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

ATP-65

OCTOBER 2004

NORTH ATLANTIC TREATY ORGANIZATION

NATO STANDARDIZATION AGENCY (NSA)

NATO LETTER OF PROMULGATION

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1. ATP-65 - THE EFFECT OF WEARING NBC INDIVIDUAL PROTECTION EQUIPMENT ON INDIVIDUAL AND UNIT PERFORMANCE DURING MILITARY OPERATIONS is a NATO/PFP UNCLASSIFIED publication. The agreement of interested nations to use this publication is recorded in STANAG 2499.

2. ATP-65 is effective upon receipt and supersedes AXP-8 which should be destroyed in accordance with local document destruction procedures.

J MAJ
Brigadier General, POL(A)
Director, NSA

RECORD OF RESERVATIONS BY NATIONS

CHAPTER	RECORD OF RESERVATIONS BY NATIONS
GENERAL	DEU
1	
2	
3	
4	DEU

NATION	**RESERVATION**
DEU	1. In implementing STANAG 2499, Germany reserves the right to deviate from the fluid replenishment regimes of ATP-65 as set forth with paras 104 and 207 in conjunction with A-4. 2. If the not yet available CD-ROM by Canada i.a.w. Annex C does not reflect the distributed STANAG version word for word, Germany reserves the right to implement the differing wording at her own discretion.

RECORD OF CHANGES

Change No	Effective Date	Date Entered	Signature, Rank and Name of Command

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CHAPTER 1

FACTORS AFFECTING PERFORMANCE DEGRADATION - GENERAL CONCEPTS

101. Purpose of ATP-65.

The purpose of this publication is to provide commanders guidance on the individual and unit performance degradation, due to NBC Individual Protection Equipment (IPE) being worn, during military operations.

102. Aim.

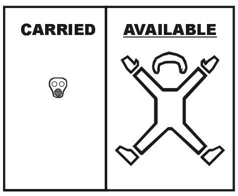
The aim of Chapter 1 is to provide general concepts about NBC Dress Category, performance degradation, Performance Degradation Factor (PDF), physiological and psychological factors affecting individual and unit performance.

103. Definitions.

The following is a list of all the relevant definitions, in addition to those in AAP-6 and AAP-21, that apply to this publication.

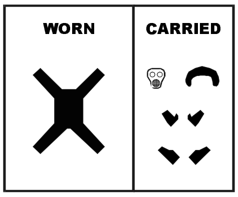
a. NBC Dress Category: state in IPE dressing, that indicate how much of the protective ensemble is being worn by an individual or individuals in a unit.

(1) NBC Dress Category "LOW": individual is in fighting order (wearing battledress uniform - BDU) with the IPE immediately available and mask carried. This category corresponds to Dress State 1 of STANAG 2984.



(2) NBC Dress Category "MEDIUM": individual is wearing NBC protective equipment at one of three different levels, corresponding to Dress State 2 to 4 of STANAG 2984, as described in the following table:

DRESS STATE (STANAG 2984)	**SUIT**	**BOOTS**	**GLOVES**	**MASK**	**HOOD**
2	Worn	Carried	Carried	Carried	Carried
3	Worn	Worn	Carried	Carried	Carried
4	Worn	Worn	Worn	Carried	Carried



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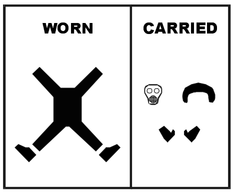
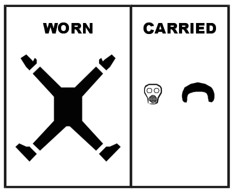


Dress State 3 (STANAG 2984)



Dress State 4 (STANAG 2984)

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

b. 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.

c. 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 category. 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.

104. Factors affecting performance degradation.

The key to selecting appropriate NBC Dress Categories lies in understanding factors contributing to performance degradation and heat casualties on one hand and protection of individuals against the NBC threat and its effects on the other hand. It is to be stressed that NBC Dress Category HIGH protects individuals by isolating them from the NBC environment. However, this encapsulation imposes both physiological and psychological stresses upon the wearer and interacts to degrade individual performance. On the other hand, lower NBC 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 vapour. 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 NBC 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 NBC Dress Category analyses section.

(2) Dehydration.
Because of higher body temperatures, soldiers in IPE sweat considerably more than usual, often more than 1.5 liters 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 nullifies 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. Thirst is not an adequate indicator of dehydration; soldiers will not sense when they are dehydrated and will fail to replace body fluids, even when drinking water is readily available. Commanders at all levels must take responsibility for enforcing regular and timely fluid replacement in personnel under their command.

