex A.

Without question, aerobic fitness, through its effects on the core temperature that can be tolerated at exhaustion, has the most substantial influence on heat tolerance while wearing CBRN clothing. Individuals with a high aerobic fitness could have heat tolerance levels that are more than 50% greater than their less-fit counterpart. Regular endurance exercise training should be included to ensure a high level of fitness among personnel.

Conscious integration of IPE design that permits easier transitioning between open and closed states may increase the utility of rest breaks to achieve cooling. A protective uniform design reduces the overall weight that must be carried (i.e. no need to carry or wear a separate uniform at the same time as IPE), potentially reducing exercise-related heat generation.

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CHAPTER 3 MITIGATING FACTORS FOR PERFORMANCE DEGRADATION

3.1. Aim

The aim of Chapter 3 is to describe some factors influencing the performance degradation of individuals and units, due to the wearing of IPE.

3.2. Introduction

As stated in Chapter 2, both psychological and physiological factors are involved in the degradation of performance of individuals and units. The adverse impact of psychological stress from IPE during operations can be minimized by the experience and confidence that realistic training in IPE provides. Wearing IPE causes physical and emotional stress. Tough, realistic, mission essential task driven training using IPE creates a stressful environment for soldiers and units, which in turn helps support unit preparations for battle stress encountered during conflict or war. Soldiers, who are in good physical condition and have trained extensively in IPE, suffer less stress when in IPE than troops that are less prepared. Physically fit soldiers are more resistant to physical and mental fatigue and acclimatize more quickly to climatic heat or the heat associated with IPE wear than less fit soldiers. Furthermore, extensive training in IPE allows soldiers to easily recognize the symptoms of related physiological and psychological stress, and to properly react in order to minimize the negative consequences.

3.3 Mitigating the degradation effects in IPE

a. It cannot be overemphasized that soldiers and their leaders must train in IPE over extended periods of time. Further, soldiers cannot be expected to fight successfully in full IPE if they have not trained as a team with their leaders and equipment. Training in full IPE helps leaders and soldiers understand the problems they will encounter, and allows them to become more confident and proficient on individual and team tasks.

b. The following actions will help to mitigate the degradation effects of operating in IPE.

(1) <u>Train thoroughly and realistically.</u>

(a) Build confidence and unit cohesion through realistic training in IPE.

(b) Practice critical visual tasks (like marksmanship) in the respirator until they become automatic.

(c) Attain and maintain peak physical fitness and acclimatization.

(d) Cross-train crews and other critical positions.

(2) Plan ahead.

(a) Check CBRN defense guidance in plans and orders to anticipate projected work requirements in the next 24-28 hours.

(b) Know the most current weather data.

(c) Plan work/rest cycles appropriate to the environment and the mission.

(d) Use SOPs to reduce command, control, and communication tasks.

(e) Keep plans simple.

(3) Think teamwork.

(a) Use methods of individual identification.

(b) Encourage "small talk" while in IPE.

(c) Pair an experienced soldier with an inexperienced soldier whenever possible.

(d) Ensure that all members of the unit are regularly checked for signs of physical stress, agent exposure and dehydration.

(4) Work smart.

(a) Provide relief from IPE as soon as the mission allows.

(b) Use work/rest ratios, slow work rate, and minimize work intensity.

(c) Work in the shade whenever possible.

(d) Enforce command drinking to reduce dehydration and heat casualties.

(e) Use collective protection when available.

(f) Enforce good eating, drinking and sleeping discipline.

(g) Rotate jobs and people during long shifts or periods of inactivity.

(h) Provide relief from extreme temperatures (hot or cold) as soon as possible.

(i) Remember that even short breaks from total encapsulation are effective in sustaining performance.

(j) Augment units or divide work between two units.

(k) Schedule work for a cooler time of day or at night.

(5) Use of long rest breaks (whenever possible) to provide relief from IPE, combined with adequate sleep, food, and drink, can sustain performance at optimal levels.

c. The following are ways in which leaders can minimize some of the difficulties arising from having to operate in IPE.

(1) Delegate more responsibilities to reduce the stress of wearing IPE over extended periods of time.

(2) Increase flexibility in IPE wear as discussed earlier in this document.

(3) Unit operating procedures must include specific unit guidance based on unit mission needs.

(4) When using the radio, ensure the microphone is held close to the voice emitter.

(5) Enhance verbal communications by speaking more slowly than normal and having orders repeated.

(6) Hand and other visual signals can be effectively employed.

(7) Issue written orders, if time permits, to ensure instructions are understood.

