NORTH ATLANTIC TREATY ORGANISATION

RESEARCH AND TECHNOLOGY ORGANISATION

AC/323(HFM-154)TP/291

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RTO TECHNICAL REPORT **TR-HFM-154**

Nutrition Science and Food Standards for Military Operations

(Nutrition et normes d'alimentation pour les opérations militaires)

Final Report of RTO Task Group RTG-154.

Published March 2010

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The Research and Technology Organisation (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote co-operative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective co-ordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also co-ordinates RTO's co-operation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of co-operation.

The total spectrum of R&T activities is covered by the following 7 bodies:

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier co-operation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

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List of Abbreviations and Acronyms

AI	Adequate Intake
AMDR	Acceptable Macronutrient Distribution Range
AMS	Acute Mountain Sickness
ANR	Average Nutrition Requirement
ANZ	Australia and New Zealand
AOAC	Association of Official Analytical Chemists
AR	Army Regulation
Arc	Arctic
ASAP	As Soon As Possible
AUS	Australia
B, L, D	Breakfast, Lunch, Dinner
BEL	Belgium
C	Celsius
CAN	Canada
CarboPack	Food Packet, Carbohydrate Supplement (USA)
CATCON	CATering CONference
cc	Cubic Centimeters
CFREB	Combat Feeding Research and Engineering Board (USA)
CFREP	Combat Feeding Research and Engineering Program (USA)
CHO	Carbohydrate
cm	Centimeters
CMNR	Committee on Military Nutrition Research (USA)
CO	Commanding Officer
COMEDS	Committee of the Chiefs of Military Medical Services in NATO
CPs	Capability Packages
CR1M	Combat Ration One Man (AUS)
CV	Coefficient of Variation
CZE	Czech Republic
D	Dimensions
DACH	German speaking countries: Germany, Austria, Switzerland
DEBQ	Dutch Eating Behavior Questionnaire
DEU	Germany
DGE	German Nutrition Society
dm	Decimeter
DoD	Department of Defense (USA)
DRI	Dietary Reference Intakes
ea	Each
EAR	Estimated Average Requirement
EE	Energy Expenditure
EPa	Einmannpackung (Individual Combat Ration) (DEU)
ET	Exploratory Team
EU	European Union

EURO	European
EURRECA	EURopean micronutrient RECommendations Aligned
F	Fahrenheit
FAO	Food and Agriculture Organization of the United Nations
FB	Fiber Board
FOB	Forward Operating Base
FRA	France
FRH	Flameless Ration Heater
FSR	First Strike Ration (USA)
g	Grams
GBR	United Kingdom
GEO	Georgia
GMO	Genetically Modified Organisms
GP	General Purpose
HFM	Human Factors and Medicine (RTO Panel)
HNS	Host Nation Support
hr	Hour
ht	Height
IMP	Individual Meal Pack (CAN)
in	Inches
INL	Individual Nutrient Level
IoM	Institute of Medicine
ISAF	International Security Assistance Force
ISO	International Organization for Standardization
ITA	Italy
kcal	Kilocalories
kg	Kilograms
kJ	Kilojoules
l	Liters
lb	Pounds
LDRR	Long Distance Reconnaissance Ration (NLD)
LMC	Light Meal Combat (CAN)
LRP	Food Packet, Long Range Patrol (USA)
LRRP	Long Range Recce Patrol Ration (BEL)
LxWxH	Length, Width, Height
m	Meters
MAACL	Multiple Affect Adjective CheckList
MAACL-R	Multiple Affect Adjective CheckList – Revised
MCW	Meal, Cold Weather (USA)
MDRI	Military Dietary Reference Intakes
MDRV	Military Dietary Reference Values (GBR)
METT-TC	Mission, Enemy, Terrain, Troops available – Time and Contractors
mg	Milligrams
MJ	Megajoules

ml	Milliliters
mo	Month
MOB	Main Operating Base
MOD	Ministry of Defence
MRE	Meal, Ready-to-Eat (USA)
Mtg	Meeting
NAMSA	NATO Maintenance and Supply Agency
NATO	North Atlantic Treaty Organisation
NCO	Non-Commissioned Officer
NCS	NATO Command Structure
NIV	Nutrient Intake Value
NLD	Netherlands
NNR	Nordic Nutrition Recommendations
NOR	Norway
NP	Not Provided
NRDC	NATO Rapid Deployable Corps
NRF	NATO Response Force
NS	Not Supplied
NSA	NATO Standardization Agency
NSOR	Nutritional Standards for Operational and Restricted Rations
NSRDEC	Natick Soldier Research, Development and Engineering Center
ORP	Operational Ration Pack (GBR)
OSJR	Operation Steadfast Jaguar
P:F:C	Protein, Fat and Carbohydrate
PAL	Physical Activity Level
PE	Polyethylene
PfP	Partnership for Peace (Nations)
POMS	Profile Of Mood States
PoW	Program of Work
PR1M	Patrol Ration One Man (AUS)
PUFA	Polyunsaturated Fatty Acids
R&DA	Research & Development Associates for Military Food & Packaging Systems, Inc.
RCIR	Ration de Combat Individuelle Réchauffable (Indiv. Reheatable Ration) (FRA)
RDA	Recommended Daily Allowance
RDC	Rapid Deployable Corps
RS	Restraint Scale
RTA	Research and Technology Agency
RTG	Research Task Group
RTO	Research and Technology Organisation
SD	Standard Deviation
SF	Special Forces
SI	*Système International d'Unités*
S.I.N.U.	Italian Society of Human Nutrition
SME	Subject Matter Expert
SNCO	Senior Non-Commissioned Officer
SoW	Statements of Work

SP	Special Purpose
STANAG	NATO Standardization Agreement
SVN	Slovenia
T&O	Training and Operational
TAP	Technical Activity Proposal
TOC	Table of Contents
ToR	Terms of Reference
TP	Technical Publication
TR	Technical Report
Trop	Tropical
TTPs	Tactics, Techniques and Procedures
ug	Micrograms
UK	United Kingdom
UL	Upper Level
UNO	United Nations University
U.S.	United States
USARIEM	U.S. Army Research Institute of Environmental Medicine
USA	United States
Varseek	Variety-Seeking Scale
WHO	World Health Organization

Acknowledgements

As Co-Chairs we want to express our sincere personal thanks and gratitude to the National Representatives/ Members of HFM RTG-154 for their individual and collective contributions to the Task Group's success. Their timely development of numerous outstanding briefings, presentations, technical materials, development of data collection tools and the input of that data underscored and supported the work of the committee and were essential to the successful technical discourse and exchange of information. Each Task Group member had significant, competing demands and burdens placed on them over the duration of the project yet managed to make the extra effort and personal sacrifice to diligently advance the Task Group objectives and enthusiastically support one another to achieve a common understanding and knowledge base. The membership was comprised of a highly experienced, culturally diverse, and technically competent group of internationally recognized scientists, medical and nutritional practitioners, and military leaders representing a cross section of the NATO alliance that provided effective synergy, skill, and talent to execute the defined objectives. The collaboration and cooperation among the membership was obvious from both professional and personnel perspectives and this exemplary teamwork and friendship transcended any national, cultural or political boundaries. While the initial work objectives and scope proved to be exceptionally challenging, we are confident that the process was both enlightening and beneficial to individual national interests and the final results will prove useful to NATO logisticians, planners, and Commanders supporting future Joint Military Operations.

We would further like to recognize the national organizations of the Task Group members from each of the following countries: Australia, Belgium, Canada, Czech Republic, France, Georgia, Germany, Italy, Netherlands, Norway, Slovenia, United Kingdom, and the United States supported this worthwhile endeavor through their commitment of resources, both manpower and financial, that enabled their continued participation in each of the RTG business meetings, workshops and ration displays despite other duties, obligations, and commitments. This effort would not have been possible without this continued support and dedication from these multiple organizations. We would like to extend our appreciation also to those individuals and respective organizations that graciously hosted the business meetings from the inception of the project. These include the following host sites in order of their occurrence:

- Erding, Germany; 18 October 2005: Initial kick-off Meeting of NATO Exploratory Team ET-059. This meeting was held in conjunction with the German Federal Office of Defence Technology and Procurement (BWB) sponsored International Defence Technology Symposium – Combat Feeding: Rations and Equipment, held 19-21 October 2005.
- Birmingham, GBR; 30 March 2006: This meeting was held in conjunction with the UK Ministry of Defence (MoD) Catering Conference (CATCON) held March 26-28, 2006. Formal Initiation of RTG-154 was approved by the HFM Panel 1 April 2006.
- Natick, MA, USA; 31 October – 3 November 2006: RTG Business Meeting #1.
- Ieper, Belgium; 1-4 May 2007: RTG Business Meeting #2.
- Rome, Italy; 27-30 November 2007: RTG Business Meeting #3.
- Naples, Florida, USA; 4-6 June 2008: RTG Business Meeting #4.
- Wageningen University and Research Centre, Netherlands; 8-10 September 2008: RTG Sub-Group Meeting, Nutrition Assessment – In Process Review.
- Ieper, Belgium; 9-11 December 2008: RTG Business Meeting #5.
- Bath, United Kingdom; 24-26 March 2009; RTG Business Meeting #6.

Lastly, we would be remiss in not recognizing the following individuals for their very special contributions to the overall progress and success of the RTG as a whole:

Dr. Robert E. Foster, Ph.D. (USA) – Director, BioSystems, Office of the Deputy Under Secretary of Defense for Science and Technology, Defense Research and Engineering. Dr. Foster is Chairman of the USA Department of Defense Combat Feeding Research and Engineering Board and currently serves as the NATO Human Factors and Medicine (HFM) Panel Chairman. Dr. Foster provided invaluable expertise and experience in NATO matters and in particular HFM interests in this important RTG subject area.

Mrs. Alison Rogers (GBR) – Team Leader Policy and Concepts, Human Systems Group, Information Management Department, Farnborough, United Kingdom. Mrs. Rogers served dutifully as the official NATO mentor to the RTG body providing her collective experience and talents.

Col. Prof. Dr. Rafael Schick (DEU) – Chief, Dept. of Internal Medicine, Federal Armed Forces Hospital Ulm, Ministry of Defence – Bundeswehrkrankenhaus Ulm, Germany. Dr. Schick graciously offered his wealth of knowledge and technical training in medicine and nutrition as well as his NATO experience to the group in a most diplomatic and gentlemanly fashion.

Col. Vincenzo Barretta (ITA) – Italian Army. Col. Barretta was officially appointed by the Italian Ministry of Defence as nutritionist supporting the needs of RTG-154. He provided nutrition expertise in support of not only the Italian representation to the RTG but further supported the larger group efforts of the RTG itself. Col. Barretta provided expertise at both the RTG business meeting hosted by Italy in Rome (2007) and at the nutritional subgroup meeting convened with Wageningen University.

The following internationally recognized subject matters experts from Wageningen University and Research Centre, Netherlands, provided an independent nutritional assessment in support of key interests and objectives of the RTG. This work is one of several keystone efforts underpinning the valued work and technical output of the RTG. These individuals include: Diewertje Sluik, MSc., Prof. Kees de Graaf, Prof. Lisette C.P.G.M. de Groot, and Dr. Adrienne E.J.M. Cavelaars.

Dr. Herbert L. Meiselman, Ph.D. (USA) – Technical consultant and Senior Research Scientist (Behavior & Performance) (Retired), U.S. Army Natick Research, Development and Engineering Center, Natick, MA, USA. Dr. Meiselman is an international authority in the fields of sensory and consumer research, product development and food service system design and evaluation. He is the author of the behavioral component of the RTG report and served as technical consultant to the group for the all behavioral and food preference aspects of this initiative.

Mr. Joseph A. Zanchi (USA) – USA Dept. of Defense Combat Feeding Directorate, U.S. Army Natick Research, Development and Engineering Center, Natick, MA, USA. Mr. Zanchi provided exemplary work in support of the RTG throughout the entire process in planning, building and implementing the complete body of ration, nutrition, and logistics data, managing support contracts in support of critical RTG work, providing briefings in support of the Chairman, developing and tracking business meeting minutes and action items, and organizing and overseeing all aspects of development, compilation, and extensive editing of the RTG final technical report. His tireless administrative support, astounding attention to detail, coupled with his consistent pursuit of excellence were instrumental in compiling this report.

Ms. Patricia Cariveau (USA) – USA Dept. of Defense Combat Feeding Directorate, U.S. Army Natick Research, Development and Engineering Center, Natick, MA, USA. Ms. Cariveau provided tireless administrative support to the RTG and was the driving force behind much of the "behind the scenes" work in organizing business meetings, support packages, briefings, travel arrangements, social engagements, establishing itineraries, arranging ration displays and ration samplings, and much work to keep the group on track and in good shape for all administrative matters.

In closing, the evolution and progress of the RTG has proven to be a journey not without many interesting challenges along the way. We believe that each of us will take from this process a considerably greater understanding of each others programs, technologies, and issues as we struggle to understand the very dynamic, global military and political landscape in an ever shrinking world. For all of the cultural distinctions and

distance between us, we do share much more in common. We hope that we have contributed as much to the group as we have benefited from it. Together, we have clearly broken some new ground in examining the issues in support of joint NATO operations. We trust the output of the RTG will have benefit to each participating nation in their future programs as well as to NATO leadership in deploying a joint, highly mobile, lethal and sustainable response force.

Respectfully,

//SIGNED//

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Nutrition Science and Food Standards for Military Operations

(RTO-TR-HFM-154)

Executive Summary

The NATO Research Task Group HFM-154, Nutrition Science and Food Standards for Military Operations, was charged with assessing the current state of NATO and Partnership for Peace (PfP) nations' individual combat rations including their nutritional value. The goal of the Task Group was to make science based recommendations to the Human Factors and Medicine Panel to develop standards for nutrition, packaging, and combat rations that support the NRF deployment doctrine, mission profile, and operational flexibility to ensure nutrition, combat feeding and performance are optimized as a combat force multiplier.

A comprehensive data collection survey was developed and distributed to all NATO and PfP nations, the first time a process of this scope and magnitude has been undertaken to identify and understand rations and nutrition within the context of joint, multinational operations and the broader impacts on human performance and mission success. The intent was to closely replicate the most stringent demands of a fully operational NATO Response Force land component with forced entry capability mobilized within 5 days and engaged in a self-sustainable, high intensity operational tempo 30 day mission without resupply. The survey included individual and special purpose ground forces individual combat rations and supplements. Twelve nations replied to the survey; 11 NATO and 1 miscellaneous country, referred to in this report as "participating nations."

The report captures four major areas of interest:

1) Nutritional assessment of rations (Chapter 4): Most participating nations' rations meet the minimum nutritional requirements and soldiers accept them. Some rations were found to need supplementation.
2) Behavioral and psychological factors that contribute to how well a ration is liked and consumed (Chapter 5): A large number of factors were identified which contribute to enhancing or depressing eating. Important factors deal with the food itself, the consumer/soldier, and the environment or location.
3) The impact of ration configuration on interoperability (Chapter 6): This showed that individual combat rations are not fully interchangeable at present, i.e. there are limitations on interoperability.
4) Collateral issues of significance but beyond the scope of the RTG mandate (Chapter 7), including national laws and regulations, procurement, individual food restrictions, the production base, warehousing and transportation capacity, and supply chain management.

Conclusions and recommendations addressing the above four areas are provided in Chapter 8 of the report.

The NRF formation represents a paradigm shift and new planning algorithm for the conduct of broad, rapid response mission operations and NATO transformation. Participating nations' combat rations are designed to meet national tastes, and while different ration systems are suitable for their intended national military objectives, they may not align with the full scope of operational requirements and technical performance characteristics supporting the specific NRF. Further, it was concluded that designing one universal combat ration which suits all NATO forces would represent a great challenge. A major outcome of this RTG effort is the common understanding of needed research leading to future improved combat ration design.

Nutrition et normes d'alimentation pour les opérations militaires

(RTO-TR-HFM-154)

Synthèse

Le Groupe de Recherche Opérationnel HFM-154, Nutrition et normes d'alimentation pour les opérations militaires, a été chargé de l'évaluation des rations de combat individuelles actuelles des Nations de l'OTAN et des Partenaires pour la paix (PpP), et de leur valeur nutritionnelle. L'objectif du Groupe Opérationnel était de faire des recommandations scientifiques à la Commission sur les Facteurs Humains et la Médecine pour développer des normes concernant l'alimentation, le conditionnement et les rations de combat qui contribuent à la doctrine de déploiement NRF, au profil des missions et à la flexibilité opérationnelle afin d'optimiser la nutrition et l'alimentation au combat avec les performances des forces combattantes.

Une étude complète a été développée et communiquée à toutes les Nations de l'OTAN et des PpP ; c'était la première fois qu'un processus d'une telle étendue et d'une telle importance était entrepris pour identifier et comprendre le problème des rations et de l'alimentation dans un contexte d'opérations interarmées multinationales et plus largement, son impact sur les performances humaines et la réussite de la mission. L'objectif était de reproduire fidèlement les besoins les plus exigeants de la composante terrestre opérationnelle d'une Force de réaction OTAN composée d'une capacité d'entrée en premier mobilisée dans un délai de 5 jours et bénéficiant d'une autonomie, dans un contexte de haute intensité, de 30 jours sans ravitaillement. L'étude comprenait des rations de combats individuelles et spéciales pour les forces terrestres et des suppléments. Douze Nations (11 Nations de l'OTAN et 1 autre Nation) ont répondu à l'étude ; elles sont référencées dans ce rapport en tant que « Nations participantes ».

Le rapport englobe quatre domaines d'intérêts :

1) Évaluation nutritionnelle des rations (Chapitre 4) : Les rations de la plupart des nations participantes répondent aux exigences nutritionnelles minimales et les soldats les acceptent. Il a été constaté que certaines rations avaient besoin de suppléments.
2) Les facteurs comportementaux et psychologiques qui influent sur la façon dont une ration est appréciée et consommée (Chapitre 5) : De nombreux facteurs contribuant à augmenter ou diminuer l'alimentation ont été identifiés. Certains de ces facteurs importants étaient liés à la nourriture elle-même, au soldat/consommateur et à l'environnement ou à la localisation.
3) L'impact de la configuration des rations sur l'interopérabilité (Chapitre 6) : Il est apparu que les rations de combat individuelles ne sont pas totalement interchangeables actuellement, c'est-à-dire qu'il y a des limitations à l'interopérabilité.
4) Les questions annexes, intéressantes mais situées hors du cadre du RTG (Chapitre 7) ; cela comprend les lois nationales et les règlements, l'acquisition, les restrictions alimentaires individuelles, la base de production, la capacité de stockage et de transport et la gestion de la chaine de production.

Les conclusions et les recommandations concernant les quatre domaines ci-dessus figurent au Chapitre 8 de ce rapport.

La NRF représente un changement radical et un nouvel algorithme de planification pour la conduite opérationnelle de missions de réaction rapide importantes et pour la transformation de l'OTAN. Les rations

de combat des nations participantes sont conçues pour satisfaire les goûts nationaux et bien qu'il existe différents systèmes de rations adaptés aux objectifs militaires nationaux, ils peuvent ne pas correspondre à l'ensemble complet des exigences opérationnelles et des caractéristiques de performances techniques spécifiques à la NRF. En conclusion, il fut établi que la conception d'une ration de combat universelle qui satisfasse toutes les forces de l'OTAN représenterait un défi important. Un des résultats principaux de cette RTG est l'accord commun sur la nécessité d'une recherche ciblée sur la conception d'une future ration de combat améliorée.

Chapter 1 – INTRODUCTION

1.1 ORIGIN OF THE TECHNICAL ACTIVITY

In spring 2005, the Human Factors and Medicine (HFM) Panel Business Meeting took place in Amersfoort, Netherlands (NLD). The revision of STANAG 2937 MED (Edition 3) Survival, Emergency and Individual Combat Rations – Nutritional Values and Packaging [Annex H] had not been fully ratified by all NATO countries. In response, HFM considered it timely to establish an Exploratory Team (ET-059) to address food technology and nutrition and the emerging need of the NATO Response Force for combat rations. Dr. Robert Foster, USA HFM Principal Panel Member and Director, Bio-Systems, Office of the Secretary of Defence, committed the USA to develop a collaborative project to explore the feasibility of a standard NATO combat ration. A U.S. Program Management Team was formed and delegated responsibility for providing a Technical Activity Proposal (TAP) [Annex A] and Terms of Reference (TOR) [Annex B] for ET-059. Canada (CAN), France (FRA), the Netherlands (NLD), Poland (POL) and the United Kingdom (GBR) agreed to participate in the ET.

1.2 OBJECTIVES OF THE RESEARCH TASK GROUP (RTG) 154

Two meetings of ET-059 were held (summarized in Chapter 2) and the original objectives for a Research Task Group (RTG) were established:

- To identify emerging technologies, products, and innovations for combat feeding, nutrition, and performance-optimizing components across various ration platforms (individual, group, and special purpose/assault rations) matched to operational mission requirements of the deployed NRF; and
- To develop standards for nutrition, packaging, and combat rations that support the NRF deployment doctrine, mission profile, and operational flexibility to ensure nutrition, combat feeding and performance are optimized as a combat force supplier.

HFM RTG-154 first met in Natick, MA (USA) on 31 October 2006. The attendees were Belgium (BEL), Canada (CAN), Germany (DEU), Italy (ITA), the Netherlands (NLD), the United Kingdom (GBR) and the United States (USA), with Australia (AUS) – a non NATO member ("Miscellaneous" nation) – invited as an observer. A mentor was appointed to the RTG, Mrs. Alison Rogers (GBR). The main purpose of this initial meeting was to consider the TAP and associated TOR on Nutrition and Food Standards relevant to the NRF. In addition to setting a timetable for future meetings – to be convened at 6-monthly intervals – a Programme of Work (POW) was put forward for approval by the HFM Panel prior to the RTG Spring meeting in 2007. RTG-154 was tasked by HFM to complete a report by 1 April 2009.

At the second meeting of the RTG (Ieper, Belgium, May 2007), members were advised that the original POW set by the RTG, which aimed to cover nutrition, food safety, hygiene, and food technology, was considered by the HFM Panel Chair and mentors to be over-ambitious. It was proposed that the RTG focus more specifically on the required components and the nutritional composition of an individual combat ration used by the NRF. A revised POW [Annex C] was developed. It was felt by the RTG that the original TAP and TOR still adequately reflected the overall objectives of the RTG and that their revision was not necessary. The documents were reviewed at each subsequent meeting to ensure that they continued to accurately reflect the work of the RTG.

The Czech Republic (CZE) and FRA had membership of the RTG and took part in one of the major activities, the development of the data matrix, but did not send a representative to any meetings. Likewise, Georgia

(GEO) provided a representative to the meetings but did not provide input to the data collection process. Slovenia (SVN) and Norway (NOR) joined the RTG in 2008. In summary, the following NATO and Miscellaneous nations had membership and participated in at least one activity of HFM RTG-154: BEL, CAN, CZE, DEU, FRA, GBR, GEO, ITA, NLD, NOR, SVN, USA and AUS. In the remainder of this report these nations are referred to as the "participating nations".

A total of six meetings of the RTG-154 were held, involving national Subject Matter Experts (SME) in nutrition, logistics and food safety from military and civilian defence backgrounds, representing the 13 participating nations. Chapter 2 of this report provides comprehensive summaries of the minutes of each meeting. The information in this report relates to data available on individual combat rations available in 2007. This information was collated in the form of a data matrix described in Chapter 3 of this report. Where there is reference to a "soldier" in the text of this report, this term is used to describe all armed forces personnel (Army, Navy, Air Force or Marines) deployed by the NRF.

RTG meetings were structured to allow sufficient time for the participating members to describe the most recent developments in military nutrition and rationing, particularly relating to combat rations, in their respective nations. These updates remained as a standing agenda item as they provided valuable information and informed debate on subjects for the report that had previously not been considered. Whilst RTG members recognized that combat ration development was an ongoing and continuous process, it was considered that current work did not significantly affect the data.

1.3 NATO RESPONSE FORCE (NRF)

The NATO Response Force (NRF) concept of a robust, readily deployable and credible force was agreed to by the NATO Heads of State at the Prague Summit held in November 2002. It is designed to provide an integrated and fully interoperable sea, land and air capability operating under the command of the Rapid Deployable Corps (RDC) to prevent conflict or a threat escalating into a wider dispute. The NRF's initial operational capability was achieved in October 2003. The NRF is capable of deployment within five days in support of the collective will of the Alliance and will be able to sustain itself for 30 days. The NRF provides an initial entry force with dedicated cutting-edge fighter aircraft, ships, army vehicles, communications, intelligence and combat service support logistics. Potential missions include non-combatant evacuation operations, humanitarian operations, and crisis response including peacekeeping, counter terrorism and embargo operations.

On initial deployment of the NRF, combat rations will be issued as part of the combat service support logistics in sufficient quantity to sustain the task force for a minimum 30-day period.

1.4 INDIVIDUAL COMBAT RATIONS

The purpose of the combat ration is to provide troops with self-sustained feeding. The individual 24-hour combat ration is intended to provide appropriate nutrition to maintain good health, physical performance, mental status and cognitive function of the military user in the field environment. The food components that make up a ration are dehydrated and/or thermally processed products and snack items. These provide a shelf-stable, long-life product range that is nutritious, wholesome and safe to eat. Some products require preparation in the field while other products can be consumed straight from the pack. Combat rations are designed to withstand multiple handling and to be used in severe conditions in all combinations of temperature, humidity and terrain.

1.5 DEVELOPMENT OF STANDARDS FOR NRF COMBAT RATIONS

The RTG recognized that participating members' combat rations were designed to meet specific national tastes, employed different styles of packaging, contained different equipment for food preparation, and used a wide variety of means of combat ration distribution. Consequently, interoperability became another focus of the RTG and is discussed in Chapter 6.

The RTG recognized that there were a number of collateral issues associated with interoperability that could directly impact on the provision and use of the recommended combat rations by NRF troops. These issues are addressed in Chapter 7.

The RTG agreed that the nutritional requirements of NRF troops should be determined in order to make recommendations on the optimal values for the nutritional content of individual combat rations to maximize physical and cognitive performance of the NRF across the range of operational conditions. It was agreed that an independent SME should undertake this work. Following the development of the recommended optimal (and acceptable) ranges of nutritional content of individual combat rations, the SME assessed the suitability of each participating nations' ration (or rations), using the recommended nutritional standards as the criteria. The contractor's report is available at Annex J; the results are discussed in Chapter 4.

The RTG also acknowledged that there were a number of factors that could either positively or negatively influence the consumption of individual combat rations in the field. An inadequate nutritional intake, by means of a reduced consumption of the components in the combat ration, would negatively affect a soldier's physical and cognitive performance. An independent SME was contracted to:

i) Determine the non-nutritional characteristics likely to influence ration consumption by NRF personnel during deployment (giving consideration to cross-cultural food and dietary preferences and aversions, religious, social and gender influences and consumer perceptions, expectations and attitudes);

ii) Develop a rationale to recommend acceptable characteristics of individual combat rations suitable for meeting non-nutritional requirements of the NRF, i.e. acceptable sensory characteristics, menus, packaging, portion size, energy density and feeding concepts; and

iii) Compare the non-nutrient characteristics of individual combat rations currently in use by participating nations (Annex E) with the recommended characteristics as defined in ii). The contractor's report is shown at Annex K; the results are discussed in Chapter 5.

Chapter 2 of this report provides a detailed summary of the various meetings conducted in support of the RTG's initiatives, an evolution of the work conducted, refinement of specific tasks and progress made toward the end state objectives.

Chapter 2 – SUMMARY OF ET-059 AND RTG-154 MEETINGS

2.1 INTRODUCTION

This chapter is intended to capture the main issues raised and discussed during each meeting, but not in an exhaustive form. In each meeting all the National Representatives gave an update on the status of progress in combat feeding and on the main studies/researches being conducted in their own countries. These are not listed here for reasons of brevity. They are recorded in the minutes of each meeting.

In between the meetings a tremendous amount of work has been conducted by mail among the RTG members in order to make every single meeting a significant progress in the overall work.

Every chapter concludes with the actions coming from the meeting which can be interpreted as the main issues of the meeting itself.

2.2 ET-059 BUSINESS MEETING #1, ERDING, GERMANY (18 OCTOBER 2005)

2.2.1 Topics

Brigadier General Dr. Erich Rödig, HFM Principal Panel Member from Germany described the NATO Response Force (NRF) and the emerging concepts supporting the NFR that emphasize mobility, sustainability and interoperability. Upon an initial review, considerable discussion was generated to include combat feeding, technology, food safety, traceability, operational environments, climatic extremes, dehydrated foods, ration cost, garrison vs. combat feeding, individual rations, group rations, survival rations, metrics for nutrition, shelf life, NATO threshold for cost per meal, branding, food related European Union (EU) / United States (USA) regulatory laws and maintenance of a production base. It was proposed that an RTG should be convened whose major activities over years 1 and 2 might include:

1) Define current state (individual/group rations, nutrition science, food safety).
2) Identify requirements/capabilities required to support NRF (30 days).
3) Identify capabilities and gaps.
4) Identify common areas of understanding and interoperable technological solutions.
5) Determine feasibility of a standard NATO Response Force individual/group combat ration:
    a) Modify/amend/adopt STANAG 2937 (achieving consensus on food ingredients, processing, hygiene, packaging, labeling, and nutrition standards);
    b) Common nutritional denominator (similar to paragraph 6 (b) 4 of STANAG 2937;
    c) Common ration components (universally acceptable); and
    d) Common equipment capability (if required for group rations).

2.2.2 Action

Convene meeting to discuss way forward.

2.3 ET-059 BUSINESS MEETING #2, BIRMINGHAM, UNITED KINGDOM (30 MARCH 2006)

2.3.1 STANAG 2937

The attendees who had provided comments appeared to be using different versions of STANAG 2937. An action item was taken to obtain a copy of STANAG 2937 Edition 4, Study Draft 2 and circulate to ET-059 members. Those members who had already provided comments were asked to review the Edition 4, Study Draft 2 and resubmit comments as appropriate to their respective liaisons.

2.3.2 Program of Work

Various NATO information gathering options were discussed in order to determine the most appropriate activity in order to conduct a successful RTG, leading up to the final deliverables.

Initial information that was to be gathered would include:

- Detailed description of individual and group combat rations – components, nutritional profiles, weight, cube, cost, operational functionality, shelf life, duration of use, etc.;
- Crosswalk of NRF member countries for military recommended daily nutrition requirements to identify common levels and potential gaps; and
- Crosswalk of NATO food regulations and laws.

This was cited as one of the more difficult and controversial issues, it was agreed that the RTG could not overcome the regulatory barriers, but would attempt to identify key issues for resolution by other NATO bodies: procurement, production, ramp-up, build to inventory, build to order issues of the various agencies and subsistence industry within the EU/USA. The RTG work is focused on exploring the feasibility of a standard NRF ration and not replacing any country's existing or planned individual or group ration.

2.3.3 Action

(1) Agreement on a Program of Work; and (2) Review of STANAG 2937.

2.4 RTG-154 BUSINESS MEETING #1, NATICK, MA, UNITED STATES (31 OCTOBER – 3 NOVEMBER 2006)

2.4.1 Meeting Outcomes

This was the initial meeting of the RTG-154 and the main outcomes recorded were as follows:

1) Acknowledgement of the importance of constructive contributions to ensure the success of the RTG as a whole; to provide meaningful output recommendations;
2) Discussions about the mission profile scenarios relevant to NRF mission, NATO structure and use of rations and Class 1 food supply in Afghanistan at International Security Assistance Force (ISAF) locations;
3) Recognition that there is variability among nations nutritional policy and nutritional supplement policy despite commonality around STANAG 2937;

4) Recognition of the uniqueness of NATO force composition and that member states are disparate in terms of defence budgets, research focus, development capability, regulatory constraints, as well as distinct cultural and ethnic diversity that impacts and challenges consumer acceptability of food from the sensory perspective;
5) Recognition of the differences in terminology and the need to establish a supporting data element dictionary or glossary;
6) Data collection of national ration assets and capabilities and the need to build up data profiles and inventory or to identify mission relevant national assets;
7) Goal or objective for the NRF is focused on shelf stable, pre-packaged combat ration at the individual level for 24 hour use without requirements for cooks, equipment, or fuel. Follow-on efforts could include transition to cook prepared meals; however, that adds more significant issues of transport assets, labor, power, cooks, field kitchens, equipment, Class 1 logistics, distribution in theatre, etc.;
8) STANAG 2937 will not be the main focus of the RTG but an output of the group might include recommendations to improve it; and
9) Consideration of austere NRF operational mission scenarios as a stress to the system and challenge, accelerate or harmonize research identifying capability gaps and technology force multipliers.

2.4.2 Action

(1) Initiate data matrix development; and (2) Develop baseline data elements and definitions.

2.5 RTG-154 BUSINESS MEETING #2, IEPER, BELGIUM (1 – 4 MAY 2007)

2.5.1 Baseline Data Sheet and Definitions

The final structure and definitions of the baseline data sheet (whose details can be seen in Chapter 3) were discussed and recommendations were: to include country field and POC on supplement page; an unclassified data call for introductory information and questions and/or instructions to request the country's source of nutrition standards; and to obtain copies of the document(s), if available, identifying who or what agency is responsible.

A quick "beta test" of the request was conducted by e-mail to:

1) General Kervella, Chief, France Veterinary Corps;
2) Christina Caruso, Military Nutrition Division, USARIEM; and
3) Chris Forbes-Ewan, Australia, RTG Observer.

Comments received from the three participants in the beta test were incorporated into the final version of data sheets.

2.5.2 Potential Lecture Series or Technical Course

There was considerable discussion on this topic which concluded as follows:

1) The final report of the RTG should include recommendations based on the analysis of the information collected;

2) A Lecture Series was considered a good way to indicate that some countries may have standards based on nutritional research that is more advanced than others and can utilize the information presented;

3) Consider whether it is reasonable to believe that a NRF Commader with his ground troops will support a ration design simply because it meets the recommendations for an NRF nutrition system;

4) Not only nutritional standards but packaging, support equipment, unit load size and weight and other factors differ among various countries' rations; and

5) While not in the HFM mandate in order to plan logistics, it is essential that the RTG understand how rations will be supplied and whether or not the current individual ration designs best support the doctrinal mission and operational requirements of the NRF.

Initial thoughts on a final technical activity were discussed. The rationale, as based on direction from the RTG Mentor, is to enhance the technical elegance of recommendations to RTO/HFM to optimize nutritional content, form, fit and function of NRF operational rations. Dr. Young agreed to take the lead to bring together Subject Matter Experts to construct the program of the technical course.

2.5.3 Baseline Data Collection

There was considerable discussion during the meeting on the data collection. Upon receipt of surveys, the RTG will:

1) Develop a data matrix;

2) Determine commonality and potential differences among the countries' nutritional composition of individual combat rations and supplements;

3) Determine how many countries meet each others standards/composition; and

4) Identify disparity and gaps.

The request for the data collection will be made from the RTG Chair to the HFM Panel Chair, who will in turn make a formal request to the HFM Principal Panel Members. The completed forms will be sent directly to the RTG Chair by the Action Officer in each country.

2.5.4 Action

(1) Investigate possibility of a lecture series/technical course; and (2) Initiate baseline data collection.

2.6 RTG-154 BUSINESS MEETING #3, ROME, ITALY (27 – 30 NOVEMBER 2007)

2.6.1 NATO Response Force

A discussion was lead by the Chairman on the subsistence support provided to Operation Steadfast Jaguar (OSJR). The individual pre-packaged ration used during the eight day exercise was France's individual combat ration. Group feeding information indicated that each participating country was provided with semi-perishable, fresh, chilled and frozen food that met their respective cultural feeding plans. It was unclear, based on the information obtained, the extent to which the individual ration was used or how often group meals were provided. This general information, despite attempts to obtain more specific lessons learned from this exercise, was considered by the RTG to be useful and adequate to continue the path forward to meet the goals of the RTG.

2.6.2 Baseline Data Input and Matrix

Copies of the individual nations' input were provided and a data matrix was presented, developed and compiled by the USA. The input was reviewed in detail by the RTG.

2.6.3 Technical Activities

Technical presentations and dialogue directly supported the overall goal of this group in identifying nutritional content of rations and their functional/operational characteristics and the potential for interoperability as well as the psychological aspects and cultural expectations of the NATO soldier. This was focused on two major activities outlined in the POW:

- Determine current state of relevant nutrition science; and
- Develop a better understanding of the psychological aspects of ration consumption (menu fatigue, cultural preferences, and stress) and their consequences on nutrition in the field.

It was suggested that in lieu of a technical course or workshop, the RTG could commission a group or sub-team appointed by the RTG to serve as an expert team and use it as a starting place to write a series of monographs, reviewing the literature as appropriate. While we would strive to achieve international participation in a technical activity, the primary goal is to publish science that would meet the goals above.

Two topics above will be addressed by developing specifically targeted statements of work (SOW) to provide a sound science base for:

1) Recommended nutritional content of rations; and
2) Psychological and cultural expectations of soldiers from NATO nations to include issues related to menu fatigue.

The SOWs will be prepared by Dr. Young and Dr. Lieberman respectively and provided to the RTG for comment. After discussion it was agreed that the USA would provide funding for both efforts. A third aspect of the RTG goal is to identify operational and functional characteristics of the ration matrix which could impact on interoperability. Belgium volunteered to take the lead to prepare a draft document for the next meeting.

2.6.4 Action

(1) Take forward technical activities/exchange; (2) Develop and coordinate statements of work; and (3) Identify operational and functional characteristics and their respective impact on the interoperability of rations.

2.7 RTG-154 BUSINESS MEETING #4, NAPLES, FLORIDA, UNITED STATES (4 – 6 JUNE 2008)

2.7.1 Combat Rations Demonstration and Ration Photos

Displays of the nations' combat rations were set up during the meeting.

2.7.2 Review of Matrix

Consensus was reached on the final content and layout of the matrix, as follows:

- General Purpose Rations – Nutrition Related Data Elements
- General Purpose Rations – Operational/Functional Data Elements
- General Purpose Rations – Components
- Special Purpose Rations – Nutrition Related Data Elements
- Special Purpose Rations – Operational/Functional Data Elements
- Special Purpose Rations – Components
- Supplements – Nutrition Related Data Elements
- Supplements – Operational/Functional Data Elements
- Supplements – Components

2.7.3 Nutrition Analysis of Ration Matrix

Dr. Young considered a list of colleagues from CAN, USA and GBR to perform the work. None were available and Dr. Meiselman (whose services are contracted by the RTG Chair to work on the behavioral/ psychological assessment) recommended Dr. Kees de Graaf from Wageningen University (NLD), who also identified Dr. Lisette de Groot, also from Waginengen, to the RTG Chair. Mr. Darsch contacted Dr. de Graff to initiate discussion on conducting the effort contained in the SOW. As a follow-on, the contract was awarded on 18 June 2008. The USA provided the matrix and initiated discussions with Dr. de Groot in order to begin the work. Dr. Young obtained an outline from Dr. de Groot and coordinated this with the RTG members via email along with relevant questions.

2.7.4 Comparative Analysis of Ration Matrix with Current Nutritional Standards

BEL reviewed and compared current nutrition standards between USA, Australia, GBR, and Belgium. Belgium is currently using standards established for the civilian sector. It should be noted that Australia is currently revising their military nutritional standard.

2.7.5 Behavioral/Psychological Analysis of Ration Matrix

Dr. Meiselman, an internationally known expert in the fields of sensory and consumer research, product development and food service system design and evaluation, presented an extensive briefing on his initial work to analyze the data matrix with regard to the behavioral and psychological aspects of eating. He described his method to organize the tasks and sought variants of three difference approaches – the three "P's" – that control eating: the **PRODUCT** (the food and the sensory aspect, what the food evokes), the **PERSON** (including psychology and physiology) and the **PLACE** (environment). He requested feedback from the members on numerous non-nutritional factors related to each of the three P's.

2.7.6 Interoperability Analysis of Ration Matrix

Lt. Steven Verberkmoes (BEL) presented a draft overview of interoperability issues based on the current information in the matrix. Labeling language will be added to the matrix, which will be further developed and included in the final report. It was acknowledged by the RTG that the final report should cite labeling issues, country differences, allergens, etc. The RTG can consider recommending that NATO develop an accessory pack that would contain items to support rations used by the NRF, such as a mess kit or cutlery that some rations do not contain but require.

2.7.7 Combat Ration Logistic Seminar in Italy

RTG-154 member Commander (Navy) Alessandro Pini (ITA) served as a representative to the Combat Ration Logistics Seminar held in Solbiate Olona (Italy) in May, 2008 under the sponsorship of the NATO Rapid Deployable Corps (NRDC) – ITA. This seminar provided an important forum for the exchange of information among logistics specialists and military personnel on combat rations, their use and technical characteristics. Commander Pini provided a detailed update on the relevant work of the NATO Research Task Group 154. The final report and output of the RTG will be of particular interest to this same logistics and military leadership in examining combat ration assets and nutritional, behavioral and interoperability factors in support of broad and demanding NATO operational mission requirements.

2.7.8 Final Report

A draft table of contents was prepared by the USA for discussion and review. The group reviewed each proposed section and made revisions to each section to effectively capture and focus the content to produce a value-added end state for the final report. It was decided that Chapter 7 (Collateral Issues) should capture and raise issues beyond the mandate of the RTG (e.g. Genetically Modified Organisms (GMO), status of STANAG, protected production base within countries, and shifting to other countries for production). The Chairman indicated it is important to NOT push any ration out of the zone of consideration; the report should assist a field commander to understand what is required with respect to proper consumption and nutrition (e.g. if you have a dehydrated ration from a certain country, you will need to plan for extra water).

2.7.9 Action

(1) Review of matrix; (2) Nutrition analysis of ration matrix; (3) Behavioral/psychological analysis of ration matrix; (4) Interoperability analysis of ration matrix; and (5) Proceed with the Final Report.

2.8 VISIT TO WAGENINGEN UNIVERSITY AND RESEARCH CENTRE (WUR), WAGENINGEN, GELDERLAND, NETHERLANDS (8 – 10 SEPTEMBER 2008)

2.8.1 Purpose

An RTG sub-group meeting was held at the Wageningen University and Research Centre whose main issues were as follows:

- **Overview of NATO RTG-154 –** The presentation was provided specifically to the University Representatives to enable them to determine precisely how their efforts fit in the RTG. Emphasis was given to a key factor, that is, the use of individual pre-packaged combat rations for 30 days with no resupply.
- **Presentation of EURRECA –** An overview was provided of EURRECA (EURopean micronutrient RECommendations Aligned) – a network in Europe to harmonize the process to work towards micronutrient recommendations for Europe.
- **Nutritional Recommendations for the NRF "Results So Far" –** Progress to date was presented on the nutrition assessment relative to the scope of work outlined in the contract. The overview captured (among other issues) Methods and Assumptions.

2.8.2 Nutritional Assessment Methods

Several sources were referenced in generating the initial recommended Dietary Reference Intakes (DRIs) and they are referred to in Annex J. It was recommended that specific nutrient values cited in the report capture which references were used. The RTG needs to know **how** the recommendations were derived and **why** that recommendation was made. Wageningen University will distill this from the literature.

Referenced situations will differentiate between:

- Normal vs. combat operations (activity level for energy expenditure);
- Hot vs. cold environment; and
- High altitude environment.

2.8.3 Nutritional Assessment Assumptions

It will be assumed that NRF soldiers are healthy going into a 30 day period of NRF activity which includes consuming combat rations. Soldiers will have optimal nutrient levels with no nutrient deficiencies. It was agreed that for females, a separate value for combat operations will not be required as the RTG felt that women would not likely be in a combat operation. However, females would likely participate in normal operations. It is important to distinguish between normal and combat operations (energy expenditure); this is also the most feasible approach. Age range differs among countries, but the current range (17 – 50) is more likely to show differences between men/women. While there are sub-groups for life, health, diet, for the NRF – not sure the requirements for 30 days will be considerably different. A minimum can be established knowing that stores in the body will suffice for the 30 days. An assumption will be that after 30 days, dining facilities and national dietary standards will prevail with a regular diet or individuals sent home to consume a regular diet.

It was agreed that no matter what values are used by the contractors in the assessment, it is most important to cite how these figures were arrived at in the narrative of their report. Assumptions for environment were discussed with regard to hot, cold and altitude. In combat conditions, increased physical activity requires elevates energy needs and depending on temperature, may result in increased sweat losses, leading to losses in micronutrients. In a hot environment, the basal metabolic rate is not altered therefore energy isn't affected but some micronutrient needs may be altered. With regard to altitude, it was noted that appetite is significantly reduced if a soldier has Acute Mountain Sickness (AMS), regardless of meals/rations provided. It was also noted that higher carbohydrate foods are better tolerated at altitude.

The RTG members agreed about the importance of hydration which has to be cited and commented on.

2.9 RTG-154 BUSINESS MEETING #5, IEPER, BELGIUM (9 – 11 DECEMBER 2008)

2.9.1 Review of Draft Chapters

The RTG members reviewed in detail the draft chapters and review of behavioral and nutrition assessment.

2.9.2 Discussion of Final Report Deliverables and Due Dates

The majority of the discussion focused on the final nutrition assessment, introduction, conclusions and potential follow-on activities for the RTG. This discussion was of great importance to members of the RTG as

it is clear that subsistence and combat feeding is essential to mission performance and success as evidenced by lessons learned and gathering of members of the subsistence communities represented by this RTG.

The following potential options were discussed:

1) Custodial working group established to continue to monitor and update the final report or specific topics addressed in the report or other topics relative to subsistence. This could potentially be accomplished outside of the NATO RTO;
2) Appoint this task to an existing panel or workgroup within NATO and populate it with the appropriate expertise;
3) Recommend some of the conclusions and observations of the RTG be pushed to a standing NATO logistics panel or group (e.g. interoperability);
4) A follow-on NATO RTO activity (RTG, Workshop, Lecture Series, etc.). A NATO technical activity would need to be recommended and approved by the HFM Panel; and
5) A non-NATO activity (e.g. International Combat Feeding Symposium), similar to the Symposium hosted by DEU in 2002.

2.9.3 Actions

(1) Finalize the Final Report; (2) Review of nutritional and behavioral assessments; and (3) Follow-on activities.

2.10 RTG-154 BUSINESS MEETING #6, BATH, UNITED KINGDOM (24 – 26 MARCH 2009)

2.10.1 Review and Discussion of Report Chapters and Annexes

Most of this last meeting was devoted to the discussion of the chapters and annexes of the Final Report, implementing the suggestions/indications offered by the RTG members, and focusing on the recommendations.

2.10.2 Key Presentation

Observations from two operational tours and plans to investigate the nutritional status of British soldiers in Afghanistan were provided by Mr. Rene Nevola. Objectives of this survey will include: anecdotal evidence of weight loss in theatre, both at Main Operating Base and Forward Operating Base, as well as increasing evidence for future collaboration with colleagues within RTG-154. Pre and post-deployment will be checked, using the following methods: static strength tests, estimate aerobic power, sit ups / press up tests, food diaries, blood assays, estimated energy expenditure, nutritional habits, general health assessment, use of accelerometer for energy expenditure, use of the new GBR ORP (Operational Ration Pack) and discard/field stripping.

2.10.3 Discussion and Follow-On Activities

A very large discussion was held on this topic and the RTG focused on the following (not an exhaustive list): interoperability, RTO activity, NATO working group to keep documents produced up to date, STANAG 2937 custodial working group (upon request from Germany which is currently international custodian), taking into consideration that the RTG would be the best group to draft a new STANAG due to its collective expertise. The final decision on this matter remains with Germany.

2.10.4 Final Report

The main issue is how to maintain this document up to date. The message to NATO is that there is a gap with regard to combat feeding and nutrition (nutrition is an orphan) as well as an opportunity for better connectivity in NATO. A good opportunity will be a Combat Feeding Workshop to be held in the near future (possibly Spring 2010) or to link to another meeting or something visible with other countries such as the Catering Conference (GBR) or Research & Development Associates for Military Food & Packaging Systems, Inc. (R&DA) (USA).

2.10.5 Country Comments and Closing of Business

All the members acknowledged the tremendous experience to be appointed to the RTG; the terrific effort and the added value if the work could continue; the excellent information sharing for the development of new combat rations; the necessity that the work of this RTG doesn't stop here and must go further.

They recognized the richness of diversity and synergy of the group which is why it has resulted in a quality product; the fact that considerable work has been accomplished without NATO resources; the excellent networking among all countries: small world – same challenges – same passion; and the need to stimulate interest and future brainstorming focused on collective joint operations.

Before declaring the meeting closed, the Chairman reflected on how much he enjoyed this experience and that he was proud to know and to work with each of the members. He noted, "We have assembled a group with the same level of passion and the product we will collectively deliver is outstanding. The dynamics of the battlefield are continually changing and more reliance on coalition forces is to be expected in the future requiring a broad understanding of each other's needs".

Chapter 3 – DATA COLLECTION, DEFINITIONS AND MATRIX DEVELOPMENT

3.1 DEVELOPMENT OF THE DATA COLLECTION, DEFINITIONS AND MATRIX

One of the key aims of the RTG was to gather information that would:

i) Allow determination of which existing combat rations provide adequate nutrition for NRF feeding; and

ii) Provide commanders with information on the ability of other nations' combat rations to meet their troops' needs and expectations when they are fed by alliance partners during joint operations.

A secondary aim was to allow recommendations to be made regarding supplementation to optimize the nutritional content of participating members' combat rations.

Participating nations agreed to provide relevant nutritional and non-nutritional information on all their general purpose rations, special purpose rations (those that apply only to particular missions, e.g. short- or long-term operations, or specific environmental conditions, e.g. cold-weather rations) and supplements[1]. This information was to be collated and used to devise a "matrix" in the form of a series of spreadsheets that would allow the aims described in the preceding paragraph to be achieved.

The following nutritional characteristics were identified as relevant: *energy*, the macronutrients *protein, carbohydrate* and *fat*, and the minerals *sodium, calcium*, and *iron*. Additional information (e.g. vitamin levels) could be included under the heading "Other (optional)". Finally, information was requested on the percentage contribution to total energy from each of the macronutrients protein, carbohydrate and fat (also known as the "macronutrient distribution ratio").

Non-nutritional characteristics were divided into those that have a major impact on nutrition, and those that are more functional/operational in nature. Relevant non-nutritional variables linked to nutrition are *duration of use* (i.e. the maximum authorised period of uninterrupted use of this ration); *basis of issue* ("is this a one-meal or one-day ration?"); *shelf life* (including any stipulated conditions of storage*)*; *menus* (total number, and specific meals provided – i.e. breakfast, lunch, dinner?); *food components* (i.e. full menu listings) and *accessories* (non-food components such as cutlery, towelette, matches). Characteristics considered to be of more functional/ operational significance are *water requirements* (the volume of water needed to reconstitute dried foods and beverage powders); *preparation and support requirements* (items that are not contained or supplied with the ration but are needed to properly consume it?); *heater* (is one supplied with the ration and if so, what type?); *weight*, *volume*, *packaging* (of the ration as a whole and of individual components); and *shipping container data (*including dimensions, weight, number of rations per container, number of rations per pallet and type of pallet).

It was agreed that the units of the *Système International d'Unités* (SI, commonly called the "metric system") would be used, with the exception of energy, for which the kilocalorie (kcal) would apply.

[1] Supplements are defined as "those additional recommended food items or components that might be used to augment an operational ration to make it more nutritionally complete, increase acceptability and consumption or enhance overall mission or performance effectiveness". Reference Annex D – Data Collection Survey and Data Element Definitions.

3.2 PROCESS OF DATA COLLECTION

Following the appropriate protocol, the request for data collection was made from the RTG Chair to the HFM Panel Chair, who in turn made a formal request to the HFM Principal Panel Members. Completed forms were to be sent directly to the RTG Chair by the Action Officer in each country (with only "unclassified" data being sought).

As a result of this process the following documents were provided to each member nation:

i) The Data Collection Survey and Data Element Definitions (Annex D); and

ii) Blank Excel spreadsheets for collection of baseline data on nutritional and non-nutritional aspects of all that nation's individual general purpose combat rations (shown in completed form at Annex E, pp. E2 – E10), special purpose combat rations (shown in completed form at Annex E, pp. E11 – E18) and supplements (shown in completed form at Annex E, pp. E19 – E21).

All participating nations provided the requested information. Follow-up requests were sent to several other NATO and PfP nations, but these did not elicit a response. Where responses were unclear or ambiguous in the data matrix, further information was sought from the Action Officer in each nation.

The information in the matrix shown at Annex E was collated and used to devise the spreadsheet shown at Annex F, which underpins the results and discussion in Section 3.3 below.

The nutrient content of each general purpose and special purpose combat ration was compared to the nutrition standards shown in Table 5-1 of Annex J. The outcomes of this comparison are detailed in Section 6 of Annex J.

The potential impacts of non-nutritional characteristics on interoperability are discussed in Chapter 6.

3.3 OUTCOMES OF DATA COLLECTION

3.3.1 General Purpose Combat Rations

BEL uses the FRA ration, and NOR has a "Tropical" and an "Arctic" version of a general purpose ration. Because the BEL and FRA rations are identical, they are treated as one ration (denoted "BEL/FRA") in this chapter. Because there are substantial differences in the nutritional characteristics of the tropical and arctic versions of the NOR ration, these are treated as separate rations, denoted "NOR Trop" and "NOR Arc".

3.3.1.1 Nutrition

Nine of the twelve general purpose rations are approved for 30 days of continuous operational use. AUS, SVN and USA specify periods of 20, 10, and 21 days respectively. The main reasons given for limiting the period of continuous use to less than 30 days relate to problems with acceptability/consumption, specifically *high discard rates*, *menu fatigue* and *lack of variety.* AUS also identifies *loss of heat-labile vitamins in storage* as a contributing factor.

All but three general purpose combat rations are supplied in the form of one pack (i.e. a complete day's "ration"). The USA and CAN provide *one-meal* packs (i.e. three packs per service person per day). The NLD combat ration consists of a breakfast/lunch pack issued separately to the dinner pack, so is mid-way between the USA and CAN concept of a one-meal pack and the more general 24-hr pack.

All participating nations require shelf lives of at least 24 (and up to 42) months for their general purpose combat rations. Most nations specify particular storage conditions – a temperature, a temperature range, a humidity range, a requirement for shade, or more than one of the above. GBR specifies "ambient temperature in a temperate climate". AUS and USA do not require particular storage conditions, but specify a maximum shelf life when their rations are exposed to particular temperatures (24 mos at 30°C for AUS, and 36 mos at 27°C for USA). For both the NOR rations recommendations are provided for storage conditions ("dry, ambient temp., shady") and a maximum shelf life when the rations are exposed to a particular temperature (3 mos if exposed to 50°C). The NLD ration makes no reference to storage conditions, or whether the shelf life (24 mos) will be affected by particular environmental conditions.

SVN and NOR could not provide detailed results for sodium, iron and calcium. The summary of results for iron and calcium presented below is based on the values in the remaining ten general purpose combat rations. The BEL/FRA ration specifies salt concentrations for specific items ("NaCl < 1% main course, < 1.5% Starters"), but does not detail total sodium. The sodium results presented below are based on the sodium values in the remaining nine rations. The BEL/FRA ration also does not specify a particular calcium level, rather that it shall be "> 800 mg". It is assumed here that the BEL/FRA ration provides 800 mg of calcium.

Table 3-1 summarises the results of the nutrition data collection for the general purpose rations.

Table 3-1: General Purpose Combat Rations – Energy and Nutrients

Nutrient	Maximum	Minimum	Mean	CV (%)
Energy (kcal)	4395	3200	3754	10
Protein (g)	141	90	106	14
Fat (g)	157	89	126	15
Carbohydrate (g)	681	414	551	15
Sodium (mg)	9381	2458	6784	33
Iron (mg)	33	11	26	23
Calcium (mg)	1705	718	1042	32

A summary of the percentage contributions to total energy by protein, fat and carbohydrate ("macronutrient distribution ratio") is shown in Table 3-2.

Table 3-2: General Purpose Combat Rations – Percentage Contributions of the Macronutrients Protein, Fat and Carbohydrate to Total Energy Availability

Macronutrient	Maximum %	Minimum %	Mean %	CV (%)
Protein	13	9	12	12
Fat	36	21	30	14
Carbohydrate	69	49	59	9

The mean number of reported menus is 8.3 (range: 2 – 20; CV[2] = 58%), with a mean menu cycle period of 8.1 days (range = 2 – 20 days; CV = 62%). However, note that the term "menu" is capable of at least two meanings – some participating nations interpret this to mean a "ration menu" (i.e. the menu for a complete 24-hr combat ration) while for others it is a "one-meal" menu. Because CAN and USA produce 18 and 24 menus of one-meal packs respectively, the numbers of "ration menus" for these nations' combat rations are 6 and 8 respectively (18/3 for CAN, 24/3 for USA). However, the total possible number of combinations of these one-meal packs taken three at a time is of the order of 1000. That is, after 6 and 8 days respectively for the CAN and USA rations there will be a repetition of at least one meal, but the total daily ration could continue to vary to some extent almost indefinitely. Hence the USA and CAN rationing systems allow for greater variety than is implied by the simple mathematical treatment used here.

AUS, SVN and USA do not specify particular breakfast, lunch or dinner meals, and CZE did not provide information on meal breakdown. All the remaining general purpose combat rations include at least some specified meals.

All general purpose combat rations provide "multiple" food components and accessory items. BEL/FRA, DEU, ITA, NOR (Trop and Arc) and GBR include water disinfection tablets, while AUS, CAN, NLD, SVN and USA do not. (CZE did not answer this question).