(3) Respiration difficulties.
When the mask 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.

(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 the field protective mask 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 an NBC environment.

b. Psychological Factors. The threat of NBC 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 recognise 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 masks make breathing more difficult; this too may create feelings of claustrophobia or panic.

(2) Combat Stress.
The threat of NBC warfare increases the overall psychological and physiological stress that is an integral part of combat. Because the highest NBC protective posture is adopted when the threat of an attack is imminent, the encapsulation can increase generalised 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.

105. Military Task Performance Problems in IPE.

a. Adding layers to the uniform reduces mobility, agility, coordination, and dexterity. Units operating in NBC 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. Practising 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 an NBC environment. Wearing the protective mask 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 mask voice emitter makes speech difficult to understand.

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

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

CHAPTER 2

RECOMMENDATIONS TO COUNTER THE HEAT STRESS OF WEARING NBC PROTECTIVE CLOTHING

201. Aim.

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

202. 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.

203. 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 vapour pressure gradient between the skin surface and the environment. The relative humidity and the temperature together determine the vapour pressure. Thus desert environments that are hot and dry can still promote effective heat loss through evaporation of sweat because a substantial vapour 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 vapour pressure gradient that is developed. Similar constraints develop if protective clothing is worn which has very low water vapour permeability.

204. Hypo-hydration.

Hypo-hydration is a state of decreased body water content, occurs when body fluid losses are not fully replaced and is a danger in military operations, where adequate re-hydration and recovery may be no possible prior to a subsequent work session. This is the case while wearing either combat or NBC 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 NBC 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. If fluid loss is not replenished during exercise while wearing the protective clothing, heat acclimatization provides no additional benefit.

205. 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 NBC clothing produces a thermal microenvironment within the clothing ensemble which is potentially much more hazardous then exercise in the hit 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 raise in body temperature while wearing the NBC clothing occurs due to a number of contributing factors:

a. Weight and stiffness. NBC 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 a 15% 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 NBC 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 NBC clothing than while performing the same exercise in combat clothing. 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 NBC clothing, severely limits the dissipation of body heat through the evaporation of secreted sweat.

206. 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 NBC protective ensemble and exposed to ambient temperatures in excess of 40°C, then implementing scheduled rest periods will not extend work performance. 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 your 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 NBC 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 NBC clothing.

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 NBC 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 NBC clothing is worn. The data supporting this latter statement were recorded when fluid replacement was restricted during the exercise period (see below). Individuals with high levels of aerobic fitness attained through regular endurance exercise can tolerate increases in body core temperatures close to 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 protective clothing is worn.

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. 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 (normal body weight) 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, the individual will become dehydrated, due to the amount of water loss being greater than the amount of water intake.

207. Recommendations.

Hydration status is one of the most important, and easily manipulated, physiological variables that determines heat tolerance while wearing NBC 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 greatly 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 NBC clothing. Adequate fluid replacement may be an equal or more effective countermeasure in minimizing heat stress than aerobic training or heat acclimation. A liberal supply of water should be available throughout exercise. But personnel should not be allowed to rely on their own sense of thirst for determining the amount of fluid replacement. In fact, beware of hyper-hydration, responsible for electrolytes want of balance, that if in excess, can lead to death. Therefore, soldiers in NBC clothing should follow a regulated drinking regimen, as reported in Annex A

Aerobic fitness through its effects on the core temperature that can be tolerated at exhaustion also has a substantial influence on heat tolerance while wearing NBC clothing. Regular endurance exercise training should be included to ensure a high level of fitness among personnel.

CHAPTER 3

MITIGATING FACTORS FOR PERFORMANCE DEGRADATION

301. 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.

302. Introduction.

As stated in Chapter 1, 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 minimised 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 do troops that are less-prepared. Physically fit soldiers are more resistant to physical and mental fatigue and acclimatise 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 recognise the symptoms of related physiological and psychological stress, and to properly react in order to minimise the negative consequences.

303. 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 protective mask 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 NBC 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 deydration.

(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 as much as possible.

(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, as much as possible, to eliminate the burden of IPE.

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

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

(2) Use collective protection as much as possible.

CHAPTER 4

EVALUATION OF PERFORMANCE REDUCTION

401. Aim.

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

In applying the process outlined in this document, limitations of the data contained in Annex A must be considered. The data is 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.

402. 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. Performance Degradation Factor (PDF). Planners can estimate the time it will take to complete most tasks in NBC Dress Category, by multiplying the time normally required to complete a task by the appropriate PDF.