(8) Use collective protection when available to reduce the burden of IPE.

d. The precautions to prevent the onset of miosis include:

(1) Have key personnel wear the respirator whenever there is a risk of encountering miosis-producing hazards.

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CHAPTER 4 EVALUATION OF PERFORMANCE REDUCTION

4.1 Aim

The aim of Chapter 4 is to describe the CBRN Degradation estimation parameters and its use to plan an action and manage a unit, when individuals are wearing IPE.

In applying the processes outlined in this document, limitations of the data contained in Annex A must be considered. The data are based on testing and evaluation of units equipped with permeable protective ensembles. The variation in permeability and type of ensembles throughout the NATO forces requires judicious application of the numbers presented in tables contained in Annex A. While the numbers in Annex A will not be strictly applicable in all cases, they provide a basis on which a plan and considerations for mitigating the degradation effects of wearing IPE may be formulated. For more background on the data see annex D

4.2 Parameters used for Estimation of Performance Degradation

a. **Performance Degradation Factor (PDF).** Soldiers depend on each other to ensure unit performance. Individual degradation will affect the unit as a whole. Unit performance will be significantly degraded due to behavioral changes and leader exhaustion. Planners can estimate the time it will take to complete most tasks in Dress Category, by multiplying the time normally required to complete a task by the appropriate PDF.

(1) Dress Category High. Soldiers wearing Dress Category HIGH will take about 1.5 times longer to perform most tasks (PDF = 1.5). Decision-making and precision control tasks are slowed even more than manual tasks. For decision-making and precision control tasks, the normally expected completion time should be multiplied by 2.5 (PDF = 2.5).

(2) Dress Category Medium. When individuals are wearing Dress Category MEDIUM, they will take about 1.2 times longer to perform most tasks (PDF = 1.2).

(3) Dress Category Low. When individuals are wearing Dress category Low, they will take about 1 times longer to perform most tasks (PDF = 1).

b. **Work intensity.** Work intensity is a major contributing factor to heat stress that can be managed by leaders. Military work is categorized as, light (L), moderate (M), or heavy (H). Table 1 - Example Work Loads - in Annex A provides examples that can be used as a guide in estimating the work intensity for a particular mission or task. The incidence of heat casualties can be reduced if soldiers can be allowed to lower their work intensity and/or take more frequent rest breaks.

c. **Maximum Continuous Work Times**. Tables 2 to 4 in Annex A, provide maximum continuous work times under varying environmental conditions. These tables provide the maximum number of minutes that work can be sustained in a single work period, without exceeding a risk of receiving greater than 5% (1 out 20 soldiers) heat casualties.

d. **Work/Rest Cycles for Eight Hours Continuous Work.** Tables 2 to 4 in Annex A provide information necessary to calculate recommended work/rest cycles for various environmental conditions, clothing levels, and work intensities for eight hours continuous work. The work/rest cycles are based on keeping the risk of heat casualties below 5%. Under some operational conditions, work/rest cycles offer no advantage to continuous work. Strict adherence to work/rest criteria may not be possible during combat operations. However, the estimates in the tables represent an average expected value within a large population and should be considered guidance and not be used as a substitute for common sense or experience. Individuals will vary in their tolerance. Once the work time limit has been reached, soldiers should rest in the shade (using the guidance in Annex A, Table 5) before returning to work. As this table shows, reduction of Dress Category level during the rest period is key to maximizing the time troops can spend performing work.

e. **Water Requirements.** Water requirements should be estimated using the guidelines in Tables 2 to 4 in Annex A. Base the recommended hourly replenishment on current work intensity, temperature, clothing layers, and wind and solar load. If possible, soldiers should drink one liter of water in the 30 – 60 minutes before donning respirators; otherwise soldiers should drink as regularly as possible before donning respirators, and frequent drinking while working is more effective in maintaining hydration than waiting until rest periods to drink. However, if work periods are less than 30 minutes and equal to or shorter than the corresponding rest period then drinking during the rest period will be effective. This practice may be easier to follow.

f. **Recovery Time.** Table 5 in Annex A provides estimated recovery times for personnel that have achieved maximum work times, as listed in Tables 2 to 4 in Annex A.