3.3.1.2 Functional/Operational

All the general purpose combat rations require the availability of water to rehydrate foods and/or beverages. The mean volume of water required to reconstitute all components is 2776 ml (range = 300 – 5170 ml; CV = 48%). Several rations also stipulate that water is needed to heat the main meals (e.g. cans or retort pouches are normally heated in a canteen cup or similar container of water), but these meals are edible cold.

A flameless ration heater is issued on a one-to-one basis with the USA ration. This allows the retort pouch meal to be heated in its pouch. Therefore, the USA ration is the only general purpose combat ration that does not need a canteen cup (or similar container) or other external support for the preparation of hot main meals. All rations need a canteen cup (or similar container) for the preparation of soups and/or beverages.

Of the four rations that include a heater, BEL/FRA and ITA use a fuel tablet and metal heater, while SVN and USA include a flameless ration heater. Fuel tablets and a metal stove are provided separately by AUS, CZE, DEU, NLD and GBR. CAN provides a separate flameless ration heater. NOR issues two "parafin based heaters" to each patrol (eight soldiers), and SVN issues an ethanol-based gel heater separately (in addition to the flameless ration heater in the ration).

The mean weight of the general purpose rations is 1.7 kg (range 1.0 – 2.3 kg; CV = 24%), and mean volume is 5224 cc (range 2977 – 8978 cc; CV = 43%).

ITA, DEU and NOR (both Trop and Arc) use the "Euro" pallet, BEL/FRA and SVN indicated the "ISO" pallet, while GBR and USA use the "NATO" pallet. Other nations apparently use non-standard (i.e. neither NATO, Euro nor ISO) pallets. Table 3-3 summarises the remaining Shipping Container Data for the general purpose rations.

[2] CV is the abbreviation for "coefficient of variation", which is the standard deviation expressed as a percentage of the mean.

Table 3-3: General Purpose Combat Rations – Packing Case and Pallet Characteristics

Characteristic	Maximum	Minimum	Mean	CV (%)
Rations per case	12	3.3	9.0	29
Gross weight of case (kg)	23	8	14.1	42
Volume of case (l)	98.9	17	43.1	50
Rations per pallet (*Note 1)*	400	106.6	222	43
Ration menus per pallet *(Note 2)*	10	1	5.3	68
Weight of rations + pallet (kg)	782	188	460	47

Note 1: The NLD ration is not included in the calculation of mean number of "rations per pallet". This is because the NLD combat ration is issued as breakfast/lunch and dinner packs separately – one pallet holds either 490 breakfast/lunch packs, 960 dinner packs (tins) or 800 dinner packs (pouches) and therefore does not provide a complete "ration". Also note that the number of "rations per pallet" for the USA and CAN is equal to one-third of the number of one-meal menus provided (see *Note 2* below and the text on Page 3-3 for explanation).

Note 2: The USA general purpose combat ration provides 24 one-meal menus, equivalent to 8 "ration menus" per pallet, while the CAN general purpose combat ration provides 18 one-meal menus, equivalent to 6 ration menus per pallet.

3.3.1.3 Food Components

The number of distinctly different types of food components per general purpose ration ranges from 9 to 27, and the number of non-food accessories from 4 to 11. Table 3-4 shows the food components in descending order of frequency.

Table 3-4: General Purpose Combat Rations (n = 12) – Food Components

Food Item	Total Rations Containing the Food Item
Main Courses	12
Coffee	12
Sports drink, energy drink or other fruit-flavoured beverage	10
Chocolate or chocolate bar	10
Sweet or oatmeal biscuits (~ "cookies")	9
Milk, "concentrated milk", coffee whitener or coffee creamer	9
Chewing gum	9
Jam, peanut butter, honey or other sweet spread	9
Tea	8
Salt	8
Crackers	8
Sugar	8
Chocolate drink or cocoa	8
Soup (or "broth")	7
Candy, hard	7
Canned or retort pouch fruit, sweet cake, dairy or other sweet dessert	7
Sweet bar (e.g. nougat, muesli, fruit, "energy")	7
Cheese or cheese spread	6
Cereal, dry (e.g. muesli mix, oatmeal block, granola)	5
Pouched bread or similar (includes 'lunch burger')	5
Starch (e.g. potato powder, potato goulash, pasta, rice, instant noodles)	5
Dried fruit (e.g. fruit grains, raisins)	5
Canned fish (e.g. tuna, mackerel)	5
Spread or Paste, savoury (e.g. mushroom, liver, chicken, pâté or canned sausage)	5
Condiments, dry (e.g. pepper, curry powder, mustard)	4
Sauces (e.g. Tabasco, chilli, soy, BBQ, steak, jalapeno ketchup)	3
Vegemite (salted, concentrated yeast extract)	2
Spread or Paste, savoury (e.g. mushroom, liver, chicken)	2
Beans (as a separate food component)	1
Nuts (or raisins and nuts)	1
Dextrose tablets	1
Corn	1

Every ration contains main courses (known in the USA and CAN as "entrées") and coffee, and the majority (at least 67%) provide a sports drink (or similar cold beverage), chocolate, sweet biscuits ("cookies"), beverage whitener, chewing gum, sweet spreads or peanut butter, tea, salt, crackers, sugar and chocolate drink. Specific rations reflect particular national or cultural preferences. As examples, "Vegemite" (concentrated, salted yeast

extract) is present only in the AUS and GBR rations, while beans are present as a separate ration component only in the USA ration.

3.3.2 Special Purpose Rations

3.3.2.1 Nutrition

Six of the twelve participating nations use a special purpose ration. The USA has three, NOR and NLD two each, and three nations (AUS, BEL and DEU) one each, for a total of ten rations.

A majority (60%) of the special purpose rations are for use by Special Forces (SF) or on Special Operations (SO). This applies to the special purpose rations of AUS, BEL, DEU, NOR (Trop and Arc) and one USA ration (Food Packet, Long Range Patrol). AUS and BEL also nominate "patrol" as an intended use for their special purpose rations, while the USA Long Range Patrol ration is also intended for "assault". The other (non SF) special purpose rations are for use on operations involving *cold weather (*NLD Arctic and USA Meal Cold Weather)*, scouts* (NLD Long Distance Reconnaissance Ration) or *assault* (USA First Strike Ration).

The recommended maximum period of continuous use varies from 10 to 30+ days.

Table 3-5 shows the energy and other nutritional characteristics of the special purpose rations.

Table 3-5: Special Purpose Combat Rations – Energy and Nutrients

Nutrient	Maximum	Minimum	Mean	CV (%)
Energy (kcal)	5190	1535	3782	34
Protein (g)	162	54	108	30
Fat (g)	183	58	127	30
Carbohydrate (g)	871	200	561	41
Sodium (mg)*	11300	2572	6436	48
Iron (mg)*	38	10	28	40
Calcium (mg)*	3600	563	1525	67

**Sodium, iron and calcium values are not available for the two NOR special purpose rations*

Table 3-6 shows the percentage contributions to total energy made by protein, fat and carbohydrate ("macronutrient distribution ratio") for the special purpose rations.

Table 3-6: Special Purpose Combat Rations – Percentage Contributions of the Macronutrients Protein, Fat and Carbohydrate to Total Energy Availability

Macronutrient	Maximum %	Minimum %	Mean %	CV (%)
Protein	17	9	12	21
Fat	39	24	31	15
Carbohydrate	67	52	58	11

The number of menus provided ranges from 3 to 12 (mean = 6.7; CV = 53%). The DEU ration and the two NOR special purpose rations include water disinfection tablets, the remaining seven do not.

3.3.2.2 Functional/Operational

All the special purpose rations need water to rehydrate foods and/or beverages. The mean water requirement for special purpose rations (3118 ml) is greater than for general purpose rations (2776 ml). This is largely attributable to the use of dehydration to minimise weight of main courses in the special purpose rations – all but the two NOR rations and the USA First Strike Ration contain "freeze dried", "lyophilized" or "dehydrated" main courses.

None of the special purpose rations includes a heater as a component. The rations of BEL and DEU specify separate requirements for a canteen cup (for heating main meals), plate and cutlery. The two NLD rations require a canteen cup and cutlery. The AUS ration requires only a canteen cup. The only preparation or support requirement for the two NOR rations is a spoon. The remaining three rations, those from the USA, have no additional preparation or support requirements (other than water).

The mean weight of the special purpose rations is 1.07 kg (range 0.45 – 1.52 kg; CV = 29%) and mean volume is 4926 cc (range 1133 – 9000 cc; CV = 64%).

Table 3-7 summarises the shipping container data for the special purpose rations.

Table 3-7: Special Purpose Combat Rations – Shipping Container Characteristics

Characteristic	Maximum	Minimum	Mean	CV (%)
Rations per case	12	4	8.3	36
Gross weight of case (kg)	17	3.6	9.8	43
Volume of case (l)	82.1	17.4	41.4	56
Rations per pallet	576	144	288	53

3.3.2.3 Food Components

The number of distinctly different types of food components per special purpose ration ranges from 9 to 20, and the number of non-food accessories from zero to 10. The food components of the special purpose combat rations are shown in Table 3-8 in descending order of frequency.

Table 3-8: Special Purpose Combat Rations (n = 10) – Food Components

Food Item	Total Rations Containing the Food Item
Main Courses	10
Coffee	10
Sweet bar (e.g. sports, nougat, muesli, fruit, "energy")	10
Sports drink, energy drink, fruit-flavoured beverage or "mineral drink"	10
Sweet or oatmeal biscuits (~ "cookies")	9
Chewing gum (including caffeinated gum)	9
Salt	8
Sugar	8
Tea	7
Chocolate or cocoa drink	7
Milk, coffee whitener or coffee creamer	7
Chocolate or chocolate bar (includes M&Ms)	7
Jam, peanut butter, honey or other sweet spread	6
Sauces (e.g. Tabasco, chilli, soy, BBQ, steak, jalapeno ketchup)	6
Crackers	6
Soup (or "broth")	5
Condiments, dry (e.g. pepper, curry powder, mustard)	4
Dried fruit (e.g. fruit grains, raisins)	4
Canned or pouched fish (e.g. tuna, mackerel)	4
Starch (e.g. potato powder, potato goulash, pasta, rice, instant noodles, tortilla)	4
Cereal, dry (e.g. muesli mix, oatmeal block, granola) or "oatmeal porridge"	4
Cheese or cheese spread	3
Candy, hard	3
Nuts (or 'nut fruit mix' or "raisins and nuts")	3
Vitamin tablet	3
Canned or retort pouch fruit, sweet cake, dairy or other sweet dessert	3
"Milky drink" (or dairy-based beverage)	3
Dextrose tablets	2
Beef jerky or "beef snacks"	2
Spread or paste, savoury (e.g. mushroom, liver, chicken)	2
Vegemite (salted, concentrated yeast extract)	1
"Energetic Complement" (type of survival ration)	1
Pouched bread or similar (includes "lunch burger" and "shelf-stable sandwiches")	1
Carbohydrate fortified apple sauce	1
Mayonnaise	1

Main courses (known in the USA as "entrées"), coffee, sweet bars and "sports drinks" are the only food components present in every ration. As with the general purpose ration, there are many components common to all rations, and also several culturally or nationally-specific components. Examples of items found in only one ration are "carbohydrate fortified apple sauce" (USA First Strike Ration) and "Vegemite" (AUS ration). The DEU ration and the two NLD rations include vitamin tablets.

3.3.3 Supplements

Two nations, CAN and USA, provide supplements. The CAN *Light Meal Combat Pack* (LMC) can be issued on the basis of one per day in addition to the three *Individual Meal Pack* (IMP) meals when activity is exceptionally arduous. It can also be provided whenever an IMP meal is missed, with a limitation of three per day for no more than 48 consecutive hours. The USA *Food Packet, Carbohydrate Supplement* (CarboPack) is issued on the basis of one per man per day during periods of arduous activity.

3.3.3.1 Nutrition

Table 3-9 shows the nutritional characteristics of the LMC and CarboPack, including a comparison of the rations in the form of a ratio of the quantity of each nutrient in the LMC to that in the CarboPack. The percentage contributions of protein, fat and carbohydrate respectively to total energy availability (macronutrient distribution ratio) for the two supplements are shown in Table 3-10.

Table 3-9: Energy and Nutrient Levels in the Supplements – CAN Light Meal Combat Pack (LMC) and USA Food Packet, Carbohydrate Supplement (CarboPack)

Nutrient	LMC	CarboPack	Ratio of the Value for LMC to that of the CarboPack
Energy (kcal)	1475	380	3.9
Protein (g)	33	4	8.3
Carbohydrate (g)	225	75	3.0
Fat (g)	49	9	5.4
Sodium (mg)	1622	215	7.5
Iron (mg)	8	0.9	8.9
Calcium (mg)	543	40	13.6

Table 3-10: Percentage Contributions of Protein, Fat and Carbohydrate to Total Energy

Supplement	Protein	Fat	Carbohydrate
LMC	9%	30%	61%
CarboPack	4%	21%	79%

3.3.3.2 Functional/Operational

Both supplements require water, and at about the same level (670 and 710 ml for the CAN and USA supplements, respectively). The shipping container for the LMC has a volume 53.1 l, weighs 10 kg and contains 24 packs per case. The corresponding figures for the CarboPack are 16.9 l, 4.6 kg and 25 packs per case.

3.3.3.3 Food Components

Each supplement contains a variety of flavours of carbohydrate/electrolyte beverage powders and carbohydrate-rich energy bars. However, these are the only components of the CarboPack, while the LMC has three menus, with each menu including a dried meat product (e.g. beef jerky), dried fruit, hot chocolate, sweet baked product (e.g. "Muffin Bar – Brownies"), a chocolate bar and another (sugar-based) confectionery item, in addition to the beverage powder and energy bar.

Chapter 4 – RECOMMENDATIONS FOR DIETARY INTAKES AND NUTRIENT COMPOSITION OF COMBAT RATIONS FOR THE NATO RESPONSE FORCE

4.1 INTRODUCTION

The NATO Response Force (NRF) is a highly ready and technologically advanced group of land, air, sea and Special Forces components that enable a swift NATO response to worldwide crises, including evacuations, disaster management, and counterterrorism operations. Since NRF personnel engaged in these missions will likely subsist partially or entirely on individual combat rations for up to 30 days without resupply, RTG-154 determined that guidance for the optimal nutrient content of such rations was needed to ensure that physical and cognitive performance of NRF personnel would be maintained. RTG-154 contracted an independent team of nutrition experts to formulate state-of-the-science-based nutritional recommendations for individual combat rations used by the NRF during their missions, to include deployments to regions where personnel would be exposed to extreme environmental conditions (heat, cold, and high altitudes). In addition, the contracted experts were asked to compare their recommendations with the nutrient contents of the 12 general purpose individual combat rations used by participating nations, and to make recommendations for supplementation strategies. The report detailing the contractor's recommendations is included at Annex J of this document. RTG-154 reviewed these expert recommendations. Most were adopted, but in a few cases, the RTG felt its own collective experience in combat feeding and military nutrition justified a different final recommendation.

4.2 ASSUMPTIONS AND APPROACH TO FORMULATING NUTRITIONAL RECOMMENDATIONS

At the recommendation of the RTG, the contractor assumed that the NRF missions would fall into two categories, with respect to physical activity level and energy requirements. "Normal" operations were considered missions comparable to urban police and peace keeping, fire fighting or construction work, while "Combat" operations represented missions involving sustained, dismounted light-infantry or Special Forces operations. The latter was thought to be the "worst-case" or the most physiologically stressful condition that NRF personnel would experience while subsisting on individual combat rations. To determine an appropriate nutrient intake value (NIV) for NRF troops, the contractor also had to make certain assumptions about the individual characteristics of personnel assigned to perform NRF missions. These assumptions, which were reviewed and approved by RTG-154, are detailed in Annex N. In summary, the NRF personnel were assumed to be healthy and physically fit men, 19 to 50 years old, with a mean weight of 79 kg and mean height of 175 cm. The RTG advised the contractor that NRF missions could last up to, but not longer than 30 days, during which combat rations might be the sole food.

Energy requirements for the NRF "reference man" described above were estimated for Normal operations using a standardized prediction model, the Schofield equation, which takes into account body size, age and physical activity. Physical activity was assumed to be equivalent to that measured in civilians engaged in the occupational activities described as comparable to "Normal" operations (i.e. PAL[1] = 2.0). The optimal macronutrient distribution (percentages of energy derived from protein, fat and carbohydrate) to achieve that energy requirement and micronutrient (i.e. vitamins, minerals) requirements were then estimated using the 2006 Australian and New Zealand national recommendations for NIVs (see Annex J for detailed rationale).

[1] PAL ("Physical Activity Level") is the mean daily energy expenditure expressed as a multiple of the basal metabolic rate.

The contractor noted that during Combat operations and exposure to environmental extremes, physiological stressors besides body size, age and activity level (e.g. sleep deprivation, psychological stress, heat, cold and high altitude) would likely influence total daily energy expenditure, so the standardized prediction model would not yield valid estimates of energy requirement. Those same physiological stressors were thought to be potential modulators of optimal macronutrient distribution and micronutrient requirements. Therefore, the contractor conducted a scientific literature review to derive estimates of the effects of high-intensity physical activity and extreme environments on energy, macronutrient, and micronutrient requirements, with emphasis on literature reporting direct measurements of energy and nutrient requirements of military personnel exposed to those stressors. Special consideration was given to specific nutrient proposals from the Committee on Military Nutrition Research (CMNR) and the American Military Dietary Reference Intakes (MDRIs) to satisfy nutritional needs of military personnel due to increased workload and environmental conditions.

4.3 RECOMMENDED NIVs FOR THE NRF

The RTG considered the scientific literature review and nutritional analysis and recommendations provided by the contractor (see Annex J for the contractor's detailed report). For most, but not all nutrient intake recommendations, RTG-154 concurred with the contractor. Therefore, the RTG's recommendations for optimal nutrient content of individual combat rations reflect the NIVs recommended by the contractor, except as explained below.

Estimated energy expenditure was determined to be approximately 3,600 kcal per day (15.1 MJ/d) for normal operations and 4,900 kcal per day (20.5 MJ/d) for combat operations. The contractor concurs with and adopted the 2006 Australian and New Zealand national recommendations for dietary macronutrient distributions for lowering disease risk. Therefore, to satisfy total daily energy requirement, the contractor recommends that dietary protein contribute 15 – 25% and dietary carbohydrate contribute 45 – 65% of total dietary energy intake, with the balance of the energy requirement derived from dietary fat intake. Using those macronutrient distributions, accordingly, the contractor recommended that daily macronutrient intake ranges to deliver 3,600 kcal per day should be 135 – 225 g protein, 404 – 584 g carbohydrate, and 80 – 140 g fat, and to deliver 4,900 kcal per day are: 184 – 307 g protein, 552 – 797 g carbohydrate and 109 – 191 g fat.

The RTG concurred with the contractor's recommendations regarding carbohydrate and fat contribution to daily energy intake for NRF personnel. However, the RTG believes that the upper limits for daily protein intake recommended by the contractor are excessive. While the RTG agrees with the contractor that heavy physical labor such as NRF personnel might perform during both normal and combat operations can potentially increase the body's protein requirement, the magnitude of increase can be accommodated by protein intakes much lower than the contractor's recommended upper limits. The RTG believes that, regardless of environment or work conditions, NRF personnel will accrue no significant health or performance benefit by consuming a daily protein intake in excess of about 2 g/kg body mass. Based on the contractor's assumption regarding body mass of NRF personnel, the RTG estimates that the average NRF member should require no more than 158 g protein per day, and very few NRF members would require more than 185 g of protein. Therefore, the RTG recommends that 185 g represents an acceptable upper limit for daily protein intake, regardless of energy requirement, i.e. both normal and combat operations. The RTG accepted the contractor's recommended lower limit for daily protein intake during normal operations, 135 g, but recommends that during combat operations the lower limit for protein intake should be 158 g.

Although the contractor reported that scientific evidence indicated that environmental conditions may influence metabolism and thus, total daily energy expenditure and macronutrient requirements, the magnitude of those effects is fairly small. In addition, in some situations (e.g. high altitude), compensatory physiological

responses to the environment can limit work capacity and endurance, which tends to offset any increased metabolism attributable to the environment. Therefore, the RTG concluded that for practical purposes, environment had a negligible effect on total energy requirements and optimal macronutrient distribution.

As mentioned above, the contractor assumed that micronutrient requirements for NRF personnel during normal operations would be the same as those recommended for civilian populations, and the Australian and New Zealand national micronutrient recommendations were identified as the most up-to-date set of guidelines promulgated for civilians. Using those micronutrient recommendations as a starting point, the contractor then searched the scientific literature for convincing evidence that sustained strenuous labor and/or exposure to extreme environmental conditions would produce physiological effects (e.g. sweating) which could, in turn, affect/increase micronutrient requirements for combat operations or for operations in the heat, cold or at high altitude. In the absence of such evidence, the micronutrient requirement was assumed to be the same as during normal operations. For most micronutrients, there was not sufficient evidence to merit a different recommendation in combat or during deployment in extreme environments. Those micronutrients for which higher intakes were recommended during combat as compared to during normal operations were: riboflavin (+92%), vitamin B_6 (+100%), zinc (+7%), iron (+75%), copper (+6%) and sodium (+30 to 422%). The contractor justified the increased recommended riboflavin and vitamin B_6 intakes based on the expectation of sustained increases in physical activity during combat operations, thereby increasing turnover of the nutrient. Additionally, for B_6 the contractor cited literature indicating that protein turnover (anabolism and catabolism) accelerated with sustained increases in physical activity, and B_6 is required for those metabolic processes. The contractor cited literature indicating that sweating associated with increased physical activity would sufficiently increase sweat losses of zinc, iron, copper and sodium to merit a compensatory increase in daily intake during combat operations. Regarding operations in extreme environments, the contractor's literature review provided, with one exception, no basis to recommend any additional increase in recommended intakes of vitamins or minerals beyond those recommended for combat operations, during operations in the heat, cold or at high altitude. The one exception was that during operations in cold or high-altitude conditions, the contractor cited literature to justify a 33% increase in recommended daily zinc intakes over the amount recommended for combat operations.

After discussion and deliberation, the RTG remained seriously concerned that the contractor's recommendations for daily sodium requirements of 920 mg (normal operations) to 4,800 mg (combat and extreme environment) were too low for NRF military personnel. The RTG notes that while the contractor's recommendations are appropriate for healthy civilians, there is strong justification for NRF personnel to be provided higher amounts during relatively short military deployments. Most NRF personnel will be from nations where food tastes are accustomed to relatively high sodium content, so providing low-sodium combat rations could adversely affect ration acceptability among the consumers. Furthermore, persons habituated to high sodium intake also typically sustain correspondingly high sodium losses in sweat, so a sudden decrease in sodium intake could increase the risk of hyponatremia[2]. Most importantly, many military tasks involve strenuous physical labor likely to stimulate profuse sweating, especially during combat and operations in extreme environments. The contractor's own literature review suggests that daily sodium losses can reach 8,000 mg during those conditions. The RTG does not know of any scientific evidence to indicate that short (i.e. up to 30 days) periods of consuming dietary sodium in amounts sufficient to compensate for that rate of loss have lasting health effects. Therefore, it is the position of RTG-154 that the daily intake range lower limit be increased to 2,300 mg, and the upper limit be extended to 12,000 mg. The RTG recommended that the lower limit be achieved by the sodium content of the ration's primary food components, with the additional sodium (up to 9,700 mg) provided in supplemental items and seasoning (salt) packets to be consumed on an individual basis as needed or as directed. The RTG

[2] Hyponatremia is a debilitating (and potentially fatal) condition involving abnormally low blood sodium levels.

recommends that sodium requirements and content for combat rations be re-evaluated periodically in light of national sodium consumption data, and the NIVs be adjusted downward if national trends to low-sodium diets become more prevalent.

The RTG had lesser concerns with regard to the contractor's recommendations for several other NIVs. The contractor recommended a daily calcium intake of 1,000 mg based on Australian and New Zealand civilian recommendations, and the literature reviewed by the contractor led them to conclude that sweat losses of calcium were likely to be negligible and have little or no impact on optimal daily calcium intake of NRF personnel during combat operations or operations in extreme (hot) conditions. However, members of the RTG noted that there is a significant scientific literature to indicate that sweat calcium losses might increase enough in hot environments to necessitate an increase in intake. On the other hand, there was no clear consensus among the RTG (or the science literature) regarding the appropriate magnitude of increase, so the contractor's recommendation was accepted. This recommendation should be re-evaluated periodically, and adjusted appropriately if warranted by new research information.

Regarding the contractor's recommendation of a daily vitamin C intake of 45 mg under all conditions, some RTG members expressed concern that the contractor failed to give adequate consideration of a recent meta-analysis suggesting that soldiers might benefit from higher daily vitamin C intakes (200 mg). Here again, there was no clear consensus among the RTG on whether an increase in recommended vitamin C intake was warranted by the evidence, so the contractor's recommendation was accepted. Finally, the contractor recommended NRF personnel consume 30 g dietary fiber daily, but provided no discussion or comment in support. The RTG accepts that recommendation but notes that this is a civilian norm, and there is no convincing scientific information concerning optimal fiber content of combat rations.

RTG-154 recommends that nutrient content for individual combat rations to be used by the NRF contain sufficient nutrients to achieve the NIV recommended (and adjusted as described above) for the "worst case" usage scenario, i.e. combat operations. These recommended nutrient content values are listed in Table 4-1.

Table 4-1: Recommended Nutrient Composition of Individual Combat Rations for Use by NRF During Combat Operations

Nutrient	Unit	Value
Energy	kcal	4,900
Carbohydrate	g	550 – 800
Protein	g	158 – 185
Total fat	g	110 – 190
Total Fiber	g	30
Vitamin A	µg	900
Thiamin	mg	1.2
Riboflavin	mg	2.5
Niacin	mg	16
Vitamin B_6	mg	2.6
Vitamin B_{12}	µg	2.4
Folate	µg	400
Pantothenic acid	mg	6
Biotin	µg	30
Vitamin C	mg	45
Vitamin D	µg	5
Vitamin E	mg	10
Vitamin K	µg	70
Choline	mg	550
Calcium	mg	1,000
Phosphorus	mg	1,000
Zinc	mg	15
Iron	mg	14
Magnesium	mg	410
Iodine	µg	150
Selenium	µg	70
Molybdenum	µg	45
Copper	mg	1.8
Chromium	µg	35
Manganese	mg	5.5
Fluoride	mg	4
Sodium	mg	2,300 – 12,000 [a]
Potassium	mg	3,800

[a] Recommend that lower limit of sodium content range be achieved by the ration primary (main course) food components, with the additional sodium (up to 9,000 mg) provided in supplemental snack items and seasoning (salt) packets to be consumed on individual basis.

4.4 NUTRIENT CONTENT OF RATIONS FROM PARTICIPATING NATIONS

During deliberations, RTG-154 identified certain "key" nutrients to be of particular importance for sustaining operational health and performance of military personnel participating in NRF deployments and missions

(the identification of "key nutrients" is not intended to disregard the physiological importance of the other nutrients listed in Table 4-1, but not all nations had information available regarding all of those nutrient values for their rations). A survey was sent to all participating nations regarding the specific content of those nutrients in their primary individual combat rations (see Chapter 3 of this report for survey details). Table 4-2 summarizes nutrient information regarding the primary individual combat rations provided by 12 nations (some nations provided nutrient information about special purpose rations, as well; see Annex E for those details and Annex J for contractor's review in light of recommended NIVs).

Table 4-2: Key Nutrients in Primary Individual Combat Rations of Nations Participating in RTG-154

	AUS	BEL	CAN	CZE	FRA	DEU	ITA	NLD	NOR	SVN	GBR	USA
RATION NAME	CR1M	C Ration	IMP	BDP	RCIR	EPa	K Ration	Combat Ration	FR3800 Tropical	Individual Ration	24-Hr GP ORP	MRE
Energy, kcal	3700	3200	4395	3351	3200	3524	3650	3682	3762	3537	4294	3995
Carbohydrate, g	593	440	681	414	440	501	521	540	649	518	618	528
Protein, g	108	104	141	111	104	96	100	108	90	95	107	126
Total fat, g	116	114	123	133	114	126	129	126	89	110	155	157
Calcium, mg	968	>800	1016	746	>800	900	1079	718	NP	NP	1444	1705
Iron, mg	32	20	26	21	20	19	33	33	NP	NP	21	26
Sodium, mg	5860	NP	9381	2458	NP	8300	5250	8061	NP	NP	8293	6850

NP – Not Provided

With respect to total energy content, RTG-154's recommendation is that the individual combat rations used by the NRF should provide 4,900 kcal per day, in order to satisfy energy requirements of "worst-case" conditions, i.e. combat operations. None of the individual general-purpose combat rations that were reported to RTG-154 provide that amount of energy. Therefore, when NRF personnel are conducting sustained combat operations and are subsisting on any of these rations, a 600 – 1700 kcal daily energy supplement should be provided to prevent negative energy balance, weight loss and health or performance impairment from developing over time. Most of the individual combat rations provide sufficient, or only negligibly less, total energy than the contractor estimated would be required to meet energy needs of NRF personnel conducting normal, i.e. non-combat operations. However, RTG-154 recommends that a 200 – 400 kcal daily energy supplement is provided when NRF personnel subsist on the BEL/FRA or CZE individual combat rations during non-combat operations. As noted below, personnel may choose not to consume all ration components provided.

With respect to the macronutrient content, none of the rations reviewed provide the recommended amount of protein for rations to be used by the NRF during combat operations, and only four (AUS, CAN, NOR and GBR) meet the carbohydrate recommendation. Therefore, the RTG recommends that the energy supplement

provided during combat rations consist primarily of protein and carbohydrate[3]. For normal, non-combat operations all rations meet the contractor's recommendation for daily carbohydrate intake, but all require supplementation to meet the contractor's recommended daily protein intake.

Not all nations reporting nutrient content of individual combat rations to the RTG provided values for sodium, iron or calcium. Of those that did provide these values, all achieved RTG-154's sodium and iron recommendations. The individual combat rations from CAN, ITA, GBR and USA achieved the RTG's recommended calcium level, but the RTG recommends that NRF personnel subsisting on the other rations be provided a calcium supplement.

Two final factors influencing dietary quality of military personnel subsisting on combat rations deserve mention. First, notwithstanding modern ration production technology, not all nutrients are indefinitely stable. There can occur some loss of nutrients, especially certain vitamins (e.g. vitamin C and the B vitamins) when combat rations are stored before distribution and use. Typically, nutrient content values reported for combat rations reflect the content measured immediately after production, and do not account for storage loss. Further, as discussed in detail in Chapter 5 and Annex K, even when rations containing the optimal amounts of all nutrients are provided, military personnel may choose not to consume rations in amounts adequate to meet requirements. Thus, commanders should attempt to provide field feeding alternatives to combat rations (i.e. a varied fresh foods diet) as soon as mission conditions allow.

4.5 CONCLUSIONS

Based on guidance provided by independent scientific experts and their own collective expertise in military nutrition and field feeding, RTG-154 formulated recommendations regarding the nutrient composition of individual combat rations for use by military personnel participating in NRF combat missions for up to 30 days. However, no individual combat ration reviewed by the RTG satisfies every nutrient recommendation. Table 4-2 provides additional information to assist a NATO commander in assessing nutritional values. Therefore, if NRF deployment is likely to involve continuous combat operations, RTG-154 recommends that a ration supplementation plan be developed that is tailored to the specific ration being supplied to the NRF. Supplementation should aim to increase total energy, protein and carbohydrate intake, and should be configured to optimize intake for the deployment environment, and cultural/national mix of personnel (see Chapter 5 for detailed consideration of the latter factor). For NRF deployments for non-combat missions, all rations reviewed meet or very nearly meet expert recommendations for nutrient intake, except for protein. The RTG recommends that commanders endeavor to provide NRF personnel access to dining facilities and group feeding arrangements that allow unrestricted food intake as soon as operational conditions allow mitigating potential nutritional impacts of prolonged subsistence on combat rations.

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Chapter 5 – BEHAVIORAL/PSYCHOLOGICAL ASSESSMENT SUMMARY

5.1 FACTORS CONTRIBUTING TO CONSUMPTION

A large number of factors contribute to how well a food is liked and how much is consumed. The latter topic is covered extensively by nutrition and dietetics. Both the latter topic and the former topic are covered by behavioral science. Early measures of liking were developed by the U.S. Army as a substitute for measures of consumption. Recent research has identified and investigated a large number of factors which contribute to food liking and food consumption.

There are a number of ways of organizing the factors which contribute to enhancing food consumption, or more specifically for this report, for operational ration consumption. One of the organizing principles which will be used in this report is to divide the factors into those dealing with the food itself, the person (or soldier) eating the food, and the environment (the field) in which the food is eaten.

The Food: Important aspects of the food include how well it is liked, its variety, and the portion sizes of the different ration components. It is still not clear from research whether portion size, which is a potent variable in civilian food settings, operates in the same way in military field settings. Soldiers might come to expect food portions such as those served in operational rations in the appropriate field settings.

Food that is liked has a much better chance of being consumed than food which is marginally liked or even disliked. One of the best ways of providing well liked foods is to select those foods from foods which are generally well liked in studies of food preference. Basically, people eat what they like. These food preferences vary across cultures, so serving well liked foods for a multi-national force faces major challenges on the issue of food preferences. Further, rations do not uniformly have content information on the outside packaging, and even when that information is provided it is not always in a language which soldiers will understand. Certain ration items will generally be disliked by certain cultural/national groups and should be avoided in rations designed for multinational use. If the rations of one country were served to another country, certain food items might have to be removed or replaced to insure adequate food consumption.

A varied diet supports adequate consumption better than a monotonous diet – data from soldiers in the field demonstrate that most soldiers prefer variety. However, rations from different NATO countries vary widely in their food variety. The number of different menus varies from low numbers such as 2, 3, 6 and 8 to higher numbers such as 20, and 24 menus. And it is important that the best liked parts of the ration are provided in appropriate portion sizes.

Another food factor is serving temperature. While the ability to provide rations at appropriate eating temperature might be an important factor in their being liked and consumed, soldiers with experience in the field might not have these expectations for rations in the field. Most operational rations provide a heating device; some are included with the ration, and others are provided separately. Further, another challenge for a multinational force is that heaters and rations from different countries might not be compatible. Serving food at the right temperatures will enhance liking, but serving at the wrong temperatures might not be as negative in the military field situation.

5.2 THE SOLDIER

Characteristics of the soldiers will also affect how much the ration is liked and how much is consumed. Understanding the demographic composition of the soldiers is important, since factors such as gender influence liking and consumption.

It is important to both understand and to try to impact the expectations of soldiers about their operational combat rations. Their opinions are led by more senior personnel by both what they say and what they do.

A large number of human traits differentiate people on their response to foods – variety seekers will want more variety, neophobics will avoid novel foods. Highly food involved people are more likely to appreciate foods from different cultures, as are neophilic people. And soldiers who are restrained eaters are more likely to use the field situation to reduce consumption. If data were available from the different NATO countries on the pattern of response of their soldiers on these trait and attitude tests, then we could better predict soldiers' responses to consuming rations in the field. Higher food involvement in some countries would suggest that those soldiers might make the effort to make their rations more acceptable (through heating, etc.). Higher food neophobia would suggest that those soldiers will avoid "foreign foods" and unfamiliar foods in general. Higher sensation seeking and higher variety seeking would suggest that rations could explore greater variety in what is offered. And higher dietary restraint would confirm that soldiers have a tendency to use situations for weight control.

In addition to these important individual traits, field feeding needs to take advantage of the phenomena of social facilitation and social modeling. Soldiers will tend to eat more in groups where eating duration is longer, and will tend to eat more when they model or copy the eating patterns of their superiors. Therefore, if the mission permits, commanders should allow soldiers to eat in a group. In combat missions, eating alone or in shifts could contribute to reduced intake, but commanders can still make use of the factor of eating duration to increase consumption even when socialization is not possible. And social modeling research suggests that NCOs and officers should eat operational rations with their troops, again to enhance consumption. Eating with superiors has multiple advantages. Watching the more senior people enjoy and eat their operations contributes to higher expectations on the part of soldiers. And the soldiers will model their superiors' behavior and eat more than if they ate alone or with their peers.

5.3 THE ENVIRONMENT

The environment has a major impact on ration liking and consumption. In fact, in military settings and other unique environments such as hospitals, the environment might have an unusually large effect on food consumption. How a food is judged in a particular environment is referred to as appropriateness. Some foods are appropriate for casual dining and others for fine dining; some foods are appropriate for eating in the field. We need to better understand the soldier's perspective when they consume operational rations in the field – is the food appropriateness judged from home meals, other Army meals, or other packaged food?

Time and effort are two of the key environmental variables. Temporal issues are critical; soldiers need adequate time to eat. One of the best ways to increase eating duration is the social effect of eating in social groups, where eating is prolonged and consumption increased. But the main factor in combat situations is simply the lack of time to prepare and consume foods. A U.S. study confirmed this in the 1980s using questionnaires to study a large number of U.S. Marines with actual combat experience.

Anything which makes obtaining food more difficult to obtain will depress eating. In university studies in cafeterias, increased effort reduced selection of the test foods to virtually zero. This is strong message that

environmental variables can have very large effects. In studies of U.S. operational rations carried out over prolonged periods (30+days) effort was identified as a key variable contributing to reduced consumption. Currently, operational rations from NATO countries do not uniformly contain some commonly used items such as tea, and vary widely in their weight and their need for hydration; all of these factors can contribute to increased effort and reduced consumption.

Another general environmental influence is the effect of meal patterns, which is another area in which the impact of culture is pronounced. Soldiers expect different meal patterns of hot and cold food depending on their cultural experience. Diverting form these patterns might depress eating. Some rations have equal numbers of rations for each of three daily meals. Others have fewer rations for some meals than others. These differences represent a major challenge for sharing rations among countries; Warfighters in countries which have specific breakfast, lunch and dinner ration menus will tend to expect such specific menus.

Another factor in the food environment is the degree of choice offered. If there is some degree of choice, menu fatigue might be reduced, and with no choice, there might be more menu fatigue. Whether you chose a food or it is chosen for you can affect the general phenomenon of menu fatigue. U.S. soldiers who selected the same food more than once rated foods significantly higher than soldiers who selected foods just once. This seems to make common sense, that a person who selects a product frequently likes it more. The same data set also show that soldiers like variety; most soldiers consumed each ration only once followed by declining frequency of selection.

5.4 COMPLEXITY OF CONSUMPTION FACTORS

Finally, two things must be emphasized concerning factors which contribute to ration consumption. First, a large number of factors have been identified which contribute to enhancing or depressing eating. It is unwise to simplify the very complex operational ration situation to one or two controlling factors. It might be helpful to keep in mind that there are important factors dealing with the food itself, the consumer/soldier, and the environment or location. Second, there needs to be a note of caution about applying data from civilian research situations to the military. The most likely situation is that the same factors apply to military and non-military eating situations, but that the degree of contributions of each factor might vary. The military situation might reflect the general patterns of institutional eating, or might represent a unique case. Further research will clarify these patterns.

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Chapter 6 – INTEROPERABILITY

6.1 INTRODUCTION

The RTG has defined "interoperability" as the interchangeability of material used by different countries without the risk of operational difficulties. In terms of combat rations, avoiding operational difficulties means soldiers eating enough of the right nutrients to sustain health and performance in a broad mix of operational mission requirements. With this in mind, behavioral/psychological, nutritional and functional aspects, as well as collateral issues have significant impacts on interoperability of ration systems. While acknowledging the dynamic interrelationship, synergy and collective influence of these issues on interoperability of ration systems, the focus here is on functional issues as each of these related factors is discussed in detail elsewhere in this report.

This chapter will focus on those functional issues that may preclude full interchangeability of individual combat rations and thus full interoperability among participating nations' unique ration systems. While primarily a national responsibility, the basic principle guiding the provision of logistic support for NATO military operations is that of collective responsibility shared between individual participating countries themselves and NATO structures developed to promote further cooperation in this area. This process requires close collaboration, mutual understanding, active communication and full cooperation across the spectrum of logistics to achieve joint mission objectives and efficient use of limited resources.

All of the functional interoperability issues that were identified by the RTG as possible concerns or issues are identified and described in this chapter. These issues can logically be divided in two categories: wholesale logistics issues and consumer/user logistics issues. Wholesale logistics issues are issues that have to be taken into account when planning and implementing logistic support systems, support and maintenance functions, acquisition and distribution of material, and supply chain management. These issues are at the very core of the challenging conundrum providing "the right ration, at the right place, and right time".

Consumer or user issues, on the other hand, tend to be more integral to the feeding concept and ration design parameters. These are issues that have a direct influence on the ability of a particular ration to be consumed by soldiers in the field. Fundamentally, if all user issues are resolved, the deployed soldier will require the least possible amount of effort to consume a given ration and thereby achieve the desired positive energy, performance, morale and health effects. (Consumer or user issues are also addressed in Chapter 5 and Annex K.)

Finally, a discussion of possible solutions to address the identified interoperability concerns is suggested for further consideration. Annex L of this report provides an overview of how the different rations are positioned with respect to these collective issues. This will, at a minimum, offer a starting point to further examine interoperability. As applies throughout this report, this chapter and Annex L are limited to the information officially provided to the RTG.

6.2 INTEROPERABILTY ISSUES

As mentioned above, the RTG has divided the interoperability issues into two groups: logistics issues and consumer or user issues. The logistic issues are issues which primarily affect mission planning and setting up logistic support. The user issues are issues that primarily affect the use and consumption of the individual ration by the soldier in the field. It is clear that there is dynamic relationship at play in that user issues can affect the logistic support scheme and that wholesale logistics issues can influence consumption by soldiers.

6.2.1 Logistics Issues

6.2.1.1 Feeding Concept

The feeding concept is a major issue when investigating interoperability. In this document, only individual combat rations have been evaluated. The feeding concept as identified in the table provided at Annex L is based on sustainment sufficient for one person for a full day (24 hours). The following feeding concept notations have been used: full ration or meal based. The full ration provides nutritional requirements for a full day and typically includes breakfast, lunch and dinner meals. The meal based concept is typically modular in design and is generally issued on an individual meal basis. As such, three meals are required for a single day's food supply unless the ration is a restricted calorie/restricted use ration.

The way the food needed by one person for one day is delivered to the person differs according to the concept. Delivery of food can be done by means of a single pack or ration for an entire day with specific meals identified, or on an individual meal basis which may not have specific breakfast, lunch or dinner meals specified. Meal-based feeding requires multiple individual packages yet maximizes modularity. There is no single optimal solution; however, this information is essential for effective logistics planning and distribution particularly in the context of operations involving combined joint, multinational forces. This data enables mission planners to order accurately and to plan transport, warehousing and distribution correctly. It also allows users to adapt their provisioning scheme and use of the ration as needed.

Eighteen of the studied rations are provided as full rations (one pack for one day), while five rations are meal-based and comprised of several individual meal-based packs to provide the daily nutritional requirement.

6.2.1.2 Intended Use

A number of nations have identified different types of rations for various uses or applications. Two types of rations were identified in this process: General Purpose rations (GP) and Special Purpose rations (SP). General purpose rations are intended to be used during standard military operations in very broad but typically moderate operational conditions, while special purpose rations are tailored towards specific circumstances, operational requirements, or unique mission needs. Special Purpose rations can be divided into two categories: environment specific rations and task specific rations. Environment specific rations are designed to meet challenges imposed by the environment (climate, altitude) in which the military operations take place (e.g. cold weather ration, hot weather ration). Task specific rations are designed to meet challenges uniquely imposed by certain specific task requirements (e.g. assault, long range patrol, scout, or reconnaissance). It is important that commanders, logisticians and mission planners alike are aware of specific mission requirements and ration system characteristics available to properly match needs with potential options. This insight to the range of general purpose and special purpose rations developed by certain countries may help when selecting the optimal ration, if available, for a given task in a particular environment.

Thirteen of the studied rations are general purpose rations; ten rations are special purpose rations.

6.2.1.3 Ration Volume, Pallet Type, Pallet Volume and Rations per Pallet

Ration volume provides a comparison of the individual rations and their respective volumes in cubic centimeters. While some rations appear to be larger or smaller, what they provide in terms of both food content and accessory items can be of great importance in satisfying and meeting the needs of individual soldiers. Packaged ration or meal pack volume may be of further interest, particularly if the packs do not meet the limitations of the combat gear pockets on backpacks of participating nations. This would require field

stripping of rations to remove packaging materials in order to accommodate soldier load carriage. There is a fair degree of variability in the individual ration volumes identified. The volumes reported for General Purpose rations range from 2977 to 8978 cubic centimeters and similarly from 1133 to 9000 cubic centimeters for Special Purpose rations. Special Purpose rations typically have lesser volume as compared to General Purpose rations with the noted exception of some cold weather specific rations. The mean weight of the general purpose rations is 1.7 kg (range 1.0 – 2.3 kg) and mean volume is 5224 cc while the mean weight of the special purpose rations is 1.07 kg (range 0.45 – 1.52 kg) and mean volume is 4926 cc.

This variability can also be seen when examining both pallet volume and rations per pallet. The tables in Annexes F and L provide identification of important weight and volume data, and information regarding the type of ration pallet used by the different countries, the pallet volume in liters and the number of total rations and/or meals provided per pallet. Discounting restricted calorie rations such as the USA LRP which is designed as a restricted calorie, single meal ration, it is important to consider the overall pallet volume in conjunction with the ration counts per pallet to assess the ability to feed soldiers on a per pallet and distribution basis. For General Purpose Rations, the number of rations per pallet includes 400 (Australian CR1M), 350 (United Kingdom 24-Hr ORP), 260 (Germany EPa), 252 (Belgian C Ration and France RCIR), 210 (Italian K Ration), 490 breakfast and 960 dinner and lunch (Netherlands Combat Ration), 160 (Slovenia Individual Ration) and 144 (Norway, FR 3800). The meal-based rations range from 576 (United States MRE) to 320 (Canada IMP) meals per pallet.

The ration logistics information as shown in Table 6-1 is important to mission planners. More important, however, is the significance of the pallet type. There are presently four different pallet types reported by the participating countries (Table 6-2). Transportation and warehousing requirements must consider the palletizing of combat rations as they relate to interoperability with transportation, shipping and handling equipment, to include vehicle and aircraft interface and capacity in staging operations, movement, distribution and use in theatre. This apparent lack of standardization must be acknowledged and its impact must be assessed in using these systems.

Table 6-1: Ration Logistics Data for GP and SP Combat Rations

Ration Type	Characteristic	Maximum	Minimum
GP	Rations per case	12	3.3
SP	Rations per case	12	4
GP	Gross weight of case (kg)	23	8
SP	Gross weight of case (kg)	17	3.6
GP	Volume of case (l)	98.9	17
SP	Volume of case (l)	82.1	17.4
GP	Pallet Volume (l)	2022	1056
SP	Pallet Volume (l)	1104	1944
GP	Rations per pallet	480	144
SP	Rations (or meals) per pallet	576	144

Table 6-2: Pallet Type Reported for Combat Rations

PALLET TYPE			
EURO	**ISO**	**NATO**	**"Other"**
DEU, ITA, NOR	BEL, FRA, SVN	GBR, USA	AUS, CAN

6.2.1.4 Water Requirements

Certain ration components are freeze dried and thus need rehydration before they can be consumed as opposed to canned components or wet pack, pouch based ration items. Usually, components such as beverage powders and in some instances main meal components may require rehydration. NRF personnel need to have access to the required quantity of potable water when preparing any given ration. The required quantity of water needed to rehydrate components in a particular ration will affect the water availability and supply that must be distributed through the logistic chain. This is also an important parameter in the decision process of how much water a soldier will need at his immediate disposal either in his backpack or available to his unit. Mission planners will have to take into account the various water requirements necessary to support preparation and consumption of rations as well as to maintain proper soldier hydration status when planning for mission related water needs. A likely discriminator of similar ration systems might be based on water requirements, particularly in view of rapid response intervention of NATO led forces where such details can quickly become significant operational concerns.

The required amounts of water range from a minimum of 0.3 liters per day to a maximum of 5.2 liters per day, with a mean value of 2.8 liters per day across both General and Special Purpose rations identified. When comparing General and Special Purpose rations, the mean water requirement for Special Purpose rations (3118 ml) is greater than that needed for General Purpose rations (2776 ml) due in large measure to the reliance on dehydrated type main components to achieve reduced total weight. General Purpose rations with low water requirements include the Italian K Ration (0.3 liters), the Belgian C Ration (0.8 liters), the French RCIR (0.8 liters), and the Netherlands Combat Ration (1.9 liters). Higher water needs include the Czech BDP (3.1 liters), German EPa (3.1 liters), the Slovenia Individual Ration (3.5 liters), the Australian CR1M (4 liters), all Norwegian rations, and the United Kingdom 24-Hr ORP (5.17 liters).

6.2.2 Consumer/User Issues

6.2.2.1 Cutlery

While some nations include the required utensils in their ration packs, others do not, as their soldiers are issued utensils or cutlery as part of their individual equipment kits. It is important that military planners are cognizant of this level of detail, particularly if combat rations from one or several countries are employed and exchanged among forces in joint, multinational operations or exercises. Appropriate actions could be taken to address this issue and enable or facilitate proper use of rations provided this is communicated and understood in the early planning stages prior to a deployment.

From the information collated in Annex L, sixteen of the total combat rations surveyed require that cutlery be provided separately from the combat ration packs, while the necessary utensils are included within only seven combat rations. For General Purpose rations, cutlery is provided only with the Australia CR1M, Canada IMP, Italy K Ration, and the United States MRE while for other countries ration this is required and addressed separately.

6.2.2.2 Mess Tin / Canteen Cup

Some rations cannot be prepared or consumed properly without the use of a canteen cup or equivalent. The canteen cup or mess tin is required to heat the ration or the water for hot beverages. From the data collected by the RTG, nineteen combat rations require a mess tin or canteen cup, and four do not. Consumption of the combat rations and overall soldier satisfaction and nutrition will be enhanced if conditions allow for proper preparation and consumption of as many individual ration components as possible. Many pouch-based rations are designed to be consumed directly from the opened pouch with a spoon. Effective consumption of provided beverages is also important to maintain proper soldier hydration as well as provide additional nutrition. Planners and field commanders must be aware of this characteristic to support this requirement if soldiers are not systematically issued or provided a canteen cup or mess tin with a combat ration that requires their use. For GP rations a mess tin is required separately in all cases, with the exception of the United States MRE.

6.2.2.3 Specific Tools

In a few instances combat rations contain food items whose packaging requires the use of specific tools to open or handle them. The lack of the appropriate tool will likely reduce the consumption level of these food items and thereby jeopardize adequate nutritional intake by soldiers. Of the combat rations examined by the RTG, only one ration, the German EPa requires a knife to open the packaging which is not included with the ration. Two rations identified the need for a can opener, however, the opener device is provided. Still other rations avoid this issue altogether, through the use of easy open pull tabs, tear notches, or scoring of packaging materials designed to facilitate packaging orientation, ease of opening and use.

6.2.2.4 Heating Device/Fuel

In accordance with provisions of STANAG 2937, all ration meals should be suitable for consumption both hot and cold. Heating a ration is not only generally recommended for most main course items, it also provides for increased palatability, overall user acceptability, and enhanced consumption, nutrition and morale. Since heating a ration component requires the appropriate heater, the heater and the ration are linked to one another. The heater for any given ration and, more importantly, its designated fuel, may not be interchangeable from one country to another. Heating devices range from chemical-based, water-activated flameless ration heaters, lightweight, collapsible metal stoves that burn match-light hexamine tablets, and stoves that utilize flammable gel-based fuels, to more complex individual lightweight squad or backpack stoves that are diesel or multi-fuel powered with considerable heat output. The obvious advantage of providing a heater with the ration, purely from a logistics perspective, is the elimination of the associated supply and re-supply problem. This is particularly true in the case of flameless ration heaters and in some instances low cost hexamine stoves that are included with the ration and are intended as disposable, single use or limited use applications.

Five of the studied ration packs include the heating devices and fuel while eighteen do not. Only one Special Purpose ration, the USA FSR, was specifically and uniquely designed to be consumed on the move, eaten out-of-hand and unheated. Coordination and supply of appropriate heaters and stoves, when not included with the ration system, present some unique challenges to logisticians to have the proper item(s) and support available and the ability to deliver it or provide it to soldiers as needed. This is particularly relevant as some fuels are classified as hazardous materials and require unique shipping and handling protocols as well as specific labeling or placarding in their movement and use. The importance of a hot meal is well understood in terms of increased consumption and soldier satisfaction, particularly to deployed soldiers. The significance of this capability and its relevance to soldiers is dramatically increased in cold weather operations. This also elevates the importance of availability of suitable heating devices with proper heat output, fuel, heating times, potable water, mess kits and cups, and methods to mitigate related safety, scald and burn hazards.

6.2.2.5 Water Treatment

Several nations provide to soldiers water treatment or disinfection tablets as components of the ration pack while other nations provide chlorine disinfection tablets, water filters, or other means such as flocculating agents via individually issued kits or as part of specific mission requirements available to special operations. Ten of the twenty three rations identified provided water treatment or disinfection tablets included as non-food components together with the ration as a convenient mechanism to provide this capability directly with the food and beverages items for use during meal periods. Table 6-3 and Table 6-4 examine rations that provide water treatment capability.

Table 6-3: Water Treatment Included with General Purpose Rations

Ration	Ration	Treatment Included
BEL	C Ration	Yes
FRA	RCIR	Yes
DEU	EPa	Yes
ITA	K Ration	Yes
NOR	FR 3800 (Tropical)	Yes
NOR	FR 3800 (Arctic)	Yes
GBR	24-Hr GP ORP	Yes

Table 6-4: Water Treatment Included with Special Purpose Rations

Ration	Ration	Treatment Included
DEU	EPa Light	Yes
NOR	FR 5000 (Tropical)	Yes
NOR	FR 5000 (Arctic)	Yes

NRF planners should put maximum effort in providing the NRF forces with ample amounts of potable water. The importance of water logistics cannot be overestimated. The provision of ample amounts of potable water in suitable means of conveyance is the best way to alleviate the need for water treatment and thus the only sure and safe way to avoid any problems with the provision or use of water treatment products. Ample provision of potable water for sustainment may still not fully eliminate the need for individual water treatment in all situations, particularly in operations where field expedient water sources may be necessary based on environment, deployment, and battlefield threats encountered.

6.2.2.6 Separate Bag for Packaging Waste

This refers to a specific bag included in the ration pack intended for collection and disposal of packing materials or packaging waste generated from consuming the ration components. Proper disposal of packaging waste may be of tactical importance during operational situations. In some rations that do not include a separate bag for

packaging waste, a part of the packaging of the ration pack itself may be conveniently used as a container to collect packaging waste and thereby accomplish the same objective. Either a specific bag or other reasonable means to address this need is identified in all but four ration systems reported.

6.2.2.7 Language

Often the only direct way to communicate to the soldiers consuming a ration is through labeling provided directly on the ration packs and components themselves. This information is essential to provide the ration type or purpose, identify food and non-food components, offer nutritional data or performance related information, and provide proper instructions for preparation, use and consumption of the ration or other items included in the ration pack. This information is critical to ensure and encourage proper use, consumption, and even identify cautions, warnings or safety of use messages for some components where a burn or other hazard or safety concern may exist. The language issue takes on considerable significance during an exchange of rations among multinational forces due to disruption of supply chains and logistics shortfalls during operations or exercises, especially in the absence of prior joint training, exposure or use of exchanged ration systems.

Of the ration systems reviewed, all but the ITA K ration have labels printed in English, and only the BEL, CAN, FRA, and NLD rations complied fully with the requirement of STANAG 2937 to provide all relevant labeling information, at minimum, in both French and English. It should be noted that the ITA combat ration will be printed in both Italian and English in future procurements.

6.2.2.8 Metric vs. Non-Metric

The use of disparate units of measure on packaging and other labeling unfamiliar to soldiers requires them to awkwardly attempt to convert quantities to some familiar baseline and may result in errors during preparation of meals and beverages. This lack of standardization may potentially and unnecessarily complicate the transport and shipment of the ration as well as use of the ration which will likely adversely affect proper use of components, overall ration consumption, and user satisfaction. Of the rations surveyed, only the United States remains non-metric. This information was not available for one ration surveyed.

6.3 DECISIONS BASED ON INTEROPERABILITY

The list of interoperability variables presented above and the data presented in Annex L permit decisions to be made about the interoperability of present-day rations and may perhaps influence future rations. Such considerations require decision rules about which interoperability variables are critical for interoperability and which variables are optional for interoperability, or perhaps for maximum interoperability.

The first decision might be on the feeding concept and intended use of an operational ration. An interoperable ration would most likely be selected from one of the 18 rations having a full concept. In addition, the intended mission application or use of the ration would need to be considered. A suitable interoperable ration would most likely be drawn from the 11 general purpose rations (Australia CR1M, Belgian CRat, Canadian IMP, Czech BDP, French RCIR, German EPa, Italian K Ration, Netherlands Combat Ration, Slovenia Individual Ration, UK 24 Hr Operational Ration Pack, and US MRE). The Norwegian FR 3800 (2 types) appears to be climate specific. For specialized situations one of the ten special purpose rations might be chosen.

Once a ration concept and use have been decided, the next issues might be logistics driven. It is important to point out that a large number of logistics issues beyond the scope of this report would need to be considered to maximize interoperability and optimize deployability, transportation, handling and distribution to effectively

enhance supply/resupply in theatre as well as maximize ration deliveries per pallet load. But even within the data covered in this report, it is clear that the apparent variability in the type and dimensions of packaging, and the pallet dimensions and type would warrant closer scrutiny. Certainly rations appear to be bigger or smaller, but the greater issue is likely what they contain or provide for that size. With respect to pallet types, the overriding issue here might be interoperability with host equipment; not size alone. It is important to emphasize that the logistics aspects of rations, their weight, size/cube, and compatibility with other essential equipment, might ultimately determine their level of interoperability.