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

b. **Work intensity.** Work intensity is a major contributing factor to heat stress, that can be managed by leaders. Military work is categorized as very light (VL), 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 2A, 2B, and 2C 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. **Water Requirements for Maximum Continuous Work Times.** Water requirements for maximum continuous work times should be estimated using the guidelines in Tables 3A, 3B and 3C in Annex A. Base the recommended hourly replenishment on current work intensity, temperature, clothing layers, and light cycle. If possible, soldiers should drink one liter of water in the 30 – 60 minutes before donning masks; otherwise soldiers should drink as regularly as possible before donning masks, 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.

e. **Work/Rest Cycles for Five Hours Continuous Work.** Tables 4A, 4B, and 4C in Annex A provide information necessary to calculate recommended work/rest cycles for various environmental conditions, clothing levels, and work intensities for five 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 6) before returning to work. As this table shows, reduction of NBC Dress Category level during the rest period, is key to maximizing the time troops can spend performing work.

f. **Water Requirements to Support Work/Rest Cycles for Five Hours Continuous Work.** Tables 5A, 5B, and 5C in Annex provide water requirements to support work/rest cycles for five hours continuous work periods. They are used in conjunction with the work/rest cycles as determined Tables 4A, 4B, and 4C in Annex A.

g. **Recovery Time.** Table 6 in Annex A provides estimated recovery times for personnel that have achieved maximum work times, as listed in Tables 2A, 2B, and 2C in Annex A.

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

a. **STEP 1A**: On the basis of the NBC 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).

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

b. **STEP 1B**: By means of Tables 1, 2A, 2B, 2C 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 3A, 3B, 3C in Annex A, and knowledge of weather conditions (temperature and relative humidity) on 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 4A, 4B, 4C in Annex A.

f. **STEP 3B**: By means of Tables 5A, 5B, 5C 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 Table 6 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.