4.3 General Procedures for Estimation of Performance Degradation, and Management of Units.

a. **<u>STEP 1A</u>**: On the basis of the Dress Category, and the knowledge of the time the work will take in normal conditions, commanders can estimate the "effective" time (t_{eff}) by multiplying the "normal" time (t) by the appropriate PDF (MEDIUM = 1.2; HIGH = 1.5 or 2.5).

$$t_{eff} = PDF \times t$$

b. **STEP 1B**: By means of Tables 2 to 4 in Annex A, and knowledge of weather conditions (temperature and relative humidity) on the field, commanders can estimate the maximum continuous working time (minutes).

c. **STEP 1C**: By means of Tables 2 to 4 in Annex A, and knowledge of weather conditions (temperature and relative humidity) in the field, Commanders can also estimate the water requirements (liters/hour) to support maximum working times.

d. **STEP 2**: If "effective" time is less than maximum continuous working time, the unit will perform the work in a single period, without exceeding a risk of receiving more than 5% heat-stress casualties. In this case commanders must ensure water supply as determined in STEP 1C above.

e. **STEP 3A**: If "effective" time is greater than maximum continuous work time, the unit will perform the work in a single period, exceeding a risk of receiving more than 5% heat-stress casualties. In this case, commanders can decide to accept that risk, or can decide to perform the work by means of one or more work/rest cycles, established in accordance to Tables 2 to 4 in Annex A.

f. **STEP 3B**: By means of Tables 2 to 4 in Annex A, and knowledge of weather conditions (temperature and relative humidity) on the field, commanders can estimate the water requirements (liters/hour) to support work/rest cycles.

g. **STEP 4**: At the end of the work, soldiers should rest for a time equal, at least, to that provided by Tables 2 to 5 in Annex A for some situations. The following is a flow-chart that can be useful to better understand the procedure for estimation of performance degradation and management of units described before.