Operational rations often require additional equipment for optimal use, including cutlery, mess tin, support tools and waste bag. These aspects are quite easy to remedy or are not viewed as critical for an interoperable ration. However, they also include the following which might be more difficult to remedy and might be seen as critical for an interoperable ration – heating device and heating fuel, water treatment/disinfection tablets, language requirements, and commonality of measurement units.

Annex L provides specific categories of information and data which may prove useful in applying decision rules to current operational rations within NATO. The decision rules can be modified for other applications as operational needs dictate and as future rations raise new issues or elevate additional requirements. This type of process can be beneficial to ration designers and military planners alike in organizing, identifying and assembling design parameters as well as dealing with logistics support issues in the conduct of joint multinational operational deployments.

6.4 ACHIEVING INTEROPERABILITY

There are at least two ways to achieve full interoperability. All of the issues mentioned above could be regulated in a standardization agreement among the NATO countries. This would require major adaptations to the different countries rations. This solution seems, at least in short term, quite difficult to achieve, since some of the interoperability issues are rooted in the basic procurement and logistic procedures of the different armed forces.

A second way to achieve full interoperability would be to remedy any possible problems regarding the issues raised in this chapter, without changing the current rations. Three levels of remedy have been identified: distribution of information (e.g. pallet size, ration type), providing additional equipment as might be needed (e.g. knife, metal stove) and providing additional consumption products (e.g. hexamine tablets) for the entire period supporting.

For some issues, distributing the necessary information is sufficient to allow mission planners to be prepared to mitigate any problems (e.g. the number of rations on a pallet). These issues are thus remedied if information such as that contained in Annex L is readily available and coordinated in the planning, preparation and execution phases of NRF or other deployment scenarios where exchange of ration systems might reasonably be anticipated or expected. For still other issues, the only remedy is to supply additional materiel with the ration. Provided here are two possible solutions for consideration. These options offer positive strategic benefit yet present tactical challenges in implementation.

- Ration systems needing additional materiel/equipment might be supplied to soldiers on a “need to have” basis through a pre-assembled standard set of auxiliary items composed and distributed to troops called upon for such missions.
- Ration systems requiring additional consumable items could be supplied in ample additional quantities or packages pushed forward to troops for the entire mission duration or period of use.

Effectively dealing with some of the larger issues of interoperability merits further study and analysis to ascertain the magnitude or significance of these matters and the impact on NATO mission and operations. It is recommended that when a decision is made to provide soldiers with rations from another nation, these soldiers and military planners should, at minimum, exchange relevant information on the ration platforms and train with those specific rations in advance of the actual deployment. This suggestion presents challenges, clearly will not always be possible, and likely represents a “best case” scenario. This process, however, will reveal potential interoperability concerns and will help soldiers to familiarize themselves with the ration, its intended application, and proper use, thereby helping to mitigate or overcome many of the indentified issues or deficiencies.

Chapter 7 – COLLATERAL ISSUES

7.1 INTRODUCTION

In the course of its deliberations, the HFM RTG-154 observed issues that are significant, but that it could not address while respecting its mandate. These issues can directly impact on the provision and use of the recommended combat rations by NRF troops. Although they are clearly beyond the mandate of the RTG, it is essential that they be identified in this report because these issues can become obstacles for the successful implementation of a combat ration for NRF.

7.2 LEGISLATION MATTERS

NATO member countries are subject to national laws and regulations affecting the food supply chain including handling and processing of food and food components. This may limit the use of combat rations produced by other nations under different legislation. Suitable combat rations from a scientific and nutritional perspective could be considered unacceptable by some countries, based on their own legislative criteria (e.g. those involving genetically modified organisms, hormones, irradiated food components, fortified food components, especially with vitamins and minerals).

Similarly, national restrictions concerning animal health and disease control (e.g. Bovine Spongiform Encephalopathy) may impact on which meat and meat products are acceptable for consumption by soldiers of some nations. Therefore, combat rations considered suitable by certain countries may not be "allowed" by others.

Furthermore, nationally imposed trade restrictions and domestic procurement legislation could prevent the use of combat rations because of issues related to the place of production or the origin of food items.

7.3 REGULATIONS ON THE PROVISION OF INFORMATION

These issues relate to two aspects of communicating information, labeling and language. Individual national laws and regulations dictating the extent of information required on food packaging vary. The resulting obligations (e.g. information on nutrient content, listing of ingredients, allergens), and restrictions may limit the use or acceptability of otherwise suitable combat rations.

To communicate effectively with their troops, most NATO countries need to use at least one language other than the NATO's official working languages, on the packaging of their combat rations. Furthermore, national laws may dictate minimum requirements of one or more languages that would not necessarily be French and English. Due to the limited space on the packaging of combat rations and their components, it is unlikely that more than two languages could be accommodated while providing all the required information. Therefore the languages used on a nation's combat ration may negatively impact its consumption by soldiers who are unable to understand the information provided. This issue is also covered in Chapters 5 and 6.

7.4 FOOD ALLERGENS

In the identification of combat rations suitable for the NRF, the RTG has based its recommendations on the assumption that the rations would be consumed by individuals who are healthy and have no medical conditions

that would restrain in any way their food consumption. Therefore, nations who would normally deploy with the NRF individuals who are subject to food restrictions need to be aware of this characteristic of the recommended combat rations for the NRF.

7.5 PRODUCTION BASE

The use of combat rations by a nation might be linked in two ways to the capacity of that nation to produce or procure combat rations. Firstly, it may be related to a minimum number of combat rations to be used by the nation in order to sustain its production base or assembly line. In this case, the nation could be obliged to use its own combat rations rather than another nutritionally suitable combat ration from a different source. Secondly, the production base capacity of a nation (for supply, packaging, assembly, and delivery) may limit the availability of its combat rations. In this case, the nation may not be able to provide sufficient combat rations to satisfy the requirement of the NRF.

7.6 WAREHOUSING AND TRANSPORTATION CAPACITY

Aside from potential production limitations, nations may face difficulty maintaining and handling the volume of combat rations necessary to satisfy the NRF requirement in addition to their own inventory holding. This could be linked to limited availability of storage space offering optimal environmental conditions as well as limited resources to ensure proper rotation and timely transportation to the operational location as required by the NRF mission.

7.7 HOST NATION SUPPORT

The capacity of the host nation to support the NRF is a factor that could influence the use of the recommended combat rations. The impact of this factor will depend upon the conditions of the NRF mission e.g. the prescription for the use of specific combat rations in the terms and conditions of the NATO mission. The RTG's recommendations for combat rations are based on the assumption that no support, including any infrastructure, can be expected from the host nation, and that the NRF will satisfy its requirement through its own logistics capability.

7.8 FOOD SAFETY AND SANITATION CONSIDERATIONS

The safety and sanitation conditions implemented during the procurement, production, handling, and storage of the combat rations as well as the continuous quality assurance process will influence their consumption acceptability, and nutritional suitability. Although this factor was not a primary objective of this RTG, it has been observed that the conditions of production and storage in terms of processes, facilities and time periods are likely to impact on the nutritional value of the combat rations. For its recommendations, the RTG assumed that optimal conditions are implemented throughout the life cycle of the combat rations. Furthermore, national safety and sanitation regulations applying to combat rations may preclude the use of otherwise nutritionally suitable combat rations by NRF soldiers of some nations.

7.9 RELIGIOUS AND PERSONAL RESTRICTIONS

Aside from reporting their availability within each nation, the RTG work did not include the combat rations designed to satisfy religious or vegetarian requirements. As reflected in Annex E, a limited number of nations

include these particular combat rations in their inventories. The fact that the combat rations provided by a nation to the NRF may not respect these requirements could limit their suitability.

7.10 NON-FOOD RELATED COMPONENTS

In accordance with their customs, some countries may require the inclusion of items unrelated to the preparation or eating of the combat rations. Based on its mandate, the RTG recommendations do not address such requirements, which could be a factor influencing the suitability of the recommended combat rations by countries.

Chapter 8 – CONCLUSIONS AND RECOMMENDATIONS

8.1 INTRODUCTION

The RTG-154 was charged with task to explore the feasibility of a standard NATO individual combat ration specifically designed for use by the NRF and make science based recommendations to the Human Factors in Medicine Panel. The assessment of the current state of NATO nations' combat rations and investigation of their suitability for supporting the NRF was one of the means that the RTG decided to use for attaining its objective.

The NRF can be deployed rapidly to undertake land, air, sea and Special Forces missions including evacuations, disaster management, counterterrorism and traditional combat operations. Therefore, NRF personnel will likely subsist partially or entirely on individual combat rations during these deployments which could be the sole source of sustenance for up to 30 days. RTG-154 developed guidance for optimal nutrient intakes and nutrient content of individual combat rations that would sustain physical and cognitive performance of NRF personnel during NRF deployments.

This chapter draws conclusions and makes recommendations on those topics where consensus exists. In addition, recommendations are made for further research.

8.2 CONCLUSIONS

The final report of RTG-154 consists of a broad range of information and offers a detailed summary of nutritional and non-nutritional data with regard to the individual combat rations of participating nations. Further, it illustrates the scientific approach taken by the RTG and details results of academic studies, which are important foundations for the following recommendations of how the combat rations of different nations may be used to sustain troops during NRF missions. The data matrix, the scientific reviews, the comparisons with regard to interoperability and the information on combat ration nutritional content provide a unique reference document and opportunity for decision-makers to select a specific combat rations to supply soldiers during NRF missions.

The data matrix is one of the core components of the final report; it highlights the similarities and differences among the combat rations of participating nations. These differences may arise from different military needs, and the requirements concerning consumption time, storage and suitability in a wide variety of environments (e.g. the full range of climatic zones). The types and characteristics of the individual combat rations and supplements are very diverse, but all are intended to provide a feeding solution that optimizes the performance of the soldier under duress. The data matrix was developed to collect information on participating nations' current (as of 2007) combat rations and supplements. Thus, the information in the matrix may change in the future (or may already have altered).

The following conclusions of the RTG membership are offered:

1) In order to remain a valid tool for the NRF commanders and to be of full value to NRF missions and to other NATO operations, the matrix and supporting documentation or similar mechanism need to be maintained and updated regularly. (Reference Chapters 1, 2, 3 and Annex E)

2) Participating nations' combat rations are designed to meet specific national and cultural tastes, they employ different styles of packaging, contain different equipment for food preparation, and use a wide

variety of means for distribution. Different ration systems are suitable for general purpose application as well as mission-specific use designed to meet the demands and rigors of unique mission profiles. While these systems are suitable for their intended national military objectives, they may not align fully or precisely with the full scope of operational requirements and technical performance characteristics supporting the specific NRF. (Reference Annexes D, E, F, and L)

3) It is acknowledged that no single NATO member's combat ration could meet all requirements at the present time. From the available data and information, designing a single "one size fits all" universal combat ration which suits all NATO forces and fulfils every operational requirement would represent great challenges and therefore is not considered to be the best solution. The risk of supplying sub-optimal subsistence in the field can be reduced by NRF commanders selecting the ration which is the most appropriate to the operation taking into account the climatic conditions, the supply chain and, importantly, the specific needs of the soldier. Furthermore, it should meet the expectations and tastes of the NRF soldiers. (Reference Annexes E, F, J and K)

4) The nutritional requirements of the soldier to optimize the individual's physical and cognitive performance across the full range of operational conditions were studied. Using the recommended optimal values as the criteria, each participating nations' ration was assessed to identify their suitability to meet the requirements. Most provided individual nations' rations meet the minimum nutritional requirements and soldiers accept them. Some rations were found to need supplementation. (Reference Chapter 4 and Annex J)

5) There are a number of behavioral and physical factors that can positively or negatively influence the consumption of combat rations. An inadequate nutritional intake, as a result of under-consumption of the combat ration, may negatively affect a soldier's physical and cognitive performance. Leaders and officers can have a big influence on combat ration consumption. Soldiers must be given sufficient time and combat rations that are easy to eat. Soldiers will tend to eat more in groups where eating duration is longer and when they model or copy the eating patterns of their peers. (Reference Chapter 5 and Annex K)

6) With regard to the assessment of psychological and cultural expectations, a large number of factors have been identified which contribute to enhancing or depressing eating. It would be inappropriate to simplify the very complex situation regarding consumption of combat rations to one or two controlling factors. There are important factors dealing with the food itself, the consumer/soldier, and the environment or location. Basically, people eat what they like. These food preferences vary across cultures, so serving well-liked foods for a multi-national force faces major challenges on the issue of food preferences. A varied diet supports adequate consumption better than a monotonous diet – most soldiers prefer variety. (Reference Chapter 5 and Annex K)

7) The final report particularly highlights the issue of interoperability of combat feeding programs between the NATO nations. The data matrix shows some gaps in interoperability, strongly suggesting that careful planning will be needed to make sure that every combat ration can be consumed adequately and meets the specific military requirements of troops in the field, depending on the nature of the mission and the ancillary equipment normally taken into the field by the troops who constitute the particular NRF. In order to reduce these limitations, studies may be needed that involve troops being fed with the rations of other NATO nations while undergoing training. This may serve to familiarize troops with these rations. There is evidence that NRF soldiers have no experience in using other nations' combat rations prior to deployment. (Reference Chapter 6 and Annex L)

8) Consumption of individual combat rations by the NRF must be sustainable. The risks associated with interoperability have to be mitigated. There is no work being undertaken at this time in the current NATO organization addressing this issue. (Reference Chapters 5 and 6 and Annexes A, B and C)

9) Standardization documents already exist (particularly STANAG 2937) but in the light of the RTG's findings, those standards may need to be revised. STANAG 2937 defines precise requirements for combat rations that include nutritional content, shelf life, and packaging. However, there is no collaborative project work or research within NATO with regard to combat ration development, feeding concepts or logistics. (Reference Annexes G, H, I)

10) There were other significant interoperability issues that were identified but not fully addressed in the report because they were outside the scope of this RTG. They could affect the acceptability of a combat ration from a national perspective even if it is suitable from a scientific and nutritional perspective. (Reference Chapter 7) These issues include:

    a) National laws, regulations and established practices affecting food items, food handling activities, procurement, provision of written information, and inclusion or not of non-food related items in combat rations.

    b) Food restrictions linked to medical, religious and personal conditions; the NRF recommendations are based on the feeding requirements of individuals who have no such food restrictions. Nations contributing members with such restrictions need to be aware of this condition.

    c) The production base, warehousing, and transportation capacity of a nation and the established conditions of the mission concerning the host nation support.

    d) Supply chain management that would include issues related to the product development of special items for combat feeding, component or complete ration pack procurement and storage, and the logistics of supplying and distributing the right ration to the soldier.

8.3 RECOMMENDATIONS

The following recommendations are provided as a result of the collaborative RTG program of work:

1) It is recommended that collaborative projects or teams conducting research into combat ration development, nutrition, feeding concepts or logistics should be considered. These would also address the interoperability issues raised in this report. At present there is a lot of work being undertaken by NATO members in the development of national combat rations, but no mechanism for collaboration.

2) It is recommended that the Committee of the Chiefs of Military Medical Services in NATO (COMEDS) convene a panel of subject matter experts to conduct some of this work. The requirement for further study into areas outside COMEDS should be referred to other committees within NATO. This would optimize future ration design to align nutritional and functional capabilities and technologies with NRF operational mission requirements.

3) It is recommended that a specialist NATO group study the logistics capability within NATO. Although this RTG did not study the supply chain management, the impact of the wide logistics capability influences the availability of a suitable ration for the NRF soldiers, and therefore consumption by the soldier. This study would include the end to end management of the supply chain, beginning with development of special items for combat feeding, procurement of items itself or the whole ration and supply/distribution of combat feeding. The logistics procedure has to be looked at while making certain that the soldier gets what he needs.

4) It is recommended that the data matrix be continually updated to continue to have relevance to NRF commanders. The data matrix was developed to collect information on participating nations' current combat rations and supplements in 2007.

5) It is recommended that the work of the RTG-154 be continued in an expert panel**.** Continuation of the RTG work has to be assured, but there are no places within NATO that could take this mandate. Therefore, such a group should be established. This expert panel should include logisticians, nutritionists and food experts, i.e. a body of excellence with different expertise has to be created, under an existing chain or should be newly set up.

6) It is recommended that further research be undertaken in order to optimize future ration design to align nutritional and functional capabilities and technologies with operational mission requirements. Specifically, the RTG recommends that NATO funds and conducts field studies into the following:

   a) The physical effects on the soldier feeding for prolonged periods (in excess of 30 days) on individual combat rations without supplements;

   b) The effects on cognitive function of the soldier when fed for prolonged periods (in excess of 30 days) on individual combat rations without supplements;

   c) The psychological factors that influence ration consumption and component selection by individual soldiers and the acceptability to troops of their nations of combat rations currently available from the NATO, PfP and Miscellaneous nations including their content and the sensory profile of components;

   d) Survey military personal gear and kitchen equipment in order to show suitability for different operations with regard to current tasks of military forces; and

   e) Commonality in fresh food supply solutions.

7) It is recommended that revision of STANAG 2937 be considered taking account the nutritional standards review.

8) It is recommended that this report be distributed widely to heighten NATO and NRF awareness of its content. A very important activity should be education, awareness and outreach of the results of the RTG. HFM should liaise with other nations to disseminate the results of the report. It should be widely distributed to commanders to remind them of the importance of interoperability issues, especially with respect to the nations that did not contribute to this RTG.

9) It is recommended that a handbook be developed for military leaders and a user manual/guideline for individual combat rations based on the information in the report.

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Annex A – TECHNICAL ACTIVITY PROPOSAL (TAP)

Activity	HFM-154	**Nutrition Science and Food Standards for Military Operations**												2006	
Activity Ref. Number	RTG													April 2006	
Principal Military Requirements		1	2	3						UU				April 2009	
Military Functions		10	11	12	13	14									
Panel and Coordination		Human Factors And Medicine Panel AC/323 (HFM)													
Location and Dates		1st Mtg: Natick, MA, USA, 31 Oct – 3 Nov 2006 2nd Mtg: Ieper, BEL, 1-4 May 2007 3rd Mtg: Rome, ITA, 27-30 Nov 2007 4th Mtg: Naples, FL, USA, 4-6 Jun 2008 Subgroup Mtg: Wageningen, NLD, 8-10 Sep 2008 5th Mtg: Ieper, BEL, BEL, 9-11 Dec 200 6th Mtg: Final, Bath, GBR, 24-26 Mar 2009											P-I	
Publication Data		TR						2009			0			UU	
Keywords	Nutrition	Research & Engineering				Combat Rations					Food Safety				
Applied Technology	Performance Enhancement	Individual Rations				Group Feeding					Special Purpose Rations				

A.1 BACKGROUND AND JUSTIFICATION

Advanced technologies in food science, food processing and preservation, packaging systems, as well as significant innovation in military ration development, combat feeding systems and food safety development are widely seen as having potential benefit to commanders in multinational operations in a field setting. Adoption of any particular technology or product for Alliance support is hindered by the lack of standards which are uniquely tailored to support the NATO Response Force (NRF) concept. It is in the context of this evolving, dynamic operational concept that an assessment of such critical, leading edge sustainment technologies be conducted for technical maturity, functionality, and operational utility for enhanced mission capability and combatant performance providing proper nutrition and the right ration at the right place at the right time. Identification of supporting technologies and platforms providing a positive impact on NRF mission performance will support development of targeted nutrition and food standards for NRF military operations. Information and technology assessment for development of standards could lead to increased deployment of such advanced food and nutrition technologies, as well as increased interoperability during combined and joint operations. Ultimately, the vision for a specific nutritionally tailored cost effective combat ration designed for all NATO forces seamlessly aligned and strategically designed to meet the operational requirements of the NATO Response Force (NRF) concept could be realized.

A.2 OBJECTIVE(S)

To identify emerging technologies, products, and innovations for combat feeding, nutrition, and performance enhancing components across various ration platforms (individual, group, and special purpose/assault rations)

matched to operational mission requirements of the deployed NRF. Develop standards for nutrition, packaging, and combat rations that support the NRF deployment doctrine, mission profile, and operational flexibility to ensure nutrition, combat feeding and performance are optimized as a combat force multiplier.

A.3 TOPIC TO BE COVERED

Discussion of most promising advanced technologies for food processing and preservation; packaging system technologies, military ration development, combat feeding systems and food safety. Examination of various operational issues; functional issues; sensory, cultural and demographic issues, human factors issues; NATO specific requirements; operational testing; production base; and standardization.

A.4 DELIVERABLE

Technical Report.

A.5 TECHNICAL TEAM LEADER AND LEAD NATION

Chair: Mr. Gerald A. DARSCH; United States

Co-Chair: Ms. Kathy-Lynn EVANGELOS; United States

Lead Nation: United States

A.6 NATIONS REALLY PARTICIPATING

Australia, Belgium, Canada, Czech Republic, France, Georgia, Germany, Italy, Netherlands, Norway, Slovenia, United Kingdom, United States.

A.7 NATIONAL AND/OR NATO RESOURCES NEEDED

Member nations generally have national programs to develop, test, and field new ration systems and introduce advanced technologies as needed to enhance military operations and mission capability. The RTG members must be able to release information on respective combat ration research and development efforts and technology leveraging and technology integration experience to the RTG for the purpose of furthering this objective.

A.8 RTA RESOURCES NEEDED

Normal support for RTO Task Group, Kick Off Meeting, Access to RTO New Wise Workspace, Editing and Disseminating Final Report.

Annex B – TERMS OF REFERENCE (ToR)

Research Task Group (RTG) on
Nutrition Science and Food Standards for Military Operations
Human Factors and Medicine Panel (HFM) 154

B.1 ORIGIN

B.1.1 Background

This Task Group responds to recommendations made during the Human Factors and Medicine Panel, AC/323 (HFM), business meeting conducted April 13-15, 2005 in Amersfoort, Netherlands. The U.S. was asked to take the lead for developing a Technical Activity Proposal (TAP) and associated TOR centered on Nutrition and Food Standards relevant to the NATO Response Force (NRF) concept. At that time allied nations Canada, France, Netherlands, Poland, United Kingdom, and United States all expressed an interest in this challenging endeavor.

Many of the allied nations military, industrial and academic sectors have in recent years been involved in advanced science and technology development and innovative technology application in areas of food science, food processing and preservation, advanced packaging systems, optimized combat ration design and development, heating technologies, combat ration supplement technologies, combat feeding systems and food safety initiatives for rapid detection of biologically contaminated foods with high sensitivity and selectivity to protect against acts of bio-terrorism and ensure a healthy, safe, food supply. These innovations represent potentially significant force multipliers and may be of great benefit for the NRF.

These initiatives are widely recognized as having potentially significant benefit to commanders in multinational operations in a field setting. Adoption of any particular technology or product for Alliance support is hindered, however, by the lack of standards which are uniquely tailored to support the NRF concept. It is in the context of this evolving, dynamic operational transformation that an assessment of such critical, leading edge sustainment technologies be conducted for technical maturity, functionality, and operational utility for increased mission capability and enhanced combatant performance providing proper nutrition and the right ration at the right place at the right time. Identification of supporting technologies and platforms providing a positive impact on NRF mission performance will support development of targeted nutrition and food standards for NRF military operations. Information and technology assessment for development of standards could lead to increased deployment of advanced food and nutrition technologies, products and platforms for improved military capabilities as well as increased interoperability during combined and joint operations. Ultimately, the vision is one of a specific nutritionally tailored, performance oriented combat ration standard for use by Alliance forces seamlessly aligned and strategically designed to meet the operational requirements of the NRF mission.

The NRF concept of a robust, readily deployable and credible force was agreed to by the NATO Heads of State at the Prague Summit held in November 2002. Subsequent NRF development has become the centerpiece and an engine of change for the Alliance as it transforms and positions itself to meet the asymmetric threats to peace, security and stability in the 21st Century. This new force structure is fundamental and far-reaching for the success of NATO's future operational capabilities. It will further be a key catalyst for focusing on and promoting improvements in Alliance overall military capabilities and responsiveness to maintain viability, relevance, strength, military effectiveness, and global influence. A significant challenge to full implementation of the NRF concept is the process of creating an entirely new force with the proper mix of

personnel, skills, equipment and operational mission capabilities. A key component in this transformation resides in the introduction of selected new technologies, concepts, and products to promote interoperability, facilitate transformation, enable increased capability, and provide comprehensive resources in support of NRF mission objectives. The new force structure would provide the Alliance with rapidly deployable, highly mobile, sustainable and flexible multinational forces enhancing their command and control capabilities.

B.1.2 Military Benefit

Technology innovations and breakthroughs in nutrition science, the relationship to human performance, vigilance, recovery and combat ration design for military operations need to be examined from a collective perspective to assess the overall suitability and constructive impact these initiatives might offer NATO in both warfighter readiness and capability. There is no standard mechanism to accomplish this on such a large scale particularly across cultural, budgetary, political, and technological barriers. The objective of this effort is to maximize warfighter performance, response, and flexibility through performance oriented nutrition and optimized ration design. This effort will support the emerging transformation to the NRF concept as well as the extensive operational capabilities NATO and coalition forces will require in the future conducting a broad spectrum of diverse military operations.

New and emerging technologies and capabilities need to be considered for their practical application, underlying functionalities, and potential value to NATO commanders to maximize flexibility, agility, interoperability, and dynamic responsiveness in all operations for mission success. Advanced sustainment capabilities are required to provide world class support to NRF doctrine that match the speed, agility, mobility, responsiveness, endurance, and lethality of a non-contiguous, asymmetric battle space. Concepts to revolutionize the manner in which warfighters are sustained are imperative in an era that demands operational readiness, rapid response, technical capability, global reach, and overwhelming force. High energy, eat out-of- hand / on-the-move combat rations with scenario driven tailorability (cold, temperate and hot environments) for use during the early stages of engagement, which contain performance enhancing components with targeted nutrition designed around operational mission requirements, and compact, modular, self-contained, remote site group feeding capabilities need to be considered for suitability to the NRF. Potential for a standardized, universal NATO combat ration may also be possible that appeals across ethnic, cultural boundaries. Pursuit of these concepts will be instrumental in transforming the NATO and NRF to be strategically responsive, permit ration interoperability, and ensure technological overmatch against potential adversaries.

This process is necessary to ensure that the NRF has the correct tools, technologies, systems, and capabilities to perform its unique and demanding mission. NRF is designed as a coherent, high readiness, joint, multinational force package. It is technologically advanced, flexible, robust, highly deployable, interoperable and sustainable. The NRF provides NATO a robust and credible high readiness capability, fully trained and certified as an armed force, able to deploy within 5 days to participate in NATO missions wherever required and able to sustain itself for duration of up to one month or longer if resupplied. It will be tailored as required to the needs of a specific operation and able to move quickly to wherever needed. It will not be a permanent or standing force. The NRF will be able to carry out specific missions on its own or serve as part of a larger force to contribute to the full range of Alliance military operations. Initial Operational Capability (IOC) for the NRF was 15 October 2003 with Full Operational Capability (FOC) expected by October 2006 with a combined force of 21,000 strong including a brigade size land element, a joint naval task force, an air force, logistics and support.

Deployed as an initial entry force; NRF will facilitate the arrival of larger follow on forces, from benign to hostile environments. Deployed as a demonstrative force package, NRF will show NATO determination and solidarity to deter crises with quick response operations to support diplomacy as required. Trained and ready for global deployment NRF will stabilize emerging threats and contain crisis. It will draw on combat-ready,

interoperable units from contributing NATO nations and national "niche" capabilities, including Special Forces. The NRF will be composed of national force contributions which will rotate through periods of training and certification as a joint force, followed by an operational stand-by phase of six months. It will form an essential element of the Alliance's transformation agenda. The tasks of the NRF are likely to focus on those requiring the ability to react with the most capable forces in a very short time. These might include deployment as a show of force and solidarity to deter aggression; deployment as a stand-alone force for Article 5 (collective defence) or non-Article 5 (crisis management, stabilization) operations; and deployment as an initial entry force for a larger force. The design is one of high readiness, joint force; expeditionary in character and design, able to execute the full range of missions from peace to high intensity conflict applying force rapidly, selectively, and decisively.

B.2 OBJECTIVES

B.2.1 Scope

The Task Group will review and assess current state-of-the-art in combat rations, various supporting/enabling sustainment relevant technologies and systems described previously, and operational mission capabilities and characteristics provided by current platforms used by representative nations. Products and systems currently used by the NATO operating members and lessons learned field experience including identified product shortfalls, shortcomings, and inconsistencies with mission will be studied. The Task Group will identify technical characteristics and operational capabilities required to support the full range and scope of NRF mission objectives and establish a benchmark and standards for nutrition science and food standards for military operations. Final recommendations, technical consultation and advice to potentially include a production base assessment, within the scope of this effort and technical expertise of this group, will be made to the HFM Panel as deemed necessary.

B.2.2 Goals

The Task Group will:

1) Define future sustainment capabilities and their potential impact on NATO training and operations specifically in support of the evolving NRF mission;
2) Increase knowledge within the NATO community of current and emerging capabilities and expected contribution and impact on overall operational effectiveness;
3) Identify requirements and capabilities for nutrition, performance, packaging and military food standards for NATO/NRF application;
4) Identify and prioritize capabilities to be employed and technical gaps to be filled in order to enhance current capabilities in areas that are of particular importance to NATO operational and transformation initiatives; and
5) Establish areas of common understanding and objectives, technological systems, missions, and environments which might provide continued exchange and collaboration in areas of mutual interest.

B.2.3 Products

Consistent with its goals, the products of the Task Group will include:

1) Annual progress reports of activities and proceedings;

2) Recommendation on existing and evolving capabilities envisioned with emerging sustainment technologies and the relevance to NATO in general and NRF specifically;
3) Identification of technical requirements and capabilities for nutrition, performance, packaging and military food standards for NATO/NRF operational and transformation initiatives to include the potential for a joint interoperable individual combat ration to support NRF during the initial stage of deployment; and
4) A standardization document to be submitted for national ratification through the NATO Standardization Agency.

B.3 RESOURCES

B.3.1 Membership

Chair: Mr. Gerald A. DARSCH; United States

Co-Chair: Ms Kathy-Lynn EVANGELOS; United States

B.3.2 Nations Really Participating

Australia, Belgium, Canada, Czech Republic, France, Georgia, Germany, Italy, Netherlands, Norway, Slovenia, United Kingdom, United States.

B.4 SECURITY LEVEL

The security level will be UNCLASSIFIED/UNLIMITED.

B.5 PARTICIPATION BY PARTNER NATIONS AND OTHER NATIONS

P-I.

B.6 LIAISON

B.7 REFERENCE

Output of HFM/ET-059.

Annex C – PROGRAM OF WORK (PoW)

C.1 NATO RTG-154 REVISED PROGRAM OF WORK

November 2007.

C.2 MAJOR ACTIVITIES

Major activities to be achieved over years 1 and 2 of the RTG include:

1) Define current types and characteristics (nutrition, package, and concept of use) of individual rations and supplements provided by each nation.
2) Determine current state of relevant nutrition science.
3) Identify requirements/capabilities required to support NRF (30 days).
4) Recommend nutritional value requirement for rations to be provided to the NRF based on Points 1, 2 and 3.
5) Identify which rations (see Point 1) satisfy the requirements of Point 4.
6) Develop a better understanding of the psychological aspects of ration consumption (menu fatigue, cultural preferences, and stress) and their consequences on nutrition in the field.
7) Make a recommendation on ration interoperability based on knowledge gained in Points 5 and 6.

C.3 INFORMATION GATHERING

In order to complete the above mentioned activities, following information will be gathered by means of a questionnaire:

- Detailed description of the currently provided individual rations and supplements in NATO member nations and "partnership for peace" (PfP) nations. This description will include: nutritional profiles, weight, cube, operational functionality (concept for use), shelf life, maximum duration of use, storage requirements, menus, packaging, heating concept, water requirements, etc.
- All relevant requirements for individual rations and supplements in NATO member nations and PfP nations. These requirements will include: nutritional requirements, weight and cube requirements, etc.
- The means or mechanism to compare the provided rations to the requirements.

C.4 TECHNICAL INPUT

Major activities 2 and 6 require scientific literature review and report which will include:

- Nutritional composition values reported by the RTG based on the data collection.
- Psychological issues regarding ration consumption.

The main focus for these technical inputs will be to provide advice on the potential implications of the deviations from the data collected from the different nations and the scientific literature.

C.5 DELIVERABLES

The deliverable for this RTG will be a final report which makes recommendations on those topics cited above where ample consensus exists. For the topics cited above where no consensus exists, recommendations for further research will be made.

The members of the RTG have decided that some topics that are of capital importance for the interoperability and daily use of an NRF ration will not fall in the scope of this RTG. These topics (e.g. food safety, logistics, relevant national and international legislation, for example, on hormones, genetically manipulated organisms) would complicate the work on basic requirements and inventory that will be done by this RTG. The final report will however contain an overview of important issues that might be addressed by additional RTGs.

C.6 FINAL REPORT

The final report of RTG-154 will include:

- An overview of the ration and supplement composition in the different NATO, PfP and miscellaneous countries.
- An overview of the current nutritional standards for rations in the different NATO, PfP and miscellaneous countries.
- Recommendations for consolidated nutritional requirements. These recommendations could lead to modification and/or amendment of STANAG 2937.
- A perspective of the academic knowledge on psychological issues with regard to rations.
- Practical recommendations/conclusions derived from this knowledge (nutritional, psychological, and operational).
- Recommendations for further research in the nutritional field, psychological/behavioral sciences field, and operational (interoperability) requirements.

C.7 PoW TIMELINE

1 April 2006

Formal initiation of RTG-154 – Nutrition Science and Food Standards for Military Operations.

31 October 2006 and 3 November 2006

- First RTG Meeting – held in conjunction with the Annual Meeting of the DoD Combat Feeding Research and Engineering Board (CFREB) (1 – 2 November 2006), RTG members were invited to observe and hear presentations of the DoD Combat Feeding Research and Engineering Program which will cover Basic Research / Food Biomolecular Science; Combat Feeding Science and Technology: Food Safety, Novel Processing, Nutrient Delivery, Revolutionary Packaging, Equipment and Energy Technology; and combat rations and combat feeding systems). Attendees toured Natick facilities and received demonstrations of USA Military developmental combat feeding systems and combat rations.
- Location: US Army Natick Soldier Systems Center, Natick, MA, USA.

- Participants (RTG Members) provided presentations on their country's nutritional standards and existing range of rations, as well as on the encountered difficulties and future plans in the field of combat feeding.
- A draft questionnaire for all NATO and PfP countries was initiated.

Spring 2007

- RTG Meeting.
- Location: Ieper, Belgium.
- Participants presented country updates.
- The draft baseline data collection questionnaire was finalized and approved.
- Technical activity topics are put forward (2 major directions: nutrition and psychology/behavioral science).

Fall 2007

- RTG Meeting.
- Location: Rome, Italy.
- Presentation of the existing range of rations for 24 hr operational feeding.
- Presentation of a matrix containing the nutritional, operational, and dietary requirements for each country based on data collection.
- Presentation of the existing range of rations.
- Analysis of the NRF requirements => proposition for consolidated requirement.
- Identify technical input topics for final report.

Spring 2008

- RTG Meeting.
- Location: Naples, FL, USA in conjunction with R&DA Meeting.
- Presentation of a matrix comparing the existing range of rations to the consolidated requirements.
- Review/discussion/decision on first drafts of subject matter experts technical inputs.
- Review/discussion/finalize of operational/interoperability issues.
- Review/discuss proposed TOC for final RTG Technical Report.

Fall 2008

- RTG Sub-group Meeting.
- Location: Wageningen University and Research Centre, the Netherlands.
- Sub-group members meeting with Nutrition Assessment Contractors.
- Progress review/discussion/feedback on Nutrition Assessment task.

Winter 2008

- RTG Meeting.
- Location: Ieper, Belgium.
- Analysis of the shortfalls of rations and proposition for improvements in order to meet consolidated requirements.
- Adoption of the conclusions on nutrition and psychological topics.
- Review status of draft report/technical input/executive summary.

Spring 2009

- Final RTG Meeting.
- Location: Bath, England.
- Finalize technical report with conclusions and recommendations (see above “Final Report”).

Annex D – DATA COLLECTION SURVEY AND DATA ELEMENT DEFINITIONS

D.1 DATA COLLECTION SURVEY

BACKGROUND

The NATO Research Task Group 154, "Nutrition Science and Food Standards for Military Operations" is charged with the task of assessing the current state of NATO and PfP nations' individual combat rations and their nutritional value. The goal of RTG is to make recommendations to the Human Factors in Medicine Panel on proposed nutrition standards for individual combat rations for the NATO Response Force. This survey is being distributed to all NATO and PfP nations with the hope that each country can provide important information to support this goal. It is respectfully requested that each nation complete the attached worksheets by August 31, 2007. Completed forms should be sent via email to Mr. Gerald Darsch, RTG-154 Leader, via email at: gerald.darsch@us.army.mil.

INSTRUCTIONS

Please provide the answers to the questions below and complete the attached baseline data collection worksheets for each **individual** combat ration, ration pack, and/or supplement used by your country's Soldiers, Marine, or Special Forces.

The attached worksheets should be completed by the appropriate organization or individual(s) responsible for the establishment/development of nutrition standards and/or the development or procurement of rations for the military.

Note: This survey does NOT apply to menus or rations or foods used for shipboard or Air Force in-flight feeding, but is focused on rations for ground forces only. It also does NOT apply for group feeding, group meals, and meals or rations requiring field kitchens or other preparation facilities.

QUESTION 1:

Please identify the agency or organization in your country is responsible for the determination of nutrition standards for military forces.

QUESTION 2:

Please identify the document that defines or describes the nutrition standards for the military and for the development or procurement of rations. If a copy of this document or web reference is available, please provide a copy with your response.

QUESTION 3:

Please describe how your rations, ration packs, and/or supplements are analyzed to insure compliance with nutritional standards and which agency conducts these assessments. If this is done by an external agency, please cite that agency and a Point of Contact, if available.

SURVEY ATTACHMENTS

1) DEFINITIONS.pdf (This file contains definitions for the data fields for both Excel worksheets).
2) NATO BASELINE DATA RATION.wks (Worksheet for combat rations, ration packs).
3) NATO BASELINE DATA SUPPLEMENT.wks.

Please use the Ration or Supplement Worksheet as appropriate for each item submitted.

The Excel worksheets should be downloaded and saved using the format for each separate survey completed.

ADDITIONAL INFORMATION

Units of Measure – please use the unit of measure cited in each data field or the most appropriate unit of measure based on your country's use of Metric, System Internationale, or English. If the data can be presented in both English and metric, please enter the information, e.g. 80°F or 27°C.

If any of the data elements require clarification, please feel free to email Mr. Darsch or Ms. Kathy Evangelos (kathylynn.evangelos@us.army.mil) for information or clarification.

If the information to be provided cannot be emailed, it can be sent via Air Mail to:

Gerald Darsch
Director, DoD Combat Feeding
US Army Natick Soldier Systems Center
AMSRD-NSC-CF-D
Natick, MA USA
01760-5018

If you have any questions or would like clarification on any questions or survey elements, please contact either Gerald Darsch or Kathy Evangelos via email. We thank you in advance for your participation in this important undertaking.

D.2 RATION BASELINE ASSESSMENT – DATA ELEMENT DEFINITION TABLE

This identification process is intended to be applied to each individual ration (or ration pack) under assessment. If a NATO/PfP nation has multiple rations or ration packs they wish to include then a separate assessment sheet should be completed for each. All references to "ration" apply to a ration or "ration pack" as appropriate.

1. COUNTRY: NATO/PfP Nation providing the self assessment identification.

2. POINT OF CONTACT: Point of Contact of Subject Matter Expert for NATO/PfP nation providing baseline data. Entry should include; Name, Organization, and relevant Contact Information including email address.

3. RATION NAME: Nomenclature, acronym, and/or common name of the packaged, shelf stable combat ration under discussion. A ration is defined as one day's supply of food. An individual operational ration is a

specially designed, nutritionally adequate ration normally composed of semi-perishable and/or shelf-stable, pre-prepared food components for use under actual or simulated combat conditions. This type of ration may be used in peacetime for training, travel, contingencies, or emergencies.

4. PRODUCT DESCRIPTION: Concise/key description of the ration or ration pack and notable key attributes.

5. INTENDED MISSION: Identify the primary operational, combat, or military mission and/or target audience (e.g. soldier, marine, special forces) of the identified ration. What is the purpose of the ration and what objective does it serve (e.g. indicate whether this is a general purpose, non-specified, cold weather, hot weather, high altitude). Also note if there are particular conditions under which this consumption period varies from the normal – e.g. is the period the same for operational use as for non-operational use?

6. DURATION OF USE: What is the maximum approved or authorized consumption duration of the identified ration? This is the number of days of continuous, uninterrupted, exclusive subsistence authorized by this ration as approved by competent national medical, health affairs, Surgeon General, dietician, nutritional, or operational agency authority. Enter the information in a through c as specified.

a. **Number of days of consumption:** What is the maximum approved or authorized consumption duration of the identified ration or ration pack as a continuous, uninterrupted, exclusive sole source of nutrition?

b. **Limiting factors:** If less than 30 days, what are the limiting factors?

c. **Current 30 day subsistence plan:** How do you provide subsistence for up to 30 days?

7. BASIS OF ISSUE: Identify the allocation of this ration on a soldier/ per day (24 hour) basis. If it is a single daily ration with a full days complement of food it would be shown as one (x1), or if it is issued on a meal basis it would be shown as three (x3).

8. SHELF LIFE: State the actual shelf life period in months and conditions of storage that apply to that shelf life. The shelf life may be indicated as a specific time period according to a particular storage temperature or a series of time periods based on a (specified) range of temperature exposures, but the ration pack should be shelf stable at ambient temperature for the specified period without the need for refrigerated storage.

9. STORAGE REQUIREMENTS: Indicate any unique or special requirements, facilities, or instructions needed for proper storage or handling of the named ration. Include temperatures and storage conditions as appropriate.

10. NUTRITIONAL COMPOSITION: Total macro nutritional composition of this ration on a soldier/ per day (24 hour) basis. If it is a single daily ration with a full days complement of food it would be shown as one (x1), or if it issued on a meal basis it would be shown three (x3). Nutritional composition should coincide with the Basis of Issue for a full day's allotment of food. Food nutrients provide energy, promote growth and repair of tissue, or regulate metabolic body function. Carbohydrates, proteins, and fats are essential to human health in relatively large amounts, when compared to the micronutrients (minerals and vitamins).

a. **Energy:** Indicate the actual average energy value of the ration per day (24 hour) basis measured in Kilocalories (kcal). This unit of measure is used to describe the amount of energy released by foods.

b. **Protein:** Indicate the actual average Protein provided by the ration per day (24 hour) basis measured in grams (g). Proteins are complex organic compounds formed from amino acids that are essential for

growth and repair of muscles, tissue, vital structural and working substances in cells and hormone synthesis. Protein provides approximately 4 kcals energy per gram.

c. Carbohydrate: Indicate the actual average Carbohydrate on a per day (24 hour) basis measured in grams (g). Carbohydrates provide approximately 4 kcals energy per gram.

d. Fat: Indicate the actual Fat on a per day (24 hour) basis measured in grams (g). Fats provide approximately 9 kcals energy per gram.

e. Sodium: Indicate the actual average Sodium on a per day (24 hour) basis measured in milligrams (mg).

f. Iron: Indicate the actual average Iron on a per day (24 hour) basis measured in milligrams (mg).

g. Calcium: Indicate the actual average Calcium on a per day (24 hour) basis measured in milligrams (mg).

h. Other (Optional): Indicate micronutrients, vitamins, mineral salts, in the ration's nutritional composition.

11. MENUS: This section deals with the total number of menus available or offered in the ration and indicates if the different menus are contained in different cases or are mixed within each case.

a. Total Number of Menus: State the total number of menus available or offered in the ration and indicate if the different menus are contained in different cases or are mixed within each case.

b. Unspecified Meals: Indicate whether or not meals are distributed for consumption without designation of traditional breakfast, lunch, or dinner meal.

c. Breakfast: Indicate the number of menus having a specific breakfast entrée or component.

d. Lunch: Indicate the number of lunch menus available.

e. Dinner: Indicate the number of dinner menus available.

f. Menu Cycle: Indicate the maximum number of days before menus repeat.

12. RATION CONTENT:

a. Food Components: Briefly identify or list the food components of the ration.

b. Accessories: Briefly identify any specific non food or accessory items included with the ration; e.g. cutlery, towelette, matches, condiments, sugar, chewing gum, tissue, candy.

c. Water Treatment: Respond either Yes or No (Y/N) whether or not there is a water treatment means included in the ration (e.g. water purification tablets, flocculation, disinfection).

13. WATER REQUIREMENTS: What is the total water requirement for preparation of the ration? Include water needed for rehydration of components or beverages. Do not include water requirements if the heater is water activated as this is addressed under heater special requirements.

14. PREPARATION & SUPPORT REQUIREMENTS: Identify any unique or special requirements associated with the ration. This should address any requirements needed to properly consume the ration that are not contained or supplied with it.

15. HEATER:

a. Furnished with the Ration: Identify if there is an individual heater furnished with the ration and, if so, the basic technology used in its operation or application; e.g. water activated chemical heater, match light fuel tablet.

b. Special Requirements: Briefly address any special requirements associated with the heater or its use.

16. PACKAGING:

a. Packaging of the Ration or Individual Meal: Indicate what type of external packaging is used for the entire pack; e.g. box, flexible pouch, bag, combination.

b. Packaging of Internal Components of the Ration: Indicate what type of packaging is used for the various items included in the pack; e.g. retort pouch, tin, bag (plastic, paper, other), box, commercial wrapping.

17. WEIGHT: Indicate the average weight in kg of the ration on a soldier/ per day (24 hour) basis.

18. DIMENSIONS/CUBE: Indicate the volume in cc of the ration on a soldier/ per day (24 hour) basis.

19. SHIPPING CONTAINER DATA: This section addresses the ration case level or shipping container data.

a. Dimensions/Cube: Indicate the dimensions and volume (SI or cubic inches/feet) of the ration case level or shipping container.

b. Weight: Indicate the average weight (SI or pounds) of the ration case level or shipping container.

c. Quantity or Yield Per Case: Identify the number of rations or meals supplied in each case or how many meals or daily rations and for how many soldiers are contained in a case, e.g. 2 days of rations for 5 soldiers; 1 meal for 12 soldiers.

d. Pallet: Provide pallet dimensions (h/w/l) in meters and standard days of provision per pallet. This describes how many rations (24 hr) per pallet.

e. Menu Variety on Pallet: Identify how many menus or different types of rations or components are on one pallet, e.g. menu variety by case, by layer.

20. ADDITIONAL DATA: Any additional/optional data may be provided on the identified ration. This may include nutritional breakdown, menu lists or other characteristics. If additional information is provided separately please enter “See Attached Data Sheets”, otherwise, leave this field blank.

21. COMMENTS: Any comments may be entered here that would be useful in describing any relevant issue or characteristic associated with the ration. Areas of consideration may include annual national procurement, lead times, improvements or changes, operational experience, etc.

D.3 SUPPLEMENT BASELINE ASSESSMENT – DATA ELEMENT DEFINITION TABLE

This identification process is intended to be applied to each supplement under assessment. If a NATO/PfP nation has multiple supplements they wish to include then a separate assessment sheet should be completed for each.

1. COUNTRY: NATO/PfP Nation providing the self assessment identification.

2. POINT OF CONTACT: Point of Contact of Subject Matter Expert for NATO/PfP nation providing baseline data. Entry should include; Name, Organization, and relevant Contact Information including email address.

3. SUPPLEMENT NAME: Nomenclature, acronym, and/or common name of the packaged, shelf stable supplement under discussion. Supplements are those additional recommended food items or components that might be used to augment an operational ration to make it more nutritionally complete, increase acceptability and consumption or enhance overall mission or performance effectiveness. Identify any available packaged, shelf stable supplements or snack items intended as additional sustainment to be consumed with the ration as needed. These are items that are packaged and issued separately from the individual ration and may be contingent on doctrine, operations, and logistics availability.

4. DESCRIPTION: Provide a brief description of the supplement.

5. INTENDED APPLICATION: Identify the primary operational mission and/or target audience (e.g. soldier, marine, special forces) of the identified supplement. What is the purpose of the supplement and what objective does it serve?

6. BASIS OF ISSUE: Identify the allocation of this supplement to a soldier/ per day (24 hour) basis.

7. SHELF LIFE: State the actual shelf life period in months.

8. STORAGE REQUIREMENTS: Indicate any unique or special requirements, facilities, or instructions needed for proper storage or handling of the named supplement. Include temperatures and storage conditions as appropriate.

9. NUTRITIONAL COMPOSITION: Identify the macro nutritional requirements (Energy, Protein, Carbohydrate, Fat, Sodium, Iron, and Calcium) for the supplemental item. Total macro nutritional composition of this supplement on a soldier/ per day (24 hour) basis. Nutritional composition should coincide with the Basis of Issue for a full day's allotment of food.

a. **Energy:** Indicate the actual average Energy value of the supplement measured in Kilocalories (kcal). This unit of measure is used to describe the amount of energy released by foods.

b. **Protein:** Indicate the actual average Protein provided by the supplement measured in grams (g). Proteins are complex organic compounds formed from amino acids that are essential for growth and repair of muscles, tissue, vital structural and working substances in cells and hormone synthesis. Protein provides approximately 4 kcals energy per gram.

c. **Carbohydrate:** Indicate the actual average Carbohydrate provided by the supplement measured in grams (g). Carbohydrates provide approximately 4 kcals energy per gram.

d. **Fat:** Indicate the actual average Fat provided by the supplement measured in grams (g). Fats provide approximately 9 kcals energy per gram.

e. **Sodium:** Indicate the actual average Sodium on a per day (24 hour) basis measured in milligrams (mg).

f. **Iron:** Indicate the actual average Iron on a per day (24 hour) basis measured in milligrams (mg).

g. **Calcium:** Indicate the actual average Calcium on a per day (24 hour) basis measured in milligrams (mg).

h. **Other (Optional):** Indicate micronutrients, vitamins, mineral salts, in the supplement's nutritional composition.

10. WATER REQUIREMENTS: What is the total water requirement for preparation of the supplement?

11. PACKAGING: Indicate what type of packaging is used for the supplement; e.g. box, flexible pouch, bag, combination.

12. SHIPPING CONTAINER DATA: This section addresses the supplement case level or shipping container data.

a. **Dimensions/Cube:** Indicate the dimensions and volume of the supplement case level or shipping container.

b. **Weight:** Indicate the weight of the supplement case level or shipping container.

c. **Quantity or Yield Per Case:** Identify the number of supplements supplied in each case.

13. ADDITIONAL DATA: Any additional/optional data may be provided on the identified supplement. This may include nutritional breakdown or other characteristics. If additional information is provided separately please enter "See Attached Data Sheets", otherwise, leave this field blank.

14. COMMENTS: Any comments may be entered here that would be useful in describing any relevant issue or characteristic associated with the supplement. Areas of consideration may include annual national procurement, lead times, improvements or changes, operational experience, accessories provided, etc.

Annex E – DATA MATRIX

The data matrix contained in this annex is the result of a comprehensive effort by Research Task Group 154 to collect meaningful baseline information on identified national ration assets for:

1) Individual Operational Rations;
2) Special Purpose Rations; and
3) Supplements.

Inputs or submissions to the data matrix were provided by 12 countries including Australia, Belgium, Canada, Czech Republic, France, Germany, Italy, Netherlands, Norway, Slovenia, United Kingdom, and the United States. These countries responded to a broad NATO solicitation for specific input which correlated to those previously identified key data elements and their respective data element definitions. The breakout of data within the matrix is shown in sequence by Nutrition, Functional/Operational, and Components for each of the three asset classes of:

1) Individual Operational Rations;
2) Special Purpose Rations; and
3) Supplements.

This process was undertaken to provide the following tangible benefits:

1) Identification of member and partner nation operational ration assets which might support NRF deployment requirements.
2) Provide a basis for objective assessment of suitability and compatibility of identified rations and supplements to support the NRF mission.
3) Serve as a catalyst to identify areas of additional research focus to optimize future ration design to align nutritional and functional capabilities and technologies with operational mission requirements.