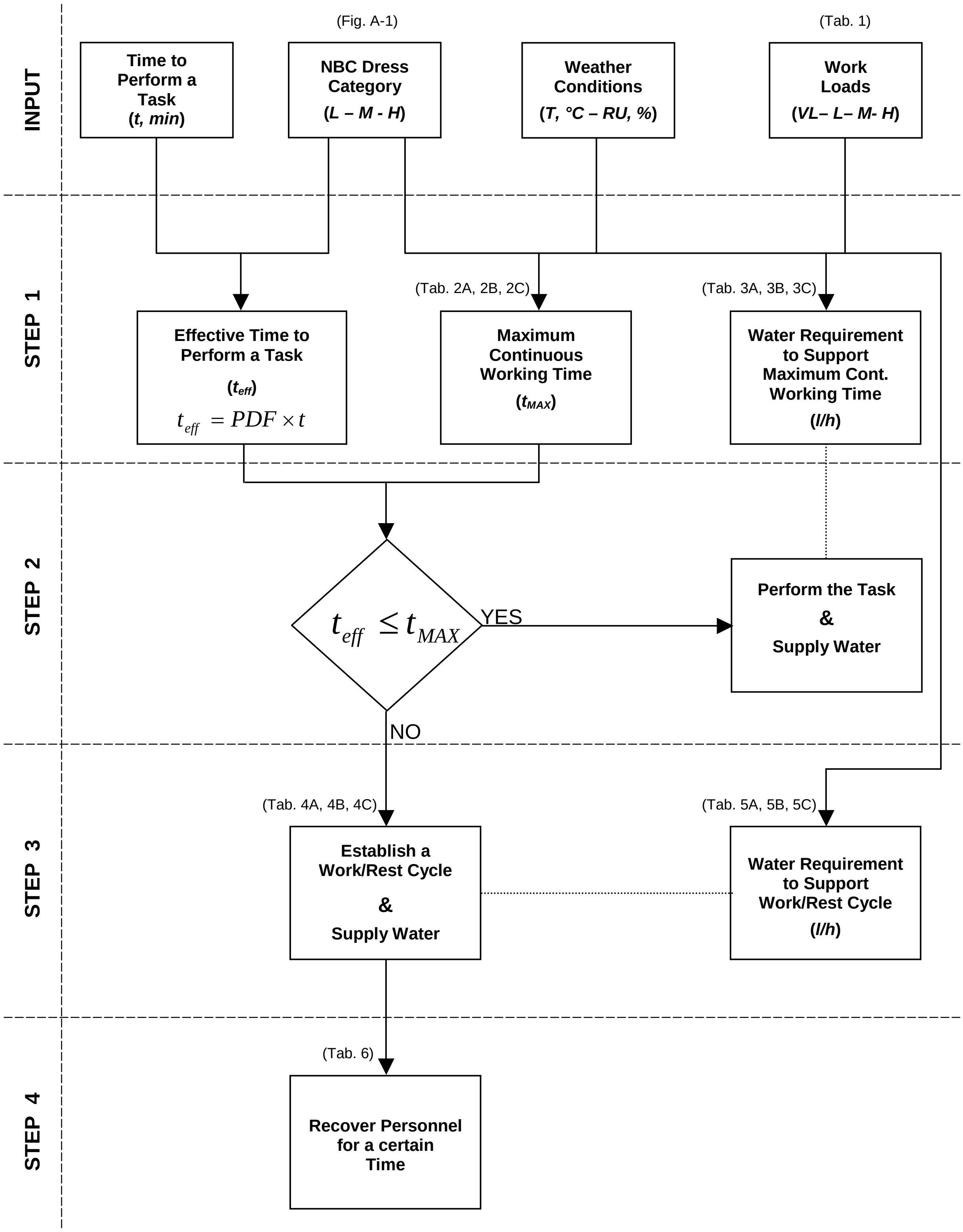


Fig. 4.1: Procedures for estimation of performance degradation and management of Units.

404. 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.

ANNEX A

PERFORMANCE DEGRADATION ESTIMATION TABLES

A-1 The figure and tables contained in this annex are provided for planning guidance for operation staffs to consider when the threat level requires consideration of increasing the NBC Dress Category level. They consists of:

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

b. Table 1 – Example Work Loads.

c. Tables 2A, 2B, 2C – Maximum Continuous Working Times.

d. Tables 3A, 3B, 3C – Water Requirements to Support Maximum Work Times.

e. Tables 4A, 4B, 4C – Work/Rest Cycle for Five Hours Continuous Work.

f. Tables 5A, 5B, 5C – Water Requirements to Support Work/Rest Cycle for Five Hours Continuous Work.

g. Table 6 – Estimated Recovery Times After Personnel Have Achieved Maximum Work Times.

A-2 Tables 2 through 5 are subdivided into NBC Dress Category levels LOW, MEDIUM, and HIGH. They provide data at various ambient air temperatures (15 to 45 °C), at Low (0 to 25%), Medium (26 to 45%), and High (> 46%) Relative Humidity (RH), while performing very light (VL), light (L), moderate (M) or heavy (H) work loads (see Table 1). No limit is represented by (-) and equates to performance of the task for at least 300 minutes.

A-3 For water requirements, one full canteen approximates one liter of water. <u>If the water requirements exceed 1.4 liters/hour then the sweat loss exceeds the maximum rate of water absorption</u>. If possible in these cases the additional fluid should be consumed during periods of reduced activity or during recovery. This fluid intake should not exceed 1 – 1.5 liters/hour.

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

A-5 The Estimated Recovery Table (6) provides data based on ambient temperature with IPE on, ambient temperature with IPE removed and inside collective protection equipped with air conditioning. Each category is divided into LOW, MEDIUM, and HIGH Relative Humidity.

A-6 Assumptions. The tables assume that:

a. Personnel are heat acclimated and fully hydrated initially.

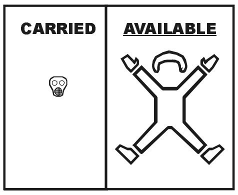
b. Maximum sweat rates are 2 liters/hr.

c. Winds are light (3-5 km/hr).

d. Work is being conducted under direct sunlight.

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

NBC DRESS CATEGORY – **LOW**

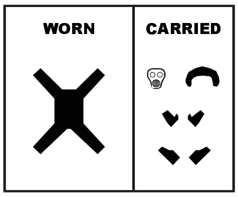


(Dress State 1 of STANAG 2984)

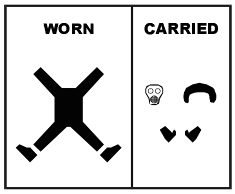
PDF = 1

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

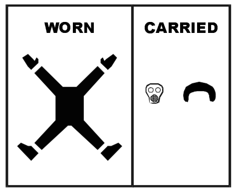
NBC DRESS CATEGORY – **MEDIUM**



Dress State 2
(STANAG 2984)



Dress State 3
(STANAG 2984)



Dress State 4
(STANAG 2984)

PDF = 1.2

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

NBC DRESS CATEGORY – **HIGH**

PDF = 1.5
PDF = 2.5 (Decision-making and Precision-control tasks)