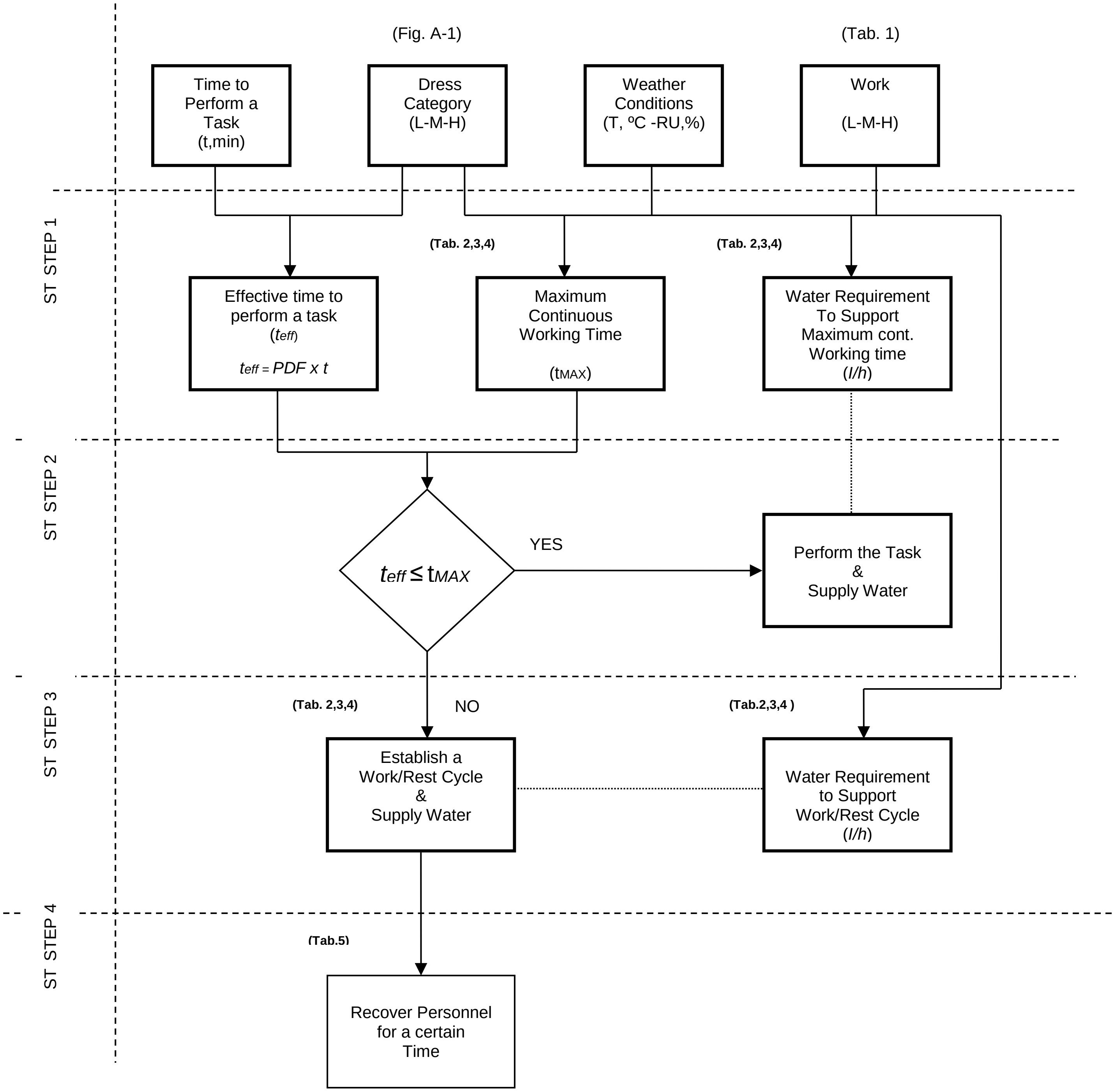

Fig. 4.1: Procedures for estimation of performance degradation and management of Units.

4.4 Performance Degradation Estimation Tables Software.

A software version of Performance Degradation Estimation tables, provided by CAN, and instruction on the use of the related CD-ROM are enclosed at Annex C.

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ANNEX A PERFORMANCE DEGRADATION ESTIMATION TABLES

The figure and tables contained in this annex are provided as planning guidance for operation staffs to consider when the threat level requires consideration of increasing the Dress Category level. The figure and tables consists of:

a. Fig. A-1 - Performance Degradation Factor (PDF) vs Dress Category.
b. Table 2,3,4 – Maximum Continuous Working Times, Rest time in 30 mins of work, and Water Requirements to Support Work/Rest Cycle, for Eight Hours Continuous Work.
c. Table 5 – Estimated Recovery Times After Personnel Have Achieved Maximum Work Times.

Tables 2 through 4 are subdivided into Dress Category levels LOW (Equivalent to NATO Dress State Zero), MEDIUM (Equivalent to NATO Dress State One, Two and Three), and HIGH (Equivalent to NATO Dress State Four). The tables provide data at various ambient air temperatures (15 to 50 °C), at Low (0 to ≤20%), Medium (>20 but <60%), and High (≥ 60%) Relative Humidity (RH), while performing light (L), moderate (M) or heavy (H) workloads (see Table 1). No limit is represented by (-) and equates to performance of the task for at least 8 hours.

For water requirements, one full canteen approximates one liter of water. The fluid replacement guidelines assume a maximum absorption rate of 1.0 L/h. Tables 2 to 4 indicate a red line diagonally across the table corresponding to 1.0 L/h, and below this line, fluid losses due to high sweat rates can greatly exceed these maximal absorption rates and therefore some degree of dehydration is inevitable. Personnel are encouraged, therefore, to continue to drink during rest periods or when meals are provided. A good guideline to follow is to always DRINK TO THIRST. This guideline accepts a marginal level of dehydration but prevents hyperhydration. Note also that these fluid replacement guidelines were generated for the 80 kg soldier and should be appropriately adjusted to higher values for larger and lower values for smaller individuals. Thus, for the 100 kg soldier, these values should be increased 25% whereas for the 60 kg soldier these values should be decreased by 25%.

The Work/Rest Cycle Tables (2 to 4) provides data on maximum work that can be achieved over an eight-hour period. The figures shown in the "Work/Rest Cycle" indicate the rest time in 30 minutes of work, the remainder period of the 30 minutes is the work time. Under some conditions, a work/rest cycle is not required since the task can be performed continuously for eight hours, which is represented by (-). Under other conditions, it is not possible to generate a work and rest schedule that can be continued for eight hours, which is represented by (X).

The Predicted Recovery Table (5) indicates predicted recovery time required for core temperature to return to normal following the increase that accompanies the attainment of maximum work times while wearing NATO Dress States. Each category is divided into LOW, MEDIUM, and HIGH Relative Humidity.

Assumptions. The tables assume that:

a. Personnel are heat acclimated and fully hydrated initially.

b. Maximum sweat rates are 2 liters/hr.

c. Winds are light (3-5 km/hr or 0.8 to 1.4 m/s).

d. Work is being conducted under direct sunlight.

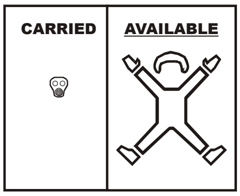
e. Personnel are wearing a tactical assault vest and torso fragmentation vest with armor plates.

f. The chemical and biological protective coverall is being worn as an over garment.

g. Light heat casualties (5%) will be encountered.

With all of the options available there are close to 5800 combinations available that predict work times, work and rest schedules and provide fluid replacement recommendations.