Table E-1: RTG-154 NATO/PfP General Purpose Ration: Nutrition Assessment

1	Country	Australia (AUS)	Belgium (BEL)	Canada (CAN)	Czech Republic (CZE)	France (FRA)
3	Ration Name	Combat Ration One Man (CR1M)	C Ration or "gevechtsrantsoen"	Individual Meal Pack (IMP)	Ration of Canned Foodstuffs (BDP) Option No. I or II.	Ration de Combat Individuelle Réchauffable (RCIR) - Indiv
4	**Product Description**	combat ration	combat ration	ready-to-eat ration	ready-to-eat ration	combat ration
5	**Intended Mission**	general purpose	general purpose	general purpose	general purpose	general purpose
6	**Duration of Use**					
	a) # days consumption:	operational (standard): 20 days	30 days	<= 30 days without supplement	30 days	30 days
	b) Limiting factors	discard rates & loss of heat-labile vitamins in storage				
	c) 30 day subsistence plan	alternate fresh feeding	fresh supplements as soon as possible	fresh supplements as soon as possible	manufacturer's control system	
7	**Basis of Issue**	1 per 24 hr	1 per 24 hr	3 per 24 hr	1 per 24 hr	1 per 24 hr
8	**Shelf Life**	24 mos	24 mos	36 mos	24 mos	24 mos
9	**Storage Reqs**	30°C, none	15°C [10°C-18°C]; rel hum [40%-60%]; no sunlight	dry, temp controlled, between 7°C and 24°C	covered, dry area	none
10	**Nutrition Composition**	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)
	a) Energy (kcal)	3700 kcal (15491 kJ)	3200 kcal (13398 kJ)	4395 kcal (18401 kJ)	3351 kcal (14030 kJ)	3200 kcal (13398 kJ)
	b) Protein (g)	108	13% (104)	141	111	13% (104)
	c) Carbohydrate (g)	593	55% (440)	681	414	55% (440)
	d) Fat (g)	116	32% (114)	123	133	32% (114)
	e) Sodium (mg)	5860	NaCl < 1% main course/ < 1.5% starters.	9381	2458	NaCl < 1% main course/ < 1.5% starters
	f) Iron (mg)	32	20	26	21	20
	g) Calcium (mg)	968	> 800	1016	746	> 800
	h) Other (optional)	see data sheet	not provided	not available	see data sheet	
	actual % Fat	28%	32%	25%	36%	32%
	actual % CHO	64%	55%	62%	49%	55%
	actual % Protein	12%	13%	13%	13%	13%
	Totals	104%	100%	100%	98%	100%
11	**Menus**					
	a) Total # menus	8	14	18	2	14
	b) Unspecifed meals	unspecified		specified		specified
	c) Breakfast	none	1	6		1
	d) Lunch	none	14	6		14
	e) Dinner	none	14	6		14
	f) Menu cycle	8	14	6		14
12	**Ration Content**					
	a) Food components	multiple	multiple	multiple	multiple	multiple
	b) Accessories	yes, variety	yes, variety	yes, variety	yes, variety	yes, variety
	c) Water treatment	no	yes	no		yes

Table E-1: RTG-154 NATO/PfP General Purpose Ration: Nutrition Assessment (cont'd)

	Country	Germany (DEU)	Italy (ITA)	Netherlands (NLD)	Norway (NOR)	Norway (NOR)	Slovenia (SVN)
3	Ration Name	Einmannpackung (EPa) (Individual Combat Ration)	Combat Ration (individual), "K Ration"	Combat Ration	FR3800 (Feltrasjon 3800 kcal) Tropical	FR3800 (Feltrasjon 3800 kcal) Arctic	Individual Ration
4	**Product Description**	combat ration	combat ration	individual combat ration	individual combat ration	individual combat ration	individual ration
5	**Intended Mission**	general purpose	general purpose	general purpose	general purpose (tropical)	general purpose (arctic)	general purpose
6	**Duration of Use**						
	a) # days consumption:	30 days	<= 30 consecutive days	30 days	30 days	30 days	10 days
	b) Limiting factors		climate & stressful actvity		acceptance, lack of variety	acceptance, lack of variety	acceptance, lack of variety
	c) 30 day subsistence plan	group rations and fresh food	field kitchens	fresh food	subsistence plan > 30 days	subsistence plan > 30 days	fresh food, cooked meals
7	**Basis of Issue**	1 per 24 hr	1 per 24 hr	1 per 24 hr	1 per 24 hr	1 per 24 hr	1 per 24 hr
8	**Shelf Life**	42 mos	24 mos	24 mos	24 mos	24 mos	24 mos
9	**Storage Reqs**	21°C, dry, ambient temp, shady	dry, ambient temp, shady	none	dry, ambient temp, shady, storage temp +22°C for 24 months	dry, ambient temp, shady, storage temp +22°C for 24 months	2-25°C, rel. hum. max 70%, no direct sunlight
10	**Nutrition Composition**	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)
	a) Energy (kcal)	3524 kcal (14754 kJ)	3650 kcal (15282 kJ)	3611-3754 kcal (15119-15717 kJ)	3762 kcal (15751 kJ)	4044 kcal (16931 kJ)	3537 kcal (14808 kJ)
	b) Protein (g)	96	100	108	90	91	95
	c) Carbohydrate (g)	501	521	540	649	614	518
	d) Fat (g)	126	129	126	89	139	110
	e) Sodium (mg)	8300	5250	8061	not available	not available	not available
	f) Iron (mg)	19	33	33	not available	not available	not available
	g) Calcium (mg)	900	1079	718	not available	not available	not available
	h) Other (optional)		not provided		see data sheet	see data sheet	not available
	actual % Fat	32%	32%	31%	21%	31%	29%
	actual % CHO	57%	57%	60%	69%	61%	60%
	actual % Protein	11%	11%	12%	10%	9%	11%
	Totals	100%	100%	103%	100%	101%	100%
11	**Menus**						
	a) Total # menus	6	7	20	8	8	3
	b) Unspecifed meals	unspecified	specified	unspecified	unspecified	unspecified	unspecified
	c) Breakfast	3	5	none	7	7	none
	d) Lunch	3	7	none	8	8	none
	e) Dinner	3	7	20	8	8	none
	f) Menu cycle	3	7	20	8	8	
12	**Ration Content**						
	a) Food components	multiple	multiple	multiple	multiple	multiple	multiple
	b) Accessories	yes, variety	yes, variety	yes, variety	yes, variety	yes, variety	yes, variety
	c) Water treatment	yes	yes	no	yes	yes	no

Table E-1: RTG-154 NATO/PfP General Purpose Ration: Nutrition Assessment (cont'd)

1	Country	United Kingdom (GBR)	United States (USA)
3	Ration Name	24 Hr General Purpose Operational Ration Pack	Meal, Ready-to-Eat (MRE)
4	**Product Description**	combat ration	ready-to-eat ration
5	**Intended Mission**	general purpose	general purpose
6	**Duration of Use**		
	a) # days consumption:	30 days	21 days continuous use
	b) Limiting factors	not applicable	menu fatigue
	c) 30 day subsistence plan	group feeding	group feeding; METT-TC
7	**Basis of Issue**	1 per 24 hr	3 per 24 hr
8	**Shelf Life**	36 mos	36 mos
9	**Storage Reqs**	ambient temp	80°F (27°C), none
10	**Nutrition Composition**	daily (24 hrs)	daily (24 hrs)
	a) Energy (kcal)	4294 kcal (17978 kJ)	3995 kcal (16726 kJ)
	b) Protein (g)	107	126
	c) Carbohydrate (g)	618	528
	d) Fat (g)	155	157
	e) Sodium (mg)	8293	6850
	f) Iron (mg)	21	26
	g) Calcium (mg)	1444	1705
	h) Other (optional)	see data sheet	US NSOR AR 40-25
	actual % Fat	32%	35%
	actual % CHO	58%	53%
	actual % Protein	10%	13%
	Totals	100%	101%
11	**Menus**		
	a) Total # menus	10	24
	b) Unspecifed meals	unspecified	unspecified
	c) Breakfast	5	none
	d) Lunch	not applicable	24
	e) Dinner	10	24
	f) Menu cycle	10	8
12	**Ration Content**		
	a) Food components	multiple	multiple
	b) Accessories	yes, variety	yes, variety
	c) Water treatment	yes	no

Table E-2: RTG-154 NATO/PfP General Purpose Ration: Functional/Operational Assessment

1	Country	Australia (AUS)	Belgium (BEL)	Canada (CAN)	Czech Republic (CZE)	France (FRA)	Germany (DEU)
3	Ration Name	Combat Ration One Man (CR1M)	C Ration or "gevechtsrantsoen"	Individual Meal Pack (IMP)	Ration of Canned Foodstuffs (BDP) Option No. I or II.	Ration de Combat Individuelle Réchauffable	Einmannpackung (EPa) (Individual Combat Ration)
13	**Water Requirements**	~4 L (250 ml ea teabag, coffee & sports drink); H2O qtys spec for other items	250ml for soup, 150 ml for cocoa, 141 ml for milk, 2x 133ml for coffee = 807 ml	800 ml to 1,100 ml depending on meal; approx 2,890 mL for one day	1.6 and 1.5 litres PET bottle. (1600/1500 ml)	1 litre (1000 ml)	3.1 liters (3100 ml) for all beverages
14	**Prep & Suppt Reqs**	stove & hex tabs (supplied separate) & canteen cup; water required for canteen cup to reheat retort pouch	canteen cup and cutlery	if users do not bring FRH, container and 250 ml of water req to heat pouch (but can be eaten cold); canteen cup req to heat and drink beverages	none	canteen cup and cutlery	water, heater unit, cutlery, plate/cup, container & heating tablets, steel knife required to open main meal
15	**Heater**						
	a) Furnished w/ ration	no	match light fuel tab, foldable stand, tool for handling hot can	no, flameless ration heaters (FRH) are supplied separately	soldier has heater & match light fuel tablet	match light fuel tab, foldable stand, tool for heating hot can	no
	b) Special requirements		do not use in enclosed atmosphere	FRH are subjected to Transport of Dangerous Goods Regulations		none	
16	**Packaging**						
	a) Packaging of the ration or individual meal	polyethylene bag, heat sealed	fiberboard box, wrapped in waterproof film	the ration is packaged in a food grade paper bag lined with foil in the inside	carton & foil wrapper	box wrapped in a waterproof film; compact, rigid, shock-resist, waterproof pkg	fiberboard box
	b) Packaging of internal components of the ration	main meals in retort pouches; other compts in polyethylene bags, tubes, laminate pouches (alfoil-based), commercial pkg, cans	cans, plastic bag, metal bag, paper boxes	foil lam retort pouches (quad pouch), foil lam pouches for other compts & commercial pkg; retort pouches in cardboard sleeve	commercial wrapping	cans, plastic and metallic bags, boxes	lt-wght aluminum-plastic containers; aluminium-plastic pouches; plastic pouches & commercial packaging
17	**Weight**	1.8 kg	1.5 kg	2.2 kg (total for breakfast, lunch, supper IMP)	1.6 kg	1600 g (1.6kg)	1.6 kg
18	**Dimensions/ Cube**	approx 24 cm x 14 cm x 10 cm = ~3.4 L (3400 cc)	303 mm x 156 mm x 63 mm = 2,977 cc	3 meals: 20 cm x 24 cm x 15.5 cm. Cube: 7,440 cm3 or 7.44 dm3	3500 cc (3500 cm3)	2800 cc (2800 cm3)	dim: 23. 8 cm x 18.2 cm x 7.4 cm; Vol: 3205 cm3
19	**Shipping Container**						
	a) Dimensions/ cube	the telescopic can has internal dimensions 245 mm x 151 cm x 470 mm = 17.4 L (17400 cc)	case (12 ea): 60 cm x 33 cm x 31 cm = 54 litres = 54,000 cc; pallet: 120 cm x 100 cm x 106 cm = 1,280 litres = 1,280,000 cc	dimensions: 41.7 cm long x 33.4 cm wide x 22 cm high. Cube: 30,641.16 cm3/cc or 0.03m cu	250 x 200 x 70 mm (3500 cm3/3.5 dm3)	1 pallet = 252 rations = 1.26 mc (m3) 1 container ISO 20 feet = 4032 rations	38.9 cm x 24.8 cm x 24.3 cm (23443 cm3)
	b) Weight	telescopic can net wght 1.1 kg; gross weight of 10.1 kg	case: 18.6 kg; pallet: 465 kg	8.95 kg/case (box)	1600 g (1.6 kg)	1 pallet = 475 kilograms	10 kg
	c) Quantity or yield per case	5 rations/can; 10 rations/carton	12 rations/case = 36 meals/ case; 252 rations/pallet	10 meals (10 breakfasts or 10 lunches or 10 suppers) i.e one meal for 10 soldiers; a mix of the 6 menus for each meal	1/ soldier per day	1 case = 12 rations 1 mixed pallet (7 menus) = 21 cases = 252 rations	1 daily ration for 6 soldiers
	d) Pallet	1160 x 1140 x 150 mm = 45.67 x 44.88 x 5.91 inches; 400 rations/ pallet	252 rations per pallet (21 cases of 12): Length: 120 cm, width: 100 cm, hgt: 106 cm	32 cases/boxes of breakfast, or lunch, or supper per pallet; 106.6 days of ration for one soldier; Pallet size: Loaded pallets measure 40" x 48" x 39" high (including the pallet) (1.016m x 1.22m x 1m)			dim: 1.15 m x 1.20 m x 0.80 m; 260 daliy rations/ pallet
	e) Menu variety on pallet	1 menu only per pallet	2 types of pallets, each with 7 different menus (1 type of pallet has no pork or alcohol)	each pallet contains 6 different menus of breakfast, or of lunch, or of supper			up to 3 different types of rations depending on task
20	**Additional Data**	pallets secured with shrink wrap	cases contain rations w/ same menu; 7 menus/pallet	procurement process takes 20 months from menu selection to assembly	compnts list inside		
21	**Comments**	compts procured over 12-mo period, packed & fielded over following 12-24 mos	Belgium buys standard French rations, approx 50,000 rations annually	a small qty of a special ration, which is certified Halal, Kosher & vegetarian, is procured separately from the regular IMPs; it is a std commercial product with a 12-month shelf line, offered in 4 different main course menus		traceability ensured; compts analysed (ISO 17025); GMO, artifi color/aromas forbidden	

Table E-2: RTG-154 NATO/PfP General Purpose Ration: Functional/Operational Assessment (cont'd)

1	Country	Italy (ITA)	Netherlands (NLD)	Norway (NOR)	Norway (NOR)	Slovenia (SVN)
3	Ration Name	Combat Ration (individual), "K Ration"	Combat Ration	FR3800 (Feltrasjon 3800 kcal) Tropical	FR3800 (Feltrasjon 3800 kcal) Arctic	Individual Ration
13	**Water Requirements**	300 ml (10.1 ounces) to rehydrate beverages	1900 ml	3.5 liters (3500 ml)	3 liters (3000 ml)	3500 ml
14	**Prep & Suppt Reqs**	heat canned lunch/dinner in 400 ml (13.5 ounces) H2O	heating tablets or heater; water purif tablets, canteen cup, cutlery, & mess tin (to heat pouches); hot water desirable to heat pouch	water and a spoon is needed for preparation	water and a spoon is needed for preparation	water and heater
15	**Heater**					
	a) Furnished w/ ration	iron-plated heater; match light fuel tabs	no	no	no	flameless heater + ethanol based gel heater supplied separately
	b) Special requirements	rehydrate bevs w/mess kit & heater; cans/ bins no direct contact with fire		no	no	do not use gel heater in enclosed atmosphere
16	**Packaging**					
	a) Packaging of the ration or individual meal	all meal items (breakfast, lunch, dinner) boxed; 3 meal boxes in container is 1 day module	fiberboard box	light-weight flexible pouch	light-weight flexible pouch	polyethylene bag
	b) Packaging of internal components of the ration	polypropylene envelopes; paper-polytene, alum-polytene envelopes; tinplates, alum cans w/ pull top, blister for pills	laminate pkg; alum cups; tins or retort pouch, comm wrap	components are comercial products; wrapping on freese dried products are different, but same contents	components are comercial products; wrapping on freese dried products are different, but same contents	retort pouches, foil lam pouches, cans
17	**Weight**	ave wght of single daily module (3 meals) 2,258 g (4.9 pounds)	1700 g (1.7kg)	1000 g (1kg)	1000 g (1kg)	1600 g (1.6kg)
18	**Dimensions/ Cube**	ave vol of single daily module (3 meals) 3600 cm3 (0.271 ft3)	2.79 dm3 + 1.36 dm3 = 4.15 dm3 (4150 cm3)	dimensions: 18 cm x 18 cm x 14 cm; volume: 4536 cm3	dimensions: 18 cm x 18 cm x 14 cm; volume: 4536 cm3	approx 30 cm x 5 cm x 35 cm (ca 5,3 L)
19	**Shipping Container**					
	a) Dimensions/ cube	packing box (undulate paperboard): 10 daily modules vol 36000 cm3 (1.3 ft3)	breakfast/lunch dim & vol: 43.8 cm x 32.8 cm x 21.8 cm = 31.3 dm3; dinner dim & vol: 1 cm x 21cm x 21cm = 13.6 dm3 total = 45 dm3 (45000 cm3)	hght=30 cm; length=39 cm; width=39 cm; 45630 cm3	hght=30 cm; length=39 cm; width=39 cm; 45630 cm3	43 cm x 59 cm x 39 cm (98 900 cm3)
	b) Weight	ave wght of box (10 daily modules) 23 kilos (50.7 pounds)	breakfast/lunch wght 12 kg + dinner wght 10 kg= 22 kg	8000 g (8kg)	8000 g (8kg)	17000 g (17kg)
	c) Quantity or yield per case	each box contains 10 modules, each contains 3 meals (breakfast, lunch dinner); each box feeds 10 people for 1 day	10 rations per case	1 daily ration for 8 soldiers	1 daily ration for 8 soldiers	10 rations
	d) Pallet	Euro pallet: h = 1.80 m; w = 0.80 m; l = 1.20 m; each pallet contains 21 boxes of 10 daily rations = 210 days of provision	breakfast/lunch 49 boxes/pallet (49x10= 490 rations) dim: 120x 100x168 (incl. pallet) dinner (tins) 96 boxes/pallet (96x10= 960 rations) dim: 120 x 100 x 140 (incl. pallet) dinner (pouches) 80 boxes/pallet (80x10 = 800 rations) 120x100x180	144 rations per pallet	144 rations per pallet	160 rations per pallet; pallet: 1.2 m x 0.8 m x 1.8 m x 1.8 m; each pallet contains 16 boxes x 10 rations = 160 days of provisions
	e) Menu variety on pallet	up to 7 different types of rations depending on task	each pallet a different menu	8	8	each pallet has a different menu
20	**Additional Data**	see weekly menu		menus provides 1 lactose free, 1 vegetarian and 1 gluten free; all menus are porc free to support muslim soldiers	menus provides 1 lactose free, 1 vegetarian and 1 gluten free; all menus are porc free to support muslim soldiers	pallets secured with shrink wrap
21	**Comments**	analysis to verify ration suitability for consumption prior to distribution		lead time 14 days for < 10.000 FR3800; rations have been tested during expeditions to Greeland, South pole, & daily in Afghanistan	lead time 14 days for < 10.000 FR3800; rations have been tested during expeditions to Greeland, South pole, & daily in Afghanistan	

Table E-2: RTG-154 NATO/PfP General Purpose Ration: Functional/Operational Assessment (cont'd)

1	Country	United Kingdom (GBR)	United States (USA)
3	Ration Name	24 Hr General Purpose Operational Ration Pack with variants - Sikh Hindu / Muslim and	Meal, Ready-to-Eat (MRE)
13	**Water Requirements**	5170 mls for all beverages based on manufacturer's recommendations	23 oz (680 ml) H2O for all beverages per meal; 2040 ml per day total
14	**Prep & Suppt Reqs**	hexamine cooker, fuel block, canteen cup, mess tin, cutlery; pouched components can be eaten hot or cold; water used to heat retort pouch is used for rehydrating beverages and consequently, water requirement for heating pouch is individual choice	none; ready to eat; optional heating; bev rehydration
15	**Heater**		
	a) Furnished w/ ration	provided with the ration	yes, H2O activated flameless ration heater (FRH) provided w/ ration; 1 ea
	b) Special requirements	water not required	2 oz (59 ml)/ meal H2O to activate FRH. 177 ml per day total
16	**Packaging**		
	a) Packaging of the ration or individual meal	ration packed in fiberboard box (inner); 10 rations packed in waterproof fiberboard box (outer)	food grade, low density polyethylene (LDPE) meal bag w/ peelable seal; case is V2 grade fiberboard box
	b) Packaging of internal components of the ration	indiv flex retort pouches; cmpnts packed in commerical packaging; sundries overwrapped in polythene bag as 2nd barrier; glass bottle for tabasco	foil laminate, flexible retort pouches, comm pkg & overwrapped in foil laminate pouches; glass bottle for tabasco sauce
17	**Weight**	1.8 to 2.0 kg/ ration; warfighter may carry up to 3 x 24 hr rations	4.5 lbs (1.5 lbs/meal x 3 meals)/ soldier/day (2.04 kg)
18	**Dimensions/ Cube**	inner carton (4180 cm3); outer carton (49190 cm3)	.24 cubic feet per soldier per day (.08 cu ft./meal x 3) (6796 cm3)
19	**Shipping Container**		
	a) Dimensions/ cube	pallet hght (including pallet) 1.65 metres; pallet width 1.19 metres, pallet length 1.03 metres; can be stowed 3 pallets high; 2.03 cu metres/ pallet; NATO pallet	case dim: 17" L x 9.6" W x 10.8" D; cube: 1.02 cu ft./case. (28880 cm3) 48 cases/pallet, wght 1,098 lbs., 56.1 cu ft.. (498 kg, 1589 dm3/1.569 m3)
	b) Weight	pallet wght 760 kgs incl pallet; outer wght 20 kg	21.8 lbs/case (9.8 kg)
	c) Quantity or yield per case	1x10 for 10 warfighters	12 meals/case; 4 soldiers can be sustained per day (24 hr) basis from a single case
	d) Pallet	350 rations/ pallet unit load (35 outers x 10 inners) 5 outers/ layer; 7 layers/pallet	48 cases, 576 total meals per pallet; each pallet consists of 3 rows of 4 cases per layer & 4 layers high; pallet load dimension of 42.92"l x 51.35"w x 37.46" h = 1.09m l x 1.304m w x .9515m h
	e) Menu variety on pallet	not applicable; mixed menu ration	pallet load has 24 cases of menus 1-12; 24 cases of menus 13-24; 192 days provision for 1 soldier
20	**Additional Data**	menu list, labels, product description, ingredients, wght, etc.	
21	**Comments**	commercial 24 hr Multi-Climate Ration under development for release 2010; nutritional content, case sizes, gross weight and pallet configuration should not change significantly	tan menu bag

Table E-3: RTG-154 NATO/PfP General Purpose Ration: Components

1	Country	Australia (AUS)	Belgium (BEL)	Canada (CAN)	Czech Republic (CZE)
3	Ration Name	Combat Ration One Man (CR1M)	C Ration or "gevechtsrantsoen"	Individual Meal Pack (IMP)	Ration of Canned Foodstuffs (BDP) Option No. I or II.
12	**Ration Content**				
	a) Food components	*in each menu (with variation in flavours between menus)* : two main meals (250 mL, retort pouched) one starch (55 g freeze-dried rice or 55 g flavoured instant noodles or 50 g potato and onion powder) bev powder (artificially sweetened) (1x12 g) sports drink powder (1x70 g) soup powder (1x30 g) cookies (2 pkts, each 32-45 g) fruit spread (1x26 g) canned fruit (1x140 g can) sauces (tubes, 10-15 g) muesli bars (3x32 g) muesli mix (60 g - in five menus) confectionary spread (1x50 g, in five menus) milk, skim, dried (1x3 g, in five menus) fruit grains (dried fruit, 1x 15 g) tuna (1x85 g pouch in three menus) curry powder (1x3.5 g, in three menus) *food items common to each menu:* chocolate drink powder (1x30 g) instant coffee (2x3.5 g) teabags (2x2.5 g) sugar (8x7 g) ration chocolate (1x50 g) candy chocolate (M&Ms, 1x55 g) cheese, cheddar, canned (1x56 g) salt (1x2 g) black pepper (1x2 g) sweetened condensed milk (1x85 g) vegetable extract (vegemite, 1x15 g) candy, hard (2x30 g) chewing gum (1 pkt of 4 pellets)	2 cooked dishes 1 starter 1 dehydrated soup 1 processed cheese or milky dessert 1 packet of salt biscuits 1 packet of sweet biscuits 1 packet of caramels 1 chocolate bar 1 breakfast kit (coffee, skimmed milk, cocoa powder and sugar) 1 nougat bar 1 fruit gelly bar 4 sugar lumps 1 packet of chewing gums 1 packet salt and pepper 1 packet sweets (in menue w/ process cheese)	each meal (breakfast, lunch and supper) contains: 1 entrée in retort pouch; 1 fruit/baked dessert in retort pouch; 1 flavoured sport drink; 1 bread in a pouch or 1 package of cheese flled crackers; 2 packets of jam or peanut butter or honey or jelly; 2 hot beverages (coffee or tea or flavoured coffee or herbal tea); condiments (salt, pepper, sugar, whitener, ketchup, mustard, chewing gum, candy); a breakfast meal also includes 1 packet of dry cereal and 1 packet of hot chocolate a lunch meal also includes 1 chocolate bar; additional condiments (pepper sauce, cranberry jelly, steak sauce, soya sauce); some lunch meals may have a dried starch (instant mashed potatoes or flavour rice or dressing mix), and a pudding a supper meal also includes 1 packet of dry soup, some meals may have a dried starch (instant mashed potatoes or flavour rice), 1 pack of cookies, and a pudding	pot roast w/rice potato goulash lunch burger 100g salty cracker 125g sweet cookies 125g jam 30g coffee extract 2g cheese 100g
	b) Accessories	bag, plastic, resealable (water/food) bag, plastic, inner (sundry) rubber bands size 32 (two) menu sheet - components opener, can, hand rubber bands size 62 (one) matches waterproof, vial ingredient sheet pads scouring, nylon spoon, plastic paper, toilet, 2 ply, 10 sheet	reheating kit (heater, matches, fuel tablets) 10 paper towels waste bag water purifying tablets	plastic spoon towelette matches paper towel toothpick	separately packed salt 2g multipurpose paper refreshment serviette PET bag instruction for warming up list of BDP components
	c) Water treatment	no, not provided in the ration--potable aqua tablets provided separately	yes	no	

Table E-3: RTG-154 NATO/PfP General Purpose Ration: Components (cont'd)

1	Country	France (FRA)	Germany (DEU)	Italy (ITA)	Netherlands (NLD)
3	Ration Name	Ration de Combat Individuelle Réchauffable (RCIR) - Indiv Reheatable Combat Ration	Einmannpackung (EPa) (Individual Combat Ration)	Combat Ration (individual), "K Ration"	Combat Ration
12	**Ration Content**				
	a) Food components	dehydrated muesli (cereals & milk) dehydrated bevs for breakfast (tea, coffee, sugar) dehydrated cold beverage biscuits (salted & sweet) 2 starters (1 dehydrated soup, 1 canned pâté) 2 main courses (canned food) 1 canned process cheese or 1 canned milky dessert sweets: choc, fruit jelly, caramels, nougat	meals 2 x 300 g dessert/snack 1 x 150 g bread 1 x 170 g cracker 1x 125 g canned sausage 2 x 50 g cheese spread 1 x 50 g jam 2 x 25 g chocolate 1 x 50 g chewing gum 1 x 12 pcs beverage powder (fortified with minerals and vitamins) 4 x 32.5 g coffee extract 2 x 3.5 g tea extract 2 x 1.2 g sugar 4 x 12.5 g coffee creamer (dairy based) 2 x 3 g salt 1 x 3 g	1 breakfast meal (cereals & chocolate bar, cookies, fruit jelly, fruit jam, coffee/ cappuccino/ concentrate milk/ tea, chocolate bar, liquor envelope (cordial), sugar) 1 lunch meal (canned tortellini w/ sauce, pasta w/ beans, raviloi w/ sauce, vegetable soup, canned beef, pork, turkey, wurstein, tuna w/ peas, crackers, canned fruit salad, polivitaminic pills, coffee, bran pills, sugar) 1 dinner meal (canned vegetable soup, rice salad, pasta w/ beans,canned tuna w/ oil, beef burgers, mackerel w/ oil, beef, chicken, turkey, tuna w/ beans, crackers, coffee, sugar, energetic bar, fuit & cereals bar)	chewing gum (1) salt (1x5 g) tea (2x2 g) coffee (2x2,5 g) coffee whitener (2x2,5 g) sugar (4x6 g) broth (1x5 g) Instant cacao drink (2x40 g) lemonade powder (1x30 g) biscuit brown (3x84 g) farmer pate (1x30 g) mushroom paste(1x30 g) chicken paste (1x30 g) liver paste (1x30 g) jam (1x30 g) apple spread (1x25 g) dextrose tablets (1x 35 g) chocolate bar (1x 40 g) candys (1x 38 g) instant soup (2x20 g) main meal (2x 400 g)
	b) Accessories	water purifying pills heater multi-purpose tissues waste bag	multipurpose paper tissue 4 sheets moist towelette 1 ea matches 20 ea water purification tablet	2 plastic cutlery sets 1 spoon for breakfast 6 napkins 3 toothpicks 3 disposable toothbrushes 1 match box 3 salt envelopes 3 ecological disposal bags 6 fuel tablets 1 heating stove 1 instruction sheet water disinfection kit	matches 1 package tissues 1 package
	c) Water treatment	yes	yes	yes	no

Table E-3: RTG-154 NATO/PfP General Purpose Ration: Components (cont'd)

1	Country	Norway (NOR)	Norway (NOR)	Slovenia (SVN)	United Kingdom (GBR)	United States (USA)
3	Ration Name	FR3800 (Feltrasjon 3800 kcal) Tropical	FR3800 (Feltrasjon 3800 kcal) Arctic	Individual Ration	24 Hr General Purpose Operational Ration Pack with variants - Sikh Hindu / Muslim and Vegetarian	Meal, Ready-to-Eat (MRE)
12	**Ration Content**					
	a) Food components	tuna energy bars energy drinks (fortied w/ minerals) (raspberry/lemon/peach) instant hot chocolate oatmeal biscuits instant black currant drink chewing gum (sugarfree) instant coffee raisins (rice bread in gluten free menu) (jam in vegetarian menu)	jam (forest berries/black currant) macerell energy bar energy drinks (fortied with minerals) (raspberry/lemon/peach) instant hot chocolate oatmeal biscuits instant black currant drink chewing gum (sugarfree) instant coffee raisins (rice bread in gluten free menu) chocolate	coffee, instant coffee whitener tee, instant vitamin-mineral drink sugar vitamin enriched bonbons energy bar chocolate honey or marmalade muesli (dehydrated) dessert (dehydrated) main course (dehydrated) main course (retort pouch) pate (liver or fish) canned course (fish or meat) bread like component	1 breakfast 1 main meal (1 or 2 retort pouches) 1 pudding 1 packet of oatmeal block 1 packet of fruit filled biscuits 1 packet of biscuits brown 2 chocolate bars 1 pate (meat or vegetarian) 1 packet boiled sweets 1 packet chewing gum 6 sachets of sugar 6 sachets of beverage whitener 6 stick packs of instant coffee 2 sachets of instant white tea 1 sachet of fruit grains 1 packet of soup 1 packet of drinking chocolate 1 sachet of isotonic drink 1 packet of vegemite 1 bottle tabasco	24 different menus with improvements/ changes annually, typical as shown; 1 entrée (chicken, beef, pork, fish, vegetable or pasta dish) 1 starch, vegetable, or fruit (spiced apples, wet pack fruit, beans, rice, nuts, mashed potato, chowder, corn, granola, stuffing, macaroni & cheese) 1 cracker or bread (plain bread, wheat bread, chipotle bread, vegetable cracker, tortilla) 1 spread (variety of cheese spreads, peanut butter, jelly, jam, apple butter) 1 dessert/snack (scone, fig bar, raisin nut mix, toaster pastry, bars, cookie, pound cake, dried fruit, muffin top, choc & vanilla pudding, brownie, pretzels, cobbler) multiple beverages (flavored coffees - french vanilla, mocha, irish cream; cocoa, dairy shake, CHO electrolyte beverage, sugar free beverage, CHO fortified beverage base) seasoning (ground red pepper, bbq sauce, hot sauce, salsa verde, bbq seasoning, butter buds, sesoning blend, pizza seasoning, steak sauce, green hot sauce, picante sauce, fat free mayonaise, jalapeno ketchup)
	b) Accessories	refreshing tissue / towelette (germicidal wipe) water purification tablets (chlorine)	refreshing tissue / towelette (germicidal wipe) water purification tablets (chlorine)	disinfection handkerchief, can opener, waste bag, matches	1 waterproof matches 1 paper tissues water purification tablets	each ration is equipped with a spoon, flameless ration heater, and specific accessory packet A, B, or C that consists of the following components; each ration will also have one of the identified candy items as shown; accessory packet A: coffee, cream sub, sugar, salt, gum, matches, tissue, towelette accessory packet B: lemon tea, salt, gum, matches, tissue, towelette accessory packet C: apple cider, salt, gum, matches, tissue, towelette candy I: toffee roll-chocolate flavored, toffee, chocolate, chocolate covered coffee beans candy II: chocolate-plain disks, chocolate with peanuts, peanut butter disks candy III: cinnamon candies, fruit flavored
	c) Water treatment	yes	yes	not included	yes, 1x10 water purification tablets	no, not included

Table E-4: RTG-154 NATO/PfP Special Purpose Ration: Nutrition Assessment

	Country	Australia (AUS)	Belgium (BEL)	Germany (DEU)	Netherlands (NLD)	Netherlands (NLD)
3	Ration Name	Patrol Ration One Man (PR1M)	Long Range Recce Patrol (LRRP) Ration	Einmannpackung, Leicht (EPa, Leicht) (Ind Combat Rat, Lt-Wght)	Arctic Ration	Long Distance Reconnaissance Ration
4	**Product Description**	light weight patrol ration	light weight special forces ration	light weight ration	individual ration	reconnaissance ration
5	**Intended Mission**	patrol, special ops	patrol, special operations	special forces	cold weather	scouts
6	**Duration of Use**					
	a) # days consumption:	30+ days	<= 14 days	21 days	30 days maximum	30 days maximum
	b) Limiting factors	discard rates & loss of heat-labile vitamins in storage		energy content/ calorific value		
	c) 30 day subsistence plan	alternate fresh feeding	fresh supplements as soon as possible	group rations and fresh food	fresh food	fresh food
7	**Basis of Issue**	1 per 24 hr	1 per 24 hr	1 per 24 hr	1 per 24 hr	1 per 24 hr
8	**Shelf Life**	24 mos	24 mos	24 mos	24 mos	36 mos
9	**Storage Reqs**	30°C, none	15°C [10°C-18°C]; rel hum [40%-60%]; no sunlight	21°C, dry, ambient temp, shady	none	none
10	**Nutrition Composition**	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)
	a) Energy (kcal)	3800 kcal (15910 kJ)	3300 kcal (13816 kJ)	2198 kcal (9203 kJ)	5185 kcal (21709 kJ)	4187 kcal (17530 kJ)
	b) Protein (g)	116	140	67	113	101
	c) Carbohydrate (g)	613	435	298	871	636
	d) Fat (g)	118	120	82	139	139
	e) Sodium (mg)	5236	not available	11300	9192	5001
	f) Iron (mg)	32	not available	37	37.5	38
	g) Calcium (mg)	1012	not available	3600	1535	1618
	h) Other (optional)	see data sheet	not available			
	actual % Fat	28%	33%	34%	24%	30%
	actual % CHO	65%	53%	54%	67%	61%
	actual % Protein	12%	17%	12%	9%	10%
	Totals	105%	102%	100%	100%	100%
11	**Menus**					
	a) Total # menus	5	3	10	4	4
	b) Unspecifed meals	unspecified		unspecified		
	c) Breakfast	none	3	4	1	1
	d) Lunch	none	3	5	1	4
	e) Dinner	none	3	5	4	4
	f) Menu cycle	5	3	5	4	4
12	**Ration Content**					
	a) Food components	multiple	multiple	multiple	multiple	multiple
	b) Accessories	yes, variety	none	yes, variety	yes, variety	yes, variety
	c) Water treatment	no	no	yes	no	no

Table E-4: RTG-154 NATO/PfP Special Purpose Ration: Nutrition Assessment (cont'd)

1	Country	Norway (NOR)	Norway (NOR)	United States (USA)	United States (USA)	United States (USA)
3	Ration Name	FR5000 (Feltrasjon 5000 kcal) Tropical	FR5000 (Feltrasjon 5000 kcal) Arctic	Meal, Cold Weather (MCW)	Food Packet, Long Range Patrol (LRP)	First Strike Ration (FSR)
4	**Product Description**	individual combat ration	individual combat ration	light weight freeze dried ration	light weight freeze dried ration	calorie dense, eat out-of-hand, ration
5	**Intended Mission**	high intensity exercise (special forces) (tropical)	high intensity exercise (special forces) (arctic)	cold weather	assault, special operations	assault
6	**Duration of Use**					
	a) # days consumption:	30 days	30 days	not stated	10 days	10 days
	b) Limiting factors	acceptance, lack of variety	acceptance, lack of variety	menu fatigue	calorie intake	calorie intake, menu fatigue
	c) 30 day subsistence plan	subsistence plan > 30 days	subsistence plan > 30 days	group feeding; METT-TC	group feeding; METT-TC	MRE, group feeding; METT-TC
7	**Basis of Issue**	1 per 24 hr	1 per 24 hr	3 per 24 hr	1 per 24 hr	1 per 24 hr
8	**Shelf Life**	24 mos	24 mos	36 mos	36 mos	24 mos
9	**Storage Reqs**	dry, ambient temp, shady, storage temp +22°C for 24 months	dry, ambient temp, shady, storage temp +22°C for 24 months	80°F (27°C), none	80°F (27°C), none	80°F (27°C), none
10	**Nutrition Composition**	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)	daily (24 hrs)
	a) Energy (kcal)	4971 kcal (20813 kJ)	5188 kcal (21721 kJ)	4599 kcal (19255 kJ)	1533 kcal (6418 kJ)	2844 kcal (11907 kJ)
	b) Protein (g)	123	119	162	54	87
	c) Carbohydrate (g)	820	770	599	200	371
	d) Fat (g)	131	183	175	58	124
	e) Sodium (mg)	not available	not available	7715	2572	4034
	f) Iron (mg)	not available	not available	29	10	15
	g) Calcium (mg)	not available	not available	1690	563	655
	h) Other (optional)			US NSOR AR 40-25	US NSOR AR 40-25	US NSOR AR 40-25
	actual % Fat	24%	32%	34%	34%	39%
	actual % CHO	66%	59%	52%	52%	52%
	actual % Protein	10%	9%	14%	14%	12%
	Totals	100%	100%	100%	100%	104%
11	**Menus**					
	a) Total # menus	7	7	12	12	3
	b) Unspecifed meals	unspecified	unspecified	unspecified	unspecified	unspecified
	c) Breakfast	7	7	3	3	1
	d) Lunch	7	7	9	9	2
	e) Dinner	7	7	9	9	2
	f) Menu cycle	7	7	4	12	3
12	**Ration Content**					
	a) Food components	multiple	multiple	multiple	multiple	multiple
	b) Accessories	yes, variety	yes, variety	yes, variety	yes, variety	yes, variety
	c) Water treatment	yes	yes	no	no	no

Table E-5: RTG-154 NATO/PfP Special Purpose Ration: Functional/Operational Assessment

1	Country	Australia (AUS)	Belgium (BEL)	Germany (DEU)	Netherlands (NLD)	Netherlands (NLD)
3	Ration Name	Patrol Ration One Man (PR1M)	Long Range Recce Patrol (LRRP) Ration	Einmannpackung, Leicht (EPa, Leicht) (Ind Combat Ration, Light-Wght)	Arctic Ration	Long Distance Reconnaissance Ration
13	**Water Requirements**	~5.4 L (250 mL ea tea & coffee; 1 L ea sports drink); H2O qty spec for meals	2,300 cc (2300 ml)	3.05 liters (3050 ml) for all beverages, dairy shake and dehydrated meals	4500 ml	3600 ml
14	**Prep & Suppt Reqs**	stove & hex tabs (supplied separately) & canteen cup	canteen cup, cutlery and plate; stove desirable but not required	water, heater unit, cutlery, plate/cup, container & heating tablets	heating tablets or heater; water purif tablets, canteen cup, cutlery; hot water	heating tablets or heater; water purif tabs; hot water req to rehydrate components; canteen cup & cutlery
15	**Heater**					
	a) Furnished w/ ration	no	no	no	no	no
	b) Special requirements					
16	**Packaging**					
	a) Packaging of the ration or individual meal	polyethylene bag	in plastic resealable bag	fiberboard box	strong polythene bags	strong polythene bags
	b) Packaging of internal components of the ration	laminate (alfoil based); plastic bags, tubes, commercial packaging	in pouch, in commercial packing bag (beef jerky, energy bar, drinks)	pouches made from aluminium-plastic (semi-rigid and flexible), plastic pouches and commercial packaging	laminate pkg; comm pkg	laminate pkg; comm pkg
17	**Weight**	900 g (0.9 kg)	1 kg	0.75 kg	1520 g (1.52 kg)	1160 g (1.16 kg)
18	**Dimensions/ Cube**	approx 24 cm x 14 cm x 10 cm = ~3.4 L (3400 cc)	2,600 cc	20 cm x 21 cm x 25.5 cm (10710 cm3) for 5 rations put together in a fiberboard box	9 dm3 (9000 cm3)	6.8 dm3 (6800 cm3)
19	**Shipping Container**					
	a) Dimensions/ cube	the telescopic can has internal dimensions 245 mm x 151 cm x 470 mm = 17.4 L (17400 cc)	case (12 ea): 60 cm x 33 cm x 31 cm = 54 litres = 54,000 cc; pallet: 120 cm x 100 cm x 106 cm = 1,280 litres = 1,280,000 cc	20 cm x 21 cm x 25.5 cm (10710 cm3) for 5 rations put together in a fiberboard box	60 cm x 48 cm x 25 cm = 72 dm3 (72000 cm3)	51cm x 46 cm x 35 cm = 82.1 dm3 (82100 cm3)
	b) Weight	telescopic can net wght 1.1 kg; gross wght 5.6 kg	12.6 kg	3.6 kg	15 kg	17 kg
	c) Quantity or yield per case	5 rations/can; 10 rations/carton	12 rations/case = 36 meals/case	1 daily ration for 5 soldiers	8 rations per case	12 rations per case
	d) Pallet	1160 x 1140 x 150 mm = 45.67 x 44.88 x 5.91 inches; 480 rations per pallet	252 rations per pallet (21 cases of 12): Length: 120 cm, width: 100 cm, hgt: 106 cm	dim: 1.15 m x 1.20 m x 0.80 m; 272 daliy rations/ pallet	24 boxes on a pallet (24 x 8=192 rations) dim: 120 x 100 x 162 (incl. pallet)	16 boxes on a pallet (16 x 12 =192 rations on a pallet) dimensions 120 x 100 x 155 (incl. pallet)
	e) Menu variety on pallet	1 menu only per pallet		up to 5 different rations depending on task	4 different menus on a pallet	4 different menus on a pallet
20	**Additional Data**	pallets secured with shrink wrap	variety of menu items			
21	**Comments**	compts procured over 12-mo period, packed & fielded over following 12-24 mos	800 rations annually, consists of all-commercial items			

Table E-5: RTG-154 NATO/PfP Special Purpose Ration: Functional/Operational Assessment (cont'd)

1	Country	Norway (NOR)	Norway (NOR)	United States (USA)	United States (USA)
3	Ration Name	FR5000 (Feltrasjon 5000 kcal) Tropical	FR5000 (Feltrasjon 5000 kcal) Arctic	Meal, Cold Weather (MCW)	Food Packet, Long Range Patrol (LRP)
13	**Water Requirements**	3.8 liters (3800 ml)	3.8 liters (3800 ml)	28-40 oz (828-1182 ml) H2O per meal; 84-120 oz (2484-3548 ml) H2O/day total	28-40 oz (828-1182 ml) H2O per meal; 84-120 oz (2484-3548 ml) H2O/day total
14	**Prep & Suppt Reqs**	water and a spoon is needed for preparation	water and a spoon is needed for preparation	rehydration and heating of water for components; water required to rehydrate components	rehydration and heating of water for components
15	**Heater**				
	a) Furnished w/ ration	no	no	no	no
	b) Special requirements	no	no	fuel tabs issued separately for heating H2O in canteen cup for rehydration	fuel tabs issued separately for heating H2O in canteen cup for rehydration
16	**Packaging**				
	a) Packaging of the ration or individual meal	light-weight flexible pouch	light-weight flexible pouch	food grade, low density polyethylene (LDPE) meal bag w/ peelable seal; case is V2 grade fiberboard box	food grade, low density polyethylene (LDPE) meal bag w/ peelable seal; case V2 grade fiberboard box
	b) Packaging of internal components of the ration	components are comercial products; wrapping on freese dried products are different, but same contents	components are comercial products; wrapping on freese dried products are different, but same contents	dehydrated entrées vac pkd in foil brickpack; compts pkg in foil lam retort pouches, comm pkg & overwrapped in foil lam pouches	dehydrated entrées vac pkd in foil brickpack; compts pkg in foil lam retort pouches, comm pkg & overwrapped in foil lam pouches
17	**Weight**	1200 g (1.2kg)	1200 g (1.2kg)	3 lbs (1 lb/meal x 3 meals) per soldier/day (1.36 kg)	1lb (1 lb/meal x 1 meal) per soldier/day (0.45 kg)
18	**Dimensions/ Cube**	dimensions: 18 cm x 18 cm x 15 cm; volume: 4860 cm3	dimensions: 18 cm x 18 cm x 15 cm; volume: 4860 cm3	.12 cubic feet per soldier per day (.04 cu ft./meal x 3) (3398 cm3)	.04 cu ft. per soldier per day (1133 cm3)
19	**Shipping Container**				
	a) Dimensions/ cube	hght=30 cm; length=39 cm; width=39 cm; 45630 cm3	hght=30 cm; length=39 cm; width=39 cm; 45630 cm3	case dim: 17" L x 9.6" W x 10.8" D; cube: 1.02 cu ft./case. (28880 cm3) 48 cases/pallet, wght 758 lbs., 56.1 cu ft. (343.8 kg, 1589 dm3/1.569 m3)	case dim: 17" L x 9.6" W x 10.8" D; cube: 1.02 cu ft./case. (28880 cm3) 48 cases/pallet, wght 758 lbs., 56.1 cu ft. (343.8 kg, 1589 dm3/1.569 m3)
	b) Weight	9600 g (9.6kg)	9600 g (9.6kg)	15.0 lbs/case (6.8 kg)	15.0 lbs/case (6.8 kg)
	c) Quantity or yield per case	1 daily ration for 8 soldiers	1 daily ration for 8 soldiers	12 meals/case; 4 soldiers can be sustained per day (24 hr) basis from a single case	12 meals/case; 12 soldiers can be sustained per day (24 hr) basis from a single case
	d) Pallet	144 rations per pallet	144 rations per pallet	48 cases, 576 meals per pallet; each pallet consists of 3 rows of 4 cases per layer & 4 layers high; pallet load dim: 42.92"l x 51.35"w x 37.46" h = 1.09m l x 1.304m w x .9515m h	48 cases, 576 total meals per pallet; pallet consists of 3 rows of 4 cases per layer & 4 layers high; pallet load dim: 42.92"l x 51.35"w x 37.46" h = 1.09m l x 1.304m w x .9515m h
	e) Menu variety on pallet	assorted pallets	assorted pallets	pallet load has 48 cases of menus 1-12; 192 days provision for 1 soldier	pallet load has 48 cases of menus 1-12; 576 days provision for 1 soldier
20	**Additional Data**	menus provides 1 vegetarian; all menus are porc free to support muslim soldiers	menus provides 1 vegetarian; all menus are porc free to support muslim soldiers		
21	**Comments**	lead time 14 days for < 10.000 FR5000; rations tested during expeditions to Greenland, South pole, & Afghanistan	lead time 14 days for < 10.000 FR5000; rations tested during expeditions to Greenland, South pole, & Afghanistan	white menu bag	tan menu bag

Table E-5: RTG-154 NATO/PfP Special Purpose Ration: Functional/Operational Assessment (cont'd)

1	**Country**	**United States (USA)**
3	**Ration Name**	**First Strike Ration (FSR)**
13	**Water Requirements**	24 oz (710ml) H2O
14	**Prep & Suppt Reqs**	none; ready to eat; bev rehydration
15	**Heater**	
	a) Furnished w/ ration	no
	b) Special requirements	none
16	**Packaging**	
	a) Packaging of the ration or individual meal	meal assmbly shrink wrapped or heat-sealed; meal bag w/peelable seal; case V2 fiberboard box
	b) Packaging of internal components of the ration	compts pkg in foil laminate pouches, comm pkg & overwrapped in foil laminate pouches
17	**Weight**	2.5 lbs per soldier/day (1.13 kg)
18	**Dimensions/ Cube**	.10 cu ft. per soldier per day (2832 cm3)
19	**Shipping Container**	
	a) Dimensions/ cube	case dim: 17" L x 9.6" W x 10.8" D; cube: 1.02 cu ft./case. (28880 cm3)
	b) Weight	25 lbs/case (gross), 2.5 lbs/ration (11.3 kg) (1.1 kg)
	c) Quantity or yield per case	9 rations/case; 9 soldiers can be sustained per day (24 hr) basis from a single case
	d) Pallet	48 cases, 432 total meals per pallet; each pallet consists of 3 rows of 4 cases per layer & 4 layers high; pallet load dim: 42.92"l x 51.35"w x 37.46" h = 1.09m l x 1.304m w x .9515m h
	e) Menu variety on pallet	pallet load has 48 cases of menus 1-9; 432 days provision for 1 soldier
20	**Additional Data**	
21	**Comments**	TTI label on each case; pallet contains 48 cases

Table E-6: RTG-154 NATO/PfP Special Purpose Ration: Components

1	Country	Australia (AUS)	Belgium (BEL)	Germany (DEU)	Netherlands (NLD)
3	Ration Name	Patrol Ration One Man (PR1M)	Long Range Recce Patrol (LRRP) Ration	Einmannpackung, Leicht (EPa, Leicht) (Individual Combat Ration, Light-Weight)	Arctic Ration
12	**Ration Content**				
	a) Food components	*in each menu (with variation in flavours between menus)* : two main meals (110 g, freeze-dried) one starch (50 g potato and onion powder or 55 g freeze-dried rice) favoured instant noodles (1x55 g) fruit grains (dried fruit, 1x15 g) beverage pwdr (artificially sweetened) (2x12 g) sports drink powder (1x70 g) confectionary spread (1x50 g) fruit spread (1x26 g) cookies (1 pkt 35–45 g) tuna in springwater (1x85 g pouch in three menus) *food Items common to all menus* : muesli bars (3x 32 g) beverage choc powder (1x50 g) beverage coffee (2x3.5 g) candy hard (1x30 g) crackers (1x36 g) pepper (1x2 g) candy chocolate (M&Ms 1x55 g) chocolate Ration (1x50 g) salt (1x2 g) sauces (soy, tomato, sweet chilli, 10–15 g) milk, sweetened condensed (1x85 g) vegetable extract (vegemite, 1x15 g) tea bags (2x2.5 g) sugar (8x7 g) chewing gum (1pkt of 4 pellets)	1 lyophilized breakfast 2 lyophilized hot meals 1 milky drink 1 mineral drink 2 packs of instant coffee 2 sugar lumps 2 bags of salt 1 instant soup 2 energy bars 1 packet of beef jerky's 1 "energetic complement" (type survival ration)	dehydrated meals 2 x 80 g dairy powder (fortified) 1 x 50 g energy bar 2 x 75 g cookies 1 x 100 g chewing gum 1 x 12 pcs sugar 2 x 12.5 salt 1 x 3 g coffee creamer (dairy based) 1 x 3 g beverage powder (fortified w/ minerals) 30 g vitamin tablets 2 x 4.5 g coffee extract 2 x 3.5 g tea extract 1 x 1.2 g	Drinks: tea bag of (4x1x4 g): 3 flavours 1 normal sachet of coffee (6x1.5 g) sachet of coffee whitener (6x2.5 g) sachet of sugar (10x10 g) sachet of cocoa powder (1x40 g) 2 x multi-vitamin orange soluble tablets 1 sachet of bouillon powder sachet of energy drink (2x40 g) Various: sachet of salt (2x5 g) 1 packet of sugar-free (Xylitol) chewing gum sachet of pepper (2x0.1 g) sachet of hot pepper sauce (2x2 g) sachet of tex mex spices (1x2 g) sachet of bourguignon herbs (1x2 g) Snack pack: pkt of brown (wholemeal) biscuits (2x84 g) packet of fruit-filled biscuits (1x95 g) tin of liver paté (1x56 g) tube of dextrose tablets (1x30 g) plain chocolate bar (1x40 g) nougat (2x30 g) energy bar (1x75 g) Breakfast: sachet of instant porridge (70 g) sachet of muesli (70 g) Main meal: Soup 2x20 g Dehydrated meal 2x125 g Apple flakes 1x30 g
	b) Accessories	bag, plastic common pads, scouring, nylon rubber bands size 32 (two) paper, toilet, 2 ply, 10 sheet rubber bands, size 62 spoon, plastic bag, plastic re-sealable matches, waterproof vial bag, plastic inner menu sheet - components	none	multipurpose paper tissue 2 sheets matches 5 ea water purification tablet	1 book of waterproof matches 2 packets of tissues 1 disposable toothbrush
	c) Water treatment	no, not provided in the ration--potable aqua tablets provided separately	no	yes	no

Table E-6: RTG-154 NATO/PfP Special Purpose Ration: Components (cont'd)

1	Country	Netherlands (NLD)	Norway (NOR)	Norway (NOR)	United States (USA)
3	Ration Name	Long Distance Reconnaissance Ration	FR5000 (Feltrasjon 5000 kcal) Tropical	FR5000 (Feltrasjon 5000 kcal) Arctic	Meal, Cold Weather (MCW)
12	**Ration Content**				
	a) Food components	muesli (1x70 g) coffee (8 x1.5 g) coffee whitener (3x2.5 g) sugar (8x6 g) tea bags (2 x) soluble tablets (multi-vitamin) (1 packet) energy drink (2 sachets of 40 g) cocoa powder (1x40 g) biscuits, brown (wholemeal) (1 packet) biscuits, fruit (1 packet) lemon energy bar (1x75 g) almond/fig energy bar (2x75 g) dextrose tablets (1x30 g) chewing gum (1x10 pieces) chocolate bar (1x40 g) instant soup (1 sachet) hot meal (freeze-dried) (3x80 g) salt (1x10 g) pepper (1 sachet) hot pepper sauce (1 sachet) bourguignon herbs (1 sachet) tex mex spices (1 sachet)	tuna macerell energy bars energy drinks (fortied w/ minerals) (raspberry/lemon/peach) instant hot chocolate oatmeal biscuits instant black currant drink chewing gum (sugarfree) candy (honey) jam instant coffee raisins	tuna macerell energy bars energy drinks (fortied w/ minerals) (raspberry/lemon/peach) instant hot chocolate oatmeal biscuits instant black currant drink chewing gum (sugarfree) candy (honey) jam instant coffee raisins chocolate	12 different menus 1 freeze dried entrée (chicken, beef, pork, turkey, pasta, egg dish) 1 starch (ramen noodles soup, rice, cream of wheat cereal, oatmeal, granola, starch jellies) 1 cracker (MRE cracker) 1 spread (cheese spread, peanut butter) 1 dessert/snack (fig bar, raisin nut mix, toaster pastry, penaut butter M&Ms, sports bar, cookie, brownie, pound cake, pretzels) multiple beverages (cappuccino, coffee, cocoa, lemon tea, cider, orange beverage, vanilla, chocolate or strawberry dairy shake drink)
	b) Accessories	matches (1 box) tissues (1 packet) disposable toothbrush re-sealable plastic bag (2 x)	refreshing tissue / towelette (germicidal wipe) water purification tablets (chlorine)	refreshing tissue / towelette (germicidal wipe) water purification tablets (chlorine)	each ration is equipped with a spoon and accessory packet that consists of the following components; accessory packet items: coffee, cream sub, sugar, salt, chewing gum, matches, tissue, hand cleaner, hot sauce, matches
	c) Water treatment	no	yes	yes	no, not included

Table E-6: RTG-154 NATO/PfP Special Purpose Ration: Components (cont'd)

1	Country	United States (USA)	United States (USA)
3	Ration Name	Food Packet, Long Range Patrol (LRP)	First Strike Ration (FSR)
12	**Ration Content**		
	a) Food components	12 different menus 1 freeze dried entrée (chicken, beef, pork, turkey, pasta, egg dish) 1 starch (ramen noodles soup, rice, cream of wheat cereal, oatmeal, granola, starch jellies) 1 cracker (MRE cracker) 1 spread (cheese spread, peanut butter) 1 dessert/snack (fig bar, raisin nut mix, toaster pastry, penaut butter M&Ms, sports bar, cookie, brownie, pound cake, pretzels) multiple beverages (cappuccino, coffee, cocoa, lemon tea, cider, orange beverage, vanilla, chocolate or strawberry dairy shake drink)	3 different menus items are light weight, calorically dense, eat-out-of-hand foods, require little or no prep 1-2 shelf stable sandwiches (bacon/cheddar, pepperoni, italian, honey bbq beef) 1 shelf stable pouched chicken or tuna 2 starch items (filled french toast, wheat snack bread, crackers, tortilla, toaster pastry) 2 beverages (powdered base orange, lemon-lime, grape or tropical punch) misc snacks (nut/fruit mix, carbohydrate fortified applesauce, energy bar) 2 beef snacks (teriyaki, bbq) 1 dessert bar (peanut butter, mocha, choc banana) 1-2 spreads (jalapeno or plain cheese, peanut butter) 1 caffeinated gum 1 hot sauce 1 mayonaise
	b) Accessories	each ration is equipped with a spoon and accessory packet that consists of the following components; accessory packet items: coffee, cream sub, sugar, salt, chewing gum, matches, tissue, hand cleaner, hot sauce, matches	1 zip-lock pouch (for item storage) 1 plastic spoon 2 towelettes 1 xylitol chewing gum 1 accessory packet A, B, or C is provided which consists of the following components; Accessory Packet A: coffee, cream sub, sugar, towelette, salt, matches, tissue Accessory Packet B: lemon tea, towelette, salt, matches, tissue Accessory Packet C: apple cider, towelette, salt, matches, tissue
	c) Water treatment	no, not included	no, not included

Table E-7: RTG-154 NATO/PfP Supplement: Nutrition Assessment

1	Country	Canada (CAN)	United States (USA)
3	Supplement Name	Light Meal Combat Pack (LMC)	Food Packet, Carbohydrate Supplement (CarboPack)
4	**Description**	ration supplement	ration supplement.
5	**Intended Application**	arduous conditions, patrol	high intensity activity
6	**Basis of Issue**	one pack	1 per 24 hr
8	**Shelf Life**	36 mos	24 mos
9	**Storage Reqs**	between 7°C and 24°C, dry, temp controlled	80°F (27°C), none
10	**Nutrition Composition**	each	each
	a) Energy (kcal)	1475 kcal (6176 kJ)	380 kcal (1591 kJ)
	b) Protein (g)	33	4
	c) Carbohydrate (g)	225	75
	d) Fat (g)	49	9
	e) Sodium (mg)	1622	215
	f) Iron (mg)	8	0.9
	g) Calcium (mg)	543	40
	h) Other (optional)		
	actual % Fat	30%	21%
	actual % CHO	61%	79%
	actual % Protein	9%	4%
	Totals	100%	104%

Table E-8: RTG-154 NATO/PfP Supplement: Functional/Operational Assessment

1	Country	Canada (CAN)	United States (USA)
3	Supplement Name	Light Meal Combat Pack (LMC)	Food Packet, CHO Supplement (CarboPack)
10	**Water Requirements**	670 ml	24 oz (710ml) H2O
11	**Packaging**	flexible laminated pouch	items pkg in foil lam & assembled in food packet; bev pwds in drink pouches
12	**Shipping Container Data**		
	a) Dimensions/ cube	dimension: 26 cm wide x 43 cm long x 47.5 cm high. Cube: 53,105 cm3/cc or 0.053 m cu	case dim: 15.75" L x 9.75" W x 6.25" D; cube: 0.6 cu ft/case; (16990 cm3); 60 cases per pallet
	b) Weight	10 kg/case, the average total weight of one LMC is 373 gr.	10.15 lbs/case (4.6 kg)
	c) Quantity or yield per case	24 pack per case	25 carbopacks/case
13	**Additional Data**		
14	**Comments**	there is no food preparation required only the reconstitution of the beverages beverage mixing bags are provided	procured via special order; easy to prepare & consume; 2 bev flavors/packet

Table E-9: RTG-154 NATO/PfP Supplement: Components

1	Country	Canada (CAN)	United States (USA)
3	Supplement Name	Light Meal Combat Pack (LMC)	Food Packet, Carbohydrate Supplement (CarboPack)
	Supplement Content		
	Food components	the pack contains a source of protein, dried fruit, pastry, granola bar, chocolate bar, candy roll and sport drink powder Menu #1 Beef Jerky 50 gr Dried Raisins 40 gr Hot Chocolate 28 gr Lemon-lime Sports Drink 21 gr Chewy Chocolate Chip Granola Bar 26 gr Rice Krispies Square 37 gr Mars Chocolate Bar 58 gr Life Savers Assorted Fruit Roll 32 gr Menu #2 Pepperoni 50 gr Strawberry Flavour Dried Cranberries 40 gr Hot Chocolate 28 gr Orange-pineapple Sports Drink 21 gr Bumble Berry Chewy Granola Bar 26 gr Muffin Bar - Brownies 38 gr Malted Milk Chocolate Bar 48 gr Caramel Candy Roll 50 gr Menu #3 Teriyaki Beef Jerky 50 gr Dried Pineapple and Papaya 40 gr Hot Chocolate 28 gr Ice Sports Drink 21 gr S'Mores Chewy Granola Bar 26 gr Muffin Bar - Carrot & Orange Zest 38 gr Mirage Chocolate Bar 41 gr Life Savers Pep-O-Mint Roll 24 gr	the contents of each food packet shall be two pouches of beverage powder and one bar; all bar types/flavors shall be procured in equal quantities and assembled in a uniform distribution; all beverage flavors shall be procured in equal quantities and assembled in a uniform distribution; each food packet shall contain two different beverage flavors 2 12-ounce beverages (powdered carbohydrate CHO electrolyte beverage base) Flavor I Fruit Punch Flavor II Grape Flavor III Lemon Lime Flavor IV Orange 1 carbohydrate rich energy bar (various flavors)

Data Collection Notes/Acronyms

Notes:

1. Areas highlighted are calculations to derive approximate percent basis of fat, carbohydrate and protein for each ration or supplement.
2. Some responses and data input may be truncated or abbreviated in order to conduct desk top analysis of ration and supplement assets.
3. Full data input resides on asset identification sheets or other directed input.