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

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

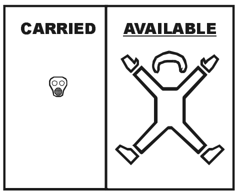
Table 1 – Example Work Loads

<table>
<tr><th>Work Load NBC Dress Category LOW</th><th>Activity</th><th>Work Load NBC Dress Category MEDIUM/HIGH</th></tr>
<tr><td>Very Light
(VL)</td><td>– Lying on the ground.
– Standing in a foxhole.
– Sitting in a truck.
– Guard duty.
– Driving a truck</td><td>Very Light
(VL)</td></tr>
<tr><td>Light
(L)</td><td>– Cleaning a rifle.
– Walking on hard surface at 1.0 m/s with 0 - 30 kg load.</td><td>Light
(L)</td></tr>
<tr><td rowspan="2">Moderate
(M)</td><td>– Walking on loose surface at 1.0 m/s with no load.
– Walking on hard surface at 1.6 m/s with no load.
– Calisthenics.</td><td>Moderate
(M)</td></tr>
<tr><td>– Walking on hard surface at 1.6 m/s with 20 kg load.
– Patrolling.
– Digging with pick and shovel.
– Crawling with full pack on.
– Assaults</td><td rowspan="2">Heavy
(H)</td></tr>
<tr><td>Heavy
(H)</td><td>– Walking on hard surface at 1.6 m/s with 30 kg load.
– Walking on hard surface at 2.0 m/s with no load.
– Walking on hard surface at 2.3 m/s with no load.
– Walking on loose surface at 1.6 m/s with no load.</td></tr>
</table>

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

Very Light	=	105 – 175	watts
Light	=	175 – 325	watts
Moderate	=	325 – 500	watts
High	=	500 +	watts

NBC DRESS CATEGORY – LOW



(Dress State 1 of STANAG 2984)

Table 2A - Maximum continuous working time (min).

	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	-	-	-	260	-	-	-	240	-	-	-	180
21 - 25	-	-	-	145	-	-	-	130	-	-	-	110
26 - 30	-	-	-	115	-	-	-	90	-	-	-	75
31 - 35	-	-	-	90	-	-	-	75	-	-	95	55
36 - 40	-	-	-	75	-	-	90	55	-	115	50	35
41 - 45	-	-	125	60	-	115	55	40	85	50	30	15

(-) no limit.

Table 3A - Water requirements (Liters/Hour) to Support Maximum Work Times.

	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	0.3	0.5	0.8	1.1	0.3	0.5	0.9	1.1	0.3	0.5	0.9	1.2
21 - 25	0.4	0.6	0.9	1.3	0.4	0.7	1.0	1.3	0.5	0.7	1.0	1.4
26 - 30	0.7	0.9	1.2	1.5	0.7	0.9	1.3	1.7	0.8	1.0	1.4	1.8
31 - 35	0.8	1.0	1.4	1.7	0.9	1.1	1.5	1.9	1.0	1.3	1.8	2.0
36 - 40	1.0	1.2	1.6	2.0	1.2	1.4	1.9	2.0	1.5	1.9	2.0	2.0
41 - 45	1.2	1.4	1.9	2.0	1.5	1.9	2.0	2.0	2.0	2.0	2.0	2.0

Shading indicates requirement exceeds maximum absorption rate and a hydration deficit occurs.
Intake should not exceed 1.5 liters per hour under any work-dress category condition.

Table 4A - Work/Rest Cycle for 5 Hours Continuous Work (minutes of work per hour).

	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	-	-	-	50	-	-	-	50	-	-	-	40
21 - 25	-	-	-	40	-	-	-	40	-	-	-	35
26 - 30	-	-	-	35	-	-	-	30	-	-	-	25
31 - 35	-	-	-	30	-	-	-	25	-	-	25	15
36 - 40	-	-	-	25	-	-	25	15	-	X	X	X
41 - 45	-	-	30	20	-	X	X	X	X	X	X	X

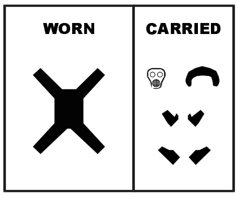
(-) no limit; (X) not possible.

Table 5A - Water requirements (Liters/Hour) to Support Work/Rest Cycle for 5 Hours Continuous Work.

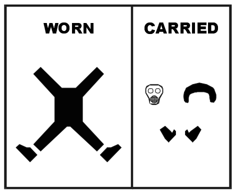
	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	-	-	-	0.9	-	-	-	0.8	-	-	-	0.9
21 - 25	-	-	-	1.0	-	-	-	0.9	-	-	-	1.0
26 - 30	-	-	-	1.1	-	-	-	1.2	-	-	-	1.2
31 - 35	-	-	-	1.2	-	-	-	1.2	-	-	1.3	1.2
36 - 40	-	-	-	1.4	-	-	1.4	1.3	-	X	X	X
41 - 45	-	-	1.5	1.4	-	X	X	X	X	X	X	X

(-) no limit; (X) not possible. Intake should not exceed 1.5 liters per hour under any work-dress category condition.