DRESS CATEGORY – **LOW**

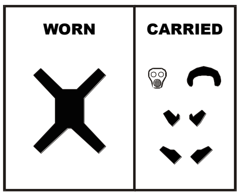


(Dress State 0)

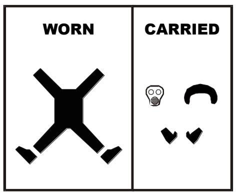
PDF = 1

$$t_{eff} = 1 \times t$$

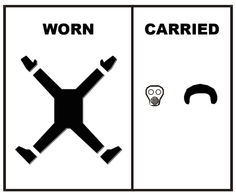
DRESS CATEGORY – **MEDIUM**



(Dress State 1)



(Dress State 2)



(Dress State 3)

PDF = 1.2

$$t_{eff} = 1.2 \times t$$

DRESS CATEGORY – **HIGH**

(Dress State 4)

PDF = 1.5

PDF = 2.5 **(Decision-making and Precision-control tasks)**

$$t_{eff} = 1.5 \times t \quad t_{eff} = 2.5 \times t$$

Fig. A-1: Performance Degradation Factor (PDF) vs Dress Category.

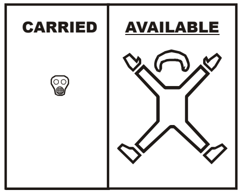
Table 1 – Example Work Loads

Work Load Dress Category LOW	Activity
Light (L)	• General duties • Driving/sitting in a truck • Guard duty • Marching/Slow patrol • (< 3.5 km/h) light load, tactical vest and PPE • Bridge lookout, upper deck sentry • Manning a local control panel in engine spaces • Cleaning a rifle.
Moderate (M)	• Patrolling (3.5 – 5.5 km/h) with tactical vest, PPE and rucksack • Shared stretcher carry • Digging with Pick and Shovel • Load artillery pieces < 25 kg • Working in dry garbage stores • Ship gun maintenance • Ship upper deck maintenance • Hand pumping fuel from drums • Handling 45 kg drums in fuel cache • Aircraft maintenance/repair
Heavy (H)	• Marching (4.5 – 6.0 km/h), with tactical vest, PPE and rucksack • Operations in complex terrain and urban environs • Load heavy artillery • Ship boarding operations and Firefighting • Ship ammunition and equipment transfer • Mechanical assembly and disassembly in tight engine spaces • Working jackstay lines during RAS • Loading rations/fuel barrels onto aircraft • Load and unload heavy items from aircraft, ships and vehicles

NOTE: The work effort categories of this table are based on metabolic expenditures:

Light = ≤ 325 watts
Moderate = 325 – 500 watts
High = > 500 watts

DRESS CATEGORY – LOW



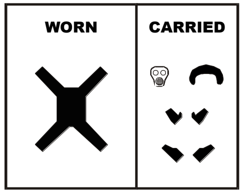
(Dress State 0)

TABLE 2 - DRESS CATEGORY – LOW (Dress State 0)

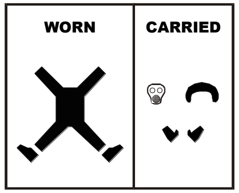
T (°C)	Relative Humidity - LOW (0 to ≤20%)							Relative Humidity - MEDIUM (>20 but <60%)							Relative Humidity - HIGH (≥ 60%)						
	L = ≤ 325 watts • General duties		M = 325 – 500 watts • Shared stretcher carry		H = >500 watts • Marching (4.5 – 6.0 km/h), with tactical vest, PPE and rucksack		Recovery time after max work time	L = ≤ 325 watts • General duties		M = 325 – 500 watts • Shared stretcher carry		H = >500 watts • Marching (4.5 – 6.0 km/h), with tactical vest, PPE and rucksack		Recovery time after max work time	L = ≤ 325 watts • General duties		M = 325 – 500 watts • Shared stretcher carry		H = >500 watts • Marching (4.5 – 6.0 km/h), with tactical vest, PPE and rucksack		Recovery time after max work time
	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work		Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work		Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	
15	-	-	-	-	-	-	< 1	-	-	-	-	-	-	< 1	-	-	-	-	-	-	< 1
20	-	-	-	-	-	-	< 1	-	-	-	-	-	-	< 1	-	-	-	-	-	-	< 1
25	-	-	-	-	-	-	< 1	-	-	-	-	-	-	< 1	-	-	-	-	5:00	0:10	< 1
30	-	-	-	-	6:15	0:05	< 1	-	-	-	-	3:30	0:10	1:00	-	-	-	-	2:30	0:15	2:00
35	-	-	-	-	3:30	0:10	1:00	-	-	-	-	2:45	0:10	1:30	-	-	2:00	0:15	1:30	0:20	3:00
40	-	-	-	-	2:45	0:10	1:30	-	-	2:00	0:15	1:30	0:20	2:00	2:00	0:15	1:00	0:10	0:45	0:25	5:00
45	-	-	4:00	0:10	2:00	0:15	1:30	2:00	0:10	1:15	0:20	1:00	0:25	3:00	X	X	X	X	X	X	X
50	-	-	2:15	0:15	1:30	0:20	1:30	1:00	0:20	0:45	0:25	0:30	X	3:30	X	X	X	X	X	X	X