Acronyms/Abbreviations:

AR - Army Regulation
ASAP - As Soon As Possible
C - celsius
cc - cubic centimeters
CHO - carbohydrate
cm - centimeters
d - dimensions
dm - decimeter
ea - each
F - fahrenheit
FRH - Flameless Ration Heater
g - grams
GMO - Genetically Modified Organisms
gp - general purpose
hgt - height
hr - hour
in - inches
ISO - International Standards Organization
kcal - kilocalories
kg - kilograms
kJ - kilojoules
l - liters
lbs - pounds
METT-TC - Mission, Enemy, Terrain, Troops available – Time and Contractors (METT-TC) on the battlefield. Feeding options and ration mix is METT-TC dependent on equipment, logistics, and battlefield posture.
mos - months
NSOR - USA Nutritional Standards for Operational Rations as identified in Army Regulation AR40–25/ BUMEDINST 10110.6/ AFI 44–141
pkg - packaging
qty - quantity
rh - relative humidity
TTI - Time Temperature Indicator
w/o - without
yr - year
<= - less than or equal to; not to exceed
- number

MEASUREMENT UNITS CONVERSION FACTORS: USA System and Metric System (SI, or System International)

COMMON S.I. Prefixes (precedes a unit of measure to form a decimal multiple)				
10^n	**Prefix**	**Symbol**	**Scale**	**Decimal Equivalent**
10^3	kilo	k	Thousand	1000
10^2	hecto	h	Hundred	100
10^1	deca	da	Ten	10
10^{-1}	deci	d	Tenth	0.1
10^{-2}	centi	c	Hundredth	0.01
10^{-3}	milli	m	Thousandth	0.001

LENGTH (unit of length of S.I. = meter)			
US to Metric System		**Metric System to US**	
1 inch (in) – US	25.40005 mm	1 millimeter (mm)	0.03937 in (US)
1 foot (ft) = (12.in) – US	0.3048006 m	1 meter (m)	3.28083 ft (US)
1 yard (yd) = (3.ft) – US	0.9144018 m	1 meter (m)	1.093611 yd (US)

ENERGY			
1 calorie [nutritional]	4.1868 kilojoule	1 kilojoule	0.238845897 calorie [nutritional]

MASS (the unit of mass of S.I. = kilogram)			
US to Metric System		**Metric System to US**	
1 ounce (oz) – US	28.34952 g	1 gram (g)	0.03527396 oz avoirdupois av. (US)
1 pound (Ib) = 16 oz – US	0.4535937 kg	1 kilogram (kg)	2.204622 lb av. (US)

VOLUME (the unit of volume of S.I. = cubic meter)			
US to Metric System		**Metric System to US**	
1 cubic inch (cu in) – US	16,3871 cubic centimeter (cm^3)	1 cubic centimeter (cm^3)	0.061023744 cu in (US)
1 cubic foot (cu ft) – US	28.316846592 cubic decimeter (dm^3)	1 cubic decimeter (dm^3)	0.035314667 cu ft (US)
1 cubic yard (cu yd) – US	0.764554 m^3	1 cubic meter (m^3)	1.307950619 cu yd (US)

MEASURE OF CAPACITY			
US To Metric System		**Metric System to US**	
1 fluid ounce (fl oz) – US	29.5735 ml	1 milliliter (ml)	0.033814023 (fl oz)
1 gallon (US, liquid)	3.785411784 liter	1 liter	0.264172052 gallon [US, liquid]

TEMPERATURE	
Fahrenheit to Celsius	**Celsius to Fahrenheit**
°C = (°F - 32) ÷ 1.8	°F = (°C x 1.8) + 32

Annex F – COMBAT RATION COMPARISON

The information contained in this annex is drawn from comprehensive data collected and provided within the Data Matrix shown in Annex E. This annex readily provides a constructive side by side comparison of meaningful characteristics of individual combat rations from each of the participating nations. This collated information also provides the basis for results and discussion provided in Chapter 3 of this report.

Table F-1: Combat Ration Comparison, General Purpose Ration – Nutrition

GENERAL PURPOSE RATION

Nation	AUS	BEL/FRA	CAN	CZE	DEU	ITA	NLD	NOR (Trop)	NOR (Arc)	SVN	GBR	USA			
Ration Name (abbreviation)	CR1M	RCIR*	IMP	BDP	EPa	K Ration	Combat Ration	FR3800 (Tropical)	FR3800 (Arctic)	Individual Ration	24-h GP ORP	MRE			
													MEAN	**STDEV**	**CV**
Energy (kcal)	3700	**3200**	**4395**	3351	3524	3650	3682	3672	4044	3537	4294	3995	**3754**	**362**	**10**
Protein (g)	108	104	**141**	111	96	100	108	**90**	91	95	107	126	**106**	**15**	**14**
Carbohydrate (g)	593	440	**681**	**414**	501	521	540	649	614	518	618	528	**551**	**81**	**15**
Fat (g)	116	114	123	133	126	129	126	**89**	139	110	155	**157**	**126**	**19**	**15**
Sodium (mg)	5680	NS	**9381**	**2458**	8300	5250	8061	NS	NS	NS	8293	6850	**6784**	**2244**	**33**
Iron (mg)	32	20	26	21	**19**	**33**	**33**	NS	NS	NS	21	26	**26**	**5.8**	**23**
Calcium (mg)	968	800	1016	746	900	1079	**718**	NS	NS	NS	1444	**1705**	**1042**	**332**	**32**
Number of Menus**	8	14	6	**2**	6	7	**20**	8	8	3	10	8	**8.3**	**4.8**	**58**
Menu Cycle	8	14	6	**2**	3	7	**20**	8	8	3	10	8	**8.1**	**5.0**	**62**
Water Reqs (mL)	4000	807	2890	3100	3100	**300**	1900	3500	3000	3500	**5170**	2040	**2776**	**1344**	**48**

*RCIR is the French name; the Belgian version, which is identical to the French RCIR, is designated the "C Ration".
**The number of "ration menus" shown for CAN and USA is one-third of the number of meal menus.
NA = Not Applicable
NS = Not Supplied
The number in **blue** is the maximum in the row.
The number in **red** is the minimum in the row.
CV = Coefficient of Variation (CV) is the standard deviation expressed as a percentage of the mean.

Percentage contributions to total energy of protein, fat and carbohydrate (macronutrient distibution ratio)

Nation	AUS	BEL/FRA	CAN	CZE	DEU	ITA	NLD	NOR (Trop)	NOR (Arc)	SVN	GBR	USA			
Ration Name (abbreviation)	CR1M	RCIR*	IMP	BDP	EPa	K Ration	Combat Ration	FR3800 (Tropical)	FR3800 (Arctic)	Individual Ration	24-h GP ORP	MRE			
													MEAN	**STDEV**	**CV**
Protein	12	**13**	**13**	**13**	11	11	12	10	**9**	11	10	**13**	**12**	**1**	**12**
Fat	28	32	25	**36**	32	32	31	**21**	31	29	32	35	**30**	**4**	**14**
Carbohydrate	64	55	62	**49**	57	57	60	**69**	61	60	58	53	**59**	**5**	**9**
TOTAL*	**104**	100	100	**98**	100	100	**103**	100	**101**	100	100	**101**			

*The percentages do not sum to 100 for AUS, CZE, NLD, NOR (Arc) and USA. They are the reported percentages, and the discrepancies probably result from "experimental error" in the nutrient analyses.
The number in **blue** is the maximum in the row.
The number in **red** is the minimum in the row.
CV = Coefficient of Variation (CV) is the standard deviation expressed as a percentage of the mean.

Table F-2: Combat Ration Comparison, General Purpose Ration – Functional/Operational

GENERAL PURPOSE RATION															
Nation	**AUS**	**BEL/FRA**	**CAN**	**CZE**	**DEU**	**ITA**	**NLD**	**NOR (Trop)**	**NOR (Arc)**	**SVN**	**GBR**	**USA**			
Ration Name (abbreviation)	CR1M	RCIR	IMP	BDP	EPa	K Ration	Combat Ration	FR3800 (Tropical)	FR3800 (Arctic)	Indiv Ration	24-h GP ORP	MRE			
													MEAN	**STDEV**	**CV**
Weight of ration (kg)	1.8	1.5	2.2	1.6	1.6	**2.3**	1.7	**1.0**	**1.0**	1.6	1.9	2.0	**1.7**	**0.40**	**24**
Volume of ration (cubic cm)	3400	**2977**	7440	3500	3205	3600	4150	**8978**	**8978**	5300	4180	6976	**5224**	**2266**	**43**
Shipping Container													**MEAN**	**STDEV**	**CV**
Number of rations per intermediate container (packing case)	10	**12**	**3.3**	NS	6	10	10	8	8	10	10	**12**	**9.0**	**2.6**	**29**
Gross weight of packing case (kg)	10.1	18.6	8.95	NS	10	**23**	22	**8**	**8**	17	20	9.8	**14.1**	**6.0**	**42**
Volume of packing case (L)	**17.4**	54	30.6	NS	23.4	36	45	45.6	45.6	**98.9**	49.2	28.9	**43.1**	**21.8**	**50**
Pallet type	AUS	ISO	CAN#	NS	Euro	Euro	NS^	Euro	Euro	ISO	NATO	NATO			
Number of rations per pallet*	**400**	252	**106.6**	NS	260	210	NA	144	144	160	350	192	**222**	**95**	**43**
Number of ration menus per pallet**	**1**	7	2	NS	up to 3##	7	**1**	8	8	**1**	**10**	8	**5.3**	**3.6**	**68**
Volume of pallet (including pallet itself) (L)	NS	1280	1240	NS	1104	1728	Variable*	**1056**	**1056**	NS	**2022**	1352	**1355**	**347**	**26**
Weight of pallet + rations (kg)	750	465	305	NS	411	503	**782**	**188**	**188**	275	720	498	**462**	**216**	**47**

^NLD pallet has dimensions 120x100x15 cm.
*The NLD ration is issued as B/L and D packs separately; one pallet holds 490 B/L packs (and weighs 553 kg), or 960 tinned D packs (972 kg), or 960 pouched D packs (822 kg). Mean of these is 782 kg (reported here), while the maximum value reported in Chapter 3 is 972 kg.
**For CAN and USA the number of menus per pallet is taken to be one-third the number of one-meal menus.
#The CAN pallet is specifically designed for out-of-country shipments.
##For DEU the number of menus per pallet is 1-3, depending on the task.
NA = Not Applicable
NS = Not Supplied
The number in **blue** is the maximum in the row.
The number in **red** is the minimum in the row.
CV = Coefficient of Variation (CV) is the standard deviation expressed as a percentage of the mean.

Table F-3: Combat Ration Comparison, General Purpose Ration – Components

GENERAL PURPOSE RATION													
	AUS	**BEL/ FRA**	**CAN**	**CZE**	**DEU**	**ITA**	**NLD**	**NOR (Trop)**	**NOR (Arc)**	**SVN**	**GBR**	**USA**	
Ration Name (abbreviation)	CR1M	RCIR	IMP	BDP	EPa	K Ration	Combat Ration	FR3800 (Tropical)	FR3800 (Arctic)	Indiv Ration	24-h GP ORP	MRE	
Food Components (at least one menu includes at least one of the following)													**TOTAL**
Main courses	1	1	1	1	1	1	1	1	1	1	1	1	12
Coffee	1	1	1	1	1	1	1	1	1	1	1	1	12
Sports drink, energy drink or other fruit-flavoured beverage	1	1	1		1		1	1	1	1	1	1	10
Chocolate or chocolate bar	1	1	1		1	1	1		1	1	1	1	10
Sweet or oatmeal biscuits (~"cookies")	1	1	1	1		1		1	1		1	1	9
Milk, "concentrated milk", coffee whitener or coffee creamer	1	1	1		1	1	1			1	1	1	9
Chewing gum	1	1	1		1		1	1	1		1	1	9
Jam, peanut butter, honey or other sweet spread	1		1	1	1	1	1		1	1		1	9
Tea	1		1		1	1	1			1	1	1	8
Salt	1	1	1	1	1	1	1					1	8
Crackers	1	1	1	1	1	1	1					1	8
Sugar	1	1	1		1	1	1				1	1	8
Chocolate drink or cocoa	1	1	1				1	1	1		1	1	8
Soup (or "broth")	1	1	1			1	1				1	1	7
Candy, hard	1	1	1				1			1	1	1	7
Canned or retort pouch fruit, sweet cake, dairy or other sweet dessert	1	1	1		1	1				1		1	7
Sweet bar (e.g. nougat, muesli, fruit, "energy")	1	1				1		1	1	1		1	7
Cheese or cheese spread	1	1		1	1						1	1	6
Cereal, dry (e.g. muesli mix, oatmeal block, granola)	1		1							1	1	1	5
Pouched bread or similar (includes "lunch burger")			1	1	1					1		1	5
Starch (e.g. potato powder, potato goulash, pasta, rice, instant noodles)	1		1	1		1						1	5
Dried fruit (e.g. fruit grains, raisins)	1							1	1		1	1	5
Canned fish (e.g. tuna, mackerel)	1					1		1	1	1			5
Savoury Spreads (includes Pâté, mushroom spread, liver spread, chicken spread, and canned sausage)		1			1		1			1	1		5
Condiments, dry (e.g. pepper, curry powder, mustard)	1	1	1									1	4
Sauces (e.g. tabasco, chilli, soy, BBQ, steak, jalapeno ketchup)	1		1									1	3
Vegemite (salted, concentrated yeast extract)	1										1		2
Beans (as a separate food component)												1	1
Nuts (or raisins and nuts)												1	1
Dextrose tablets							1						1
Corn												1	1
TOTAL	25	18	21	**9**	15	15	16	**9**	11	14	17	**27**	

The number in **blue** is the maximum in the row.
The number in **red** is the minimum in the row.

Table F-4: Combat Ration Comparison, Special Purpose Ration – Nutrition

SPECIAL PURPOSE RATION

	AUS	BEL	DEU	NLD	NLD	NOR	NOR	USA	USA	USA			
Ration name (abbreviated)	PR1M	LRRP	EPa light	Arctic	LDRR	FR5000 (Trop)	FR5000 (Arc)	MCW	LRP	FSR			
Purpose or main user group	Patrol/SF	Patrol/SF	SF	Cold	Patrol ("Scouts")	SF (Tropical)	SF (Cold)	Cold	Assault/ Spec Ops	Assault			
											MEAN	**STDEV**	**CV**
Energy (kcal)	3800	3300	2200	5185	4190	4970	**5190**	4600	**1535**	2845	**3782**	**1285**	**34**
Protein (g)	116	140	67	113	101	123	119	**162**	**54**	87	**108**	**32**	**30**
Carbohydrate (g)	613	435	298	**871**	636	820	770	599	**200**	371	**561**	**228**	**41**
Fat (g)	118	120	82	139	139	131	**183**	175	**58**	124	**127**	**38**	**30**
Sodium (mg)	5236	NS	**11300**	9192	5001	NS	NS	7715	**2572**	4034	**6436**	**3085**	**48**
Iron (mg)	32	NS	37	37.5	**38**	NS	NS	29	**10**	15	**28**	**11**	**40**
Calcium (mg)	1012	NS	**3600**	1535	1618	NS	NS	1690	**563**	655	**1525**	**1024**	**67**
Number of Menus*	5	**3**	10	4	4	7	7	4	**12**	**3**	**5.9**	**3.1**	**52**
Menu Cycle	5	**3**	5	4	4	7	7	4	**12**	**3**	**5.4**	**2.7**	**50**
Water Requirements (mL)**	**5400**	2300	3050	4500	3600	3800	3800	3016	1005	**710**	**3118**	**1462**	**47**

*Number of "ration menus" for the USA MCW is one-third of the number of meal menus.
**Water requirements shown for USA MCW and LRP are means of the range of values provided.
NA = Not Applicable
NS = Not Specified
Number in **blue** is the maximum in the row.
Number in **red** is the minimum in the row.
CV = Coefficient of variation (CV) is the standard deviation expressed as a percentage of the mean.

Ratio of contributions to total energy of protein, fat and carbohydrate (macronutrient distibution ratio)

Nation	AUS	BEL	DEU	NLD	NLD	NOR	NOR	USA	USA	USA			
Ration name (abbreviated)	PR1M	LRRP	EPa light	Arctic	LDRR	FR5000 (Trop)	FR5000 (Arc)	MCW	LRP	FSR			
Purpose or main user group	Patrol/SF	Patrol/SF	SF	Cold	Patrol ("Scouts")	SF (Tropical)	SF (Cold)	Cold	Assault/ Spec Ops	Assault			
											MEAN	**STDEV**	**CV**
Protein	12	**17**	12	**9**	10	10	**9**	14	14	12	**12**	**3**	**21**
Fat	28	33	34	**24**	30	**24**	32	34	34	**39**	**31**	**5**	**15**
Carbohydrate	65	53	54	**67**	61	66	59	**52**	**52**	**52**	**58**	**6**	**11**
TOTAL*	**105**	**103**	100	100	**101**	100	100	100	100	**103**			

*The percentages do not sum to 100 for AUS, BEL, NLD (LDRR) and USA (FSR). They are the reported percentages, and the discrepancies probably result from "experimental error" in the nutrient analyses.
Number in **blue** is the maximum in the row.
Number in **red** is the minimum in the row.
CV = Coefficient of variation (CV) is the standard deviation expressed as a percentage of the mean.

Table F-5: Combat Ration Comparison, Special Purpose Ration – Functional/Operational

SPECIAL PURPOSE RATION													
	AUS	**BEL**	**DEU**	**NLD**	**NLD**	**NOR**	**NOR**	**USA**	**USA**	**USA**			
Ration name (abbreviated)	PR1M	LRRP	EPa light	Arctic	LDRR	FR5000 (Trop)	FR5000 (Arc)	MCW	LRP	FSR			
Purpose or main user group	Patrol/ SF	Patrol/ SF	SF	Cold	Patrol ("Scouts")	SF (Tropical)	SF (Cold)	Cold	Assault/ Spec Ops	Assault			
											MEAN	**STDEV**	**CV**
Weight of ration (kg)	0.90	1.00	0.75	**1.52**	1.16	1.20	1.20	1.36	**0.45**	1.13	**1.07**	**0.31**	**29**
Volume of ration (cubic cm)	3400	2600	2140	**9000**	6800	8978	8978	3398	**1133**	2832	**4926**	**3154**	**64**
Shipping Container											**MEAN**	**STDEV**	**CV**
Number of rations per intermediate container (packing case)	5	**12**	5	8	**12**	8	8	**4**	**12**	9	**8.3**	**3.0**	**36**
Gross weight of packing case (kg)	5.6	12.6	**3.6**	15	**17**	9.6	9.6	6.8	6.8	11.3	**9.8**	**4.3**	**43**
Volume of packing case (L)	17.4	54	**10.7**	72	**82.1**	45.6	45.6	28.9	28.9	28.9	**41.4**	**23.0**	**56**
Number of rations per pallet*	480	252	272	192	192	**144**	**144**	192	**576**	432	**288**	**153**	**53**
Number of ration menus per pallet	**1**	NS	#up to 5	4	4	NS	NS	4	**12**	3	**4.7**	**3.8**	**81**
Volume of pallet (including pallet itself) (L)	NS	1272	**1104**	**1944**	1860	NS	NS	1589	1589	1589	**1564**	**297**	**19**

*The number of rations for the USA MCW is one-third of the number of individual meal menus (one "ration" consists of three meals). The number of rations for the USA LRP is based on a single meal per day as this is a restricted ration which provides suboptimal levels of energy (approximately 1500 calories) and nutrients and is intended for only short periods of use.
#For DEU the number of menus per pallet is 1-5 depending on the task.
NA = Not Applicable
NS = Not Supplied
The number in **blue** is the maximum in the row.
The number in **red** is the minimum in the row.
CV = Coefficient of Variation (CV) is the standard deviation expressed as a percentage of the mean.

Table F-6: Combat Ration Comparison, Special Purpose Ration – Components

SPECIAL PURPOSE RATION											
	AUS	**BEL**	**DEU**	**NLD**	**NLD**	**NOR**	**NOR**	**USA**	**USA**	**USA**	
Ration name (abbreviated)	PR1M	LRRP	EPa light	Arctic	LDRR	FR5000 (Trop)	FR5000 (Arc)	MCW	LRP	FSR	
Purpose or main user group	Patrol/ SF	Patrol/ SF	SF	Cold	Patrol ('Scouts')	SF (Tropical)	SF (Cold)	Cold	Assault/ Spec Ops	Assault	
Food Components (at least one menu incl at least one of the following)											**TOTAL**
Main meals	1	1	1	1	1	1	1	1	1	1	10
Coffee	1	1	1	1	1	1	1	1	1	1	10
Sweet bar (e.g. sports, nougat, muesli, fruit, "energy")	1	1	1	1	1	1	1	1	1	1	10
Sports drink, energy drink, fruit-flavoured beverage or "mineral drink"	1	1	1	1	1	1	1	1	1	1	10
Sweet or oatmeal biscuits (~"cookies")	1		1	1	1	1	1	1	1	1	9
Chewing gum (including caffeinated gum)	1		1	1	1	1	1	1	1	1	9
Salt	1	1	1	1	1			1	1	1	8
Sugar	1	1	1	1	1			1	1	1	8
Tea	1		1	1	1			1	1	1	7
Chocolate or cocoa drink	1			1	1	1	1	1	1		7
Milk, coffee whitener or coffee creamer	1		1	1	1			1	1	1	7
Chocolate or chocolate bar (includes M&Ms)	1			1	1		1	1	1	1	7
Jam, peanut butter, honey or other sweet spread	1					1	1	1	1	1	6
Sauces (e.g. tabasco, chilli, soy, BBQ, steak, jalapeno ketchup)	1			1	1			1	1	1	6
Crackers	1			1	1			1	1	1	6
Soup (or "broth")		1		1	1			1	1		5
Condiments, dry (e.g. pepper, curry powder, mustard)	1			1	1					1	4
Dried fruit (e.g. fruit grains, raisins)	1			1		1	1				4
Canned or pouched fish (e.g. tuna, mackerel)	1					1	1			1	4
Starch (potato pwdr, potato goulash, pasta, rice, inst noodles, tortilla)	1							1	1	1	4
Cereal, dry (muesli mix, oatmeal block, granola) or "oatmeal porridge"				1	1			1	1		4
Cheese or cheese spread								1	1	1	3
Candy, hard	1					1	1				3
Nuts (or "nut fruit mix"or "raisins and nuts")								1	1	1	3
Vitamin tablet			1	1	1						3
Canned or retort pouch fruit, sweet cake, dairy or other sweet dessert								1	1	1	3
Milky drink' (or dairy-based beverage)		1						1	1		3
Dextrose tablets				1	1						2
Beef jerky or "beef snacks"		1								1	2
Spread or paste, savoury (e.g. mushroom, liver, chicken)				1	1						2
Vegemite (salted, concentrated yeast extract)	1										1
"Energetic Complement" (type of survival ration)		1									1
Pouched bread or similar (incl "lunch burger" & "shelf-stable sandwich"										1	1
Carbohydrate fortified apple sauce										1	1
Mayonnaise										1	1
TOTAL	21	**10**	11	21	20	11	12	22	22	**24**	

The number in **blue** is the maximum in the row.
The number in **red** is the minimum in the row.

Table F-7: Combat Ration Comparison, Ration Supplement – Nutrition/Functional/Operational

SUPPLEMENTS									
	CAN	**USA**			**% Energy from Protein, Fat, CHO**				
Name of Supplement	LMC	Carbo Pack				Protein	Fat	CHO	**TOTAL***
Intended Application	Arduous conditions, patrol	High intensity activity			**CAN**	9	30	61	100
Basis of Issue	One pack	One per 24 hr			**USA**	4	21	79	**104**
Shelf Life	36 mos	24 mos	Ratio of value for LMC						
Storage Requirements	24°C/ 75°F, dry, temp controlled	80°F (27°C), none	to that of CarboPack						
Energy (kcal)	1475	380	3.9						
Protein (g)	33	4	8.3						
Carbohydrate (g)	225	75	3.0						
Fat (g)	49	9	5.4						
Sodium (mg)	1622	215	7.5						
Iron (mg)	8	0.9	8.9						
Calcium (mg)	543	40	13.6						
Water requirements (mL)	670	710							
Packaging	Flexible laminated pouch	Foil laminate/food packet							
Shipping Container Data									
Dimensions (cm)	26x43x47.5	40x24.8x15.9							
Volume (L)	53.11	16.99							
Weight per case (kg)	10	4.6							
Quantity per case	24	25							
Weight of pallet + rations (kg)	260	NS							
Comments		Procured by special order							

*The percentages do not sum to 100 for USA. They are the reported percentages, and the discrepancies probably result from "experimental error" in the nutrient analyses.
NA = Not Applicable
NS = Not Supplied

Table F-8: Combat Ration Comparison, Ration Supplement – Components

SUPPLEMENTS		
	CAN	**USA**
Name of Supplement	LMC	Carbo Pack
Intended Application	Arduous conditions, patrol	High intensity activity
Components	Menu 1	2 x 355 mL CHO/electrolyte beverage
	Beef Jerky 50 g	plus 1 CHO-rich energy bar (various flavours)
	Dried Raisins 40 g	
	Hot Chocolate 28 g	Flavor I Fruit Punch
	Lemon-lime Sports Drink 21 g	Flavor II Grape
	Chewy Chocolate Chip ganola Bar 26 g	Flavor III Lemon Lime
	Rice Krispies Square 37 g	Flavor IV Orange
	Mars Chocolate Bar 58 g	1 carbohydrate rich energy bar (various flavors)
	Life Savers Assorted Fruit Roll 32 g	
	Menu 2	
	Pepperoni 50 g	
	Strawberry Flavoured Dried Cranberries 40 g	
	Hot Chocolate 28 g	
	Orange-pineapple Sports Drink 21 g	
	Bumble Berry Chewy granola Bar 26 g	
	Muffin Bar - Brownies 38 g	
	Malted Milk Chocolate Bar 48 g	
	Caramel Candy Roll 50 g	
	Menu 3	
	Teriyaki Beef Jerky 50 g	
	Dried Pineapple and Papaya 40 g	
	Hot Chocolate 28 g	
	Ice Sports Drink 21 g	
	S'Mores Chewy granola Bar 26 g	
	Muffin Bar - Carrot & Orange Zest 38 g	
	Mirage Chocolate Bar 41 g	
	Life Savers Pep-O-Mint Roll 24 g	

Annex G – COMBAT RATION PHOTOGRAPHS

G.1 AUSTRALIA

G.1.1 Combat Ration One Man (CR1M)

Figure G-1: Combat Ration One Man (CR1M) – Australia.

G.1.2 Patrol Ration One Man (PR1M)

Figure G-2: Patrol Ration One Man (PR1M) – Australia.

G.2 BELGIUM

G.2.1 C Ration (Gevechsrantsoen)

Figure G-3: C Ration (Gevechsrantsoen) – Belgium.

G.2.2 Long Range Recce Patrol

Figure G-4: C Long Range Recce Patrol – Belgium.

G.3 CANADA

G.3.1 Individual Meal Pack (IMP)

Figure G-5: Individual Meal Pack (IMP) – Canada.

G.4 FRANCE

G.4.1 Ration de Combat Individuelle Réchauffable

Figure G-6: Ration de Combat Individuelle Réchauffable (RCIR) – France.

G.5 GERMANY

G.5.1 Individual Combat Ration (Einmannpackung (EPa))

Figure G-7: Individual Combat Ration (Einmannpackung (EPa)) – Germany.

G.5.2 Individual Combat Ration, Light-Weight (Einmannpackung, Leicht (EPa, Leicht)) (contains meals for five solders)

Figure G-8: Individual Combat Ration, Light-Weight (Einmannpackung, Leicht (EPa, Leicht)) – Germany.

G.6 ITALY

G.6.1 Combat Ration Individual (K-Ration)

Figure G-9: Combat Ration Individual (K-Ration) – Italy (cont'd on next page).

Figure G-9: Combat Ration Individual (K-Ration) – Italy.

G.7 NETHERLANDS

G.7.1 Combat Ration

Figure G-10: Combat Ration – Netherlands.

G.7.2 Long Distance Reconnaissance Ration

Figure G-11: Long Distance Reconnaissance Ration – Netherlands.

G.7.3 Arctic Ration

Figure G-12: Arctic Ration – Netherlands.

G.8 NORWAY

G.8.1 FR3800 (Feltrasion 3800 kcal) Arctic

Figure G-13: FR3800 (Feltrasion 3800 kcal) Arctic – Norway (cont'd on next page).

Figure G-13: FR3800 (Feltrasion 3800 kcal) Arctic – Norway.

G.9 SLOVENIA

G.9.1 Individual Ration

Figure G-14: Individual Ration – Slovenia.

G.10 UNITED KINGDOM

G.10.1 24 Hr General Purpose Operational Ration Pack

Figure G-15: 24 Hr General Purpose Operational Ration Pack – United Kingdom.

G.11 UNITED STATES

G.11.1 Meal, Ready-to-Eat™ (MRE™)

Figure G-16: Meal, Ready-to-Eat™ (MRE™) – United States.

G.11.2 First Strike Ration® (FSR®)

Figure G-17: First Strike Ration® (FSR®) – United States.

G.11.3 Food Packet, Carbohydrate Supplement (CarboPack)

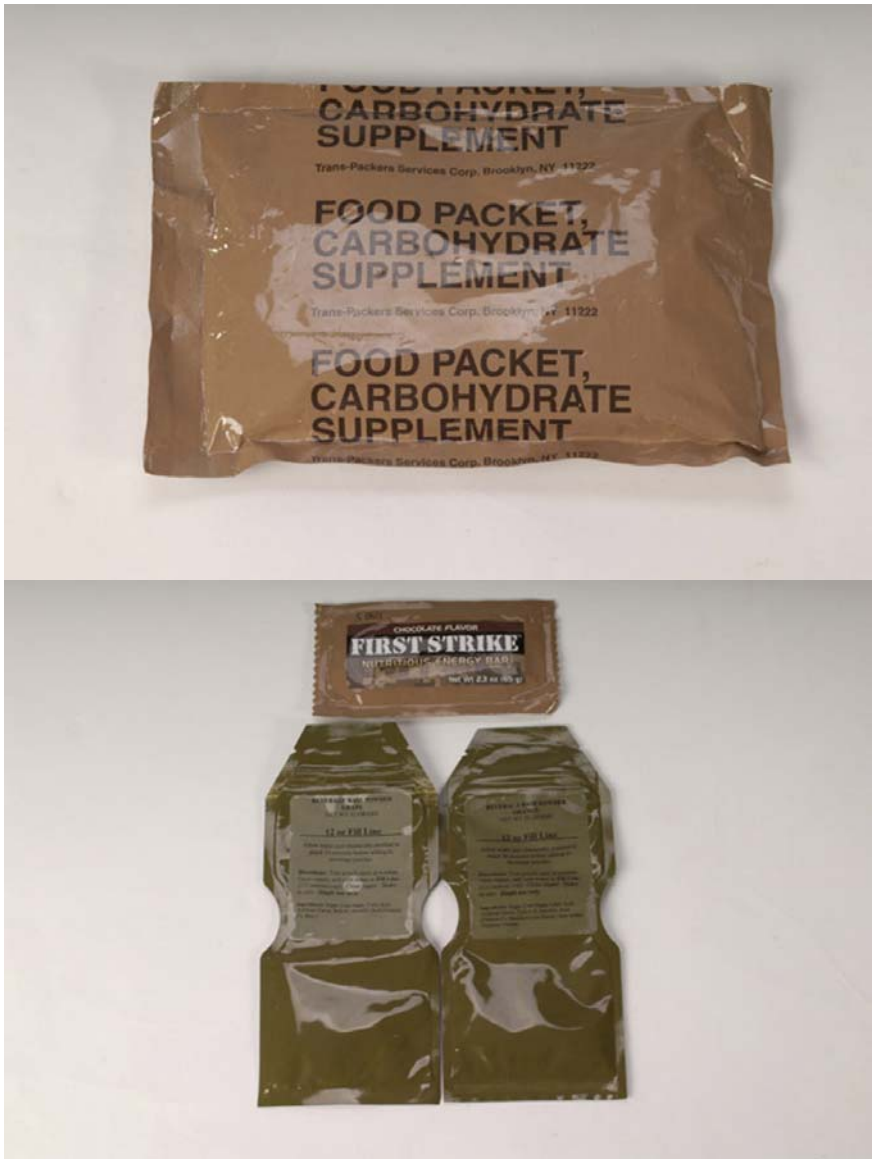

Figure G-18: Carbohydrate Supplement (CarboPack) – United States.

G.11.4 Food Packet, Long Range Patrol (LRP)

Figure G-19: Food Packet, Long Range Patrol (LRP) – United States.

G.11.5 Meal, Cold Weather (MCW)

Figure G-20: Food Meal, Cold Weather (MCW) – United States.

Annex H – STANAG 2937 MED (EDITION 3): SURVIVAL, EMERGENCY, AND INDIVIDUAL COMBAT RATIONS – NUTRITIONAL VALUES AND PACKAGING

Standardization Agreement (STANAG) 2937, Edition 3, referenced in this annex and promulgated on 9 May 2001, is classified as 'NATO/PFP UNCLASSIFIED' and therefore cannot be published as an annex to the report. This document is available, however, to all authorized parties and can be obtained from the NATO Standardization Agency at nsa@nsa.nato.int.

The objective of the agreement is to standardize nutritional values and certain key elements of the contents of combat rations, specifically survival, emergency and individual combat rations, in order to facilitate the interoperability of rations between alliance nations and coalition forces during joint, multinational operations. The definitions of each of these ration types is established in the STANAG along with performance based characteristics for nutrition, shelf life, general contents or composition, operational use, preparation for consumption, quality, packing and marking requirements, and ancillary items.

The participating nations that ratify, implement, or implement with limitations, will comply, to the extent practical, with the requirements contained in the agreement. It is important to note that this STANAG is periodically revisited within the NATO community in coordination with the participating nations and modified as needed to reflect performance requirements that align with interoperability goals and satisfy operational requirements which support emerging military plans and doctrine.

The relevance of STANAG 2937 to this Research Task Group is that it provides an initial baseline for performance related requirements for individual combat rations from which further analyses can be conducted. These analyses include rather broadly the assessment of nutritional composition, evaluation of the extent of interoperability, examination of possible collateral issues facing member countries, and more importantly, consideration of current and future military needs and mission requirements.

Annex I – NATION NUTRITION STANDARDS INFORMATION

The Nation Nutrition Standards Information contained in this Annex is the result of a comprehensive survey conducted by the NATO Research Task Group 154 in August 2007. This survey was distributed to all NATO and PfP nations in an attempt to collect detailed information regarding both military rations and nutritional standards in order to evaluate the suitability and compatibility of identified ration assets in best serving NRF operational mission requirements.

The following specific nutrition related questions were addressed as part of this broad survey.

QUESTION 1:

Please identify the agency or organization in your country is responsible for the determination of nutrition standards for military forces.

QUESTION 2:

Please identify the document that defines or describes the nutrition standards for the military and for the development or procurement of rations. If a copy of this document or web reference is available, please provide a copy with your response.

QUESTION 3:

Please describe how your rations, ration packs, and/or supplements are analyzed to insure compliance with nutritional standards and which agency conducts these assessments. If this is done by an external agency, please cite that agency and a Point of Contact, if available.

Table I-1: NATO RTG-154 Nutrition Policy Regulatory and Compliance Survey

Country		Abbrev.	SURVEY QUESTIONS			Nutrition Reference Document Provided
			Q1: Agency/organization responsible for determination of nutrition standards for military forces?	Q2: Document that defines nutrition standards for the military and for the development or procurement of rations.	Q3: Describe how rations are analyzed to insure compliance with nutritional standards; what agency conducts assessments? Identify agency/ Point of Contact.	
1	Australia	AUS	Joint responsibility of Directorate of Logistics-Army (DLOG-A), & Defence Catering Policy Cell (DCPC) within Strategic Logistics Branch. DSTO-Scottsdale provides S&T support/ advice on nutrition standards.	"User Requirements" for ration packs are being developed by DLOG-A, DCPC, the Australian defence procurement agency Defence Material Organisation (DMO) with involvement from DSTO Scottsdale. The nutritional stds are described in DSTO-Scottsdale report, "ADF Nutrient Requirements in the 21st Century" (2002); recommendations updated in DSTO report, "Australian Defence Force Nutritional Requirements in the 21st Century (Version 1)" (2009).	This is being addressed as a component of the development of user requirements for ration packs. In the past, DSTO-Scottsdale has provided this capability. Consideration is being given to the appointment of a prime contractor for ration pack procurement, packing and dissemination. Negotiation is proceeding between DSTO-Scottsdale and DMO on the nature of the S&T support (including quality assurance with respect to nutrition) that will be provided in future. An S&T plan for the provision of this support by DSTO-Scottsdale to DMO is being developed. (Agreement in place and a prime contractor to be appointed in 2009.)	Yes ADF Nutrient Requirements in the 21st Century
2	Belgium	BEL	Nutritional requirements are historical and have not been reviewed in recent years.	STANAG 2937 MED is reference document.	Belgium procures rations from the French Army and they perform Quality Control. During storage, samples might be analyzed for food safety issues by the Veterinary Service. When we were buying rations or components, analyses were performed by the Veterinary service.	Yes STANAG 2937 MED

Table I-1: NATO RTG-154 Nutrition Policy Regulatory and Compliance Survey (cont'd)

	Country	Abbrev.	SURVEY QUESTIONS			Nutrition Reference Document Provided
			Q1: Agency/organization responsible for determination of nutrition standards for military forces?	Q2: Document that defines nutrition standards for the military and for the development or procurement of rations.	Q3: Describe how rations are analyzed to insure compliance with nutritional standards; what agency conducts assessments? Identify agency/ Point of Contact.	
3	Canada	CAN	Responsibility for the determination of nutrition standards for the Canadian Forces is the Directorate of Food Services. Standards are based on Canada's Food Guide (CFG), and adjusted to satisfy the particular requirements linked to the military activities and supported by published scientific research. The CFG defines and promotes healthy eating for Canadians by translating the science of nutrition and health into a healthy eating pattern. It emphasizes the importance of combining healthy eating and physical activity. CFG is based on the Canadian Dietary Reference Intakes (DRIs), a comprehensive set of nutrient reference values for healthy populations that can be used for assessing and planning diets. The DRIs are established by Canadian and American scientists through a review process overseen by the U.S. National Academies, which is an independent, nongovernmental body.	The nutrition standards are found in the Food Svcs Manual, which is issued on the authority of the Chief of the Defence Staff. The development and procurement of combat rations is based on the Statement of Requirement, which is produced by a Working Group composed of the primary stakeholder (the Army) and staff from the Directorate of Food Services.	Analysis of the nutrients is done for every meal by preparing a composite (slurry) of all the components of each meal. External agencies perform the analysis on a contractual basis. The last contract was awarded to the University of Guelph, Guelph, Ontario. Since the contract is given on a competitive basis, there is not a specific point of contact attributed on a continuous basis.	Not provided
4	Czech Republic	CZE	University of Defence Brno, Czech Republic	STANAG 2937 MED	Individual combat rations are analyzed by maker (producer) and they are controled by Ministry of health service.	Yes STANAG 2937 MED
5	France	FRA	SCERCAT / food department (organization of the french ministry of defense) - SCERCAT is compliant with ISO 9001 standard. SCERCAT works in cooperation with the Health Central Direction of the ministry of defense.	STANAG 2937 MED The components of the rations are detailed in technical specifications.	Each batch of component is analysed by the LCAT (internal laboratory of the ministry of defense, located near the packaging centre). The LCAT is compliant with ISO 17025 standard for microbiological and chemical food analysis (multilateral agreements ILAC and IAF). The traceability of each batch of components and rations is guaranteed. The packaging centre (within the ministry of defense) is equiped with a global computing system. The laboratory is also equiped with a LIMS (Laboratory Information Management System).	Not provided

Table I-1: NATO RTG-154 Nutrition Policy Regulatory and Compliance Survey (cont'd)

Country		Abbrev.	SURVEY QUESTIONS			Nutrition Reference Document Provided
			Q1: Agency/organization responsible for determination of nutrition standards for military forces?	Q2: Document that defines nutrition standards for the military and for the development or procurement of rations.	Q3: Describe how rations are analyzed to insure compliance with nutritional standards; what agency conducts assessments? Identify agency/ Point of Contact.	
6	Germany	DEU	For the Federal Armed Forces, the Federal Ministry of Defense is responsible for the determination of nutrition standards for military forces.	The nutrition standards for the Federal Armed Forces are set down in the Federal Armed Forces regulations. The composition of the rations is written down in the so-called stockpiling plans. The stockpiling plans for the Individual combat ration (EPa) and the Individual combat ration, light-weight (EPa, leicht) are attached. For the procurement of the rations there are so-called technical specifications for every item noted that contain requirements concerning the packaging, ingredients, analytical parameters, content etc. Those technical specifications can be seen in the internet on the website www.bwb.org, via the link "technical specifications".	The compliance of the rations with nutrition standards is guaranteed by the quality assessment of every delivery. This quality assessment is done by several means: - inspection begins within the manufacturer's plant performed by the Quality Assurance Inspector - sensory analysis is conducted by the Federal Office of Defense Technology and Procurement - analytical assessment is performed by the laboratories of the Central Medical Service of the Federal Armed Forces; analytical assessment provided by labs of Defence Medical Service and by external labs.	Yes An extract of the Federal Armed Forces regulations concerning the nutrition standards is provided.
7	Italy	ITA	Responsibility for determination of nutrition standards for military forces resides with the General Directorate for Supply and General Services, in cooperation with the General Directorate of Military Health (through the nutritional experts appointed by each Service), under the high supervision of the National Institute for Research on Food and Nutrition.	The document is under development by the aforementioned bodies, having as reference the "Livelli di Assunzione Raccomandati di Energia e Nutrienti per la Popolazione Italiana (L.A.R.N.)", revisione 1996, S.I.N.U. (Società Italiana di Nutrizione Umana); "Recommended Energy And Nutrients Assumption Levels For The Italian Population (L.A.R.N.)", Issue 1996, S.I.N.U. (Italian Society of Human Nutrition), Rome.	Prior to consumption all combat rations are subject to a test carried out by a technical team which insures compliance with the Technical Specifications. All analyses are presently conducted by certified external national agencies.	Yes STANAG 2937 MED

Table I-1: NATO RTG-154 Nutrition Policy Regulatory and Compliance Survey (cont'd)

	Country	Abbrev.	SURVEY QUESTIONS			Nutrition Reference Document Provided
			Q1: Agency/organization responsible for determination of nutrition standards for military forces?	Q2: Document that defines nutrition standards for the military and for the development or procurement of rations.	Q3: Describe how rations are analyzed to insure compliance with nutritional standards; what agency conducts assessments? Identify agency/ Point of Contact.	
8	Netherlands	NLD	The organisation responsible for the determination of nutrition standards for the military forces in the Netherlands is Paresto (the military catering organisation) department Quality management. These standards are based on the directions mentioned in the STANAG 2937 and based on several scientific studies made by TNO Nutrition and Food Research.	We use several documents made by TNO Nutrition and Food research. These documents describe the nutrition standards we use for the development of our rations. In the following documents you will find the nutrition standards we use. TNO rapport • Modular operational rations Part I & II V6385/TD 2005-0387 May 2005 • Modular operational rations Part III: Filling up, computation and evaluation conceptual version V7238/ TD 2006-0628 November 2006 • Rations 'hot climates' V 5814/TD 2004-0268 June 2004 • The investigation of energy expenditure of personnel of the Royal Armed Forces. V99.641/TD 99-0317 May 1999 • Desirability of vitamin enrichment of food rations V97.326/TD97-0204 February 1997 For the procurement of our rations we use technical specifications. In these specifications we describe the ingredients the way of packaging and printing, the nutritional values the products need to have. We also mention several chemical and microbiological parameters which we demand.	The compliance of the rations with nutritional standards and the technical specifications is guaranteed by the quality assessment per delivery. There is an inspection from our Quality Assurance Inspector during each production. After production samples will be tested by sensory analyses at our own department. If necessary we ask certificated laboratories to do an analytic assessment.	Not provided
9	Norway	NOR	Norwegian Defence/Systems Management Division/ Soldier and Base Systems	National/Nordic recommendations based on age/physical activity are used in the design of military rations (Nordic Nutrition Recommendations 2004-Integrating nutrition and physical activity).	The Norwegian military has used Norsk Matanalyse, a laboratory that analyzes field rations. Point of contact is Steffen Solem, Director Sensory, +47 90954801, e-mail: sts@matanalyse.no; Post@matanalyse.no	Yes Nordic Nutrition Recommendations 2004. 4th edition, *Integrating nutrition and physical activity*, Nord 2004:13

Table I-1: NATO RTG-154 Nutrition Policy Regulatory and Compliance Survey (cont'd)

Country		Abbrev.	SURVEY QUESTIONS			Nutrition Reference Document Provided
			Q1: Agency/organization responsible for determination of nutrition standards for military forces?	Q2: Document that defines nutrition standards for the military and for the development or procurement of rations.	Q3: Describe how rations are analyzed to insure compliance with nutritional standards; what agency conducts assessments? Identify agency/ Point of Contact.	
10	Slovenia	SVN	For Determination of nutrition standards for Slovenian Armed Forces Ministry of Defence, Armament and Equipping Office, Military Technology, Research and Development Division is responsible. The Military Technology, Research and Development Division sets nutrition standards, which are reviewed and discussed also with experts from Nutrition Division of Ljubljana University before they are issued. The authorizing authority is Minister of Defence. The Regulations of Quality of Military Combat Ration also determine part of nutrition standards for combat rations together with other quality determinants. They are issued by The Military Technology, Research and Development Division.	Nutrition Standards for Slovene Armed Forces (in Slovene) define military nutrition. In these standards all types of military nutrition are defined, mainly according to degree of physical activity, sex, etc. The Regulations of Quality of Military Combat Ration (each type) define quality and some nutrition parameters for combat rations. They are also procurement regulations for combat rations.	Representative samples of all items in each shipment are analysed for macronutrient content, energy and microbiologically. Chemical analyses for potential chemical hazards (toxins, antibiotics, pesticides etc.) are done occasionally. Independent stately proven laboratory is responsible for analytical assessment (usually Zavod za zdravstveno varstvo Ljubljana). Beside analysis inspection of each shipment is done by Quality Department and later on during life cycle by Military Medical Service (veterinarians) and their laboratories.	Yes Regulations of Quality of Military Combat Rations
11	United Kingdom	GBR	DFS IPT have funded contractors to develop guidelines. This was initially a Services Nutrition Advisory Panel (SNAP) role and the new guidelines will be presented to SNAP in early 2008 for their endorsement.	The guidelines that are currently in use are those that were proposed in a review conducted in 2004. The new draft guidelines are still to be endorsed and a copy will be forwarded to the RTG as soon as they become available. Reference: UK Military Dietary Reference Values (MDRV) 2007 DRAFT (GBR), (Dec 2007); prepared on behalf of the UK Defence Food Service IPT by QinetiQ Ltd.	DFS IPT have out sourced their laboratory support for analysing ORP. The current contractor to provide this service is: CCFRABSI Chipping Campden Gloucester GL55 6LD	Yes Draft of UK MDRV 2007 provided

Table I-1: NATO RTG-154 Nutrition Policy Regulatory and Compliance Survey (cont'd)

Country		Abbrev.	SURVEY QUESTIONS			Nutrition Reference Document Provided
			Q1: Agency/organization responsible for determination of nutrition standards for military forces?	Q2: Document that defines nutrition standards for the military and for the development or procurement of rations.	Q3: Describe how rations are analyzed to insure compliance with nutritional standards; what agency conducts assessments? Identify agency/ Point of Contact.	
12	United States	USA	The Surgeon General, US Army, exercises US Department of Defense (DoD) responsibility for Nutritional Standards and Education and establishes nutritional standards for military forces. This includes all meals served to military personnel subsisting under normal operating conditions, while under simulated or actual combat conditions, and nutritional standards for operational rations and restricted rations.	Army Regulation AR40-25/ BUMEDINST 10110.6/ AFI 44-141, Nutrition Standards and Education, 15 June 2001. This regulation establishes nutritional standards, termed "military dietary reference intakes" (MDRIs), for military feeding and establishes nutritional standards for operational rations (NSOR). It covers responsibilities of the services' Surgeons General and the services' food service programs. It identifies the effects of environmental factors on energy and nutrient requirements and outlines nutrition education policy. The nutrition standards apply to the services' hospital food service programs, the services' food service programs, and the DoD Combat Feeding Program. Compliance with this regulation is required for all food service operations, whether provided by government sources or through contractor support. The nutrition education policy applies to the services' medical, personnel and logistics communities.	Nutritional analysis is conducted by NSRDEC, CFD to design recommended menus & ensure rations provide adequate nutrition as mandated by the Surgeon General in compliance with NSOR (AR40-25). Contractors req to provide formulations & nutritional information on military unique components using Genesis Nutrition Software program by ESHA. Vendors provide a copy of nutritional facts label for each commercial item purchased for the ration. Data is compiled/ entered into Excel database for menu planning. Analytical data, if available, is used before Genesis data or nutrition facts labels for compts. USDA validates selected macro and micro nutrients at the point of production. CFD conducts research on subsistence storage eval including sensory, chemical, micro & nutritional chgs, stability, shelf life, menu dev, nutritional content & consumer acceptability on recipes, menus & portion size, IAW AR 40-25 regulatory guidance & policy. CFD collaborates with US Army MRMC, USARIEM in maintaining access to nutrient database & joint performance & nutrition research. Point of Contact: DoD, CFD, ATTN: RDNS-CFI, NSRDEC 15 Kansas Street, Natick, MA. 01760-5018.	Yes Army Regulation AR 40-25

Annex J – RECOMMENDATIONS FOR NUTRIENT COMPOSITION OF COMBAT RATIONS FOR THE NATO RESPONSE FORCE

Energy and Nutrient Recommendations and Consideration of Current Combat Rations

This work and output report were conducted during 2008 by leading nutrition researchers at Wageningen University and Research Centre, Wageningen, Netherlands on behalf of this Research Task Group. The objective of this effort was to determine recommendations for energy, all macro and the most relevant micronutrients for personnel deployed for missions of the NRF, based on the worst-case mission scenario of high-intensity, continuous combat operations and exposure to extreme environments (heat, cold, and/or high altitudes). These recommendations are applicable to combat rations which are consumed for up to 30 days. The nutrient content of existing individual combat rations of eleven NATO countries were evaluated based on these recommendations with supplementation recommended where it was believed to be necessary.

Recommendations for nutrient composition of combat rations for the NATO Response Force

Energy and nutrient recommendations and consideration of current combat rations

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Colophon

Title	Recommendations for nutrient composition of combat rations for the NATO Response Force: Energy and nutrient recommendations and consideration of current combat rations
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Content

1 Introduction

The NATO Response Force (NRF) is a highly ready and technologically advanced force made up of land, air, sea and special forces components that the Alliance can deploy quickly wherever needed. The NRF enables the NATO to respond swiftly to various types of crises anywhere in the world. It is capable of 1) performing missions worldwide across the whole spectrum of operations, such as evacuations, disaster management, counterterrorism, and 2) acting as 'an initial entry force' for larger, follow-on forces. It can number up to 25,000 troops and start to deploy after five days' notice and sustain itself for operations lasting 30 days or longer if resupplied (1).

NRF ground missions are diverse and can take place all over the world, in extreme environments and situations. Thus, the activities of NRF personnel might require high intakes of energy and specific nutrients to maintain their health. Furthermore, nutrition recommendations for NRF personnel will not only be designed to preserve health but also to optimize performance. Therefore, tailored nutrition recommendations are essential for an optimal physical and cognitive performance of personnel deployed to these missions.

Hence, the objective of this white paper is to determine recommendations for energy, all macro- and the most relevant micronutrients for personnel deployed for missions of the NRF, based on the worst-case mission scenario of high-intensity, continuous combat operations and exposure to extreme environments (heat, cold, and/or high altitudes). These recommendations are applicable to combat rations, which are consumed up to 30 days. Furthermore, the nutrient content of existing individual combat rations of eleven NATO countries are evaluated based on these recommendations and supplementation is recommended, where they are believed to be necessary.

2 Methods

2.1 State-of-the-science review

In order to provide a state-of-the-science review, we performed a literature study regarding the effect of high-intensity physical activity and extreme environments (heat, cold, and high altitudes) on energy, macro-, and micronutrient requirements of NRF personnel. For this review, we used reports of the Committee on Military Nutrition Research (CMNR) as well as scientific papers of studies involving soldiers, mountaineers and athletes.

2.2 Proposing energy and nutrient recommendations

In the current report, we propose recommendations for energy and macro- and micronutrients of which literature suggests that their need is altered during NRF operations or in an extreme environment. We also address some nutrients which we consider relevant. These nutrients include carbohydrate, protein, fat, the vitamins thiamin, riboflavin, B_6, B_{12}, folic acid, A, C, D, E and the minerals calcium, zinc, iron, magnesium, selenium, copper, sodium, and potassium. Although fluid requirements are affected by physical activity and in a hot and cold environment (2, 3), no specific recommendations are made for fluid since this is outside the scope of the current report. The recommendations for energy and nutrients are specific for age, gender, and body size of the NRF population and tailored to the activity levels and the extreme environments they may encounter. Figure 2.1 shows the general method we used.

2.2.1 Terminology

Many terms of nutrition recommendations exist. We have chosen to use the terminology as recently proposed by King *et al.* (4) to present nutrient intake values (NIVs). The NIV is an umbrella term for all types of nutrition recommendations: average nutrition requirement (ANR), acceptable macronutrient distribution range (AMDR), adequate intake (AI), individual nutrient level$_{97.5}$ (INL$_{97.5}$), and upper level (UL). The NIV is equivalent to the concepts dietary reference intakes and dietary reference values. The terms which we used for our energy, macronutrient, and micronutrient recommendations are listed in Table 2.1.

2.1.

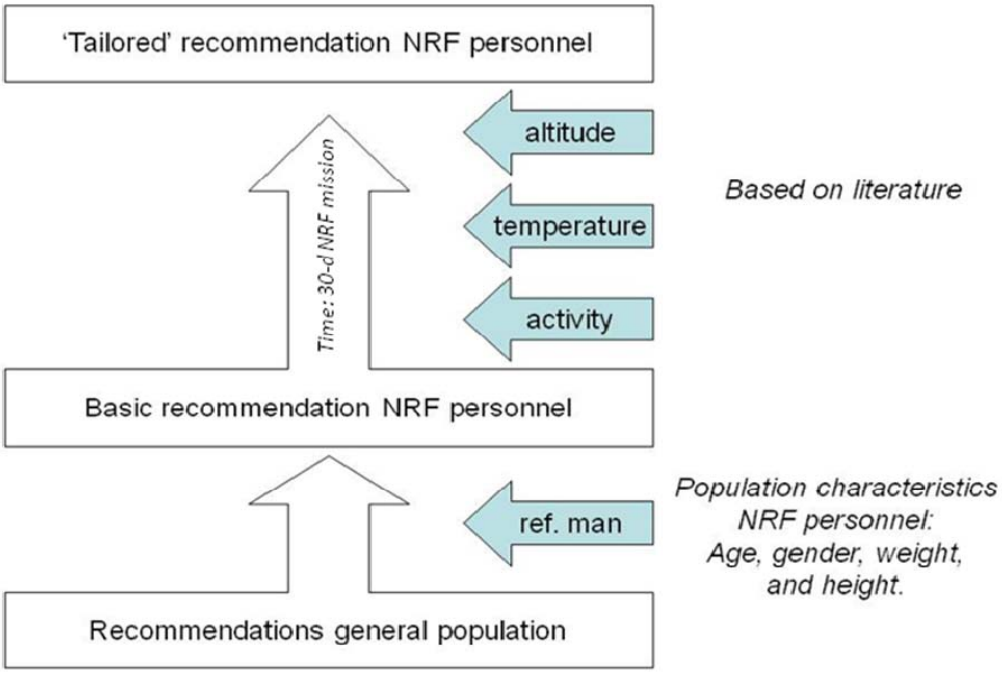

Figure J-2.1 Method of proposing basic and tailored recommendations for energy and nutrient intakes for NRF personnel.

2.2.2 Recommendations general population

We used recommendations which are set for the general population, i.e. the civilian norms as a starting point for estimating the energy and macro- and micronutrient recommendations. Most countries have set their own NIVs, using different concepts and methods. EURopean micronutrient RECommendations Aligned (EURRECA) is a network of excellence funded by the European Commission, established to identify and address differences between countries in setting micronutrient recommendations. One of the objectives of EURRECA is to compare and evaluate existing nutrient recommendations for different populations, published in Europe and in other key non-European countries (5). This comparison identified the following NIVs as most recent, set up from scratch by an expert commission and covering a large geographical area (6, 7).

- Australia and New Zealand, 2005;
- Nordic countries (Denmark, Finland, Iceland, Norway, Sweden), 2004;
- World Health Organization (WHO), 2004;

Table J-2.1 Terminology of nutrient recommendations used in this report.