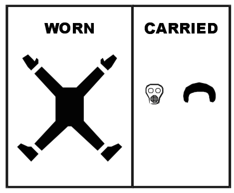
NBC DRESS CATEGORY – MEDIUM



Dress State 2
(STANAG 2984)



Dress State 3
(STANAG 2984)



Dress State 4
(STANAG 2984)

Table 2B - Maximum continuous working time (min).

	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	-	-	110	50	-	-	100	45	-	-	90	45
21 - 25	-	-	85	45	-	-	75	45	-	-	70	40
26 - 30	-	-	70	40	-	-	60	35	-	-	55	35
31 - 35	-	-	60	40	-	210	50	35	-	100	45	30
36 - 40	-	225	50	35	-	90	40	25	165	65	35	20
41 - 45	-	100	45	30	155	65	35	25	80	50	30	15

(-) no limit.

Table 3B - Water requirements (Liters/Hour) to Support Maximum Work Times.

	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	0.5	0.9	1.5	2.0	0.6	0.9	1.6	2.0	0.6	0.9	1.7	2.0
21 - 25	0.7	1.0	1.7	2.0	0.7	1.0	1.8	2.0	0.8	1.1	1.9	2.0
26 - 30	0.9	1.2	1.9	2.0	0.9	1.3	2.0	2.0	1.0	1.5	2.0	2.0
31 - 35	1.0	1.4	2.0	2.0	1.1	1.6	2.0	2.0	1.3	1.8	2.0	2.0
36 - 40	1.2	1.7	2.0	2.0	1.4	1.9	2.0	2.0	1.9	2.0	2.0	2.0
41 - 45	1.4	1.9	2.0	2.0	1.8	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Shading indicates requirement exceeds maximum absorption rate and a hydration deficit occurs.
Intake should not exceed 1.5 liters per hour under any work-dress category condition.

Table 4B - Work/Rest Cycle for 5 Hours Continuous Work (minutes of work per hour).

	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	-	-	35	20	-	-	30	20	-	-	30	20
21 - 25	-	-	30	20	-	-	25	15	-	-	25	15
26 - 30	-	-	20	15	-	-	15	10	-	-	10	5
31 - 35	-	-	15	10	-	20	5	X	-	X	X	X
36 - 40	-	35	5	X	-	X	X	X	X	X	X	X
41 - 45	-	X	X	X	X	X	X	X	X	X	X	X

(-) no limit; (X) not possible.

Table 5B - Water requirements (Liters/Hour) to Support Work/Rest Cycle for 5 Hours Continuous Work.

	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	-	-	1.0	0.9	-	-	1.0	0.9	-	-	1.0	0.8
21 - 25	-	-	1.1	0.9	-	-	1.0	0.9	-	-	1.1	0.9
26 - 30	-	-	1.1	1.0	-	-	1.1	1.0	-	-	1.1	0.9
31 - 35	-	-	1.2	1.0	-	1.2	1.1	X	-	X	X	X
36 - 40	-	1.1	1.3	X	-	X	X	X	X	X	X	X
41 - 45	-	X	X	X	X	X	X	X	X	X	X	X

(-) no limit; (X) not possible. Intake should not exceed 1.5 liters per hour under any work-dress category condition.

NBC DRESS CATEGORY – HIGH

Table 2C - Maximum continuous working time (min).

	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	-	-	85	45	-	-	75	40	-	-	70	40
21 - 25	-	-	70	40	-	-	65	40	-	-	60	35
26 - 30	-	-	60	35	-	-	55	35	-	220	50	30
31 - 35	-	-	55	35	-	120	45	30	-	85	40	25
36 - 40	-	115	45	30	-	80	40	25	190	60	35	20
41 - 45	-	80	40	25	125	60	35	20	75	50	30	15

(-) no limit.

Table 3C - Water requirements (Liters/Hour) to Support Maximum Work Times.