1 liter/hrs
1 liter/hrs
1 liter/hrs

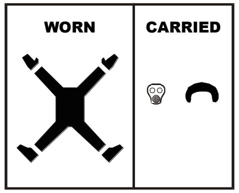
DRESS CATEGORY – MEDIUM



Dress State 1



Dress State 2



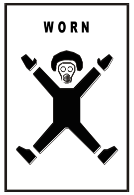
Dress State 3

TABLE 3 - DRESS CATEGORY – MEDIUM (Dress State 1, 2, 3)

T (°C)	Relative Humidity - LOW (0 to ≤20%)							Relative Humidity - MEDIUM (>20 but <60%)							Relative Humidity - HIGH (≥ 60%)						
	L = ≤ 325 watts • General duties		M = 325 – 500 watts • Shared stretcher carry		H = >500 watts • Marching (4.5 – 6.0 km/h), with tactical vest, PPE and rucksack		Recovery time after max work time	L = ≤ 325 watts • General duties		M = 325 – 500 watts • Shared stretcher carry		H = >500 watts • Marching (4.5 – 6.0 km/h), with tactical vest, PPE and rucksack		Recovery time after max work time	L = ≤ 325 watts • General duties		M = 325 – 500 watts • Shared stretcher carry		H = >500 watts • Marching (4.5 – 6.0 km/h), with tactical vest, PPE and rucksack		Recovery time after max work time
	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work		Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work		Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	
15°C	-	-	-	-	-	-	< 1	-	-	-	-	5:00	0:10	< 1	-	-	-	-	4:00	0:10	< 1
20°C	-	-	-	-	3:45	0:10	< 1	-	-	-	-	3:00	0:10	< 1	-	-	-	-	2:40	0:10	< 1
25°C	-	-	-	-	2:45	0:10	< 1	-	-	-	-	2:15	0:10	< 1	-	-	6:00	0:10	2:00	0:15	< 1
30°C	-	-	-	-	2:15	0:10	1:00	-	-	3:30	0:10	1:45	0:15	1:30	-	-	2:15	0:15	1:30	0:20	2:30
35°C	-	-	3:45	0:10	2:00	0:15	1:00	-	-	2:00	0:15	1:30	0:20	2:00	3:45	0:10	1:30	0:20	1:00	0:20	4:00
40°C	-	-	2:30	0:15	1:30	0:20	2:00	3:00	0:10	1:30	0:20	1:00	0:20	2:00	1:45	0:15	1:00	0:20	0:45	0:25	X
45°C	-	-	2:00	0:15	1:15	0:20	1:30	1:45	0:10	1:00	0:20	0:45	0:25	4:00	X	X	X	X	X	X	X
50°C	2:45	0:10	1:30	0:20	1:00	0:20	2:30	1:15	0:15	1:00	0:25	0:30	X	5:00	X	X	X	X	X	X	X

1 liter/hrs
1 liter/hrs
1 liter/hrs

DRESS CATEGORY – HIGH (4)



Dress State 4

TABLE 4 - DRESS CATEGORY– HIGH (4)

T (°C)	Relative Humidity - LOW (0 to ≤20%)						
	L = ≤ 325 watts • General duties		M = 325 – 500 watts • Shared stretcher carry		H = >500 watts • Marching (4.5 – 6.0 km/h), with tactical vest, PPE and rucksack		Recovery time after max work time
	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	
15°C	-	-	2:30	10	1:30	15	< 1
20°C	-	-	2:15	10	1:30	15	< 1
25°C	-	-	2:00	15	1:15	15	< 1
30°C	4:15	10	1:45	15	1:15	20	1:30
35°C	3:00	10	1:30	15	1:15	20	1:30
40°C	2:30	10	1:15	20	1:00	20	2:30
45°C	2:00	10	1:00	20	1:00	20	3:00
50°C	1:45	15	1:00	20	1:00	25	3:30