Nutrient	Term	Explanation
Energy	Average Nutrient Requirement (ANR)	The average or median requirement estimated from a statistical distribution of requirements for a specific criterion and for a particular age- and sex-specific group. Equivalent to: Estimated Average Requirement (EAR)
Macronutrients: protein, carbohydrates, fat	Acceptable macronutrient distribution range (AMDR)	A range of safe intakes; given when insufficient information is available
	Adequate Intake (for poly-unsaturated fatty acids)	Nutrient intake of apparently healthy people that is assumed to be adequate
Vitamins and minerals: Vitamin A, C, thiamin, riboflavin, B_6, folic acid, B_{12}, calcium, iron, zinc, magnesium, selenium	Individual Nutrient $Level_{97.5}$ ($INL_{97.5}$)	Derived from the ANR and its distribution: the average requirement + 2 standard deviations, sufficient to meet the requirements of 97.5% of the population. Equivalent to: Recommended Dietary Allowance (RDA)
Vitamins and minerals: Vitamin D, E, sodium, potassium, copper	Adequate Intake (AI)	Nutrient intake of apparently healthy people that is assumed to be adequate
Dietary fiber	Adequate Intake (AI)	Nutrient intake of apparently healthy people that is assumed to be adequate

- Institute of Medicine (IoM), USA, 1997 to 2004;
- DACH (Germany, Austria, Switzerland), 2002.

We decided to use the NIVs of Australia and New Zealand (ANZ) as a starting point for the energy, macro- and micronutrient recommendations, since they are the most recent, they provide a thorough scientific background and they have critically evaluated the NIVs of the WHO and the IoM. For comparative purposes we additionally present the Nordic recommendations. In the current report, we will make a notification when large variations appear to exist in recommendations between countries (8). Australia and New Zealand estimated energy requirements by using the Schofield equation. Therefore, we directly estimated energy requirements with this equation, which will be given in paragraph 4.2.1 (9). With the NIVs of

Australia and New Zealand as a starting point, we formulated basic recommendations, specific for the age, gender, and body size distribution of NRF personnel.

2.2.3 Tailored recommendations NRF personnel

Based on the literature review, we made situation-specific nutrient recommendations considering the activity level, and a hot, cold and high-altitude environment. These tailored nutrient recommendations are based on existing recommendations from literature. We adopted specific nutrient recommendations from the Committee on Military Nutrition Research (CMNR), which was established in 1982 to advise the US Department of Defense on the need for and conduct of nutrition research and related issues. The CMNR is part of the Food and Nutrition Board of the Institute of Medicine. We made use of the following reports of the CMNR in which they have made nutrition recommendations for soldiers in specific situations:

- Nutritional needs in hot environments: applications for military personnel in field operations. National Academy Press. Washington, D.C. 1993
- Nutritional needs in cold and in high-altitude environments: applications for military personnel in field operations. National Academy Press. Washington, D.C. 1996
- Mineral requirements for military personnel: Levels needed for cognitive and physical performance during garrison training. National Academy Press. Washington, D.C. 2006
- Nutrient composition of rations for short-term, high-intensity combat operations. Committee on optimization of nutrient composition of military rations for short-term, high-stress situations. National Academy Press. Washington, D.C. 2006

Furthermore, we used the American Military Dietary Reference Intakes (MDRIs) which were last published in 2001 by the Military Nutrition Division of the U.S. Army Research Institute of Environmental Medicine.

2.3 Consideration of current combat rations

We evaluated the current combat rations of eleven NATO countries by comparing their nutrient content with our proposed recommendations. Furthermore, we will propose supplementation strategies where we think they are necessary.

3 Assumptions and definitions

3.1 General assumption

We assume that all individuals who are deployed by the NRF are healthy, fit and have sufficient nutrient stores.

3.2 Age, gender, and body size

Since no specific data on population characteristics were available, we assume that 99 percent of the NRF population is male and that the average man is comparable to the reference military man, described in the American Military Dietary Reference Intakes. This man is 19 to 50 years old, with a body weight of 79 kg and a height of 175 cm (10). We assume that the number of men aged 18 to 30 years old equals the number of men in age category 30 to 50 years. These assumptions were checked with all members of the Research Task Group 154 and general agreement was obtained.

3.3 Physical activity level

We have based the basic requirements for the NRF on a Physical Activity Level (PAL) of 1.6, which represents a sedentary lifestyle (11). No specific data exist on the activity level and thus energy expenditure of the NRF. Therefore, we divided their activities into two operating conditions:

- Normal operations:

We assume that the activities of these operations are comparable to garrison training[1], firemen activities, urban police keeping, peacekeeping forces, and construction work. Accordingly, we assume that the PAL of these activities amounts to 2.0 (11). This PAL is the lowest level in the range which reflects a vigorous or vigorously active lifestyle. Examples of individuals with this activity level are construction workers, farmers, forest workers, miners, and high performance athletes (11, 12). In addition, we assume that the vitamin and mineral requirements for the general population are also applicable to the requirements of NRF personnel during normal operations.

[1] During garrison training, soldiers spend the day performing military mission or training exercises while living in a military base.

- Combat or special forces operations:

These are sustained or continuously dismounted light-infantry operations which probably represent worst-case or highest activity levels. The NRF is expected to conduct unsupported combat operations lasting up to 30 days. We assumed that these operations are comparable to assault missions. During an assault mission, there may be as much as 20 hours per day of physical activity, with an average of four hours per day of sleep (13). We assume that the PAL during combat operations is 2.4, which is the highest PAL-value in the range which corresponds to a vigorous or vigorously active lifestyle (11).

3.4 Definition of environments

No fixed definitions of a hot, cold, or high-altitude environment exist. Therefore, the cut-off points for these environment used by Askew (14) in his review on environmental and physical stress and nutrition requirements, are used in this paper. These are:

- Hot environment: >30 °C or >86 °F;
- Cold environment: <0 °C or <32 °F;
- High-altitude environment: >3,050 m or >10,000 ft elevation.

4 State-of-the-science review

4.1 Physiological responses to exercise and extreme environments

4.1.1 Exercise and physical labor

During exercise, metabolic heat is produced and as a result the body core temperature rises. Whereby body heat is mainly dissipated through sweating, the blood flow to the surface increases and raises the skin temperature, which allows sensible heat loss by radiation and convection. In addition, vasoconstriction in the abdominal organs increases the blood flow to active tissues and adds to the overall increase in the cardiac output. Evaporation occurs through sweating and is the primary heat-dissipating mechanism. Due to sweating, water needs are increased as well as those of minerals zinc, iron, and sodium which are present in sweat (2, 15). In heavy and continuous physical exercise, carbohydrate and fluid requirements are elevated, as both carbohydrate depletion and dehydration have been shown to decrease physical performance. Carbohydrate is an essential fuel during exercise for the strenuous muscle contractions. Carbohydrate stores in the body are, however, limited. Therefore, a person who engages in regular or strenuous, high-intensive, prolonged physical exercise should consume substantially greater amounts of energy and carbohydrate to fuel the demands of training (16). Furthermore, protein needs are increased due to muscle recovery and synthesis (17).

4.1.2. Hot environment

During exercise in a hot and humid environment, convection and radiation are negligible. Therefore, sweat evaporation is the main heat dissipating mechanism and is essential for maintaining the body core temperature. In case of intense exercise in the heat, the cardiovascular system cannot meet the demands of the skin and muscle at the same time. In addition, if the humidity is high, evaporation is less effective for cooling. The main priority is to maintain blood pressure and cardiovascular function, however, this can also lead to hyperthermia and metabolic inefficiency. Heat-stress and dehydration will eventually lead to a premature onset of fatigue or reduced performance compared to exercise in a normal environment (2, 15).

4.1.3. Cold environment

In a cold environment, heat will flow from the body core to the environment, mainly via dry heat-loss mechanisms. To prevent a decrease in core temperature, the human body responds in two ways: vasoconstriction which reduces the blood flow to the skin and extra production of metabolic heat. Metabolic heat is produced by the muscles voluntarily by means of physical activity and involuntarily by shivering. The thermoregulatory response to a cold environment is affected by gender, age, and acclimatization. However, these effects have most likely no implications for nutrition requirements. Body composition is probably the most important physiological determinant of thermoregulatory tolerance in cold environments (18).

4.1.4. High-altitude environment

Next to the physiological responses to the cold, high-altitude environments have some specific effects on the human body. First, the partial oxygen pressure in the atmosphere is decreased at altitude. This leads to a reduction of blood oxygenation (hypoxia) in humans, and is the main cause of altitude-related illnesses. Acute mountain sickness (AMS) is an example of an altitude-related illness. Symptoms of acute mountain sickness usually start after several hours of exposure to altitude and include among others headache, nausea, vomiting, weakness, and general malaise. Furthermore, a common effect of altitude exposure is anorexia. However, acclimatization is possible: during long exposure to high altitude, hematocrit and hemoglobin levels increase to improve oxygen transport. Next, relative humidity is generally lower and ventilatory rates are higher with increasing altitude and consequently water loss is higher (19, 20). Moreover, oxidative stress is increased at high altitude. Oxidative stress is the accumulation of oxygen radicals, reduced forms of oxygen with toxic properties. The main causes of increased free radical production at high altitude are the respiratory chain itself, hypoxia, and increased ultraviolet radiation (20). Therefore, it is suggested that antioxidant nutrients such as vitamin E, C, beta-carotene, selenium, copper, and zinc may be required in greater amounts in cold and high-altitude environments to reduce lipid peroxidation. However, equivocal scientific evidence that antioxidant supplementation is beneficial is lacking (14, 20-22).

4.2 Energy requirements

4.2.1 Approach

The energy requirements of NRF personnel during normal and combat operations and in extreme environments were established using different references. First, we estimated the energy recommendations according to civilian norms from the Schofield-equation. Next, we established energy requirements during normal operations also with the Schofield equation but with an increased physical activity level. For combat operations, we could not use the Schofield equation, since other factors (e.g. sleep deprivation and stress) next to basal metabolic rate and physical activity play a role in defining the energy need. Therefore, we estimated the energy requirement from various studies of soldiers during combat operations using the doubly labeled water method. Finally, to estimate the energy need in cold and high-altitude environments, we used the energy requirement from the American MDRIs last published by the Military Nutrition Division of the U.S. Army Research Institute of Environmental Medicine in 2001.

4.2.2 Civilian norms

The basal metabolic rate is the energy needed for all basal metabolic activities of cells and tissues plus the energy needed to maintain blood circulation, respiration, and gastrointestinal and renal processing. The basal metabolic rate can be calculated with an equation given by Schofield (9). Next, the basal metabolic rate is multiplied by the physical activity level of a person, giving the individual estimated energy requirement. The equation for estimating the energy needs of reference NRF personnel is shown in table 4.2.1. Thus, the energy requirement of the reference NRF man with a PAL of 1.6 is 3,034 kcal per day in the age category 18 to 30 years old and 2,781 kcal per day for men aged 30 to 60 years. Finally, assuming an equal distribution of people in the age categories, the basic energy requirement we estimate for the NRF man aged 19 to 50 years amounts to 2,868 kcal per day (12.0 MJ/d) (9). With regard to the assumptions that the weight of the NRF soldiers was 79 kilograms, if we had assumed that a NRF soldier weighs 5 kilograms more, his energy needs are increased by only 143 kcal to 3,011 kcal per day. The assumptions we made about the physical activity level could have a bigger effect on the estimated energy requirements. The energy requirements of the IoM are estimated with another regression equation which is based on doubly labeled water and also takes height and the exact age into

account (23). For the reference NRF man, the energy requirement based on the IoM equation (2,799 kcal per day) resembles our estimate of 2,868 kcal per day.

Table J-4.2.1 Equation to estimate energy requirements for men, aged 18 to 60 years, 79 kg, and PAL 1.6 (9).

Age (y)	Equation	EER (kcal/day)
18 – 30	BMR (15.057*79[kg] + 692.2) * PAL(1.6)	3,034
30 – 60	BMR (11.472*79[kg] + 873.1) * PAL (1.6)	2,781

4.2.3 Normal operations

As discussed in the assumptions, normal NRF operations are comparable to garrison training, urban police keeping, or peacekeeping forces and reflect a PAL of 2.0. According to Schofield (9), the estimate energy requirements are 3,792 kcal per day for men aged 18 to 30 years and 3,476 kcal per day for men of 30 to 60 years old. Thus, our estimate of energy requirement for NRF personnel during normal operations becomes 3,595 kcal per day (15.1 MJ/d). This estimate is in accordance with the expenditures which were found in eight studies in soldiers, using the doubly labeled water method, performing activities with a comparable PAL. These activities included (medical) support, construction, and driving and repairing vehicles. The energy expenditure ranged from 3,343 to 4,179 kcal per day, with a mean of 3,630 kcal per day (15.2 MJ/d) (24).

4.2.4 Combat or special forces operations

We assumed that the PAL during combat or special forces operations is 2.4. According to Schofield, this PAL goes with an energy requirement of 4,516 kcal per day for NRF personnel aged 18 to 30 years and 4,270 kcal per day for NRF personnel of 30 to 60 years old (9). However, energy requirements during these operations are not only increased due to higher physical activity, but also due to sleep deprivation. Therefore, it is not possible to estimate the energy requirements with the Schofield-equation. Combat or special forces operations are highly unpredictable, and the exact circumstances, and, therefore, the energy requirements, are difficult to anticipate. Tharion *et al.* (24) reviewed 24 studies which measured energy expenditure in soldiers during simulated combat operations using the doubly labeled water method in a temperate or hot environment. Large variation existed in tasks, location, duration, and activity. Therefore, the mean energy expenditure of those 24 studies is assumed to be a good reflection of

the circumstances in combat or special forces operations of the NRF. Energy expenditures ranged from 3,463 to 6,663 kcal per day, with an average of 4,435 kcal per day. However, body weight of soldiers in these studies was below that of the reference NRF man (79 kg). We accounted for this difference by multiplying the energy expenditure per kilogram body weight with the reference body weight of the NRF man. The energy expenditure per kilogram body weight was assessed in 17 of the 24 studies and amounted to 0.26 MJ per kilogram bodyweight, resulting in an average energy requirement of 4,905 kcal per day for the NRF soldier (24). In conclusion, we estimated the energy requirement of NRF personnel during combat or special forces operations at 4,905 kcal per day (20.5 MJ/d). To put this energy need in perspective, a cyclist riding the Tour de France requires 6,000 to 8,000 kcal per day. These energy requirements during Tour de France are the highest values ever reported for athletes over a period longer than seven days (25).

4.2.5 Hot environment

For a long time, it was believed that metabolic rates were elevated during activities in the heat compared to temperate environments (26). This increase was attributed to a number of factors, which included a lack of acclimatization, raised body core temperature, increased sweat gland activity, increased pulmonary ventilation and an elevated anaerobic metabolism. However, more recent studies did not demonstrate a significant increase in metabolic rate in a hot environment (27). In addition, Tharion *et al.*(24) showed that military personnel's energy expenditures were not affected by environmental heat stress. It appears that energy expenditure during exercise in the heat is mainly influenced by circumstances and conditions and the type and amount of physical activity performed, not on the ambient temperature itself. Although it appears that activities in the heat may increase energy needs by 2.5 to 10 percent, more rest is also necessary (10). Therefore, we concluded that energy requirements in the heat are not altered compared to a temperate environment and remain 3,595 and 4,905 kcal per day, during respectively normal and combat operations.

4.2.6 Cold environment

Energy needs are elevated during military operations in a cold environment due to the increase in metabolic heat production to maintain body core temperature and the increased costs of moving in snow- or ice-covered terrain and of wearing heavy clothing and equipment. The weight of the

additional clothing may increase energy needs by 8% over temperate clothing. Metabolic costs are further increased with 15% as a result of the hobbling effects of cold weather, multi-layered clothing, and cold-weather footwear (24, 28). In the MDRIs, the energy requirements for sedentary conditions in the cold are 54 kcal per kilogram body weight, which makes a total of 4,266 kcal per day for the reference NRF man. During high levels of physical activity in the cold, i.e. maneuvering for prolonged periods (longer than two hours) with heavy foot gear over snow- or ice-covered terrain, energy needs are increased to 62 kcal per kilogram body weight (29). This reflects an estimated daily intake of 4,898 kcal per day for the reference NRF man. In conclusion, since it is not likely that NRF personnel will encounter sedentary conditions in the cold, we suggest an energy requirement of 4,898 kcal per day (20.5 MJ/d). This energy requirement of 4,898 kcal per day is in concordance with energy expenditure studies among soldiers in a cold environment. In eleven studies of combat operations in the cold, energy costs ranged from 3,630 to 7,116 kcal per day. The mean energy expenditure was 4,800 kcal per day. In addition, the average energy costs per kilogram bodyweight from nine of the eleven studies suggest a daily energy requirement of 4,905 kcal per day (20.5 MJ/d) for the reference NRF soldier (24).

4.2.7 High-altitude environment

Energy needs at high altitude (>3,050 m) are substantially increased. Individual energy requirements will depend on body size, weight of additional clothing and equipment and the (mountainous) terrain (24, 29). Furthermore, basal metabolic rate is increased at high altitude with 7 to 17 percent during at least the first days, due to the acute hypoxia (24, 30). For moderate activity, the MDRI of energy is set at 50 to 55 kcal per kilogram body weight. In addition, for prolonged periods of higher physical activity in full winter gear, energy needs are estimated at 60 kcal per kilogram body weight. For the reference NRF man this implies 4,418 kcal per day in moderate activity and 4,740 kcal per day at high levels of physical activity (29). Thus, our estimate of the energy requirements for NRF personnel in a high altitude environment becomes 4,740 kcal per day (19.8 MJ/d). These energy requirements are in accordance with the results from Hoyt *et al.* who estimated total energy expenditure with DLW in six male soldiers during six days combat training at 4,392 meter altitude. This was also a cold environment, with temperatures of -15 to 5°C. Mean energy expenditure was 4,251 kcal per day (17.8 MJ/day) (31). In addition, Pulfrey and Jones studied energy expenditure in five man and one woman with the DLW method while climbing at 6,000 meter altitude for a seven-day period. Their mean energy expenditure was 4,633

kcal per day (32). Finally, Reynolds *et al.* showed an average energy expenditure of 5,394 kcal per day in seven climbers at high altitude, using the doubly labeled water method (33). However, this was at an extreme altitude of 5,300 to 8,848 meters, which resulted in extremely high energy needs.

4.3 Macronutrient requirements

4.3.1 Approach

To determine macronutrient requirements, we used the recommendations from Australia and New Zealand. We chose to express protein, carbohydrate and fat needs both as an percentage of the total dietary energy intake and as absolute intakes. Next, for normal and combat operations and extreme environments, we checked the literature to evaluate whether or not needs are different. For the high-altitude environment, we used the macronutrient recommendation of the CMNR.

4.3.2 Civilian norms

The civilian norms for protein, carbohydrates and fats are listed in table 4.3.1. The column with the recommendation expressed in energy percentages are derived from the report of Australia and New Zealand also presenting macronutrient ranges for optimizing diets for lowering disease risk (8, 34). Our recommendations for NRF personnel in the final column are based on the AMDR and for poly unsaturated fatty acids (PUFA) on the AI (8). By and large, these requirements are in concordance with the recommendations set by the IoM, the WHO, the DACH, and the Nordic countries (11, 12, 23, 35-37)

4.3.3 Normal operations

The physical activity level during normal operations is higher than the level for which basic requirements are derived, but no evidence was found that this increase asks for a change in macronutrient distribution. Since the energy requirements are higher during normal operations (3,595 kcal/d), and the NIVs are energy percentages, the proposed daily amounts of protein, carbohydrates and fats are increased: 135 to 225 gram protein, 404 to 584 gram carbohydrate, and 80 to 140 gram fat, of which maximum 40 gram saturated fat, and 16 to 40 gram poly unsaturated fatty acids (8).

Table J-4.3.1 Macronutrient recommendations for the general population according to the Nutrient Reference Values for Australia and New Zealand (ANZ) and the Nordic Nutrition Recommendations (Nordic) translated into recommended intake ranges for the reference NRF man, PAL 1.6.

Macronutrient	$INL_{97,5\%}$ and AI (g/d)[b]		AMDR (en%)		acceptable intake range for NRF personnel (g/d)*
	AZN	Nordic	AZN	Nordic	Based on AZN
Protein[a]	0.84 g/kg body weight	0.8 g/kg body weight	15-25	10-20	108 – 179
Carbohydrate			45-65	50-60	323 – 466
Fat • Total fat • Saturated fat • PUFA	13		20-35 <10 4–10[c]	25-35 <10 5-10	64 – 111 < 32 13 – 32
Dietary fiber[d]	30	25-35 g/d		3 g/MJ	30

* the ranges for the reference civilian man also apply to the reference NRF-solier with a Physical Activity Level of 1.6 (sedentary) and an energy requirement of 2868 kcal.

Abbreviations: INL: Individual Nutrient Level (equivalent to RDA), AI: Adequate Intake, AMDR: Acceptable Macronutrient Distribution Range

a: For protein, an INL and AMDR exist. We will use the AMDR.

b: For protein the INL is shown in this column, for PUFA and dietary fiber the AI

c: Linoleic acid (plus 0.2 en% for α-linolenic acid)

d: Association of Official Analytical Chemists (AOAC) methods for dietary fibre

4.3.4 Combat or special forces operations

In heavy and continuous physical exercise, such as combat operations, protein recommendations are increased due to protein losses and increased protein needs for muscle recovery and synthesis. For persons engaged in regularly physical exercise, such as endurance athletes, a daily intake of 1.5 gram protein per kilogram body weight is advised instead of 0.84 gram per kilogram body weight by Tarnopolsky *et al.* (17), which reflects a protein intake of 119 gram for the reference NRF man. However, this amount is already covered in the current basic protein recommendations expressed as a percentage of the total energy requirements. In addition, no differences in carbohydrate and fat distribution are needed. Thus, according to the energy requirements of 4,905 kcal per day, the suggested macronutrient recommendations during

combat or special forces operations are: 184 to 307 gram protein, 552 to 797 gram carbohydrate, and 109 to 191 gram fat, of which maximum 55 gram saturated fat and 22 to 54 g poly unsaturated fatty acids (8).

4.3.5 Hot environment

Carbohydrates are the main fuel when exercising in a hot environment. However, no evidence was found that carbohydrate recommendations are increased independent of physical activity level in a hot environment. Furthermore, there are indications that protein degradation is increased when exercising in the heat (2). However, there is insufficient evidence to recommend higher protein intakes (27). Therefore, protein requirements are not altered. In addition, no data were found to prove that fat and dietary fiber requirements are altered in hot environments. In conclusion, no evidence exists that macronutrient requirements are changed in a hot environment compared to the basic requirements, therefore, the values from Table 4.3.1 are also considered in a hot environment.

4.3.6 Cold environment

Since the diet of indigenous cultures in the arctic is particularly high in fat and proteins, it has been suggested that the macronutrient requirements should be different in cold environments. However, there is insufficient evidence to suggest a different macronutrient distribution in the diet of NRF personnel in the cold (28). Considering the energy requirements of 4,898 kcal, we suggest the following macronutrient intakes: 184 to 306 gram protein, 551 to 796 gram carbohydrates, and 108 to 190 gram fats, of which maximum 54 gram saturated fat and 22 to 54 gram poly unsaturated fatty acids.

4.3.7 High-altitude environment

Most people at high altitude prefer a high-carbohydrate and low-fat diet. Fatty foods can actually become distasteful and they might worsen the symptoms of AMS (19, 38). On the other hand, carbohydrate supplements can relieve symptoms of AMS by enhancing blood oxygenation, especially in fluid form (38). In addition, some evidence exists that protein metabolism is altered with moderate hypoxia, however, not enough to change protein recommendation. Therefore, protein recommendations remain some 15 energy percent and carbohydrate some 60 energy

percent. Fat intake could be as low as 25 energy percent. This amount may decrease some of the intestinal problems that may accompany intake of simple carbohydrates (39). For that reason, with an energy need of 4,740 kcal per day, our proposed macronutrient intake becomes: 178 gram for protein, 711 gram for carbohydrates and 132 gram for fat, of which maximum 52 gram saturated fat and 21 to 53 gram poly-unsaturated fatty acids.

4.4 Vitamin requirements

4.4.1 Approach

To determine the vitamin requirements according to civilian norms and during normal operations, we used the current recommendations for the general population set by Australia and New Zealand in 2005 (ANZ) and present the Nordic recommendations for comparative purposes (Nordic). We also checked recommendations from other countries and international bodies and will mention when large variations exist. Moreover, Appendix I gives an overview of the micronutrient recommendations of Australia and New Zealand, DACH, the IoM, the Nordic countries, and the WHO. For combat operations and extreme environments, we searched for new evidence for increased needs and adopted existing recommendations from the review of Woolf and Manore of 2006 (40) and several reports of the CMNR of 1993 to 2006 when new evidence was lacking (13, 41-43).

4.4.2 Vitamin A

Vitamin A is a fat-soluble vitamin which is important for normal reproduction, vision, and the immune function. The recommendation set by Australia and New Zealand for men aged 19 to 50 years is 900 µg as retinol equivalents per day (8). This value is in line with that of other reports, except for the WHO, who recommends an intake of 600 µg per day (44). The upper level of vitamin A is 3,000 µg per day (8). Only one study examined the effect of vitamin A supplementation and exercise and found no significant difference. It seems that vitamin A stores are generally adequate to meet the demands of exercise, and, thus, NRF operations. This is probably because a period of about six months to two years is required for a person consuming a diet poor in vitamin A to become deficient. Furthermore, no information was found on the effect of heat, cold or high-altitude stress on vitamin A requirements (45). Therefore, the proposed level of intake for NRF personnel is 900 µg per day.

INL's in sum: ANZ: 900 µg/d; Nordic: 900 µg/d; NRF: 900 µg/d (as retinol equivalents)

4.4.3 Thiamin

4.4.3.1 Civilian norm and normal operations

Thiamin plays an important role in the metabolism of fats, proteins, and especially carbohydrates. Furthermore, thiamin is also essential in the breakdown of the branched chain amino acids. Therefore, it was thought that thiamin requirements are dependent on energy intake and some older thiamin recommendations are based on energy intake. However, in the report of Australia and New Zealand it is concluded that direct evidence is lacking and their thiamin recommendation is independent of energy intake. The civilian recommendation for thiamin is 1.2 mg per day for men aged 19 to 50 years old. No upper level of thiamin intake exists (8). During NRF normal operations requirements presumably resemble those of the civilian population.
INL's in sum: ANZ: 1.2 mg/d; Nordic: 1.5 mg/d (men 18-30 yr); NRF: 1.2 mg/d

4.4.3.2 Combat operations

Thiamin deficiency may impair physical performance, however supplementation does not appear to enhance performance in subjects with an adequate status. Furthermore, physical activity does not seem to alter thiamin status nor to influence thiamin requirement. However, since thiamin is essential for carbohydrate metabolism, its requirement is probably elevated with a high energy intake, but the evidence is ambiguous. Woolf and Manore conclude in their review that an inadequate thiamin status may impair physical performance, but that the prevalence of a deficiency is very low in active people (40). Therefore, we conclude that thiamin requirements are not elevated during combat operations and we suggest a thiamin intake of 1.2 mg per day for NRF personnel.

4.4.3.3 Hot environment

High temperatures have no effect on thiamin requirements. Thiamin loss through sweat is considered to be around 10 mcg per 100 ml. Working in the heat can produce up to 10 liters of sweat, and, therefore, the thiamin loss would be 1.0 mg. However, we think that a well-balanced diet should be sufficient to replace this thiamin loss (45). Therefore, we propose a daily intake of 1.2 mg thiamin for NRF personnel in a hot environment.

4.4.3.4 Cold and high-altitude environment

The CMNR proposes a thiamin intake of 3 mg per day in the cold and at high altitude, since energy needs are elevated in these environments. Furthermore, carbohydrate requirements are increased at the expense of fat intake at high altitude. However, this recommendation is based

upon 1989 guidelines. At that time, expert opinion was still that thiamin intake is dependent of energy intake (46). Therefore, we adopt the view of the more recent report of Australia and New Zealand and we assume that thiamin needs are increased in the cold and at high altitude; thus recommended intake is 1.2 mg per day for NRF personnel in the cold and at high altitude.

4.4.4 Riboflavin

4.4.4.1 Civilian norm and normal operations

Riboflavin functions as a component of two co-enzymes in the catabolism of fatty acids and energy and it is important for fatty acid synthesis. In that role it is essential for energy production. Furthermore, it plays a role in conversing vitamin B_6 to its bioactive form and tryptophan to niacin. The recommended intake of riboflavin is 1.3 mg per day for men of 19 to 50 years old. No upper level is established (8). The recommendation for riboflavin set by the Nordic countries is somewhat higher: 1.7 mg per day (37).

INL's in sum: ANZ: 1.3 mg/d; Nordic: 1.7 mg/d; NRF: 1.3 mg/d

4.4.4.2 Combat operations

Several studies have shown that riboflavin requirements are increased in physically active persons, but the extent is not known. Furthermore, riboflavin deficiency may impair exercise performance. A riboflavin-deficient diet must be consumed two to six weeks to develop symptoms of a riboflavin deficiency. Thus, within a 30-day period, NRF personnel could become depleted, and physical performance can be decreased. Woolf and Manore conclude that athletes may need more riboflavin than the general population, and more than the current recommendation (40). Since Woolf and Manore do not give an exact amount, we adopted the riboflavin recommendation from the CMNR in a cold and high-altitude environment of 2.5 mg per day (46).

4.4.4.3 Hot environment

The amount of riboflavin lost through sweating in a hot environment is very small. Therefore, sweating does not seem to affect riboflavin requirements in the heat (45). In addition, since energy requirements are not increased in hot environments, riboflavin requirements are probably not altered in hot climates. In conclusion, we have set the riboflavin recommendation for NRF

personnel in a hot environment at 1.3 mg per day in normal operations. For combat operations in hot environments the value of 2.5 mg per day is adopted (40, 46).

4.4.4.4 Cold and high-altitude environment

The CMNR states that maintaining an adequate riboflavin status can be difficult during military operations in the cold and at high-altitude since the major diet source of riboflavin is dairy, which may be limited during prolonged expeditions in these environments. Furthermore, since energy requirements are elevated both in a cold and high-altitude environments, the riboflavin needs are increased as well. Therefore, the CMNR propose a riboflavin intake of 2.5 mg per day for NRF personnel in these extreme environments (46). Accordingly, we recommend a riboflavin intake of 2.5 mg per day for NRF personnel in the cold or at high-altitude.

4.4.5 Vitamin B_6

4.4.5.1 Civilian norm and normal operations

Vitamin B_6 is important for the metabolism of amino acids and glycogen. Increased protein breakdown or consumption may elevate the need for vitamin B_6 The civilian recommendation for vitamin B_6 for the reference NRF man, as well as during normal operations, is 1.3 mg per day. The upper level is set at 100 mg per day (8).

INL's in sum: ANZ: 1.3 mg/d; Nordic: 1.6 mg/d; NRF: 1.3 mg/d

4.4.5.2 Combat operations

Strenuous high-intensive prolonged physical exercise does not seem to alter vitamin B_6 status, but some studies suggest that acute exercise can alter B_6 status. In addition, supplementation with vitamin B_6 does not appear to enhance physical performance (45). However, increased protein consumption or breakdown may increase vitamin B_6 requirements and vitamin B_6 plays an important role in the metabolic pathways required for exercise (8, 40). Since protein requirements are increased during combat operations, vitamin B_6 intake are probably also elevated. Woolf and Manore suggest that athletes might require 1.5 to 2.5 times the recommendation to maintain an adequate status (40). Therefore, we suggest a daily intake of 2.6 mg vitamin B_6 per day for NRF soldiers during combat missions, which is twice the recommendation for civilians or NRF personnel during normal operations.

4.4.5.3 Hot environment

There are no data regarding vitamin B_6 needs in the heat. The amount of vitamin B_6 lost in sweat is insignificant (45). Furthermore, protein requirements are not altered in a hot environment. Therefore, our suggested vitamin B_6 recommendation for NRF personnel in the heat is 1.3 mg per day for normal operations in a hot environment. For combat operations in a hot environment we adopt the value of Woolf and Manore and CMNR (40, 46), i.e. 2.6 mg vitamin B6.

4.4.5.4 Cold and high-altitude environment

There are no known benefits of vitamin B_6 supplementation on endurance or physical performance in the cold or at high altitude. There is also no evidence that vitamin B_6 needs are increased in the cold and/or at high altitude. Thus, the CMNR does not recommend an increased vitamin B_6 intake in these environments (46). However, as protein intake is generally taken into account in setting requirements for vitamin B6 (8), we propose a vitamin B_6 intake of 2.6 mg per day for NRF soldiers in a cold or high-altitude environment.

4.4.6 Vitamin B_{12}

Vitamin B_{12} plays a role in DNA synthesis and is necessary for the formation of red blood cells. Vitamin B_{12} is found exclusively in animal products. Therefore, vegetarians are at risk of developing a deficiency. However, many vegetarian products are fortified with vitamin B_{12} and the body can store vitamin B_{12} for many years. The recommendation for the general population is 2.4 µg per day for men aged 19 to 50 years (8). In comparison, the recommendation of the DACH is somewhat higher, 3.0 µg per day (11) and the recommendation of the Nordic countries is 2.0 µg per day (37). It is suggested that vitamin B_{12} metabolism is altered in athletes compared to sedentary individuals, but evidence is limited (40). In addition, vitamin B_{12} supplementation has no effect on physical performance (45). The vitamin B_{12} requirement thus does not seem to be altered in active persons. Moreover, no data were found on the effects of a hot, cold and/or high-altitude environment on vitamin B_{12} status (46). In conclusion, since there is limited evidence that vitamin B_{12} needs are elevated in situations NRF personnel may encounter and given that it is nearly impossible to develop a deficiency within 30 days, the proposed vitamin B_{12} recommended intake for NRF personnel is 2.4 µg per day.

INL's in sum: ANZ: 2.4 µg/d; Nordic: 2.0 µg/d; NRF: 2.4 µg/d

4.4.7 Folic acid

Folic acid is essential for DNA synthesis and amino acid metabolism. Furthermore, it is needed for cell synthesis to repair muscle cells. The civilian norm for folic acid is 400 µg per day for men in the age category 19 to 50 years (8). Since folic acid is important for muscle cell repair, folate needs might be increased during exercise. However, no data have been found that its requirement is elevated in high-intensity physical activity (40). Nor is it found that folic acid requirements are altered in the heat, cold or at high altitude (45, 46). However, folic acid is mainly present in green leafy vegetables and these products are generally scarce in the cold or at high altitude. Therefore, it is advisable that sufficient amounts of folic acid, i.e. 400 µg per day for the reference NRF man, should be made available in the foods consumed in these environments (46).

INL's in sum: ANZ: 400 µg/d; Nordic: 300 µg/d; NRF: 400 µg/d

4.4.8 Vitamin C

4.4.8.1 Civilian norm and normal operations

Vitamin C is an antioxidant and protects lipids in plasma and probably low density lipoprotein against oxidative damage. Furthermore, it helps with the absorption of iron and copper. The civilian norm for men in the age category 19 to 50 years old is 45 mg per day (8). The vitamin C recommendations from DACH, IoM and the Nordic countries are higher (respectively 100, 90, and 75 mg per day) (11, 37, 47). This is because Australia and New Zealand have used a different health indicator to set vitamin C recommendations. The upper level is 1,000 mg vitamin C per day (8).

INL's in sum: ANZ: 45 mg/d; Nordic: 75 mg/d; NRF: 45 mg/d

4.4.8.2 Combat operations

As an antioxidant, vitamin C protects cells from free radical damage. In addition, Because muscle ache after exercise may result from muscle tissue damage, it could be hypothesized that vitamin C supplementation may affect the development of soreness (45). However, there is no evidence to suggest that chronic exercise creates a vitamin C deficiency. A more recent review by Peake

confirms that vitamin C plays a role in different pathways which are important to exercise metabolism. However, given the similar dietary intake and response to supplementation of athletes and non-athletes, Peake suggests that the vitamin C requirement is not altered with regular physical exercise (48). In conclusion, we propose a vitamin C intake of 45 mg per day for NRF personnel during combat operations.

4.4.8.3 Hot environment

The CMNR recommends a daily intake of 250 mg vitamin C in the heat, since this amount seems to reduce heat stress in unacclimatized subjects with adequate but low vitamin C status. Furthermore, vitamin C might also be needed during extended periods in a hot environment. It is suggested that vitamin C cures heat stress. In addition, the process of sweating requires vitamin C, and it has been shown to be beneficial in treating prickly heat (inflammation of sweat glands) (45). However, we believe there is no convincing evidence that a supplement of vitamin C will improve the physical performance. In conclusion, we propose an intake of 45 mg vitamin C for NRF soldiers in a hot environment.

Though routine supplementation with daily 0.2 g vitamin C for preventing or treating the common cold does not appear effective in the community (Cochrane Database of Systematic Reviews 2007, issue 3 Art no CD000980.DOI:10.1002/14651858.CD000980.pub3) the collective evidence from 6 studies suggests that vitamin C supplementation up to 1 g/d may reduce the incidence of common colds in special circumstances. This subgroup of six studies involved marathon runners (4 studies), skiers (1 study in youngsters), and soldiers (1 study) exposed to significant cold and/ or physical stress. All of these studies had serious methodological limitations (inadequate allocation concealment in 4 studies; involvement of only children in one study; high drop-out rate (75%) in the placebo-arm of the final study) so that further research in this area is warranted.

4.4.8.4 Cold and high-altitude environment

Vitamin C may play an important role in several mechanisms in the body which are important in the cold: synthesizing adrenal hormones, maintaining core and surface body temperature, maintaining pulmonary and immune function. Furthermore, vitamin C is important as an antioxidant at high altitude due to the increased oxidative stress. Due to this reasons and the

relative low toxicity, the CMNR recommends a daily intake of 250 mg vitamin C per day in the cold and at high-altitude (46). In a more recent review, Dosek *et al.* conclude that indications exist that antioxidant supplementation, such as vitamin C, has been shown to have beneficial effects and can attenuate and/or prevent oxidative damage associated with high altitude exposure. However, the researchers provide no direct evidence that supplemental vitamin C is beneficial in a cold and high-altitude environment (21).Therefore, we recommend an intake of 45 mg vitamin C per day for NRF personnel in these climates.

4.4.9 Vitamin D

Vitamin D helps maintaining serum calcium concentrations in the body. It also enhances the absorption of phosphorus. One form of vitamin D is produced by the exposure of skin to the sun. It is almost impossible to obtain sufficient vitamin D from the diet alone. The recommendation for vitamin D is 5.0 μg per day for men of 19 to 50 years, regardless of exposure to sunlight (8). No evidence was found that vitamin D requirements are different at higher levels of physical activity (45). Although NRF soldiers are probably fully clothed with not much skin exposed, no data was found that this might lead to a vitamin D deficiency. Furthermore, the Australian and New Zealand vitamin D recommendation does not take sunlight exposure into account, and in extreme environments sunlight is in abundance (heat), reflected on snow and ice (cold and high altitude) or more direct and intense due to the thinner atmosphere (high altitude) (46). Finally, new evidence suggests that vitamin D recommendations may need to be elevated (49), and the requirements are currently being revised by the IoM. Based on the currently available evidence, we recommend a vitamin D intake of 5 μg per day for NRF personnel.

AI's in sum: ANZ: 5 μg/d; Nordic:7.5 μg/d; NRF: 5 μg/d

4.4.10 Vitamin E

Vitamin E is a fat soluble vitamin and an antioxidant and its primary role is to protect polyunsaturated fatty acids (PUFA) from oxidation. The recommendation of vitamin E for men aged 19 to 50 years is 10 mg per day as α-tocopherol equivalents. A deficiency has never been reported in normal individuals consuming a diet low in vitamin E. The upper level is 300 mg per day (8). In its role as an antioxidant, vitamin E may reduce muscle damage from strenuous exercise. However, no convincing evidence exists that vitamin E supplementation decreases muscle damage. There are also indications that vitamin E might also reduce heat stress (45). Furthermore, in a cold environment vitamin E might, increase oxygen supply for, for instance, energy production. Next, vitamin E might reduce the incidence of high-altitude related illnesses. In addition, analyses from two large cohort studies, the Nurses Health Study and the Health Professional Follow Up Study, showed in 1993 a beneficial effect of vitamin E on coronary heart disease (50, 51). For these reasons and the very low toxicity of vitamin E at that moment, the CMNR advises a daily intake of 400 mg vitamin E in a cold or high-altitude environment (46),(52). A recent systematic meta-analysis from Bjelakovic *et al.* showed that treatment with, among others, vitamin E may increase mortality. The reviewers advise that vitamin E intake should not exceed the upper level (8, 53). Given this probable unfavorable effect of vitamin E supplementation, we propose a daily intake of 10 mg vitamin E per day for NRF personnel.

AI's in sum: ANZ: 10 mg/d; Nordic: 10 mg/d; NRF: 10 mg/d

4.5 Minerals

4.5.1 Approach

To establish mineral requirements, we applied the same method as with vitamins. For basic requirements and normal operations, we used the nutrient intake levels from Australia and New Zealand and mentioned when these values differed much from other countries and organizations. Appendix I shows the mineral recommendations of the WHO, DACH, Nordic countries and the IoM. For combat operations and extreme environments, when evidence suggested that a higher intake was necessary, we adopted existing recommendations from several reports of the CMNR (13, 41-43).

4.5.2 Calcium

Calcium is essential for the development and maintenance of the skeleton. It is also important for the proper functioning of neuromuscular and cardiac function. Calcium is stored in the teeth and bones and low intakes have been associated with low bone density conditions. The recommendation for men in the age category 19 to 50 years old is 1,000 mg calcium per day. The upper level is set at 2,500 mg per day (8). It is not yet clear whether calcium requirements are increased or decreased for NRF personnel due to the increased physical activity (54). Yet, the current Australian / New Zealand recommendations included estimates of calcium losses through sweat (8). Furthermore, there are no indications that calcium requirements are further increased in the cold or at high altitude (46). The calcium requirements are currently being revised by the IoM. Based on the currently available evidence, we propose a calcium intake for NRF personnel of 1,000 mg per day.

As yet there is some evidence for increased Ca-losses with heat-stress. With acclimation these losses tend to go down and may not markedly affect Ca-intake requirements. Yet, for individuals exposed to exercise or environmental stress is it considered particularly important to achieve recommended dietary calcium intakes from a variety of foods also providing adequate energy (ADA, DC, ACSM Position statement. Nutrition and athletic performance; Med Sci Sports Exerc, February 2009). An intake of 1000 mg/d is recommended by most authorative bodies, which exceeds the amount recommended by the Nordic Countries (800 mg/d) and by the

Committee on Mineral Requirements for cognitive and physical performance of military personnel (750-850 mg/d) (13).

INL's in sum: ANZ: 1000 mg/d; Nordic: 800 mg/d; NRF: 1000 mg/d

4.5.3 Zinc

4.5.3.1 Civilian norm and normal operations

Zinc is a component of several enzymes which, among others, preserve the structural integrity of proteins and regulate gene expression. Given that zinc binds to protein, protein intake contributes to the efficiency of zinc absorption. The recommendation for men aged 19 to 50 years is 14 mg per day and the upper level is 40 mg per day (8). This value is higher than the recommendation of the WHO (8.4 mg/day), Nordic countries (9 mg/day), DACH (10 mg/day), and the IoM (11 mg/day) (11, 37, 44, 55).

INL's in sum: ANZ: 14 mg/d; Nordic: 9 mg/d; NRF: 14 mg/d

4.5.3.2 Combat operations

There is no clear evidence that moderate increases in zinc intake (5-30 mg/day) improve physical performance or reduce oxidative stress associated with exercise. However, exercise results in larger zinc losses from sweat (54). Furthermore, stress situations, acute trauma and infection can lead to lower plasma zinc (8). The CMNR have, therefore, set the recommended daily intake of zinc at 15 mg per day for men, and we adopted this recommendation for NRF personnel during combat operations (54).

4.5.3.3 Hot environment

Exposure to heat by itself can result in change in zinc metabolism by stimulation of the acute-phase response. Sweat losses of zinc can range from 0.5-1 mg/l. Prolonged exercise in a hot environment may have a negative impact on the zinc balance, therefore zinc supplementation might be needed in these situations. For this reason, the CMNR advise an intake of 15 mg zinc per day in a hot environment. However, caution must be used, since high zinc intakes might

interfere with copper absorption (56,54). In conclusion, our recommended zinc intake for NRF personnel in hot environments is 15 mg per day.

4.5.3.4 Cold and high-altitude environment

Zinc deficiency is associated with poor thermoregulation (57). Furthermore, various stresses increase urinary excretion of zinc, especially in periods of maximum physical exertion. In addition, at high altitude zinc plays a role in modulating eating behavior and urinary excretion of this mineral is found to be increased at high altitudes. It is suggested that zinc supplementation may be useful to prevent anorexia at high altitude. Moreover, zinc is an antioxidant and can fight the increased oxidative stress (58). Therefore, the CMNR have set their recommendation at 20 mg zinc per day for soldiers in a cold and high-altitude environment (46). We adopted this recommendation and propose a daily intake of 20 mg zinc for NRF personnel working in the cold and/or at high altitude.

4.5.4 Iron

4.5.4.1 Civilian norm and normal operations

Iron is a constituent of several proteins, including hemoglobin, myoglobin, cytochromes and enzymes which are involved in redox reactions. The recommendation for adult men (19- 50 y) is 8 mg per day with an upper level of 45 mg per day. High intakes of iron can lead to gastrointestinal complaints such as constipation and they can negatively affect zinc and calcium absorption (8). This recommendation is relatively low compared to the recommendation of the WHO (15.4 mg/day), DACH (10 mg/day) and the Nordic countries (9 mg/day), which is due to differences in food matrixes (11, 37, 44).

INL's in sum: ANZ: 8 mg/d; Nordic: 9 mg/d; NRF: 8 mg/d

4.5.4.2 Combat operations

Anemia as a result of an iron-deficiency can decrease physical performance, but it is not a common complication of chronic exercise. However, regular exercise can lead to an increased destruction of red blood cells, decreased iron absorption, and increased iron losses primarily due to sweating. Due to these increased sweat losses, the CMNR proposes an iron intake of 14 mg

per day, and, accordingly, we recommend 14 mg per day for NRF personnel in combat operations (54, 56).

4.5.4.3 Hot environment

Although results from various studies show a wide range of iron losses through sweating, it is overall suggested that iron loss through sweat can be substantial for military personnel in hot climates. Therefore, and in line with the CMNR recommendation during combat operations, we recommend an intake of 14 mg iron per day for NRF personnel in the heat (54, 56).

4.5.4.4 Cold and high-altitude environment

There is a clear link between iron deficiency and poor thermoregulation. Furthermore, Iron is essential in hemoglobin for the binding and transport of oxygen by erythrocytes, therefore, adequate iron status is important for those working at high altitudes (57). Therefore, the CMNR recommends an intake of iron of 15 mg per day for soldiers operating in the cold and at high altitude. This value is believed low enough to prevent constipation (46). In conclusion, we propose an iron intake of 15 mg per day for NRF personnel in a cold and high-altitude environment.

4.5.5 Magnesium

Magnesium is a cofactor for over 300 enzyme systems and it is important for aerobic and anaerobic energy production. The recommendation for magnesium is 400 mg per day for men aged 19 to 30 years and 420 mg per day for men in the age category 30 to 50 years. The upper level of magnesium supplements, i.e. on top of the regular magnesium intake from food, is set at 350 mg per day (8). Magnesium requirements during heavy exercise are not increased. Magnesium losses can occur through sweating, however, no evidence exists that these amounts lead to an impaired physical performance. In addition, supplementation with magnesium has not always shown to increase magnesium status (54, 56). Furthermore, no data was found that magnesium recommendations are substantially changed in extreme environments. In conclusion, with regard to the assumption of equal number of men in both age categories, the overall recommended intake for NRF personnel becomes 410 mg per day.

INL's in sum: ANZ: 400/420 mg/d; Nordic: 350 mg/d; NRF: 410 mg/d

4.5.6 Selenium

4.5.6.1 Civilian norm and normal operations

Selenium is an antioxidant and plays a role in redox reactions and the thyroid metabolism. The recommendation for men in the age category 19 to 50 years old is 70 µg per day (8). The WHO recommends a much lower value, i.e. 34 µg per day (44). The upper level of selenium is 400 µg per day (8).

INL's in sum: ANZ: 70 µg/d; Nordic: 50 µg/d; NRF: 70 µg/d

4.5.6.2 Combat operations

No studies have been found on the effects of selenium deprivation on physical performance. In addition, there is no strong evidence that selenium losses are substantial or that increased selenium intake will benefit military personnel in combat operations (54, 59). Given that, the CMNR does not recommend an increased intake of selenium and we suggest an intake of 70 µg selenium per day for NRF men during combat operations.

4.5.6.3 Hot environment

The CMNR concludes there is no evidence that selenium requirements are higher in hot environments (56). Thus, we advise an intake of 70 µg selenium per day for NRF personnel in the heat.

4.5.6.4 Cold and high-altitude environment

No data was found that selenium requirements are altered in a cold environment. Since selenium is an antioxidant, it might reduce the oxidative stress associated with high altitude. However, we believe there is not enough evidence to suggest higher intakes of selenium to prevent oxidative stress (20-22). In conclusion, we propose a selenium intake of 70 µg per day for NRF personnel in a cold and high-altitude environment.

4.5.7 Copper

4.5.7.1 Civilian norm and normal operations

Copper is a constituent of various metalloenzymes. High intakes of zinc and iron may hinder copper absorption. A copper deficiency is associated with vascular and skeletal problems and anemia related to a distorted iron metabolism. The recommendation for men of 19 to 50 years old is 1.7 mg per day (8). This is higher than the recommendation of the IoM and the Nordic countries, who both advise 0.9 mg per day (37, 55). The upper level of copper is 10 mg per day (8).

AI's in sum: ANZ: 1.7 mg/d; Nordic: 0.9 mg/d; NRF: 1.7 mg/d

4.5.7.2 Combat operations

A severe copper deficiency could have major effects on energy synthesis and iron transport. There is no evidence that increased copper intakes will benefit physical performance. During exercise, increased amounts of copper are lost through urine and sweat. Studies of copper losses through sweat are limited, however, it appears that at least 300 µg copper per day can be lost (54, 56). For that reason, the CMNR advises a daily intake of 1.8 mg per day for male soldiers during training (54). In conclusion, we also recommend a copper intake of 1.8 mg per day for NRF personnel during combat operations.

4.5.7.3 Hot environment

Copper losses occur in a hot environment through sweating. The combination of strenuous exercise and heat would probably accelerate these losses. Given this, the CMNR advises a copper intake of 1.8 mg per day during exercise in the heat (54, 56) and we also propose an intake of 1.8 mg per day for NRF personnel in hot environments.

4.5.7.4 Cold and high-altitude environment

The CMNR concludes that there is no evidence that copper requirements are higher in the cold or at high altitude (46). Therefore, our recommended copper intake for NRF personnel in a cold and high-altitude environment remains 1.7 mg per day.

4.5.8 Sodium

4.5.8.1 Civilian norm and normal operations

Sodium is essential to maintain extracellular volume and serum osmolality. Furthermore, it is important for preserving the membrane potential of cells and for active transport of molecules across cell membranes. The acceptable intake range for men is 460 to 920 mg sodium per day and the upper level is 2,300 mg per day (8). For NRF soldiers during normal operations, we recommend the upper level of the range of the acceptable intake, i.e. 920 mg per day, since NRF personnel has a higher physical activity level and, therefore, sweat production compared to the general population. In comparison, the IoM recommends 1,500 mg sodium per day and the recommended amount sodium by DACH is 550 mg (11, 60).
AI's in sum: ANZ: 460-920 mg/d; NRF: 920 mg/d

4.5.8.2 Combat operations

Strenuous physical activity greatly increases sodium losses through sweating. The amount of sodium lost may reach amounts as high as 8,000 mg per day. Extra salt intake may be needed when more than 3 L of water is required to replace sweat losses. The need for extra salt depends on the severity of exercise, and, thus, sweat losses and the degree of acclimatization. The CMNR advises a sodium content in rations for short-term high-intensity combat operations of 1,200 up to 4,800 mg per day as a supplement for persons who lose salt in excess or when in extremely hot situations (13, 61). In line with this, we recommend a sodium intake of 920 mg with a supplemental 1,200 to 4,800 mg per day for NRF soldiers during combat operations.

4.5.8.3 Hot environment

Exposure to heat without exercise also alters the sodium concentration of sweat (8). Especially when a subject is not heat acclimatized, substantial amounts of sodium can be lost through sweating. Consequently, we recommend the same amount as during combat operations: a sodium intake of 920 mg per day with a supplement of 1,200 to 4,800 mg per day, dependent of the sweat rates (13, 61).

4.5.8.4 Cold and high-altitude environment

It is difficult to predict fluid losses in the cold as various factors influence increased fluid losses and reduced fluid intake (3). Provided that appropriate clothing is worn and some exercise to generate heat is possible, the CMNR concludes that exposure to a cold environment does not lead to changes in sodium recommendations. However, when sweating is present, sodium will be

lost. Therefore, the sodium requirement will depend on sweating rate (62). At high altitude, salt intake appears to be inhibited by the physiologic processes associated with adaptation to altitude. However, fluid requirements nor sweat rates are increased in a high-altitude environment (30). In conclusion, our sodium recommendation for NRF personnel in a cold and/or high-altitude environment is 920 mg per day with a supplement of 1,200 to 4,800 mg when extensive sweating is present.

4.5.9 Potassium

Potassium is the main component of intracellular fluid and lean body tissues. The recommendation for men aged 19 to 50 years is 3,800 mg per day and for dietary sources, no upper level has been set (8). The recommendation of the IoM and DACH are somewhat higher, respectively 4,700 and 4,000 mg per day (11, 60). No data have been found that indicated that potassium requirements were different during high-intensity physical activity or in extreme environments (62). There was limited scientific evidence on potassium recommendations in the situations NRF soldiers may encounter. Until future research provides more insight, we propose a potassium recommendation for NRF personnel of 3,800 mg per day.

AI's in sum: ANZ: 3800 mg/d; Nordic: 3500 mg/d; NRF: 3800 mg/d

5 Proposed nutrient intakes NRF personnel

Table 5.1 shows our proposed nutrient intakes for male NRF personnel.

Table J-5.1 Proposal for recommended intakes of energy and nutrients for use in planning diets for male NRF personnel, 19 to 50 years, 79 kg, 1.75 m in five different situations.

Nutrient	Unit	Civilian norm	NRF Operations		Extreme environments		
			Normal operations	*Combat operations*	*Hot environment (combat) (>30 °C)*	*Cold environment (<0 °C)*	*High altitude (>3,050 m)*
Energy	kcal	2,900	3,600	4,900	4,900	4,900	4,700
Carbohydrate	g	395 (323-466)	494 (404-584)	675 (552-797)	675 (552-797)	675 (552-797)	711 (533-770)
Protein	g	144 (108-179)	180 (135-225)	246 (184-307)	246 (184-307)	246 (184-307)	178 (178-296)
Total fat Saturated fat PUFA - Linoleic - α-linolenic - Total LC n-3	g g g g g mg	88 (64-111) < 32 22 (13-32) 13 1.3 160	110 (80-140) < 40 28 (16–40)	150 (109-191) < 55 38 (22-54)	150 (109-191) < 55 38 (22-54)	150 (109-191) < 55 38 (22-54)	132 (105-184) < 52 37 (21 – 53)
Dietary fiber	g	30	30	30	30	30	30
Total water	L	3.4	3.4	+[a]	+[a]	+[a]	3.4
Vitamin A	µg	900	900	900	900	900	900
Thiamin	mg	1.2	1.2	1.2	1.2	1.2	1.2
Riboflavin	mg	1.3	1.3	2.5	2.5	2.5	2.5
Niacin	mg	16	16	16	16	16	16
Vitamin B_6	mg	1.3	1.3	2.6	2.6	2.6	2.6
Vitamin B_{12}	µg	2.4	2.4	2.4	2.4	2.4	2.4
Folate	µg	400	400	400	400	400	400
Pantothenic acid	mg	6	6	6	6	6	6
Biotin	µg	30	30	30	30	30	30
Vitamin C	mg	45	45	45	45	45	45
Vitamin D	µg	5	5	5	5	5	5
Vitamin E	mg	10	10	10	10	10	10

Vitamin K	µg	70	70	70	70	70	70
Choline	mg	550	550	550	550	550	550
Calcium	mg	1,000	1,000	1,000	1,000	1,000	1,000
Phosphorus	mg	1,000	1,000	1,000	1,000	1,000	1,000
Zinc	mg	14	14	15	15	20	20
Iron	mg	8	8	14	14	15	15
Magnesium	mg	410	410	410	410	410	410
Iodine	µg	150	150	150	150	150	150
Selenium	µg	70	70	70	70	70	70
Molybdenum	µg	45	45	45	45	45	45
Copper	mg	1.7	1.7	1.8	1.8	1.7	1.7
Chromium	µg	35	35	35	35	35	35
Manganese	mg	5.5	5.5	5.5	5.5	5.5	5.5
Fluoride	mg	4	4	4	4	4	4
Sodium	mg	920	920	920 + 1,200 – 4,800[b]	920 + 1,200 – 4,800[b]	920 + 1,200 – 4,800[b]	920 + 1,200 – 4,800[b]
Potassium	mg	3,800	3,800	3,800	3,800	3,800	3,800

a Extra need on top of the civilian norms, however, not defined in this report.
b: Depending on sweat rate

6 Current combat rations

6.1 Introduction

In this section, we will consider the combat rations of NATO countries which are full day rations and designed to be consumed in the situations NRF soldiers may encounter (i.e. normal and combat operations and a hot, cold, and, high-altitude environment). We will compare these rations with the recommended intakes of energy, macro- and micronutrients for NRF soldiers. When a certain ration does not meet energy, macronutrient or micronutrient recommendation, we suggest adding this constituent to the ration to the recommended level.