	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	0.6	0.9	1.7	2.0	0.6	1.0	1.8	2.0	0.6	1.0	1.8	2.0
21 - 25	0.7	1.1	1.9	2.0	0.8	1.2	2.0	2.0	0.8	1.2	2.0	2.0
26 - 30	0.9	1.3	2.0	2.0	1.0	1.5	2.0	2.0	1.1	1.6	2.0	2.0
31 - 35	1.0	1.5	2.0	2.0	1.2	1.7	2.0	2.0	1.4	2.0	2.0	2.0
36 - 40	1.3	1.8	2.0	2.0	1.5	2.0	2.0	2.0	1.9	2.0	2.0	2.0
41 - 45	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Shading indicates requirement exceeds maximum absorption rate and a hydration deficit occurs.
Intake should not exceed 1.5 liters per hour under any work-dress category condition.

Table 4C - Work/Rest Cycle for 5 Hours Continuous Work (minutes of work per hour).

	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	-	-	30	15	-	-	25	15	-	-	25	15
21 - 25	-	-	25	15	-	-	20	15	-	-	20	10
26 - 30	-	-	15	10	-	-	10	5	-	X	X	X
31 - 35	-	-	10	5	-	X	X	X	-	X	X	X
36 - 40	-	X	X	X	-	X	X	X	X	X	X	X
41 - 45	-	X	X	X	X	X	X	X	X	X	X	X

(-) no limit; (X) not possible.

Table 5C - Water requirements (Liters/Hour) to Support Work/Rest Cycle for 5 Hours Continuous Work.

	Relative Humidity - LOW				Relative Humidity - MEDIUM				Relative Humidity - HIGH			
T (°C)	VL	L	M	H	VL	L	M	H	VL	L	M	H
15 - 20	-	-	1.0	0.8	-	-	1.0	0.8	-	-	1.0	0.8
21 - 25	-	-	1.1	0.9	-	-	1.1	0.9	-	-	1.0	0.8
26 - 30	-	-	1.1	1.0	-	-	1.1	0.9	-	X	X	X
31 - 35	-	-	1.1	1.0	-	X	X	X	-	X	X	X
36 - 40	-	X	X	X	-	X	X	X	X	X	X	X
41 - 45	-	X	X	X	X	X	X	X	X	X	X	X

(-) no limit; (X) not possible. Intake should not exceed 1.5 liters per hour under any work-dress category condition.

Table 6 – Predicted Recovery After Maximum Work Time Achieved (Hours)

	Ambient Temperature Encapsulated in IPE			Ambient Temperature IPE Removed			Air Conditioned (In COLPRO)		
T (°C)	L	M	H	L	M	H	L	M	H
15	<1	<1	<1	<1	<1	<1	<1	<1	<1
17	<1	<1	<1	<1	<1	<1	<1	<1	<1
19	<1	<1	<1	<1	<1	<1	<1	<1	<1
21	<1	<1	<1	<1	<1	<1	<1	<1	<1
23	<1	<1	1	<1	<1	<1	<1	<1	<1
25	<1	1	1	<1	<1	<1	<1	<1	<1
27	1	1	1.5	<1	<1	1	<1	<1	<1
29	1	1.5	2	<1	1	1.5	<1	<1	<1
31	1.5	2	3	<1	1	2	<1	<1	<1
33	1.5	2.5	4	1	1.5	2.5	<1	<1	<1
35	1.5	3	5	1	1.5	3	<1	<1	<1
37	2	4	X	1	1.5	3.5	<1	<1	<1
39	2	5	X	1	1.5	3.5	<1	<1	<1
41	2.5	X	X	1.5	2	4.5	<1	<1	<1
43	2.5	X	X	1.5	3	5	<1	<1	<1
45	3	X	X	1.5	3	5	<1	<1	<1

(L) Low Humidity (M) Medium Humidity (H) High Humidity

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 NBC Threat Level 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 NBC Threat Level High because of recent chemical attacks on neighbouring units, and soldiers are wearing complete IPE as in NBC Dress Category HIGH.

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

c. Calculation.

(1) The NBC Dress Category HIGH - PDF = 1.5 (see Annex A, pg. A-7), 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 NBC High is 40%. Therefore, if an air attack involved 20 aircraft, the air defence unit would expect to disable or destroy:

(1) At NBC Threat Level Low = 20 x 60% = 12 aircraft.

(2) At NBC Threat Level 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 2 hours when not wearing IPE. However, the NBC Threat Level is Medium and commander decided to make the soldiers wear partial IPE as in NBC Dress Category MEDIUM. The weather is warm (temperature of 22 °C, relative humidity of 30%) and road marching is assessed as "moderate" 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 it?

c. Calculation.

(1) The NBC Dress Category MEDIUM - PDF = 1.2 (see Annex A, pg. A-6), so the increased time actually spent marching = 1.2 x 2 hours = 2.4 hours = 2 hours 24 minutes (i.e. 144 minutes).