T (°C)	Relative Humidity - MEDIUM (>20 but <60%)						
	L = ≤ 325 watts • General duties		M = 325 – 500 watts • Shared stretcher carry		H = >500 watts • Marching (4.5 – 6.0 km/h), with tactical vest, PPE and rucksack		Recovery time after max work time
	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	
15°C	-	-	2:30	10	1:30	15	< 1
20°C	-	-	2:00	10	1:30	15	< 1
25°C	-	-	2:00	15	1:15	20	1:00
30°C	3:30	10	1:30	15	1:15	20	2:00
35°C	3:00	10	1:30	20	1:00	20	3:00
40°C	2:00	10	1:15	20	1:00	25	X
45°C	1:30	10	1:00	20	0:45	X	X
50°C	1:15	15	1:00	25	0:30	X	X

T (°C)	Relative Humidity - HIGH (≥ 60%)						
	L = ≤ 325 watts • General duties		M = 325 – 500 watts • Shared stretcher carry		H = >500 watts • Marching (4.5 – 6.0 km/h), with tactical vest, PPE and rucksack		Recovery time after max work time
	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	Max working time (hh:mn)	Rest time in 30 mins of work	
15°C	-	-	2:45	10	1:30	15	< 1
20°C			2:00	15	1:30	15	< 1
25°C	5:00	10	1:45	15	1:15	20	1:00
30°C	3:00	10	1:30	20	1:00	20	3:00
35°C	2:45	10	1:30	20	1:00	25	5:00
40°C	1:45	15	1:00	20	0:45	X	X
45°C	X	X	X	X	X	X	X
50°C	X	X	X	X	X	X	X

1 liter/hrs

1 liter/hrs

1 liter/hrs

Table 5 – Predicted Recovery After Maximum Work Time Achieved (Hours)

Relative Humidity L/M/H (°C)	Ambient Temperature NATO Dress State 4			Ambient Temperature NATO Dress State 2 or 3			Ambient Temperature NATO Dress State 0 or 1		
	L	M	H	L	M	H	L	M	H
15	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
20	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
25	< 1	1	1	< 1	< 1	< 1	< 1	< 1	< 1
30	1.5	2	3	1	1.5	2.5	< 1	1	2
35	1.5	3	5	1	2	4	1	1.5	3
40	2.5	NP	NP	2	2	NP	1.5	2	5
45	3	NP	NP	1.5	4	NP	1.5	3	NP
50	3.5	NP	NP	2.5	5	NP	1.5	3.5	NP

NP= not possible

Table 5 indicates predicted recovery time required for core temperature to return to normal following the increase that accompanies the attainment of maximum work times while wearing NATO Dress States. Recovery times are predicted at different ambient temperatures and Low (0 to ≤20%), Medium (>20 but <60%), and High (≥ 60%) Relative Humidity relative humidity under conditions where personnel remain in their current NATO Dress State or where the protective clothing can be removed to the equivalent of NATO Dress State 0 but personnel remain in the ambient conditions. If personnel can recover in an air conditioned collective protection area then recovery times will be less than 1 hour. The recovery times do not include the recovery from the fatigue of exercise per se and the time required restoring normal body hydration levels. These processes require additional recovery time. As a result, it is not correct to assume that maximum work times will be achieved again if work is resumed in any NATO Dress State following these recovery periods. Under certain conditions where the individual remains encapsulated or in very extreme environmental conditions recovery is not possible (NP).

ANNEX B EXAMPLES

B.1. EXAMPLE 1: (DEGRADATION IN PERFORMANCE)

a. Situation. A unit of air defence artillery is deployed around an airbase perimeter. During an enemy air attack at Dress Category Low, the air defence unit would expect to disable or destroy 60% of the attacking aircraft (i.e. 60% kill probability). However, the airbase is currently at CBRN Threat Level High because of recent chemical attacks on neighbouring units, and soldiers are wearing complete IPE as in Dress Category HIGH.

b. Problem. What is the reduced kill probability at CBRN Threat Level High caused by the degradation in performance of the air defence unit?

c. Calculation.

(1) The Dress Category HIGH - PDF = 1.5 (see Annex A, Figure A-1), so the degraded level of performance is equal to 1/1.5 = 0.67 (67%), i.e. 0.67 x performance without IPE.

(2) Kill probability without IPE = 60%.

(3) Degraded kill probability = (0.67 x 60%) = 40%

d. Result. The reduced kill probability at High is 40%. Therefore, if an air attack involved 20 aircraft, the air defence unit would expect to disable or destroy:

(1) At Dress Category Low = 20 x 60% = 12 aircraft.

(2) At Dress Category High = 20 x 40% = 8 aircraft.