6.2. Energy content

Figure 6.1 shows the energy content of the proposed rations of the NRF during normal and combat operations and a cold or high-altitude environment and rations of 11 NATO countries. Depending on the type of operations and the environment, it can be seen whether the given NATO ration provides enough energy to meet the demands of NRF soldiers. When a specific ration does not provide the recommended amount of energy, supplementation of kcal will be needed. Considering that the NRF soldiers needs a minimum amount of 3,600 kcal per day, we can see that at least the following rations will need additional kcal to meet the energy recommendations: the American First Strike Ration and the Long Range Patrol, the German Individual Combat Ration (Light), the French combat ration, the Czech Republic's Ration of Canned Food Stuffs, and the Belgian Combat Ration and the Long Range Recce Patrol Ration.

6.3 Macronutrient content

From **Figure 6.2**, we can conclude that fat and carbohydrate content of all but one (USA First Strike Ration and NLD arctic region, respectively) are within the AMDR-ranges. The protein content of almost all rations is below the reference values derived from the Australian and New Zealand recommendations (15-25%). Though this range is within the AMDR-range of the IOM. (10-35%), it is well above the earlier ANZ-AMDR (11-15%) and shifts towards higher values as compared to the Nordic AMDR for protein (10-20%). So there is scope for more protein in most of the rations at the expense of those macronutrients in which these diets are relatively rich.

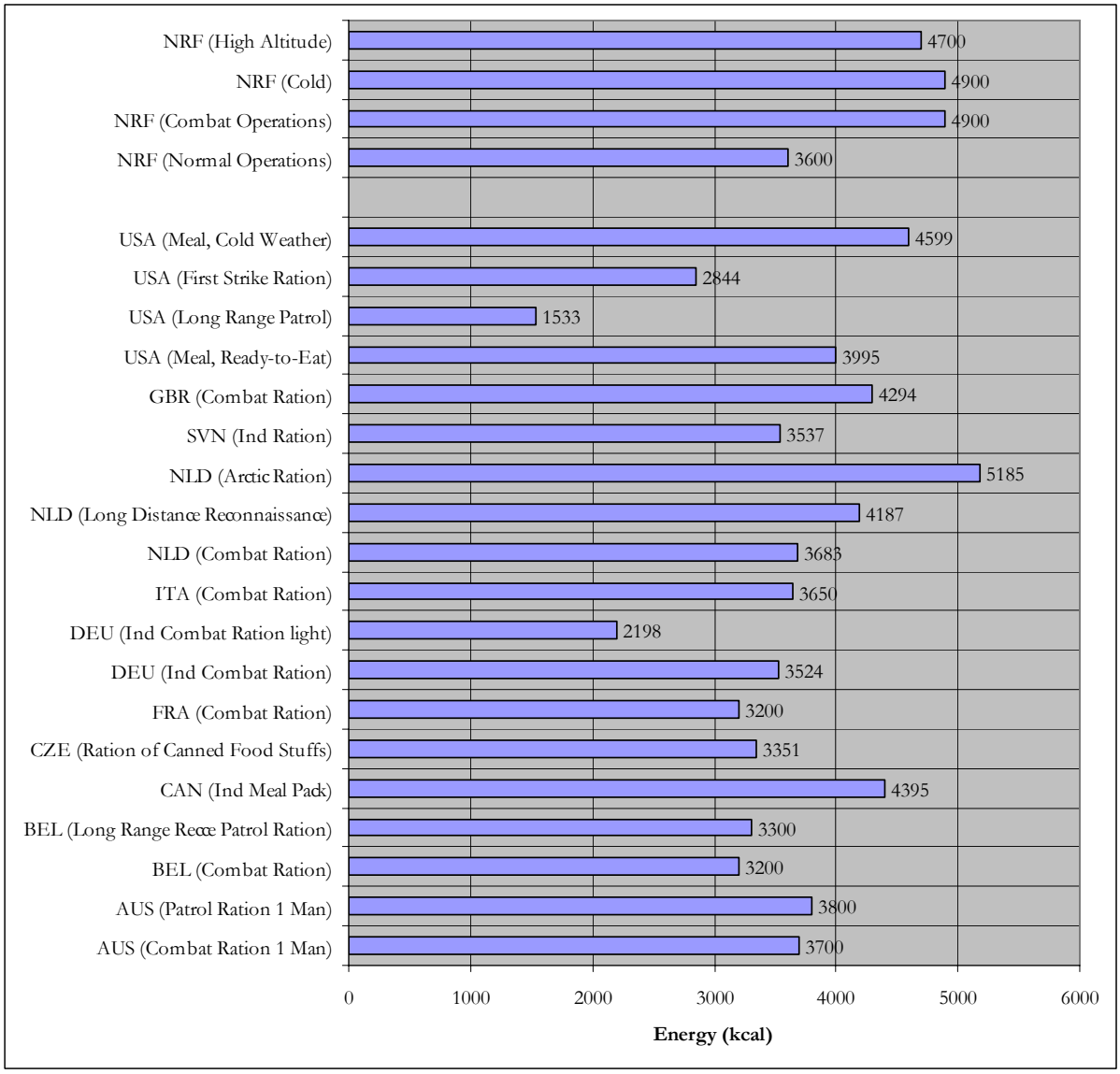

Figure J-6.1 Energy content (kcal/day) of the proposed NRF rations compared to the energy content of general and special purpose rations of 11 NATO countries.

6.4 Sodium content

All NATO rations meet our sodium recommendation for normal operations (**Figure 6.3**). However, in case of combat operations or operations in the cold and/or at high-altitude, the American First Strike Ration and Long Range Patrol and the ration of Canned Food Stuffs from the Czech Republic will need some additional sodium to reach the recommended level of 4,800 mg per day.

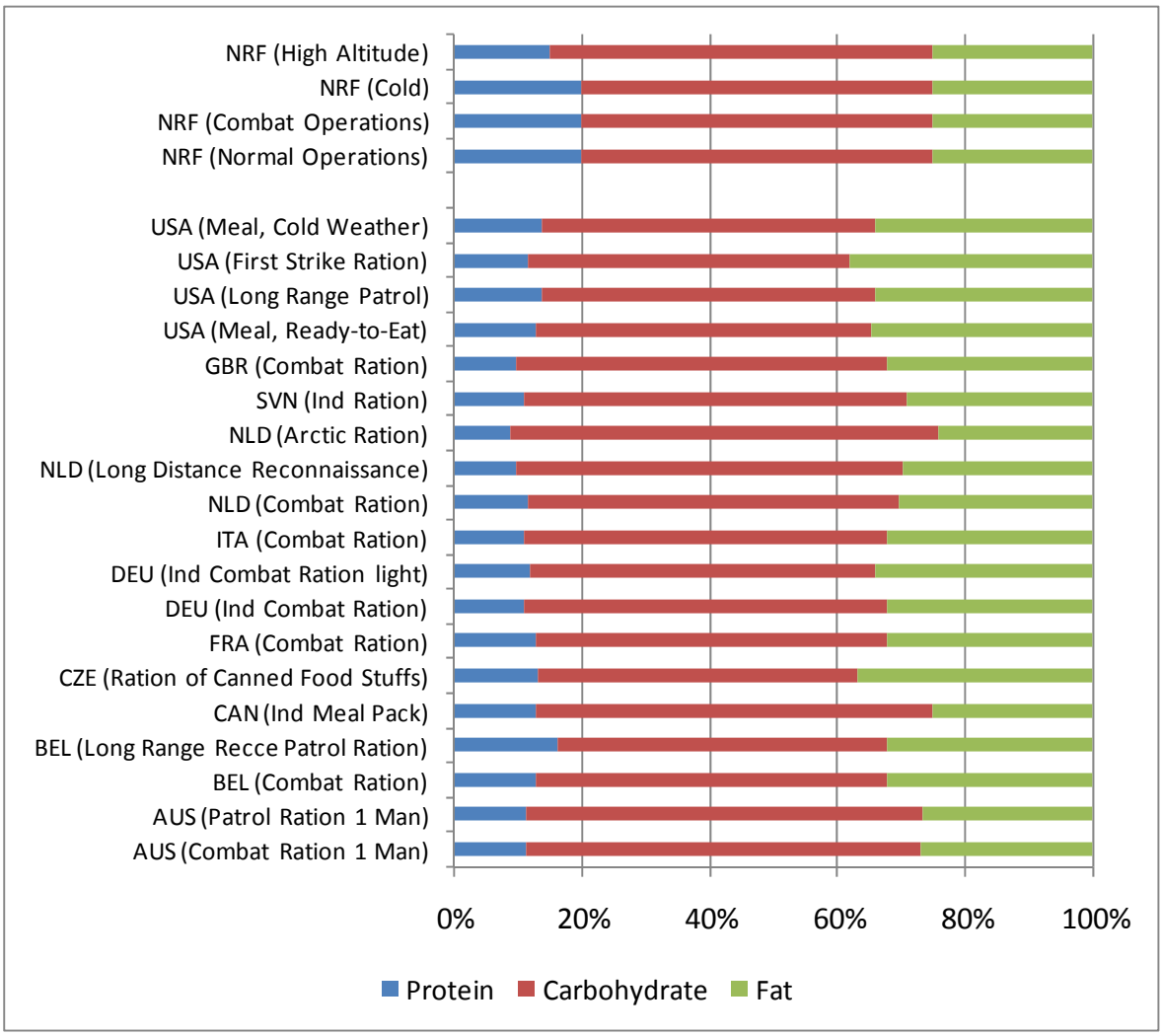

Figure J-6.2 Proposed macronutrient distribution (en%) of NRF rations compared to the macronutrient distribution of the general and special purpose rations of 11 NATO countries.

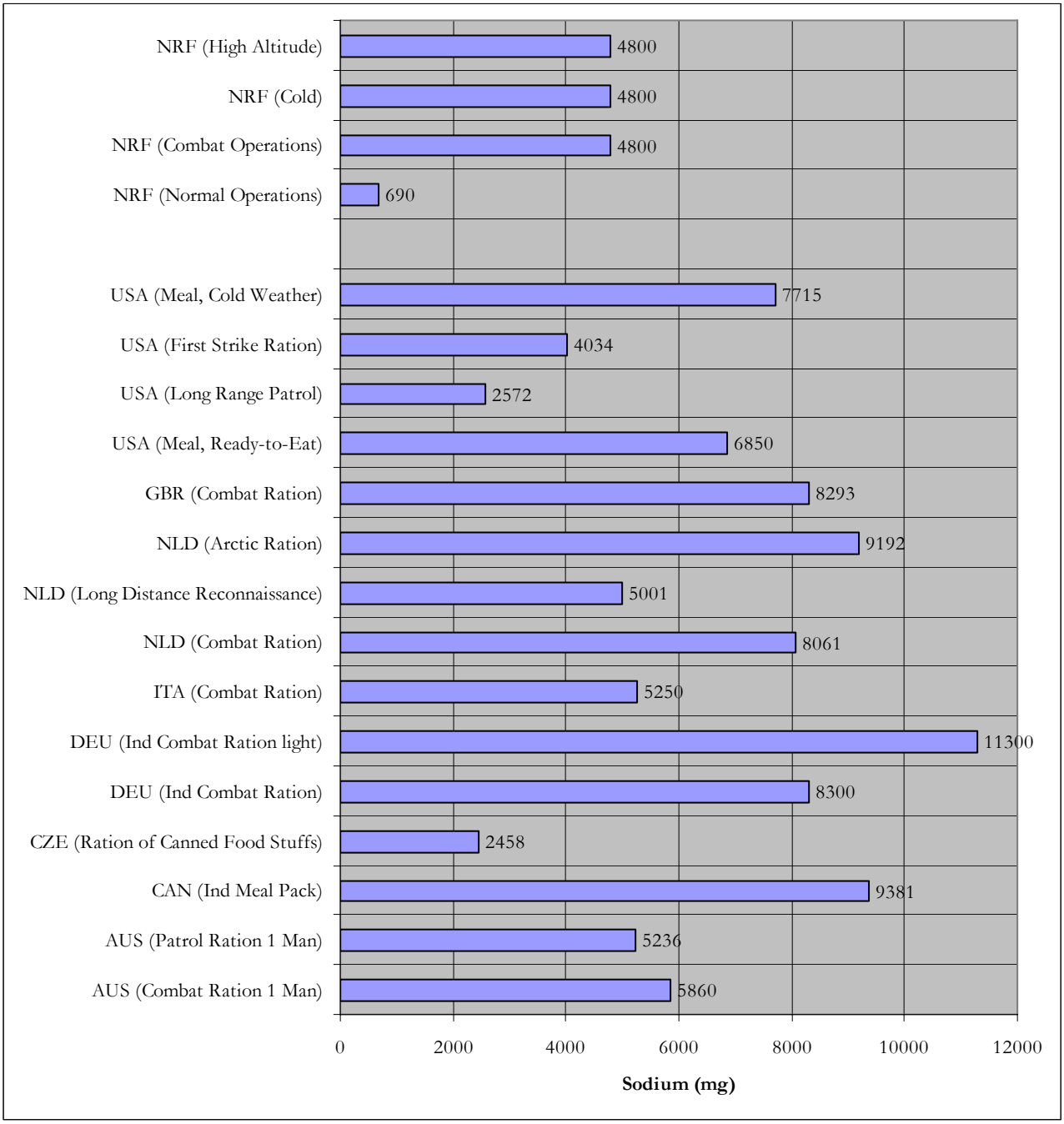

Figure J-6.3 Proposed sodium content (mg/day) of the NRF rations compared to the sodium content of the general and special purpose rations of eight NATO countries.

6.4 Iron content

In **Figure 6.4,** it is shown that most rations meet the iron recommendation for NRF soldiers. However, in case of combat operations or operations in a cold or high-altitude enviornment, the American Long Range Patrol Ration will probably not meet the recommendations.

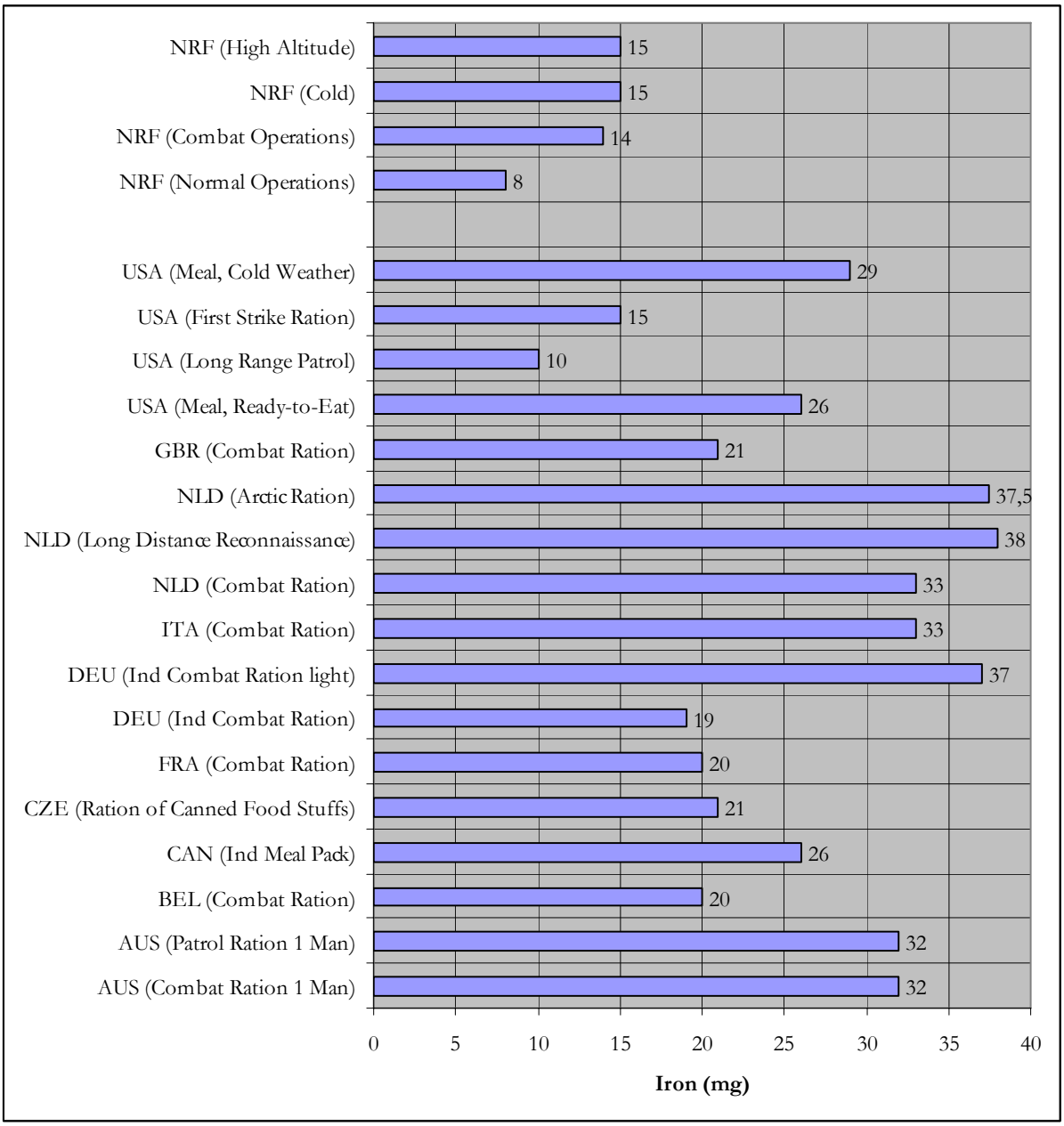

Figure J-6.4 Proposed iron content (mg/day) NRF rations compared to the iron content of the general and special purpose rations of ten NATO countries.

6.5 Calcium content

The combat ration of the Netherlands, France, Czech Republic and Belgium will not meet the recommended value of calcium of 1,000 mg per day (**Figure 6.5**). In addition, the calcium content of the German Individual Combat Ration Light is above the upper level of 2,500 mg per day.

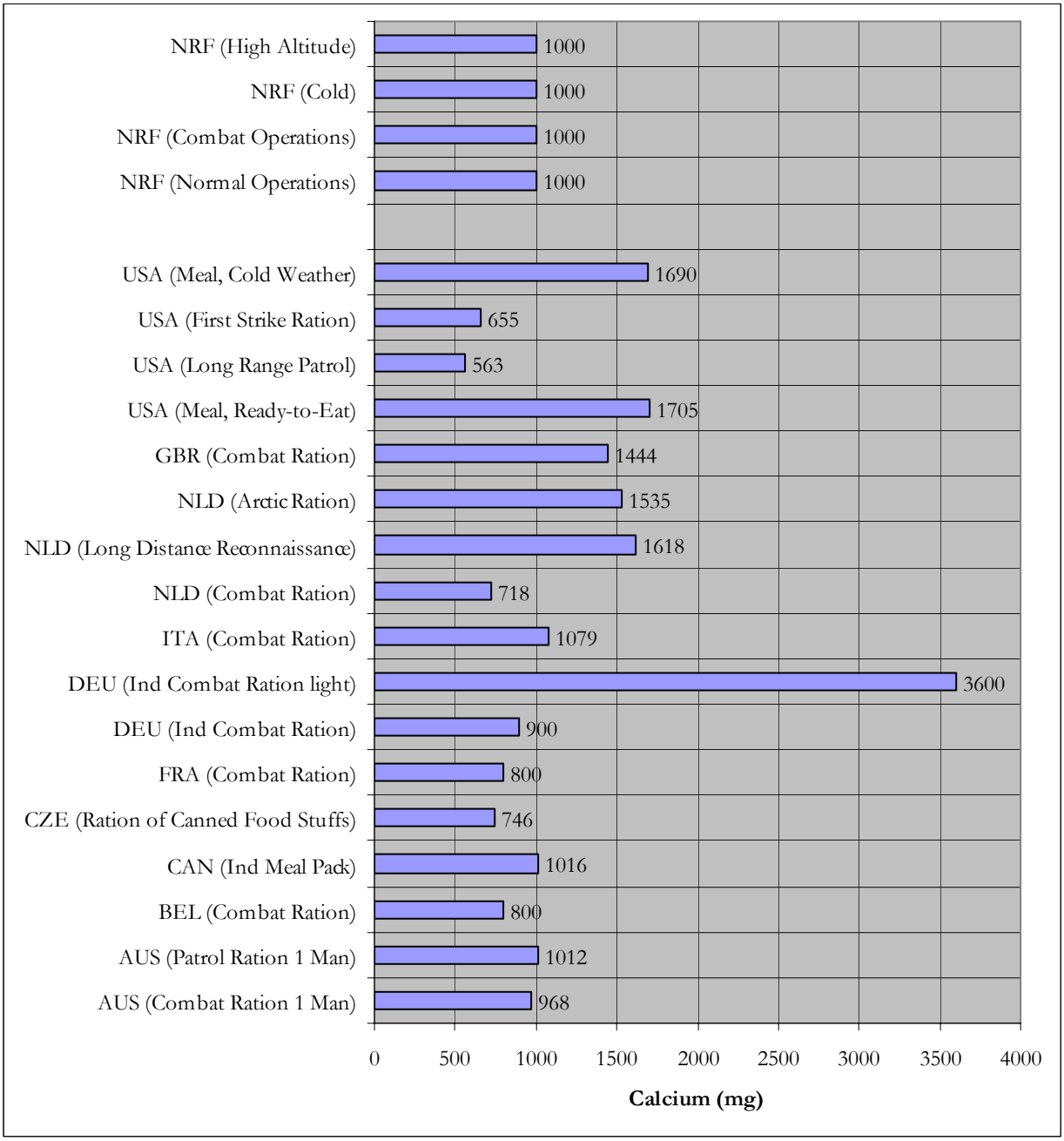

Figure J-6.5 Proposed calcium content (mg/day) NRF rations compared to the calcium content of the general and special purpose rations of ten NATO countries.

6.6 Conclusion

We can conclude from this comparison that all rations generally meet the recommendations for NRF soldiers in several situations. Some rations may need some additional energy, protein or micronutrients to reach the recommended value. However, taking into account a maximum deployment of 30 days, we believe there is no indication for drastic changes of the current rations.

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Glossary

AI	Adequate intake
AMDR	Acceptable macronutrient distribution range
ANR	Average nutrient requirement
CMNR	Committee on Military Nutrition Research
DACH	German speaking countries: Germany, Austria, Switzerland.
EAR	Estimated average requirement
EURRECA	EURopean micronutrient RECommendations Aligned
INL	Individual nutrient level
IoM	Institute of Medicine
MDRI	Military dietary reference intake
NATO	North Atlantic Treaty Organization
NRF	NATO response force
NIV	Nutrient intake level
PAL	Physical activity level
PUFA	Poly unsaturated fatty acids
RDA	Recommended dietary allowance

Appendix I: Nutrient intake levels of micronutrients for Australia and New Zealand, DACH, the IoM, the Nordic countries, and the WHO

Micronutrient	Unit	Australia and New Zealand 2005(8)	DACH 2002(11)	IoM 1997-2005 (47, 55, 63, 64)	Nordic countries 2004(37)	WHO 2004(44)
Vitamin A	µg	900	1,000	900	900	600
Thiamin	mg	1.2	1.2	1.2	1.5	1.2
Riboflavin	mg	1.3	1.4	1.3	1.7	1.3
Niacin	mg	16	16	16	19-20	16
Pantothenic acid	mg	6.0	6	5	x	5
Vitamin B_6	mg	1.3	1.5	1.3	1.6	1.3
Biotin	µg	30	45	30	x	30
Folate	µg	400	400	400	400	400
Vitamin B_{12}	µg	2.4	3.0	2.4	2.0	2.4
Vitamin C	mg	45	100	90	75	45
Vitamin D	µg	5	5	5	7.5	5
Vitamin E	mg	10	14	15	10	10
Vitamin K	µg	70	70	120	x	65
Calcium	mg	1,000	1,000	1,000	800	1,000
Copper	mg	1.7	1.3	0.9	0.9	x
Choline	mg	550	x	550	x	x
Chromium	µg	35	65	35	x	x
Fluoride	mg	4.0	3.8	4	x	x
Iodine	µg	150	183	150	150	150
Iron	mg	8	10	8	9	15.4
Magnesium	mg	420	350	420	350	260
Manganese	mg	5.5	3.5	2.3	x	x
Molybdenum	µg	45	75	45	x	x
Phosphorus	mg	1,000	700	700	600	x
Potassium	mg	3,800	2,000	4,700	3,500	x
Selenium	µg	70	50	55	50	34
Sodium	mg	460 – 920	550	1,500	x	x
Zinc	mg	14	10	11	9	8.4

Annex K – NATO RATION CHARACTERISTICS LIKELY TO INCREASE/DECREASE CONSUMPTION

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K.1 INTRODUCTION

K.1.1 Outline of this Report

This report on "NATO Ration Characteristics Likely to Increase/Decrease Consumption" is organized into three broad sections: Food/Ration, Individual/Soldier, and Environment/Field. Available data have been applied to the factors listed in this report. The findings are summarized in a set of Conclusions. References to military rations apply only to the general use ration of each country. In general, a ration is "one day's supply of food" (see Annex D.3), a meal is the food consumed at one time, and a menu is the variety offered at a meal. Inclusion of special rations is beyond the scope of this paper.

The outline of factors likely to increase or decrease consumption was first presented to the NATO RTG in April 2008 and is shown in Appendix 1. This same outline is used below with some modification. In addition, an overall decision is presented on whether each factor can enhance or decrease food consumption in Appendix 2. A plus (+) sign indicates potential enhancement of consumption, and a negative (-) sign indicates potential decrease of consumption.

K.1.2 Three Factor Model: Rations, Individuals, Environments

Military rations are consumed by an individual in a particular location. Thus eating can be viewed as the interaction of a person, a product, and an environment. In the context of military rations, these three factors become the ration, the soldier, and the field. There has been a great deal of research on food or product variables, and human or individual variables. Contextual research has received far less attention than either product research or person research, probably because both of these classes of variables are the main foci of major stakeholders. The huge product industry is the main stakeholder for product research; the huge health industry is the main stakeholder for person research.

There are very few references to research including all three factors before the 1980s. Researchers at the US Army Natick Laboratory began to study the context in which soldiers eat beginning in the 1980s and first reported their work (Meiselman, Hirsch and Popper, 1988) at the 1988 conference on Food Acceptability at Reading, England (Thomson, 1988). They discussed the lack of agreement between product liking (acceptability) and product consumption in their data – products which were most liked were not necessarily most consumed. They were just beginning to become aware that environmental variables were controlling intake, as they do under certain conditions. At the same Reading meeting Schutz (1988) introduced the concept of appropriateness which tries to include situational concerns in food behavioral research. Following that, Meiselman (1992a, 1992b) argued for greater use of natural contexts in research, suggesting that we "...refocus human eating research towards greater use of real meals, served to real people (not subjects),

in real eating situations." (p. 54). Military research in the human factors of eating was ahead of both commercial research and academic research; the former depended on central location tests and the latter depended on laboratory tests. Both avoided testing in natural locations because the focus was on the product or on the person. By working in natural locations where rations are actually consumed ("the field"), military research pioneered this area of research, which is now being investigated world-wide.

Starting in the 1990s there was growing discussion of the importance of context and contextual variables. Rozin and Tuorila (1993) discussed context at the first Pangborn Sensory Science Symposium, and presented an organizational scheme for contextual variables. Meiselman (1996) discussed context within the three-part organizational scheme of the food, the person and the environment. More recently, Wansink (2004), Stroebele and de Castro (2004), and Meiselman (2006, 2007a, 2007b) have reviewed work relating eating to the environment.

Wherever research is conducted, the researcher is usually interested in two classes of information: how much the food is liked (and why), and how much is consumed (and why). Liking is also believed to correlate highly with product consumption (deGraaf et al, 2005; Lahteenmaki and Tuorila, 1995) but the degree of that correlation varies widely. Liking and intake are the two main facets of product experience; in the commercial sector, the shopping experience is an additional facet. Some researchers discuss many facets of the food process, sometimes called the provisioning process. For example, Marshall's food provisioning process (Marshall, 1995), based on earlier cross cultural research, contains five sequential stages: acquisition, preparation, cooking, eating, and disposal. Several of these factors are relevant to military feeding, in which soldiers must deal with acquiring rations, preparing some rations (for example, heating), eating and disposal. In general individual combat rations do not require cooking.

The goal of this chapter is to consider food variables, human or individual variables, and environmental variables involved in the consumption of military rations. The chapter will aim to be complete, and an attempt will be made to highlight or identify the more important variables.

K.2 THE FOOD / THE RATION

K.2.1 Portion Size

The research on portion size has been clear on the effect of portion size, but not necessarily the mechanism of that effect. A number of studies have shown a significant effect of portion size; the bigger the available portion, the greater the intake. The effect is seen both in the laboratory (Rolls, Roe, & Meengs, 2006) and in a restaurant setting (Diliberti, Bordi, Conklin, Roe, & Rolls, 2004), and when consumers serve themselves as well as when foods are served to them (Rolls et al, 2002).

Rolls et al (2007) conducted a series of three studies to test the effect on energy intake of changing the size of the plate used at a meal. The studies differed in whether the foods were served by the participants or by the researchers, in the number of foods that were offered, and in the effort involved in obtaining the food. There was no effect of plate size in any of the tests. Thus, portion size affects how much we eat, but the size of the serving vessel is not clearly related to how much we eat. Perhaps the use of larger plates in restaurants or homes has led to increased portion sizes.

Within the military context, there needs to be a discussion of whether ration size contributes to the issue of consumption. Recent evidence suggests that condensed, calorie dense foods might operate differently. Brunstrom and Wilkinson (2007) at the University of Bristol UK observed greater "learned expected satiety"

in energy dense desserts than in lower energy desserts. This raises the question whether people can adjust their meal size to what they expect the energy density of food to be.

K.2.2 Food Temperature

The ability to provide foods at the appropriate serving temperature is an important part of foodservice, and is a challenge for military field feeding. There seems to be some general agreement about ideal eating temperatures. For example, studies of coffee and soup show similar best eating temperature. Coffee is ideally consumed when it is in the mid to upper part of the range of 62.8±68.3°C (145±155°F) (Borchgrevink et al, 1999). Kahkonen, Tuorila & Hyvonen (1995) studied the acceptability of soups at different levels of fat and different temperatures. The soups at 63°C were rated the most pleasant. The highest temperature was also considered the most appropriate one. The unusual serving temperatures (lukewarm 48° and 33°C) decreased pleasantness in line with other studies (Cardello & Maller, 1982; Zellner et al, 1988).

However, we are not only dealing with ideal serving temperatures, as defined by consumer research, but with what consumers expect the serving temperatures to be. In a series of studies, Zellner et al (1988) examined how our expectations for proper serving temperatures affect our liking. The actual taste of beverages at temperatures at which they are not usually consumed is better than most people believe and the rejection of such beverages is at least in part influenced by learned expectations and/or ideas of appropriateness. Foods at unfamiliar temperatures may be rejected as inappropriate for food, although caution must be exercised in application of these results to military situations.

The above information suggests that the ability to provide rations at appropriate eating temperature will be an important factor in their being liked and consumed. This applies to both hot and cold appropriate temperatures. However, soldiers with experience in the field might not have these expectations for rations in the field. Most operational rations provide a heating device; some are included with the ration, and others are provided separately. Further, it should be noted that heaters and rations from different countries might not be compatible. We are probably left with the conclusion that serving food at the right temperatures will enhance liking, but serving at the wrong temperatures might not be as negative in the military field situation.

K.2.3 Food Compatibilities

A ration is a meal, and meals have certain rules and traditions of what foods go with what meals and with what other foods. Food combinations in meals are not random. In a study of meal food combinations, Marshall and Bell (2003) asked students in both Scotland and Australia to construct snacks, and lunch and dinner meals composed from 51 common food names for 11 different physical locations. They identified 6 different meal types: main meal, light meal, fast food, snack, camping trip, and seafood snack. They emphasized that some foods are associated with specific meal types (hamburgers in fast food), and many food items belong in different meal types and in different locations (pasta). Fast food items fell into a separate cluster. The main meals for both lunch and dinner were similar to the British “proper meal” with a meat, vegetable and starch. Light meals contained the types of main dishes (pizza, pasta, sausage) not usually associated with main meals. Pizza fit into fast food, light meal, and snack depending on country and meal group. The effect of location on food choices was more important at lunch than dinner. One of the overall conclusions by Meiselman’s new book on *Meals in Science and Practice* (Meiselman 2009) is that the traditional rules of meal main dishes and combinations are changing: meat need not be the center of the meal, and side dishes can vary from the traditional. We can expect to see these traditions changing in the future.

Another way of looking at food patterns within meals is to examine what foods are consumed at which meals (Makela, 2002). The large Nordic study of 1200 people in each of four Nordic countries presents detailed data on

what people eat at meal-times. Every meal pattern contains a main dish ("centre") by definition, and almost all (>95%) meals contain a beverage. Other meal components range from 10 – 65% present in meals. Hot meal patterns vary considerably, with the pattern of main dish/starch/vegetable with or without sauces being the most common. This is similar to the British proper meal studied by Douglas (1976) and others. Considering all meals, most meals have 2 or 3 components, with 1 and 4 component meals about equal in frequency.

People have not only studied what we eat at meals, but how those meal components contribute to the overall meal experience. The earlier work on food acceptability within meals produced a clear pattern of data, showing that the main dish within a meal contributes the largest portion (about 50%) to overall meal acceptability (Rogozenski & Moskowitz, 1982; Turner & Collison, 1988). Instead of modeling questionnaire meals, Hedderley and Meiselman (1995) modeled actual University cafeteria meals (n = 309) freely selected by University students in the U.K. They found that the main dish accounted for varying amounts of overall meal acceptability depending on the type of meal and the type of main dish. Traditional meals with a main dish were the most frequent and the main dish accounted for 60% of overall meal acceptance. Sandwich meals and pizza meals were less frequent, and the main dish accounted for relatively more of the overall meal's acceptability, 70% and 90% respectively.

Many operational rations represent combinations of products not based on traditional combinations within that country. Products are often chosen because of their individual popularity, rather than how well they combine with others to form a meal. This remains a challenge for many ration developers.

K.2.4 Food Quality, Acceptance

Perhaps no single factor captures the attention of product developers and those involved in predicting consumer behavior more than acceptance. Whether a product is liked or not liked has a major impact, some say *the* major impact on whether that product is consumed or how much is consumed. In their review of psychological factors contributing to consumption, Pliner and Rozin (2007) note that "… people eat larger meals when they are eating food they like". This has been shown to be true whether "liking" is defined in terms of individual preferences, or manipulated by "doctoring" the food to alter its palatability; it is true for meals consisting of several courses or a single course, as well as sandwich meals and snacks; it is true for neonates and children, as well as for adults; it occurs in the laboratory and when individuals are observed in natural environments or report on their behaviour in such environments" (Pliner and Rozin, 2000, p. 29, numerous references removed). If I had to name one variable which must be maximized to ensure consumption, I would say that consumers must like a product in order to insure consumption. Those who try to get consumers to eat foods which are good for them constantly struggle with this simple truth: people eat what they like, and people do not eat what they do not like.

Therefore the task in both commercial and military product development is to make products which people like. And the task in nutrition and dietetics is to design meals around foods which people like. Designers of military rations have struggled with this issue for many years, and have continued to improve rations in attempts to meet consumer expectations for acceptable product quality.

The data needed to discuss this critical issue within the NATO context would be a chart of acceptance values for military ration components in each country. In the US we usually use the nine point hedonic scale, developed by the US Army in the 1950s. This scale measures food on a scale from dislike extremely (scale value 1) to neither like nor dislike (scale value 5) to like extremely (scale value 9). Above and below the midpoint (5) lie the terms slightly (scale values 4 and 6), moderately (scale values 3 and 7) and very (scale values 2 and 8). Most commercial food products aimed at the general public rate from 6 – 8. Popular foods rate 7 and above. Many product companies will not release a product from development until it rates 7.

There are extensive data on ration acceptability from the US Army. A number of these studies are summarized in a series of papers in the journal *Appetite* in 2003 (Volume 40, Issue 3) and 2005 (Volume 44, Issue 1). Interestingly, Army food in the field is often rated positively by soldiers. It appears as though the same food is rated more highly in the field than it would be in a cafeteria. For example, Kramer and colleagues collected information in 1998 from soldiers who were in the field continuously for 10 days subsisting entirely on operational rations (MREs) (Kramer, personal communication). They filled out questionnaires on eating including liking scores. Almost 93% of all liking scores were positive, that is, they rated 5 or greater on the nine point hedonic scale.

Institutional food products often rate less than this, both because of their sensory attributes and the effects of lower expectations (Cardello et al, 1996; Meiselman, 2009). Expectations are discussed separately in this report. There are a number of examples where professionals have hoped that people would accept products of lower acceptance for health and other reasons. In most cases this does not work. For example, it was expected that people would accept lower quality for natural food products or functional food products. Research has shown that people expect these added features in addition to quality, not instead of quality. Consumers do not want to make a trade-off for quality.

K.2.5 Food Packaging and Labeling

K.2.5.1 Packaging Effort and Uncertainty

The two tables below present information designed to reduce the effort and uncertainty in consuming operational rations. The table of Content Information (Table K-1) provides information to the Warfighter/ consumer, informing them whether the ration meets their preferences and, in some cases, meets their personal or religious beliefs (such as vegetarian consumers or Muslim consumers). While information is not complete at this time, Table K-1 suggests that content information is not clear on every ration.

Table K-1: Content Information

COUNTRY	Content Information on Package Exterior
DEU	No
ITA	Yes
NLD	No
SVN	Yes
GBR	No
USA	Yes, main dish only
AUS	Yes, folded
BEL	Yes
CAN	Yes, main dish only
CZE	
FRA	
NOR	Yes

The table of Multilingual Information (Table K-2) also represents an element which can reduce uncertainty and provide convenience. If rations are to be consumed by Warfighters from different countries then multilingual information on the ration package (not the ration case, and not the individual ration components) is necessary so that consumers know what they are receiving. The lack of a standard for multilingual information which has been ratified by all countries is surprising within the European context.

Table K-2: Multilingual Information on Package Exterior

COUNTRY	English	French	Germany	Comments
DEU			X	
ITA				English and French in next purchase
NLD	X	X		Dutch
SVN	Inside			
GBR	X			
USA	X			
AUS	X			
BEL	X	X		
CAN	X	X		
CZE				
FRA		X		
NOR	X			Norwegian and Finnish

K.2.6 Food Presentation (Dishes, Utensils)

People try to improve the food experience by presenting food well. This is true in most, if not all, cultures in the world. Presentation reaches its heights in upscale restaurants, banquets, and holiday events. These seem to be the opposite of military field feeding with operational rations in which the practical aspects of the situation rule the event. Very little is known about whether improving the presentation of individual rations in the field would have any consequence, either positive or negative. We know that presentation is important in some commercial and private food situations, but how it translates to the military field situation is unknown, and is unlikely to be investigated.

K.2.7 Food Variety and Monotony

A key element in any institutional food service is the number of menus available and also the frequency with which those menus repeat. In settings where repetition is less a problem, such as hospitals with rapid turnover of people, this can be less of a general concern. In a university setting, repetition might be more of a problem. Operational rations can be viewed as an extension of an institutional food service, providing food to people who might otherwise eat in military dining facilities.

There are substantial national differences in how much variety is expected (Table K-3). Rozin et al studied consumers' preferred choice in two different hypothetical situations, the number of choices of ice cream and

the number of menu choices of food in a restaurant. In general, consumers in the US and the UK expect a large variety of choice. Consumers in France and Switzerland expect the least variety of choice, with Italy holding a middle ground. Thus there is probably not a simple single solution to consumers' expectation of appropriate variety and choice.

Table K-3: Variety Preferences in Europe and the USA (Source: Rozin et al, 2006)

	FRA	DEU	ITA	CZE	GBR	USA
% Prefer 50 choices of ice cream vs. 10	32	33	39	28	44	56
% expect many menu choices	19	22	29	18	40	36

Results from a study of US soldiers suggest that the situation for soldiers might be different (Bell et al, 1999). Soldiers were satisfied with limited variety unless they had to eat operational rations 3 times per day. Further they were willing to have limited variety as long as there were items which they liked or at least were willing to eat. Soldiers seemed to divide into two groups on variety with the US operational ration: one group accepted the variety within the ration, while the other group would like more side dishes and snack items with little or no main dish. The former group wanted a larger portion of the main dish, while the latter group wanted larger portions of snacks. These results caution us to not treat soldiers as one uniform group and also caution us to not automatically apply civilian lessons to military situations.

The Number of Menus (Table K-4) within different operational rations is perhaps surprising, given the general requirement to provide a varied diet to Warfighters to encourage consumption. It should be noted that very fussy eaters might prefer less variety, as long as their favorite foods were included. But most Warfighters want more variety. The number of different menus varies from low numbers such as 2, 3, 6 and 8 to higher numbers such as 20, and 24 menus. Perhaps these reflect the perceived operational needs for these different rations. But there is clearly no uniformity in how many different menus are considered necessary or optimal. A word of caution is needed about the terms meal, menu and ration. The term "meal" refers to the food provided at one of the three traditional eating occasions, although it must be pointed that operational rations are not always served at the traditional meal-times for that culture. In some NATO countries "menu" refers to the foods provided at a meal, but this is not always the case. And in some NATO countries such as the US, the term "ration" refers to the food provided for one day, but again this is not always the case.

Table K-4: Number of Meals Overall and the Number of Menus per Meal

COUNTRY	Variety – Number of Menus	Variety – Number of Menus per Meal
DEU	9 incl Breakfast	3
ITA	7 per week	1
NLD	20	20
SVN	3	9
GBR	10	5 or 10
USA	24	24
AUS	16	8
BEL	28	2
CAN	18	6
CZE	2	
FRA	14	
NOR	23	7 or 8

The Duration of Use (Table K-5) is related to the number of Different Menus (Table K-4). In general, a small number of menus are associated with a shorter the duration of use, but this is not always the case as seen below:

2 menus – 30 days; 3 menus – 10 days; 6 menus – 14 days; 8 menus – 20, 28 days; 20 menus – 30 days, 24 menus – 21 days

Table K-5: Maximum Uninterrupted Duration of Use for Operational Rations

COUNTRY	Duration of Use
DEU	14
ITA	<=30
NLD	30
SVN	10
GBR	30
USA	21
AUS	20
BEL	30
CAN	<=30
CZE	30
FRA	30
NOR	30

While duration of use is 10 days or above for all rations, it might be expected that Warfighters who have never subsisted on operation rations for more than 10 days might find it more difficult to use rations for 30 days.

Variety on the Pallet (Table K-6) might be used to represent the general variety available to Warfighters. If pallets contained one menu per pallet, it would be expected that there would be a higher probability that Warfighters would have access to fewer pallets and access to fewer menus, hence less variety. The results shown in Table K-6, while incomplete, suggest a very broad range of variety per pallet. Use of those rations which can have only one menu per pallet might be more risky when feeding a broader range of Warfighters from a number of different countries.

Table K-6: Variety of Operational Rations on a Pallet

COUNTRY	Menu Variety on Pallet (Menus per pallet)
DEU	1
ITA	up to 7
NLD	1
SVN	1
GBR	10
USA	24
AUS	1
BEL	7 (1 pallet)
CAN	6 (Breakfast, Lunch, Dinner)
CZE	
FRA	14
NOR	7 (Breakfast), 8 (Lunch), 8 (Dinner)

Sensory specific satiety is a phenomenon associated with food variety. Sensory specific satiety occurs during eating when one experiences the taste of a food over a period of time. One usually observes a decline in acceptance of a product over several minutes. This decline in acceptance is thought to stimulate variety in eating; in order to maintain food liking, one samples from one food after another, rather than eating all of one food at the meal, which would increase sensory specific satiety and decrease liking. The application of sensory specific satiety to eating complex in complex situations has not been fully explored.

K.2.8 Traditional Food, Food Authenticity and Country of Origin

One of the best predictors of food acceptance is familiarity; most people like familiar food. One example of familiar foods is traditional food, the basic foods which are used within each culture. Traditional food is used in everyday eating and on special occasions. Traditional food not only conveys the “safety” of known ingredients and flavors, but also conveys some strong psychological components as shown below (Figure K-1). The following data come from an ongoing European Union study of traditional foods in six European countries: Belgium, Norway, France, Italy, Poland, and Spain. Note that these countries represent southern and northern

Europe, as well as eastern and western Europe. Table K-7 shows that "traditional foods" have slightly different meanings to consumers in the different countries.

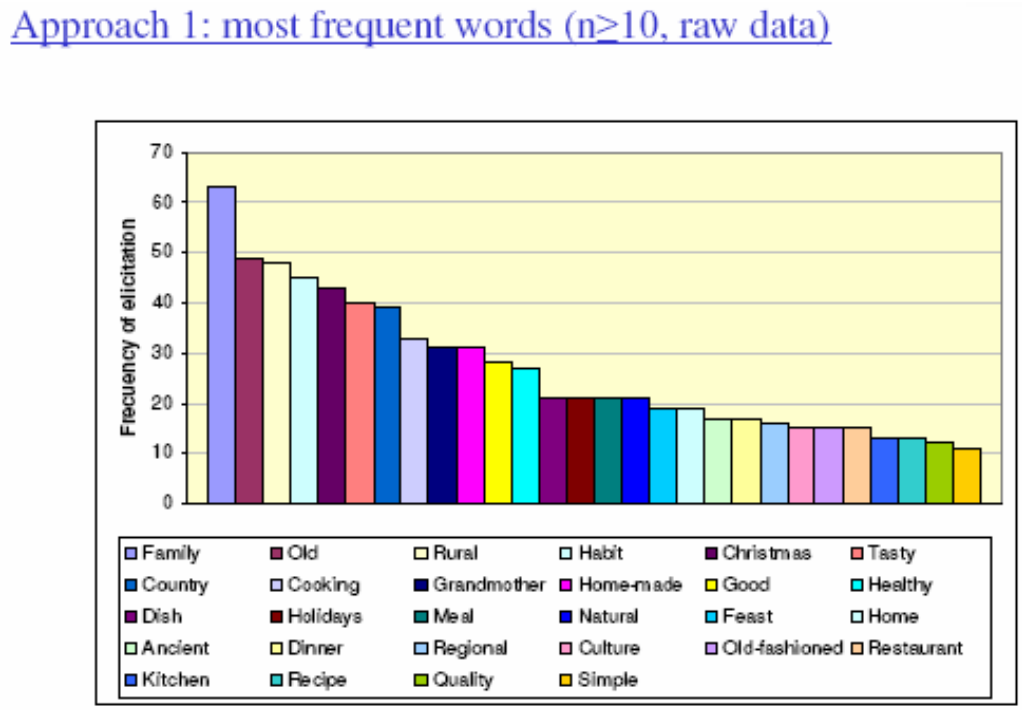

Figure K-1: Differences in the Meaning of Traditional Foods Across Six European Countries; Word Associations (Source: Guerrero et al, 2008).

Table K-7: Differences Across Six European Countries in the Meaning of Traditional Foods (Source: Guerrero et al, 2008)

COUNTRY	MEANING OF "TRADITIONAL FOODS"
BEL	marketing, variety, habit
NOR	special occasions, origin
FRA	elaboration
ITA	sensory properties, health
POL	sensory properties, health
ESP	heritage, habit

A related phenomenon is food authenticity. This is a phenomenon which is seen much more in Europe than in North America. Food authenticity relates to foods being prepared in traditional and authentic ways. It relates, for example, to cheese being processed from authentic ingredients (buffalo milk for mozzarella cheese) and with authentic techniques. There is an ongoing movement in many European countries to protect authentic regional foods. It is worth noting that authenticity of foods generally relates to regions rather than countries.

Traditional foods are probably related to military ration acceptability. If such dishes were included in military rations of particular countries then those items would be expected to be popular within that country but not necessarily popular elsewhere. Consumers might react negatively to the adaptation of the traditional dish to the requirements of ration design.

K.3 THE INDIVIDUAL / THE SOLDIER

Ration design has considered the psychology of the soldier for some time. In the US this history goes back to WWII, when a program on consumer acceptability of rations was developed at the Quartermaster Laboratory in Chicago. This laboratory eventually moved to Natick where it still exists. Similar programs on the psychology of military rations existed in a number of other NATO countries.

The psychology research in military rations is comparable to consumer research conducted in commercial product development (see Frewer and van Trijp, 2007). During the course of consumer research, large samples are often divided or segmented into smaller groups for more detailed analysis. Consumer segmentation is not new, but simple segmentation based on demographics (age, gender, socio-economic variables) is still the norm (van Kleef et al, 2005). The newer approach to segmentation focuses more on consumer attitudes and emotions and less on specific demographics such as age, gender and income.

K.3.1 Age

Because most military personnel are within a relatively narrow age range compared to the whole population, differences in age are not a major factor. What does need to be considered is whether young people are less critical or more critical than the general population. Edwards et al (2003) observed an age effect working in the UK, with hedonic rating increasing with age from teenage until middle age (46 – 65), when it declines slightly for older consumers. This higher criticality of younger consumers has been noted in other studies. It might be interesting to study this cross-culturally to determine whether this trend holds across different countries, and within the military consumer group.

K.3.2 Gender

Few studies have investigated differences in eating in the field between male and female soldiers. Baker-Fulco et al (2002) reviewed prior US Army research and presented new data from dietary records and energy expenditure using doubly labeled water. Men ate more than women. But nutrient intakes normalized for energy intake and body size were not significantly different. The interested reader is referred to a 1998 Report on Assessing Readiness in Military Women on the Institute of Medicine website: www.iom.edu/CMS/3788/4615/6822.aspx.

In addition to differences in eating, young men and women differ in their food preferences. In an earlier study of the food habits of US Air Force personnel, Wyant and Meiselman (1984) reported higher preferences by women of vegetables, salads and fruit. In fact, men never preferred any vegetable, starch or salad more than women. Many male preferences were meat or meat containing. Wansink et al (2003) also noted the male preference for meat and the female preference for vegetables in their study of the comfort food preferences of American men and women (Table K-8 and Table K-9).

Table K-8: Comfort Food Preferences for North American Men and Women (Source: Wansink et al, 2003)

Females have different comfort food preferences than males

	Favorite comfort foods	Comfort food ratings[a]			
		All (1003)	Females (602)	Males (401)	*F* values
Snack-related foods	Potato chips	3.0	3.0	3.1	1.8
	Ice cream	3.0	3.2	3.1	3.6*
	Cookies	2.8	2.9	2.8	2.5
	Candy/chocolate	2.9	3.0	2.7	19.2**
Meal-related foods	Pasta or pizza	2.8	2.7	2.9	5.5*
	Steak or beef	3.0	2.8	3.2	17.8**
	Casseroles/side dishes	3.0	2.9	3.1	5.7*
	Vegetables or salads	2.3	2.4	2.3	3.8*
	Soup	2.8	2.6	2.9	4.1*

[a] 1 = *strongly disagree*; 5 = *strongly agree*.
* $P < .05$.
** $P < .01$.

Table K-9: Healthy Image Comfort Food Preferences of American Men and Women (Source: Wansink et al, 2003)

What comfort foods make you feel healthy?

Type of comfort food	Gender			
	All (1003) (%)	Male (401) (%)	Female (602) (%)	χ^2
Potato chips	67	8	5	2.1
Ice cream	11	12	9	1.9
Cookies	6	7	5	1.9
Candy/chocolate	7	7	6	0.2
Pasta or pizza	50	49	51	0.5
Steak or beef burgers	52	58	46	6.3**
Casseroles/side dishes	48	53	43	6.1**
Vegetables or salads	87	85	89	1.9
Soup	55	52	57	2.1

Turrell (1997) examined the relationship between food preferences and other food related behavior in a representative sample in Australia. He found the greater preference among women for healthy foods such as fruits and vegetables noted above. He also found a relationship between healthy food preferences and women's greater acceptance of dietary guidelines. So the preference differences of men and women might be related to the different strategies for health maintenance in men and women. While women were more concerned with their appearance than men, this was not a factor in their increased dietary compliance as compared with men.

So men and women have different intakes, and have somewhat different food preferences. These differences are not generally reflected in rations. Females, on average, eat less food, but are provided the same amount as men. Obviously it would be very difficult to design and produce separate rations for men and women, because of the added costs and logistic burden. And this might be less of a risk for combat units which contain fewer females.

K.3.3 Expectations

Cardello et al (1996) asked people how good they expect the food to be in a number of different locations in a questionnaire study. He observed consistent differences in expected liking in the following order:

home>restaurant>fast food>school>military>airline>hospital

Note that home and restaurant occupy one end of the distribution and institutional settings like school, military, airline and hospital occupy the other end.

Customers expect products in fine restaurants to be better, and expectation theory shows that actual product ratings move in the direction of expectations (see Cardello, 2007). A product which is expected to be better, rates better than the identical product with lower expectation.

Lower expectations remain one of the major challenges of military rations. If military consumers expect rations to be lower in quality, then these lower expectations have a major impact on their appreciation of the product – product ratings move in the direction of the expectation, meaning that product ratings move lower. Expectations can be manipulated in NATO response forces. There are several ways to get around the lower expectations associated with institutional products; one of these is to use familiar branded products within institutions. Imagine the use of McDonalds or another brand within a hospital foodservice. In the same way, the addition of commercial branded products within military rations might raise the expectation and rating of the ration.

K.3.4 Religious and Cultural Influences

Expectations and preferences are easy to discuss in general and difficult to discuss in specifics. I have used several food examples to look for foods which might represent “problems” for the typical preferences of national groups. Some ration items are unacceptable to some soldiers. I am most familiar with the preferences of young Americans, who typically do not like fish or lamb, and strongly dislike liver. Pork represents a problem item for those who follow Halal and Kosher laws. From the table of Specific Food Items in Operational Rations (Table K-10), one can see that these items appear in many operational rations. Some rations do have specific menus for religious groups.

Table K-10: Specific Food Items in Operational Rations

	Ration Items				
COUNTRY	**Liver**	**Fish**	**Pork**	**Lamb**	**Special Menus**
DEU	X		X		Pork free, vegetarian
ITA		X	X		
NLD	X		X		Pork free, vegetarian
SVN	X	X	X		
GBR		X	X	X	Hindu, Muslim, Vegetarian
USA		X	X		Vegetarian
AUS		X		X	Vegan, Fish
BEL	X	X	X	X	
CAN		X	X	X	1 menu: Kosher, Vegetarian, Halal
CZE					
FRA					
NOR		X		X	Pork free, vegetarian

When rations do not have certain foods, it might also be a problem for those groups which prefer those foods. For example, a fish eating culture would probably like to include fish in their rations. Therefore, we have the problem of including foods which are popular with some cultures and unpopular with other cultures.

K.3.5 Other Dietary Influences – The Food Choice Questionnaire – Cross Cultural Differences

One of the most widely used questionnaires to assess important factors in how people select foods is the Food Choice Questionnaire (Steptoe, Pollard and Wardle, 1995) which was developed in England. The Food Choice Questionnaire contains 36 items on the following nine factors: Health*; Mood; Convenience*; Sensory Appeal*; Natural Content; Price*; Weight Control; Familiarity; Ethical Concern.

Sensory appeal, health, convenience, and price were identified by Steptoe et al as the most important factors (* in the above list). While all nine factors in the Food Choice Questionnaire are considered important for making food choices, these four are the most important and this probably applies to operational combat rations as well, although this has not been directly studied. Military rations would probably be considered high on convenience and price (for the soldier), but probably perceived to be lower than fresh food on sensory appeal and health for the soldier. If the soldier compared operational rations to the risks of not eating at all, or eating locally provided food, then operational rations might be considered high on health also.

Eertmans et al (2006) studied the structure of nine factors in the Food Choice Questionnaire in three western countries (Italy, Belgium, Canada), showing good agreement but some differences in factor structure. Some countries might need a 10 factor structure. The Food Choice Questionnaire has also been studied in several AustralAsian countries (Prescott et al, 2002).

The Food Choice Questionnaire is a good instrument to compare the factors underlying food choice in different groups. It is available in many languages.

K.3.6 Traits and Attitudes

Traits are the longer lasting building blocks of personality, and traits represent the ways people differ from each other. For example, passivity and aggressiveness are two (opposing) traits, representing two different personality types. Tests for attitudes and traits can be referred to as psychographics. Traits help us to understand how people respond differently to foods. There has been very little published research applying these trait tests to military personnel with respect to product development. This is an interesting avenue of future research, because this would help us to understand why military consumers accept or reject food products.

K.3.6.1 Food Neophobia

Food neophobia is the reluctance to try new foods; it is an important dimension of food acceptance for young children. It can very important when trying to predict soldiers' acceptance of novel food, including foreign rations. Basically, neophobic soldiers will not eat foreign rations because of their novelty. Neophobia is not the same as fussy eating in which both familiar and novel foods might be avoided.

Food neophobia is easy to measure with the Food Neophobia Scale (Table K-11). More recent testing cross cultural study of the Food Neophobia scale has shown that items 1, 3, 4, 6, 7, 10 form a uni-dimensional group of questions that can be used as a shorter questionnaire (Ritchey et al, 2003).

Table K-11: The Food Neophobia Scale (Source: Pliner and Hobden, 1992)

1. I am constantly sampling new and different foods. (R)
2. I don't trust new foods.
3. If I don't know what is in a food, I won't try it.
4. I like foods from different countries. (R)
5. Ethnic food looks too weird to eat.
6. At dinner parties, I will try a new food. (R)
7. I am afraid to eat things that I know I have never had before.
8. I am very particular about the foods I will eat.
9. I will eat almost anything (R)
10. I like to try new ethnic restaurants. (R)

The items marked with (R) are reversed in scoring on the 7 point scale; therefore a score of 6 becomes a 2.
Source: Pliner and Hobden, 1992.

Investigators, especially those working in commercial studies, define the test panel using demographics, and sometimes using product usage statistics. (Henriques et al, 2008). Recent analyses of the composition of test panels has demonstrated that recruited test panels are not representative of all consumers with respect to food neophobia. The large range of neophobia observed by Pliner and Hobden (1992) has never been reported again

in published research. This would be expected to be true in testing of military rations as well. Neophobics will not volunteer for a taste test, and will not be represented in the test population.