(2) From Table 2B in Annex A, the maximum continuous working time for that conditions is 75 minutes. Because the unit must avoid significant heat-stress casualties, a work/rest cycle should be employed.

(3) From Table 4B in Annex A (work/rest cycles for NBC Dress Category MEDIUM), at temperature range 21 to 25 °C, relative humidity MEDIUM and moderate physical effort, the maximum safe work/rest cycle values are 25/35 minutes respectively.

(4) The reinforcing unit must, therefore, spend 35 minutes resting for every 25 minutes marching. The 144 minutes must be split into 5 periods of 25 minutes march, each followed by 35 minutes rest and one period of 19 minutes march with a rest period of 26.6 minutes (i.e. in the proportion 25/35). To keep casualties below 5% (see Chapter 2, par. 202, point e.), the additional time spent resting is about 202 minutes.

(5) The full road march will therefore take:

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

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

Total time = 144 + 202 = 346 minutes = 5 hours 46 minutes.

d. Result. Under the stated conditions for the road march, the reinforcing combat unit will take 5 hours 46 minutes (346 minutes; 144 minutes marching and 202 minutes resting) to reach and occupy the defensive positions, i.e. 3 hour and 46 minutes longer than it would take in non-NBC conditions. Note that, although the positions could be reached in 319 minutes, the rest time of 27 minutes when they arrive, and a water supply of 1.0 litres/hour (see Table 5B in Annex A) will be needed to ensure heat-stress casualties are below 5%.

B-3 EXAMPLE 3: (INCREASE IN TASK TIME)

a. Situation. An aircraft operational turnaround (OTR) team of 9 men has been tasked with preparing an aircraft for its next mission. Without NBC IPE this would take about 1.5 hours. However, the airbase has been attacked with persistent chemical agents and the NBC Threat Level is High. The temperature is approximately 25 °C and relative humidity is 23%. The OTR task could be compared to “Crawling with full pack on” in Table 1 – Annex A, and is considered to be “heavy” physical effort.

b. Problem. How much longer will it take to complete the OTR satisfactorily, with the minimum heat-stress casualties, at NBC Threat Level High?

c. Calculation.

(1) The NBC Dress Category HIGH - PDF = 1.5 (see Annex A, pg. A-3), so the increased time actually spent performing the OTR = 1.5 x 1.5 hours = 2.25 hours = 2 hours 15 minutes (i.e. 135 minutes).

(2) From Table 2C in Annex A, the maximum continuous working time for that conditions is 40 minutes. Because the OTR team must not incur significant heat-stress casualties, a work/rest cycle should be employed.

(3) From Table 4C in Annex A (work/rest cycles for NBC Dress Category HIGH), at temperature range 21 to 25 °C, relative humidity LOW, and heavy physical effort, the maximum safe work/rest cycle values are 15/45 minutes respectively.

(4) The OTR team must, therefore, spend three times as long resting as working if it is to minimise heat-stress casualties. The 135 minutes must be split into 9 periods of 15 minutes work, each followed by 45 minutes rest. The resulting time spent resting will be 405 minutes = 6 hours 45 minutes.

(5) The full OTR will therefore take:

– 135 minutes working (time from (1) above) plus

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

Total time = 135 + 405 = 540 minutes = 9 hours.

d. Result. For the given NBC Dress Category, ambient temperature and heavy physical effort, the aircraft OTR will take an extra 7 hours and 30 minutes to complete with a minimum heatstress casualties. Whilst the OTR itself will be completed in 8 hours 15 minutes (i.e. after the final working period), the team will need to rest for a further 45 minutes after this, and each component must drink 0.9 litres/hour of water (see Table 5C in Annex A) before starting another OTR, in order to keep heat-stress casualties below 5%.

ANNEX C

SOFTWARE VERSION

C-1 AIM

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

C-2 INSTRUCTIONS

This Canadian software version of ATP-65 performance degradation estimation tables can be used by NATO/PfP nations as long as NATO/PfP nations realise that the software is intended for the Canadian military wearing Canadian IPE. Furthermore, the information is available to NATO/PfP 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.

Proprietary Notice

Notification de propriété

Compact Disk enclosed:

The Defence R&D Canada (DRDC) Toronto point of contact is:

Dr. T. McLellan

Tel: (416) 635-2151
Fax: (416) 635-2132
Email: tom.mclellan@drdc-rddc.gc.ca

Address: DRDC Toronto
1133 Sheppard Avenue West
P.O. Box 2000
Toronto, Ontario, Canada, M3M 3B9