B.2. EXAMPLE 2: (INCREASE IN TASK TIME)

a. Situation. A reinforcing combat unit is required to road march to defensive positions. The march would take the unit 1 hour when not wearing IPE. However, the CBRN Threat Level is Medium and the commander has decided to make the soldiers wear partial IPE as in Dress Category MEDIUM. The weather is warm (temperature of 30 °C, relative humidity of 30%) and road marching is assessed as “heavy” physical effort (see Table 1 in Annex A).

b. Problem. How long will it take the reinforcing unit to reach the defensive positions without heat-stress casualties or, at least, minimising them?

c. Calculation.

(1) The Dress Category MEDIUM - PDF = 1.2 (see Annex A, Figure A-1), so the increased time actually spent marching = 1.2 x 1 hours = 1.2 hours = 1 hours 12 minutes (i.e. 72 minutes).

(2) From Table 3 in Annex A, the maximum working time without recovery for this condition (temperature range 30 °C, relative humidity MEDIUM and heavy physical effort) is 1 hr 45 minutes. Therefore, no recovery time is required after the march, as the working time is only 1 hour 12 minutes.

(3) Because the unit must avoid significant heat-stress casualties, a work/rest cycle should be employed. From Table 3 in Annex A, the maximum safe work/rest cycle values are 15/15 minutes respectively.

(4) The reinforcing unit must, therefore, spend 15 minutes resting and 15 min marching for every 30 minutes. The 72 minutes must be split into 4 periods of 15 minutes march, each followed by 15 minutes rest and ending with one period of 12 minutes march. No additional rest or recovery period is required per item (2). To keep casualties below 5% the additional time spent resting is about 60 minutes.

(5) The full road march will therefore take:

– 72 minutes marching (time from (1) above) plus

– 60 minutes resting (time from (4) above)

Total time = 72 + 60 = 132 minutes = 2 hours 12 minutes.

Result. Under the stated conditions for the road march, the reinforcing combat unit will take 2 hours 12 minutes (132 minutes; 72 minutes marching and 60 minutes resting) to reach and occupy the defensive positions, i.e. 1 hour 12 minutes longer than it would take in non-CBRN conditions, and require ample hydration, following, to ensure heat-stress casualties are below 5%.

ANNEX C SOFTWARE VERSION

C.1. AIM

To allow the operational staff to quickly estimate working times and drinking requirements, a software version of the Performance Degradation Estimation tables is enclosed, provided by Canada.

C.2. INSTRUCTIONS

The software version of ATP-65 performance degradation estimation tables can be used by NATO/IP nations as long as NATO/ IP nations realise that the software is intended for the Canadian military wearing Canadian IPE. Furthermore, the information is available to NATO/ IP nations at no charge, provided that each NATO nation receives prior written authorization from Defence R&D Canada (DRDC), DRDC Toronto.

The following information appears inside the CD ROM insert and on the first window when the software is activated.

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ANNEX D BACKGROUND

D.1. AIM

To allow the operational staff to understand how the data used in the work/rest cycle tables was derived in order to be able to compare with their current physical protection ensemble. The data come from QSTAG 1288 Edition 1, which is from the 1990's.

D.2. BACKGROUND

Calculation of Performance Degradation.

a. The data are based on testing and evaluation of units equipped with air permeable protective ensembles. The relationship between the air permeable protective ensemble data and current NATO standards for CBRN protective ensembles and low burden ensembles is not known. Levels of protective dress in use by ABCA Armies are identified in QSTAG 1045.

Operational staff can also refer to the AAMedP 4-1 that includes a work/rest cycle for the battle dress uniform (BDU).

<u>National Ratifying References - Details of Implementation</u>

Nation	Ratifying Reference	National Implementing Document	Date of Implementation Services				
			Forecast	Actual	A	N	AF
US	AMSSB-RAS-1 (34-1d)	FM 3-4 NBC Protection	Nov 98	Nov 98	X	-	-
UK							
CA							
AS	841/17/224 dtd 24 Aug 99	LWI 3-9	On Promulgatio n		X	-	-
NZ	TBA	TBA					

D.3. TEST METHOD

The test method for heat stress should follow AEP-38 Vol.1.

ANNEX E REFERENCES

E.1 AMSSB-RAS-1 (34-1d)
E.2 jappl.1997.83.3.1017
E.3 Pandolf et al model a160513
E.4 Message_Draft-3
E.5 FM3-4 NBC protection
E.6 Heat Stress of wearing IPE
E.7 QSTAG 1288 Edit 1
E.8 AJMedP-4-1
E.9 TECHNICAL REPORT BRL-TR-3155

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