K.3.6.2 Food Involvement

Involvement refers to how important a product category is to consumers. Understanding food involvement is important in understanding soldiers' reactions to rations because high involved people respond differently to products than low involved people. Higher involved soldiers can be expected to exert more energy into finding food and preparing food to meet their higher expectations. For example, they can be expected to season food and heat food.

The idea of involvement came from the service literature rather than the product literature. Bell and Marshall (2003) applied the involvement concept to food products, measuring the importance of food to the individual. The Food Involvement Scale comprises 12 items, 6 positive and 6 negative, relating to the five stages of the food cycle from acquisition to disposal (Table K-12). This makes the food involvement scale particularly relevant to soldiers in the field, where soldiers often have to deal with food from finding food through preparing and eating food, to disposing of the leftovers and packaging. On the food involvement scale, the 12 statements are rated on a 7-point agree-disagree scale (Table K-12). The potential range of scores is 12 – 84, and the average score is 45.

Table K-12: The Food Involvement Scale (Source: Bell and Marshall, 2003)

1. I don't think much about food every day. (R)
2. Cooking or barbequing is not much fun. (R)
3. Talking about what I ate or am going to eat is something I like to do.
4. Compared with other daily decisions, my food choices are not very important (R)
5. When I travel, one of the things I anticipate most is eating the food there.
6. I do most or all of the clean up after eating.
7. I enjoy cooking for others and myself.
8. When I eat out, I don't think or talk much about how the food tastes (R)
9. I do not like to mix or chop food.
10. I do most or all of my own food shopping.
11. I do not wash dishes or clean the table. (R)
12. I care whether or not a table is nicely set.

The items marked with (R) are reversed in scoring on the 7 point scale; therefore a score of 6 becomes a 2.

Although currently there appear to be no published food involvement data from a commercial product development setting, preliminary reports indicate that those recruited for commercial product testing score on the upper end of food involvement. If this pattern holds up with further testing, then this imbalance of panelists on food-relevant issues would add to the neophobia findings. That is, consumer panelists participating in studies run by food companies tend to be more neophilic and more product-involved than one might expect from average consumers.

There is also a lack of data on food product involvement from military personnel. It would be expected that military personnel who are higher in involvement would spend more energy in obtaining food and preparing food.

K.3.6.3 Dietary Restraint

Of interest here are the scales of restrained eating, introduced to measure the attempt to control intake in order to control body weight. It is important to understand that restrained eating does not equate with dieting but refers to a broad and not always successful attempt to control eating.

Scales of restrained eating are the most widely used of all of the attitude and trait scales mentioned in this paper. Their wide use in the health fields has promoted a great deal of research. A web search of "restrained eating" generates hundreds of thousands of hits! Recent research has shown the complex nature of the restraint concept (van Strien et al, 2007). It is important to note that restrained eating almost always shows a gender effect; women exhibit more dietary restraint than men. This field began in the 1970s with the first development of a scale of restrained eating (Herman and Polivy, 1980). The Revised Restraint Scale of Herman and Polivy (1980) consists of 10 items (e.g. "How often are you dieting?") that are rated on 4- or 5-point scales (see Table K-13). Scores range from 0 to 35, with high scores reflecting a high degree of restraint.

Table K-13: The Restraint Scale (RS)
(Source: Herman and Policy, 1980)

1. How often are you dieting? Never, rarely, sometimes, often, always (scored 0 – 4) – CD
2. What is the maximum amount of weight (in kilos) you have ever lost within 1 month? 0 – 2.5, 2.5 – 5, 5 – 7.5, 7.5 – 10, 10+ (scored 0 – 4) – WF
3. What is the maximum amount of weight gain (in kilos) within a week? 0 – 0.5, 0.5 – 1, 1 – 1.5, 1.5 – 2.5, 2.5+ (scored 0 – 4) – WF
4. In a typical week, how much does your weight fluctuate? 0 – 0.5, 0.5 – 1, 1 – 1.5, 1.5 – 2.5, 2.5+ (scored 0 – 4) – WF
5. Would a weight fluctuation of 2.5 kilos affect the way you live your life? Not at all, slightly, moderately, very much (scored 0 – 3) – CD
6. Do you eat sensibly in front of others and splurge alone? Never, rarely, often, always (scored 0 – 3) – CD
7. Do you give too much time and thought to food? Never, rarely, often, always (scored 0 – 3) – CD
8. Do you have feelings of guilt after overeating? Never, rarely, often, always (scored 0 – 3) – CD
9. How conscious are you what you are eating? Not at all, slightly, moderately, extremely (Scored 0 – 3) – CD
10. How many kilos over your desired weight were you at your maximum weight? 0 – 0.5, 0.5 – 3, 3 – 5, 5 – 10. 10+ (Scored 0 – 4) – WF

CD = Concern for Dieting; WF = Weight Fluctuation

Another widely used restraint scale was developed by Van Strien et al (1986). The restraint scale (Table K-14) is part of a longer questionnaire referred to as the Dutch Eating Behavior Questionnaire. The Dutch restraint scale has 10 items, and uses a temporal response format as follows: never (1), seldom (2), sometimes (3), often (4), very often (5). The overall average score was 2.2, with average scores of 1.84 for males and 2.49 for females.

Table K-14: The Restrained Eating Scale from the Dutch Eating Behavior Questionnaire (DEBQ) (Source: Strien et al, 1986)

Response Scale: Never (1), Seldom (2), Sometimes (3), Often (4), Very Often (5).
1. If you have put on weight, do you eat less than you usually do?
2. Do you try to eat less at mealtimes than you would like to eat?
3. How often do you refuse food or drink offered because you are concerned about your weight?
4. Do you watch exactly what you eat?
5. Do you deliberately eat foods that are slimming?
6. When you have eaten too much, do you eat less than usual the following day?
7. Do you deliberately eat less in order not to become heavier?
8. How often do you try not to eat between meals because you are watching your weight?
9. How often in the evening do you try not to eat because you are watching your weight?
10. Do you take into account your weight with what you eat?

Finally, a 28 Item questionnaire on Rigid and Flexible control was introduced by Westenhoefer, Stunkard and Pudel (1999). Rigid control of eating is characterized by an all-or-nothing approach to dieting, whereas flexible control is characterized by a more moderate approach in which decisions can be traded in order to affect overall restraint.

The concept of dietary restraint is very important to understanding soldiers' consumption of rations in the field. It has been suggested that soldiers regulate their intake of rations in the field to control their bodyweight, that is, they use the field situation to diet as a balance to their usual consumption practices when not in the field. This reason did not emerge as a critical factor in a questionnaire study of Marines in actual combat (Popper et al, 1984). Using field time in order to control eating might be more typical of training situations rather than combat situations, and deserves further study.

K.3.6.4 Sensation Seeking

Sensation seeking is the need for varied, novel and complex sensations and experiences, and the willingness to take physical and social risks for the sake of such experience. Sensation seeking could be important for military personnel who might fit into the sensation seeking paradigm. Sensation seeking manifests within food behavior as the desire for stimulating meals and stimulating meal situations. Those who seek exotic foods in exotic situations might be exhibiting sensation seeking, while those avoiding these same things might be low on sensation seeking. Eating the unfamiliar rations of another country might be an example of sensation seeking.

There are a number of scales of Sensation seeking. Some are longer scales, and others are shorter scales. The shorter scales are evaluated on five point scales from strongly agree-strongly disagree, or from not at all-very often (Stephenson et al, 2003). One shorter Sensation Seeking Scale is presented in Table K-15.

Table K-15: The Four Item Sensation Seeking Scale (BSS4) (Source: Stephenson et al, 2003)

a. I would like to explore strange places.
b. I like to do frightening things.
c. I like new and exciting experiences, even if I have to break the rules.
d. I prefer friends who are exciting and unpredictable.

K.3.6.5 Variety Seeking and Sensation Seeking

Van Trijp and Steenkamp (1992) introduced a scale of Variety Seeking (Varseek), which is related to Sensation Seeking. One way to seeking new experiences is to seek variety. Variety seeking is also related to Food Neophobia; those high in Variety seeking are usually lower in Food Neophobia. In contrast to scales of involvement, dietary restraint and sensation seeking, there is only one scale of variety seeking. The Variety Seeking Scale appears in Table K-16.

Table K-16: The Variety-Seeking Scale (Varseek) (Source: van Trijp and Steenkamp, 1992)

1. When I eat out, I like to try the most unusual items, even if I am not sure I would like them.
2. While preparing foods or snacks, I like to try out new recipes.
3. I think it is fun to try out food items one is not familiar with.
4. I am eager to know what kind of foods people from other countries eat.
5. I like to eat exotic foods.
6. Items on the menu that I am unfamiliar with make me curious.
7. I prefer to eat food products I am used to ®.
8. I am curious about food products I am not familiar with.

If data were available from the different NATO countries on the pattern of response of their soldiers on these trait and attitude tests, then we could better predict soldiers' responses to consuming rations in the field. Higher food involvement would suggest that soldiers might make the effort to make their rations more acceptable (through heating, etc.). Higher food neophobia would suggest that soldiers will avoid "foreign foods" and unfamiliar foods in general. Higher sensation seeking and higher variety seeking would suggest that rations could explore greater variety in what is offered. And higher dietary restraint would confirm that soldiers have a tendency to use situations for weight control.

K.3.7 Cross-Cultural Food Preferences and Aversions

One of the key factors in the design of food products and food service systems is food preference – what foods are liked and disliked. Food service can use both widely liked foods, and less widely liked foods in niche markets such as ethnic restaurants. Institutional products and systems must be geared to provide foods which are widely liked by the target audience. In order to accomplish this, organizations, including the military, have studied the food preferences and food dislikes of their target population.

In the US Army there have been a series of reports documenting the study of US food preferences. The most recent report was conducted in 1992 – 1993 (Kluter et al, 1994). This study covered ratings of 342 food names by 2000 soldiers. The authors report substantial changes in preference since the previous studies in the 1970s and 1980s.

One potential study by NATO food personnel would be the comparison of food likes and dislikes by military personnel in these NATO countries. Or one could simply compare the food preferences of each NATO country. The data could provide important information on what ration items might be generally acceptable and unacceptable.

K.3.8 Socialization/Commensality – Eating Together and Eating Alone

Eating is a social activity. Most people eat meals with other people, which is the definition of commensality (Sobal, 2000). Eating alone is devalued in many cultures. The broad issue here is whether established military field feeding practices enhance consumption or contribute to reduced consumption through social isolation during meals.

Sobal and Nelson (2003) conducted a cross-sectional mail survey of 663 people in one US area. Most respondents ate alone at breakfast, alone or with co-workers at lunch and with family members at dinner. Unmarried individuals more often ate breakfast and dinner alone and more often ate lunch with friends. Thus, work oriented society leads people to eat alone during the day and with family in the evening. People maintained commensal relationships mainly with family, which is consistent with data from the large Nordic study (Holm, 2002) presented below. Sobal and Nelson found no gender differences. Sobal and Nelson suggest that commensal eating is healthier because of social facilitation (prevent under-consumption, risking over-consumption), social support (healthy food choices), and social control (healthy food choices).

The 4-country Nordic study on eating patterns provides detailed data on commensal patterns (Holm, 2002) and confirms many of the observations of Sobal and Nelson. The study was based on 1200 surveys each in Norway, Sweden, Denmark, and Finland. About 2/3 of respondents reported eating alone at least once on the day before the survey. The proportion of people eating alone and with family members was about the same, with the latter increasing in the evening.

People living alone ate alone 3 times more often, and older people ate alone more than younger people. The chance of eating a full (proper) lunch or dinner did not vary whether eating alone or with others. Eating with colleagues peaked at mid-day, during the typical lunch time, as reported by Sobal and Nelson. Eating with friends and others occurred on weekends and was very infrequent, also confirming Sobal and Nelson.

K.3.8.1 Social Facilitation

The relationship between commensality and food intake has been the subject of a lot of research, most of it within the context of health. It was first reported by de Castro and colleagues in a series of papers based on the food diary method. De Castro and de Castro (1987) trained people for one day on how to fill out a dietary diary and then had them keep detailed records for the next week including with whom they ate. They observed that people eating alone had fewer daily meals (1.6 meals) than people eating with others (2.1 meals) and ate less food per meal (410 Kcal) than people eating with others (591 Kcal). This effect is called social facilitation of eating. In many replications of the same pattern, de Castro and his associates found that the amount consumed increased with the number of people present. This social facilitation of eating effect produced a large number of studies focusing on effects of other variables on intake. Variables which should increase eating also increased

with the number of people present (deCastro, Brewer, Elmore and Orozoco, 1990). For example dinner is the biggest meal and has the most people present; restaurant meals typically have more people present and are bigger, and meals with alcohol have more people present and are bigger. Social facilitation of eating was reviewed by Herman et al (2003). In the context of military feeding, one will notice that the factors which correlate highly with social facilitation (number of people present, alcohol, restaurant meals, etc.) are not present in most military eating situations. Hence the factors that might increase consumption are missing. In the typical combat situation, eating in shifts or eating alone could reduce consumption. If the situation permits, military commanders should encourage soldiers to eat as a group to maximize food consumption. Another possible solution to the problem is to be aware of, and to apply, the impact of meal duration, which is discussed immediately below.

Several authors have suggested that eating duration might be critical in social facilitation of eating effects including Feunekes et al (1995). Pliner, Bell, Hirsch, and Kinchla (2006) independently varied eating duration and group size, and found that the increased intake was related to eating duration and not to group size. This is an important effect which needs to be replicated in a variety of eating environments; it might present an important mechanism to increase or decrease eating. Social facilitation of eating remains an important phenomenon, but it might work through duration, and food intake might be especially sensitive to changes in eating duration. In the military context, food consumption can probably be increased by providing more time for meals, and food consumption can be reduced by rushing the meal. One way to achieve this is socially, since people in groups tend to spend more time eating. But more time can be allowed with or without the social aspect of eating.

K.3.8.2 Social Modeling

People tend to "copy" the pattern of eating of those with whom they eat (for example, see Engell et al, 1996). Social modeling occurs quite often when the people involved are of opposite sex or enjoy different social status. People eat less in order to make a good impression with strangers and business co-workers (as opposed to family and friends), eat less with a person of superior rank (e.g. for soldiers and their superiors), and finally eat less with someone who eats very little. Unfortunately for researchers, people also eat less when they are observed, making research more difficult.

Therefore one way to encourage more consumption of rations by solders is for them to observe their superiors eating well. Eating with superiors has multiple advantages. Watching the more senior people enjoy and eat their operations contributes to higher expectations on the part of soldiers. And modeling research suggests that the soldiers will model their superiors' behavior and eat more than if they ate alone or with their peers.

K.3.9 Impact of Foods on Moods and Emotions

Mood and emotion are relatively new topics in food research, but are beginning to receive more attention in both the research sector and in the commercial sector. Psychologists distinguish the terms mood and emotion. Mood is thought to describe longer term affective behaviors that build up gradually, are more diffuse, and have no specific referents. Emotions, in contrast, are shorter term affective responses to specific referents, and can be more intense than the longer term moods. In practice it is sometimes difficult to be clear whether one is measuring a mood or an emotion, especially since often the same term is used to describe both a mood and an emotion.

Both academics and health researchers have examined the impact of mood on food consumption (for example see Lieberman, Kanarek, and Prasad, 2005, and Gibson, 2006). Most of this research has been carried out

within the context of "health research" looking at the impact of foods on cognitive and physical performance. Researchers often include mood questionnaires in such studies, and the changes in mood with food is more easy to measure than the more subtle shifts in cognitive and physical performance. Caffeine is the most studied and most reliable food ingredient which produces changes in both performance and mood.

Moods and emotions are measured using a variety of techniques including questionnaires and checklists, selection of a face on a facial scale, measurement of facial movement, and physiological measures. The most common methods for measuring moods and emotions are questionnaires and checklists. It is important to note that most of these were developed for psychiatric work and are used clinically and in academic research settings. Most categorizations of emotions follow this clinical orientation, although recently King and Meiselman (2008) proposed a questionnaire to measure emotions in a commercial setting. Using this questionnaire, one can categorize foods as calming or invigorating, and in many other ways; it would appear that there are obvious military implications for categorizing foods in emotional terms. Coming from the marketing perspective, Laros and Steenkamp (2005) emphasize the basic positive-negative distinction of emotions. Other authors have confirmed the basically positive emotional response to eating and to commercial food products (Desmet and Schifferstein, 2008; Gibson; 2006). It would be interesting to test whether operational rations in the field setting elicit mainly positive emotions.

Mood is usually measured with standardized mood questionnaires. One of the earliest mood questionnaires is the Profile of Mood States (POMS), which can focus on a variety of time-frames: feelings during the past week, today, right now, and the past three minutes. The POMS contains 65 mood terms, which cover six dimensions of mood: tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment. The 65 mood terms are each rated on a 5 point rating scale. The POMS survey has been used extensively in research, and may well be the most widely used questionnaire for research in clinical and academic environments, and the military environment (e.g. Lieberman, 2005).

Another widely used measurement form is the Multiple Affect Adjective Checklist or MAACL, now used in a revised version or MAACL-R (Zuckerman and Lubin, 1985). The questionnaire is in an easy check list format with instructions to "Check as many words as you need to describe your feelings." The checklist takes about 3 minutes to complete. The MAACL-R exists in two forms; the state form asks for moods to describe "how you feel now", and the trait form asks "how you generally feel". The MAACL-R is available in full length and shortened forms, containing 132 items and 66 items respectively. Both are divided into 5 scales. There are three negative scales: anxiety, depression, hostility, and two positive scales. The first of these is Positive Affect which is more passive. The second is Sensation Seeking which is more active and energetic. The Sensation Seeking scale correlates with other measures of the sensation seeking trait.

Not only are there effects of food on moods and emotions, but there are important effects of emotions on eating. In one of the only retrospective studies of men in actual combat situations, Popper et al (1984) used questionnaires to study a large number of US Marines with actual combat experience. Most Marines reported eating much less than usual in an actual combat situation. One of the main reasons was the lack of time, discussed below, but another main reason was the effect of fear on desire to eat. The Marines reported that fear decreased over the days of a combat situation, and decreased from the first combat situation to the second. Thus, while fear contributed to not eating enough, the effects of fear declined with experience.

K.3.10 Satiety/Satiation

This topic can be covered as both a Nutritional factor and a Non-Nutritional factor. Physiologic models of eating tend to view eating as beginning with meal initiation and terminating with meal satiation. This model

usually views the human as responding to a variety of internal (physiological) signals as well as external (non-physiological signals). An example of the former is blood glucose level and an example of the latter is the clean-your-plate phenomenon.

Under modern, western lifestyles, meal initiation and meal termination are much more complex than suggested by physiological models. The exceptions are babies and small children in whom internal signals of hunger and satiation are probably very important. But adults learn to respond to many individual and social cues for beginning and ending meals. It is interesting, in this regard, how different cultures provide meals – some cultures eat heavy breakfasts and some much lighter. Some provide a heavy meal in the middle of the day and some in the evening. Also, in some cultures it is polite to clean your plate (eat everything); while in others it is polite to eat modestly. These observations support the view that meal patterns and satiety are socially modified.

It is an interesting question whether soldiers eat until they are satisfied in the field. Certainly when soldiers are under time or other pressure, it is doubtful whether they follow the meal initiation-meal termination model. Their eating is largely under external control of when they are permitted to eat by the conditions and by their superiors. In addition, the study of Marines' recollections of their actual combat experiences suggest that lack of time, fear, and not feeling hungry contributed to their low consumption (Popper et al, 1984). Do soldiers feel hunger? More than normal or less than normal? More research in this critical area is needed, and the presence of a new group of combat veterans might provide opportunities for further study.

K.4 THE LOCATION OR ENVIRONMENT OF EATING / THE FIELD

K.4.1 Location (Confounding of People and Location)

Rations are experienced differently in different locations. This is difficult to study because different people occupy different locations. When two things vary together they are said to be confounded. For example, height and weight vary together; taller people tend to weigh more than shorter people. Ideally we would be able to test the same people in a variety of different eating locations, but this is rarely possible. A number of studies have observed that the acceptability of food in institutional settings (hospital, school, military) is lower than in restaurant settings.

K.4.2 Appropriateness

Appropriateness was a term introduced by Schutz (1988) to broaden the consideration of food to factors beyond acceptance. He wanted to consider more than product liking. Appropriateness includes many of the factors which are discussed in this chapter under the grouping of context and environment. In addition to asking "liking" Schutz recommended that we ask how appropriate a product is for a particular situation. This concept is of obvious interest to ration developers, who are developing and producing products aimed at a very specific application. Thus, a product which might be very appropriate for the family dining table might be totally inappropriate for military field feeding, and vice versa. Appropriateness is usually measured on a 7 point scale from very appropriate to very inappropriate.

Appropriateness can be investigated by location and by meal occasion. Thus, some products are more home products, others are more restaurant products, and still others might be camping/outdoor products. A ready meal might be a typical home product. In addition, products are more or less appropriate for different meals: dry cereal is most appropriate for breakfast, but is sometimes eaten as a meal or snack throughout the day. Sandwiches are appropriate for the lighter meal of the day, not the main meal when a hot meal is usually served.

Thus, we can examine military rations from the traditional views of meal appropriateness and location appropriateness. Military rations are very different in appropriateness from traditional foods which we eat at home, but they are very appropriate for their intended use. We need to better understand the soldier's perspective when they consume these meals – is their appropriateness judged from home meals, other Army meals, or other packaged food? What is the basis for their judgments of appropriateness?

Some operational rations provide separate menus for specific daily meals (here called Breakfast, Lunch and Dinner). Other rations have a separate breakfast menu but one menu for lunch and dinner. And still other rations have only one ration designation, shown as unspecified in the table of Specificity of Menus (Table K-17). Some rations have equal numbers of rations for each of three daily meals. Others have fewer rations for some meals than others. These differences represent a major challenge for sharing rations among countries; Warfighters in countries which have specific breakfast, lunch and dinner menus will tend to expect such specific menus.

Table K-17: Specificity of Menus (B, L, D) in Operational Rations

VARIETY NUMBER OF MENUS				
COUNTRY	**Breakfast**	**Lunch**	**Dinner**	**Un/specified**
DEU	3	3	3	Unspecified
ITA	5	7	7	Specified
NLD	1	1	20	
SVN	0	0	0	Unspecified
GBR	5		10	Unspecified
USA	0	24	24	Unspecified
AUS	0	8	8	Unspecified
BEL	1	14	14	
CAN	6	6	6	Specified
CZE				
FRA	14	14	14	Specified
NOR	7	8	8	Unspecified

Note: Blank indicates that there is no information available.

K.4.3 Time of Day and Meal Patterns

In the 1970s Mary Douglas, the pioneering English meals researcher, presented a framework for studying meals, within the social context (for example, see Douglas, 1976). Her work remains a major influence to this day. Douglas emphasized that meals are highly structured events following a series of rules about where, when, and in what sequence foods could be served. What constitutes a meal is constantly evolving and changing. The meal most changed from its traditional form is probably breakfast.

Meals vary across time (history) and across cultures. One hundred years ago most people ate three hot meals a day. This pattern persists in some areas, but most people in the West today eat one or two daily hot meals

(for example see Chapters in Walker, 2002 and Meiselman, 2009). The NATO RTG countries typically have a cold breakfast, but countries vary on a hot mid-day meal and a hot evening meal. Although these reflect civilian patterns in these countries, these trends are important for maximizing food consumption; people expecting a hot meal for their mid-day or evening meal might be expected to eat less with a non-traditional pattern. Research is needed to determine how much cultural patterns translate to military eating**.** Such research will help ration designers to understand the cultural limits of military feeding programs, especially for operational rations. The current pattern of hot and cold rations is shown in Table K-18.

Table K-18: Hot and Cold Operational Rations at Three Mealtimes

COUNTRY	Breakfast	Lunch	Dinner
DEU	C	H	H
ITA	C	H	H
NLD	C	C	H
SVN	C	H	H
GBR	H	C	H
USA	H	H	H
AUS	C/H	C/H	C/H
BEL	C	H	H
CAN	H	H	H
CZE			
FRA	C	H	H
NOR	H	H	H

H = Hot; C = Cold

K.4.3.1 Grazing

There has been much written about grazing in the past decade, and much of it is negative. There is a storm of writing, much of it from the health community, on the dramatic rise in grazing and snacking, and the corresponding drop in proper meals especially family meals. The only thing missing from these reports on the demise of the meal are facts. And the facts suggest that while meals are changing gradually, there are no drastic changes taking place. Much of the data come from studies in Western European countries. Makela (2002) reports on data from the large four country Nordic study, and Mestdag (2005) reports on data from the low countries. Both large scale studies report on the continuation of structured meals as the basis for eating.

Given the need for snacks and the preference for snacks by some military (Bell et al, 1999), there seems to be a variation in whether snacks are provided. This is not always easy to determine from the list of ration components. Table K-19 lists items such as snack bars under “snacks” and item such as chocolates and cookies under “sweets”. Inclusion of more snack items would probably help to promote consumption of more calories.

Table K-19: Snack Items in Operational Rations

SNACK ITEMS		
COUNTRY	**Snacks**	**Sweets**
DEU	Yes	Yes
ITA	Yes	Yes
NLD	No	Yes
SVN	Yes	Yes
GBR	Yes	Yes
USA	Yes	Yes
AUS	Yes	Yes
BEL	No	Yes
CAN	No	Yes
CZE	No	Yes
FRA	No	Yes
NOR	Yes	Yes

K.4.4 Choice

Choice of foods is a part of the natural eating experience. Almost all natural dining environments present the diner with a number of choices. These choices extend to the question of whether the diner should eat at all, should have a beverage, or should have a full meal or a snack. Even at home, diners can (politely) refuse certain foods and select others. The variable of choice is one of the least studied variables and it is potentially one of the most important because choice varies tremendously across eating situations. When one chooses a food to eat, there is a greater emotional involvement in the choice, and there is also more attention directed to the chosen food.

The infant has very little choice, almost none, whereas the diner in a fine restaurant has many choices. One of the main issues of the laboratory research situation is that the laboratory provides almost no choice. Subjects in laboratory studies are expected to sample the products provided to them for test. Research protocols rarely ask the subject which sample they want or whether they want to skip samples. While human use regulations require that subjects can terminate a study, in fact most subjects feel pressured to conform to what is expected of them, especially because many experimental subjects are compensated. Academic subjects are usually performing for course credit and the pressure of serving as a subject for a professor.

In a demonstration of the role of choice on eating, Kramer et al (2001) compared the traditional laboratory approach to a more natural research model with more choice using military personnel and military rations. In the traditional approach, the same daily lunch meal was served for a week, and led to reduced acceptance scores and reduced intake, but not when the meal varied (Meiselman et al, 2000). This is a demonstration of the laboratory effects of monotony (reduced acceptance and intake) and variety (increased acceptance and intake). However, Kramer et al (2001) found that this monotony effect did not occur with military personnel choosing foods in the field (Kramer et al, 2001, Table K-20). They observed that soldiers who select the same

meal every day actually rate that product higher, and this effect held for both all foods and main dishes; these data are presented below. Soldiers who selected an item only once over the course of a field exercise, rated that food 7.41 or 6.80 on the 9 point scale in two test sites. However, soldiers who selected the same food more than once, from 2 – 10 times, rated that food 7.70 or 7.23, significantly higher. This seems to make common sense, that a person who selects a product frequently likes it more. Also, notice that soldiers indeed like variety; most soldiers consumed each ration only once followed by declining frequency of selection.

Table K-20: The Impact of Variety Selected on Food Acceptance Ratings in the Field by Soldiers; As Items are Consumed More Frequently, the Acceptance Increases (Source: Kramer et al, 2001)

	SITE 1		SITE 2	
# of Times Item Was Consumed	**Frequency**	**Accept Rating**	**Frequency**	**Accept Rating**
1	2159	7.41	1085	6.80
2	1037		395	
3	538		162	
4	263		72	
5	140		46	
6	95		24	
7	60		19	
8	45		14	
9	39		9	
10	35		0	
<10	187		0	
2 or More	2439	7.70	7.41	7.23

In further demonstrations of the important role of choice, King et al (2004, 2007) demonstrated the criticality of choice in two successive product development tests. In both studies, providing choice enhanced acceptance scores. In the first study, subjects were tested in a sensory laboratory and additional contextual variables were added to determine their effects on product liking. Giving the subjects a choice of which products to sample had a bigger effect than the physical environment itself, and increased overall liking scores from 6.7 to 7.2 on the 9 point scale. King et al (2007) replicated this effect by showing an increase in liking scores in a natural restaurant condition which included choice. In this study, subjects were tested in a laboratory, a restaurant without choice and without a real meal context, and in a restaurant with choice and meal context. Scores for the first two conditions did not differ, but providing choice in the third condition increased liking scores.

K.4.5 Comfort (vs. Stress)

Some field conditions which enhance or depress ration consumption are not under the control of the commander; two of these factors are comfort and temperature. People probably eat more in more comfortable surroundings, although there is no direct, controlled published research on this. However, comfort itself might not be the

primary variable. Comfort might exert its effects through duration, effort, or other contextual variables. Since those variables have been studied, and their effects well known, I recommend that we address comfort through recommendations to deal with factor such as effort and duration.

K.4.6 Temperature/Weather

Commanders are even less able to control temperature and weather in order to optimize eating conditions. There is a research background on the effects of extreme weather on physiology and nutrition (for example see Marriott, 1993). Commanders should familiarize themselves with this in order to predict soldier response to climate, and to avoid risks such as dehydration. While ration test have been performed under a variety of hot and cold climates, there has not been systematic research to identify the effects of temperature. Hirsch and Kramer (1993) summarize some of the research on ration acceptance and consumption in different climates, without reaching a clear conclusion on the effects of climate.

K.4.7 Convenience

While everyone accepts that convenience is one of the major trends in eating in the past decades, with convenience food products and convenience (fast) food service, relatively little research has studied what constitutes convenience to the consumer. In the questionnaire study of Marines who had served in actual combat situations (Popper et al, 1984), convenience did not rate high as a factor which had contributed to their reduced consumption. However, the major factor was inadequate time to prepare and consume foods, so obviously convenience was involved from the perspective of time.

Candel (2001) suggested that meal preparation convenience has 2 key dimensions, time and effort. Candel proposed a 6 item rating scale to measure convenience orientation in food preparation. Jaeger and Meiselman (2004) added that convenience be considered throughout the entire food provisioning process, including acquisition, preparation, eating and cleaning up. They studied female US consumer perceptions of convenience, time and effort using a repertory grid analysis of responses to written scenarios. The scenarios included the elements of food acquisition/shopping, preparation, and cleaning up. They confirmed the importance of time and effort in the perception of convenience but noted that these two variables were highly interdependent.

The importance of convenience was further demonstrated by development of the Food Choice Questionnaire (Steptoe, Pollard and Wardle, 1995). The Food Choice Questionnaire contains 36 items on nine factors. Sensory appeal, health, convenience, and price were identified by Steptoe et al as the most important factors. Eertmans et al (2006) studied the invariance of the Food Choice Questionnaire structure in three western countries, showing good agreement but some differences in factor structure.

K.4.8 Effort

Effort to obtain food is one of the most important environmental variables. In the early studies from the Stunkard group, Myers et al (1980) examined the effect of product placement or “accessibility” in a cafeteria service line. Products placed with easier access, and therefore less effort, were selected more often. The US Army studies reported by Natick researchers in several publications (Marriott, 1995; Hirsch et al, 2005) mention the critical role of effort. The situations in which these studies were conducted, cafeterias and military field feeding, might exaggerate the role of effort in day-to-day household eating. But the importance of effort in human eating is consistent with its importance in animal eating in which efficiency is a main driver.

Meiselman et al (1994) manipulated the effort required to obtain food in a university cafeteria in England. Food choice, acceptability and intake were measured. The studies took place in a student refectory or cafeteria

where students ate daily, and paid for their food. To manipulate effort, one food item in each of two studies was moved from its usual location to a new location. In order to obtain the test food, the student had to obtain and pay for the meal in one meal line, and then go to the new line to obtain the test food. Both studies began with a baseline period in which regular eating was measured In the first study using chocolate confection the effort manipulation lasted one week, and in the second study using potato chips or crisps the effort condition lasted three weeks followed by a recovery phase in which the chips were returned to their former location.

Increased effort reduced selection of the test foods to virtually zero. This was a strong message that environmental variables can have very large effects. The acceptability of the test foods did not vary with the effort manipulation, showing that choice, acceptance and intake are not always correlated.

The second study might be the only study in which recovery from an effort condition was measured (Table K-21). When the chips/crisps were returned to their original location for a three week recovery period, the choice of chips did not fully recover to its baseline level. Under the effort condition the chip selection rate decreased from 0.71 to 0.09, but only increased back to 0.32 in recovery. Thus, a three week recovery did not produce even 50% recovery of the former behavioral pattern. We do not know whether we had introduced a very long-term change. The reduction in chip selection was associated with an increase in selection of other starch products; thus these substitutions do not seem to be random.

Table K-21: The Impact of Effort on Item Selection (Source: Meiselman et al, 1994)

Condition	Main Meal	Starch Items	Bread	Crisps
Baseline	0.385	0.274	0.000	0.718
Effort	0.408	0.462	0.005	0.092
Recovery	0.398	0.398	0.006	0.322
Difference between the Three Periods	N.S.	P<0.01	N.S.	P<<0.001
Contrast between Baseline and Manipulation	N.S.	P<0.05	N.S.	P<<0.001

N.S. = Not Significant

The effort studies raise the important general question whether there is enough long term research to see whether consumer trends are short-term or longer term. One of the current trends in sensory and consumer food research is greater interest in longer term testing. The US Army began longer term testing of operational rations in the 1980s (Hirsch et al, 1984). Effort was uncovered as a key variable in this early military research and remains one of the key variables in enhancing consumption of operational rations.

In the following section I consider variables that might affect effort. Increased effort is associated with less consumption, and reduced effort is associated with more consumption.

Operational rations from the NATO RTG countries all provide coffee, but do not uniformly provide tea (Table K-22). For serious tea drinkers, this poses a serious inconvenience. And because caffeine has properties which might be important in the field (Lieberman, 2005), the availability of coffee and tea might have important implications.

Table K-22: Tea

COUNTRY	Tea Included
DEU	Yes
ITA	Yes
NLD	Yes
SVN	Yes
GBR	No
USA	Yes, some
AUS	Yes
BEL	No
CAN	Tea or Coffee
CZE	No
FRA	Yes
NOR	No

The availability of salt and pepper (Table K-23) can also be viewed as an important item for those who use it frequently. Operational rations do not uniformly provide pepper; it appears to be more common in rations of English speaking countries within NATO. Salt is more commonly, but not universally, provided.

Table K-23: Salt and Pepper in Operational Rations

COUNTRY	Pepper	Salt
DEU	No	Yes
ITA	No	Yes
NLD	No	Yes
SVN	No	No
GBR	Tabasco	No
USA	Yes	Yes
AUS	Yes	Yes
BEL	Yes	Yes
CAN	Yes	Yes
CZE	No	Yes
FRA	Yes	Yes
NOR	No	No

The table of Water Required for operational rations (Table K-24) provides an index of the convenience of ration preparation, and the effort required to obtain and carry the necessary water. The available data indicate a very broad range of water requirements – from 300 ml/day to 5170 ml/day. It is not clear whether these figures represent the true daily total amount per Warfighter.

Table K-24: Water Needed if you Rehydrate Everything

COUNTRY	Water Requirements (ml/day)
DEU	2300
ITA	300
NLD	1900
SVN	3500
GBR	5170
USA	2040
AUS	4000
BEL	807
CAN	2890
CZE	1600
FRA	1000
NOR	3500

The weight of the operational ration (Table K-25) provides another index of effort. Rations vary more than two-fold in weight, from 1.0 kg to 2.29 kg.

Table K-25: Weight of Operational Rations

COUNTRY	Weight of Operational Rations (kg)
DEU	1.6
ITA	2.29
NLD	1.7
SVN	1.6
GBR	1.8 – 2.0
USA	2.04
AUS	1.8
BEL	1.5
CAN	2.2 (B,L,D)
CZE	1.6
FRA	1.6
NOR	1

The easy availability of eating utensils provides another index of effort. Most operational rations do not provide eating utensils. Accessory packs provide a plastic spoon in the General Purpose Rations of Australia, Canada, Italy and the US. In addition to the plastic spoon for breakfast, the Italian ration provides two plastic cutlery sets. The rations of Belgium, France, Czech Republic, Germany, the Netherlands, Slovenia and Great Britain contain no utensils in the accessory packs.

K.4.9 Time

Above, I noted that stress/fear affect one's desire to eat in actual combat situations. But the main factor in combat situations is simply the lack of time to prepare and consume foods. Popper et al (1984) used questionnaires to study a large number of US Marines with actual combat experience. About half of the Marines reported eating much less than usual in an actual combat situation. On day 1 of their first combat situation, Marines reported eating only 58% of what they normally ate; this recovered to about 70% of what they normally eat. The main reason for eating less was that they simply did not have they time – well over 50% reported this on their first and second combat experience, and on days 1, 2 and 3 of both combat experiences. These data show that rations must be designed to be eaten quickly and easily when a quick meal is needed.

K.4.9.1 Meal Duration

Because of the importance placed on the presence of other people at meals, studies have documented eating durations in restaurants in the United States and correlated eating duration with the number of people present. Sommer and Steele (1997) observed eating in both American coffee shops and restaurants, and reported increased duration at the table for groups rather than individuals, and for those reading rather than non-reading. Being in a group added approximately 10 minutes to a meal and reading added approximately 10 minutes. Bell and Pliner (2003) observed eating duration and the number of people at tables in three types of eating establishments in the US and found moderate correlations between the two measures in all restaurant

types. The data are presented below. They also documented that people eat much longer in worksite cafeterias and moderately priced restaurants than in fast foods restaurants. Pliner and colleagues have also studied the impact of duration on social facilitation of eating, the phenomenon of eating more in the presence of other people. This is discussed under social effects above (Section K.3.8)

Table K-26: Meal Durations at Different Group Sizes in Three Different Foodservice Settings (Source: Bell and Pliner, 2003)

Meal duration by lunch setting and group size at table

Lunch setting	Group size	Minutes at table		Number of tables
		Mean	SD	
Worksite cafeteria	1	12.6	3.8	24
	2	23.0	7.9	34
	3	33.0	11.3	28
	4	41.1	10.6	41
	5 +	44.0	14.2	21
Moderately priced restaurant	1	27.6	6.7	8
	2	44.9	10.8	29
	3	47.2	10.1	13
	4	52.3	8.5	24
	5 +	58.5	13.1	21
Fast-food restaurant	1	10.7	3.3	22
	2	18.2	6.0	33
	3	18.4	6.8	23
	4	19.7	7.2	28
	5 +	21.9	5.8	18

Holm (2002) reported estimated meal durations from the Nordic study of 1200 consumers in each of four countries. The most frequent response, in ten minute intervals of response, for all meals in all countries was 10 – 20 minutes, with 21 – 30 minutes the second most frequent for 3 countries. The most infrequent response in all countries was 31 – 40 minutes.

Thus meals are shorter than many people think. However there still needs to be a minimum amount of time for eating, and one needs to consider the cultural variation in average meal time. Rushed meals will tend to be smaller.

K.4.10 Price, Value and Free Food

One of the major differences between military food and civilian food is that much of the former is provided free to soldiers, especially under field conditions. When food is free it removes one of the major factors in civilian food selection. The Food Choice Questionnaire (Steptoe et al, 1995) shows price as one of the major factors in determining how we make food selections. Less is known about how food selections change when price is removed from the food choice situation. Price has two elements, one negative and one positive (Jaeger, 2006). Price requires us to pay and that is negative; but higher price also suggests quality to people and that is positive. The absence of any cost for military rations might actually convey a lower quality. The impact of free food on soldiers needs further investigation.

K.5 OVERALL CONCLUSIONS

In order to increase and or maintain adequate consumption of military operational rations, one must consider a broad range of variables. These variables involve the food itself, the people eating the food (soldiers), and the environment in which they eat. All of these classes of variables are potentially important, and their relative importance will vary with the situation.

Important aspects of the food include how well it is liked (its baseline acceptability), its variety, and the portion sizes of the different ration components. Food that is liked has a much better chance of being consumed than food which is marginally liked or even disliked. One of the best ways of providing well liked foods is to select those foods from foods which are generally well liked in studies of food preference. Of course these food preferences can be expected to vary across cultures. A varied diet will support consumption better than a monotonous diet – data from soldiers in the field demonstrate that most soldiers prefer variety. And it is important that the best liked parts of the ration are provided in appropriate portion sizes.

Characteristics of the soldiers will also affect how much the ration is liked and how much is consumed. Understanding the demographic composition of the soldiers is important, since factors such as gender influence liking and consumption. A large number of human traits differentiate people on their response to foods – variety seekers will want more variety, neophobics will avoid novel foods. Highly food involved people are more likely to appreciate foods from different cultures, as are neophilic people. And soldiers who are restrained eaters are more likely to use the field situation to reduce consumption. In addition to these important traits, field feeding needs to take advantage of the phenomena of social facilitation and social modeling. Soldiers will tend to eat more in groups where eating duration is longer, and will tend to eat more when they model or copy the eating patterns of their superiors.

And the environment will also impact ration liking and consumption. Time and effort are two of the key variables. Anything which makes obtaining food more difficult will depress eating. And temporal issues are critical; soldiers need adequate time to eat. One of the best ways to increase eating duration is the social effect of eating in social groups, where eating is prolonged and consumption increased. Another general environmental influence is the effect of meal patterns. This is another area in which culture is pronounced. Soldiers expect different meal patterns of hot and cold food depending on their cultural experience. Diverting form these patterns might depress eating.

From the above overview it should be clear that no one operational ration provides the optimal operational ration for all NATO countries. In fact, each operational ration appears to have certain benefits and certain limitations:

Germany: The German ration is in the lower range of weight, which enhances convenience and reduces effort. However, the German ration contains a relatively low number of menus for variety, and also low variety per pallet.

Italy: The Italian ration requires the least water, reducing effort. It contains a relatively large number of overall menus, as well as a relatively large numbers of specific breakfast, lunch, and dinner menus, enhancing consumption through variety.

Netherlands: The Netherlands operational ration has a relatively large number of menus, enhancing consumption through variety, but a low variety per pallet increasing risk for low variety in the field. There are also fewer snack options. The use of pate and paste items might be less acceptable to some NATO countries.

Slovenia: Slovenia has contents listed on the package along with several other countries. This promotes consumption by reducing neophobia and clarifying expectations. However, the Slovenia ration contains a

relatively low number of menus, and a low variety per pallet. It also contains dehydrated items which require hydration increasing time and effort.

Great Britain: The GBR ration is designed for 30 days along with several other countries; this is the longest duration of use, enhancing consumption through variety.

United States: The US operational ration contains the largest variety of menus, and the largest variety per pallet, also enhancing consumption through variety. The US ration lacks a specific breakfast ration.

Australia: The Australian ration contains convenience items such as tea and pepper, enhancing overall acceptability and reducing effort to obtain these items. However, the Australian ration contains a relatively low number of menus, and a low variety per pallet. It also does not contain a specific breakfast meal.

Belgium: Belgium has a relatively light ration, and requires relatively little water; both of these reduce effort and enhance consumption. However, the ration has fewer snack options.

Canada: The Canadian ration has specified rations for breakfast, lunch and dinner, enhancing variety and consumption. These are complete meals for each time of day. However, the ration has fewer snack options.

Czech Republic: The Czech ration is one of the lighter rations, with a lower than average water requirement. Both of these factors reduce effort and enhance consumption. However, the Czech ration contains a relatively low number of menus, reducing variety, and lower snack options.

France: The French operational ration contains the largest number of specific breakfast, lunches and dinners, enhancing variety and consumption. However, there are fewer snack options.

Norway: Norway has the lightest ration, enhancing consumption through reduced effort.

The above outline of ration characteristics likely to increase or decrease ration consumption clearly show the importance of continued research on understanding these variables and determining their specific impact on consumption of military rations. Eating adequate food in the field is of critical importance for maintaining soldier health and performance. Further research in these factors will provide further guidance on how to achieve optimal soldier consumption of operational rations.

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Appendix 1: MEISELMAN NATO RTG TOPICS (APRIL 25, 2008)

THE FOOD

- Portion Size (nutrition?)
- Food temperature
- Food compatibilities
- Food quality, acceptance
    - Correlation of liking and intake (nutrition?)
- Food packaging and labeling
    - Packaging effort
- Food presentation
    - Dishes, Utensils? (environment?)
- Food variety and monotony
    - Sensory specific satiety
    - Interaction with choice
- Food authenticity and country of origin (cross-cultural?)

THE INDIVIDUAL

- Age
- Gender
- Expectations
- Religious influences
- Other dietary influences
    - Vegetarian
    - Food choice questionnaire – cross cultural differences
- Traits and attitudes
    - Food Neophobia
    - Food Involvement
    - Dietary Restraint
    - Variety seeking and Sensation seeking
- Cross-cultural food and dietary preferences / aversions
- Commensality – eating together
    - Social facilitation
    - Social isolation

- Impact of foods on moods and emotions
- Satiety

THE LOCATION/ENVIRONMENT OF EATING

- Location (confounding of people and location)
- Appropriateness
    - By location
    - By meal
- Time of day
    - Meal patterns
    - Grazing
- Choice
- Comfort (vs. stress)
- Temperature/weather
- Speed of eating/eating duration
    - Duration and social facilitation
- Convenience
    - Effort
    - Time
        - Enough time to eat under stress
        - Meal duration
    - Eating dishes and utensils
- Meal components
    - Hot and cold meals
    - Food/meal appropriateness
- Price, value and free food

Appendix 2: POSITIVE AND NEGATIVE INFLUENCES ON CONSUMPTION USING THE THREE FACTOR MODEL

Table K-27: The Food

THE FOOD		
Factors	**Can Enhance Eating (+)**	**Can Decrease Eating (-)**
Portion Size	+	-
Food Temperature	+	-
Food Compatibilities	+	-
Food Quality, Acceptance	+	-
Food Packaging and Labeling	+	-
Packaging Effort	+	-
Food Presentation (dishes, utensils)	+	-
Food Variety and Monotony	+	-
Sensory Specific Satiety	+	-
Food Authenticity/Country of Origin (cross cultural)	?	?

Table K-28: The Individual

THE INDIVIDUAL		
Factors	**Can Enhance Eating (+)**	**Can Decrease Eating (-)**
Age	?	?
Gender	+	-
Expectations	+	-
Religious Influences	?	-
Other Dietary Influences		
- Vegetarian		-
Traits and Attitudes		
- Food Neophobia	+	-
- Food Involvement	+	-
- Dietary Restraint		-
- Variety Seeking	+	-
- Sensation Seeking	+	-
Cross-Cultural Food and Dietary Preferences/Aversions	+	-
Commensality – Eating Together		
- Social Facilitation	+	
- Social Modeling	+	-
Satiety	+	-

Table K-29: The Location or Environment

THE LOCATION OR ENVIRONMENT		
Factors	**Can Enhance Eating (+)**	**Can Decrease Eating (-)**
Appropriateness	+	-
Time of Day		
- Meal Patterns	+	-
- Grazing	+	
Choice	+	-
Location	+	-
Comfort (vs. stress)	+	-
Temperature/Weather	+	-
Speed of Eating/Eating Duration	+	-
Convenience		
- Effort	+	-
- Time	+	-
Price and Free Food	+	?

Appendix 3: ABOUT THE AUTHOR

Dr. Herbert L. Meiselman is an internationally known expert in the fields of sensory and consumer research, product development and food service system design and evaluation. He is Co-Editor of Food Quality and Preference published by Elsevier, and was a founding Editor of Journal of Foodservice published by Blackwell. He has held Visiting Professorships at both Reading University and Bournemouth University, UK, and Orebro University, Sweden. He is currently on the Research Committee of the Institut Paul Bocuse, Lyon, France.

He recently retired as Senior Research Scientist at Natick Laboratories where he was the highest ranking Research Psychologist in the U.S. government. In 2005, he was awarded a Presidential Award for Meritorious Service by The President of the United States. In 2003, he was Co-Chairman of the 5th Pangborn Sensory Science Symposium in Boston, the largest international food sensory and consumer research meeting. Dr. Meiselman is the co-founder and a principal lecturer in the Targeting the Consumer short course series. Dr. Meiselman is the author of over 160 research papers and 4 books, and has lectured extensively in the United States, Europe, New Zealand and Japan. He recently edited a book on Meals in Science and Practice.

Annex L – COMBAT RATION INTEROPERABILITY

The following relevant categories of information gleaned from collected data is provided in this annex at Table L-1 and support the discussion provided in Chapter 6 of this report.

Feeding Concept

The feeding concept as identified in the table provided is based on sustainment sufficient for one person for a full day (24 hours). The following feeding concepts notations have been used: full ration or meal based. The full ration provides nutritional requirements for a full day and typically includes breakfast, lunch and dinner meals. The meal based concept is typically modular in design and is generally issued on an individual meal basis. As such, three meals are required for a single days food supply unless the ration is a restricted calorie ration.

Intended Use

Some nations have different types of rations for different uses or mission applications. Two types of rations are identified: General Purpose rations (GP) which are rations to be used for standard military operations in moderate conditions; and Special Purpose rations (SP), which are tailored towards specific circumstances mainly on two levels: climate specific rations (e.g. cold weather ration, hot weather ration) and task specific rations (e.g. first strike ration, long range patrol, or reconnaissance).

Ration Volume

The ration volume provides a comparison of the individual rations and their respective volume in cubic centimeters.

Pallet Type, Pallet Volume and Rations per Pallet

The table provides identification of the type ration pallet used by the different countries, the pallet volume in liters and the number of total rations and/or meals provided per pallet.

Cutlery

Some nations include cutlery in their ration packs while others distribute these items separately. If cutlery is provided integral with the ration it is identified as such. Likewise, if cutlery is needed but not included in ration it is marked as required separately.

Mess Tin / Canteen Cup

A mess tin or canteen cup might be necessary to properly consume a ration (for example to heat the ration in or to heat water for coffee, etc.). The table in this annex provides an overview of those rations that require a mess tin or canteen cup to be consumed correctly.

Specific Tools

Some rations contain packaged food items that require specific tools to open or handle them. The table in this annex shows the tools required alongside the ration to consume it. If specific tools are needed to open or handle the packaging this is identified along with whether or not the tool is supplied in the ration pack.

Heating Device/Fuel

If a heating device and/or fuel are required, the type of device and associated fuel is specified.

Water Treatment

If some sort of water treatment or disinfection method is contained or provided with the ration this is indicated with a simple yes or no.

Separate Bag for Packaging Waste

This refers to a specific separate bag included in the ration pack intended for storage of packaging material of a food item after consuming it. If a waste bag is included or not included this is marked in table. In instances where a specific waste or environmental bag is not provided, however, a part of the packaging of the ration can be used as a container for packaging waste, this is specified. The following abbreviations have been used in this table entry: Polyethylene (PE) and Fiber board (FB).

Language

The table identified the language(s) used on the packaging. For reasons of simplicity, a language is listed as being used when a consumer is able to identify the contents (name of the item) of a component and has the necessary information to prepare this component or item correctly, in that language.

Metric vs. Non-Metric

The system of units used on packaging, labelling, or instructions is identified as either Metric or Non-metric. Metric units are units defined in the SI (Systéme International), such as meter, kilogram, etc. Non-metric units are the units generally used in the Anglo Saxon countries such as pound, foot, etc., and are typically based upon Imperial units or the Imperial system.

Water Requirements

The total quantity of water (in liters) needed to rehydrate all items in a ration is indicated in this entry. In cases where menus vary in their specific water requirements to hydrate beverages or other components, the figure indicated represents a mean of the range of values.

Table L-1: Combat Ration Interoperability

Country	Ration Name	Feeding Concept	Intended Use	Ration Vol (cubic cm)	Pallet Type	Pallet Vol Incl Pallet (liters)	Rations per Pallet	Cutlery	Mess Tin/ Canteen Cup	Specific Tools	Heating Device/ Fuel	Water Treatment Included	Separate Bag for Pkg Waste	Language	Metric/ Non-metric	Water Reqs (liters)
Australia (AUS)	CR1M	full ration	GP	3400	AUS	not supplied	400	included	required separately	can opener provided	stove & hexamine (not included)	no	yes	English	metric	4 liter
Australia (AUS)	PR1M	full ration	SP	3400	AUS	not supplied	480	included	required separately	not required	stove & hexamine (not included)	no	yes	English	metric	5.4 liter
Belgium (BEL)	C Ration	full ration	GP	2977	ISO	1280	252	required separately	required separately	not required	heater & fuel tablets included	yes	not included; may use FB box	French English	metric	0.807 liter
Belgium (BEL)	LRRP	full ration	SP	2600	ISO	1272	252	required separately	required separately	not required	stove & hexamine (not included)	no	not included; may use plastic bag	French English	metric	2.3 liter
Canada (CAN)	IMP	B, L, D meals	GP	7440	CAN*	1240	320 meals	included	required separately	not required	FRH (not included)	no	not included; may use paper bag	French English	metric	2.890 liter
Czech Rep (CZE)	BDP	full ration	GP	3500	NS	info not available	info not available	required separately	required separately	not required	stove & fuel tablet (not included)	no	yes	Czech English	info not available	3.1 liter
France (FRA)	RCIR	full ration	GP	2977	ISO	1280	252	required separately	required separately	not required	heater & fuel tablets included	yes	yes	French English	metric	0.807 liter
Germany (DEU)	EPa	full ration	GP	3205	Euro	1104	260	required separately	required separately	knife to open main meal not provided	stove & fuel tablet (not included)	yes	not included; may use FB box	German English	metric	3.1 liter
Germany (DEU)	EPa Light	full ration	SP	2140	Euro	1104	272	required separately	required separately	not required	stove & fuel tablet (not included)	yes	not included; may use FB box	German English	metric	3.05 liter
Italy (ITA)	K Ration	full ration	GP	3600	Euro	1728	210	included	required separately	not required	stove & fuel tablet included	yes	yes	Italian	metric	0.3 liter
Netherlands (NLD)	Combat Ration	B, L, D meals	GP	4150	NS	variable	490 B; or 960 L & D	required separately	required separately	not required	stove & hexamine (not included)	no	not included may use FB box	Dutch English French	metric	1.9 liter

Table L-1: Combat Ration Interoperability (cont'd)

Country	Ration Name	Feeding Concept	Intended Use	Ration Vol (cubic cm)	Pallet Type	Pallet Vol Incl Pallet (liters)	Rations per Pallet	Cutlery	Mess Tin/ Canteen Cup	Specific Tools	Heating Device/ Fuel	Water Treatment Included	Separate Bag for Pkg Waste	Language	Metric/ Non-metric	Water Reqs (liters)
Netherlands (NLD)	Arctic Ration	full ration	SP	9000	NS	1944	192	required separately	required separately	not required	stove & hexamine (not included)	no	not included; may use PE bag	Dutch English French	metric	4.5 liter
Netherlands (NLD)	LDDR	full ration	SP	6800	NS	1860	192	required separately	required separately	not required	stove & hexamine (not included)	no	not included; may use PE bag	Dutch English French	metric	3.6 liter
Norway (NOR)	FR 3800 Tropical	full ration	GP (Tropical)	8978	Euro	1056	144	required separately	required separately	not required	hot water (stove, tablet, mess tin) (not included)	yes	not included	Norwegian English Finnish	metric	3.5 liter
Norway (NOR)	FR 3800	full ration	GP (Arctic)	8978	Euro	1056	144	required separately	required separately	not required	hot water (stove, tablet, mess tin) (not included)	yes	not included	Norwegian English Finnish	metric	3 liter
Norway (NOR)	FR 5000 Tropical	full ration	SP (Tropical)	8978	Euro	info not available	144	required separately	required separately	not required	hot water (stove, tablet, mess tin) (not included)	yes	not included	Norwegian English Finnish	metric	3.8 liter
Norway (NOR)	FR 5000 Arctic	full ration	SP (Arctic)	8978	Euro	info not available	144	required separately	required separately	not required	hot water (stove, tablet, mess tin) (not included)	yes	not included	Norwegian English Finnish	metric	3.8 liter
Slovenia (SVN)	Indiv. Ration	full ration	GP	5300	ISO	info not available	160	required separately	required separately	can opener provided	FRH provided; additional heater & gel fuel (not included)	no	yes	Slovene English	metric	3.5 liter
United Kingdom (GBR)	24-Hr GP ORP	full ration	GP	4180	NATO	2022	350	required separately	required separately	not required	stove & hexamine (not included, issued separately)	yes	not included; may use FB box	English	metric	5.17 liter
United States (USA)	MRE	3 indiv meals	GP	6976	NATO	1352	192 (576 meals)	included	not required	not required	FRH (included)	no	not included; may use PE bag	English	non-metric	2.04 liter
United States (USA)	MCW	3 indiv meals	SP	3398	NATO	1589	192 (576 meals)	included	not required	not required	FRH or stove (not included)	no	not included; may use PE bag	English	non-metric	3.016 liter

Table L-1: Combat Ration Interoperability (cont'd)

Country	Ration Name	Feeding Concept	Intended Use	Ration Vol (cubic cm)	Pallet Type	Pallet Vol Incl Pallet (liters)	Rations per Pallet	Cutlery	Mess Tin/ Canteen Cup	Specific Tools	Heating Device/ Fuel	Water Treatment Included	Separate Bag for Pkg Waste	Language	Metric/ Non-metric	Water Reqs (liters)
United States (USA)	LRP	1 indiv meal	SP	1133	NATO	1589	576 meals **	included	not required	not required	FRH or stove (not included)	no	not included; may use PE bag	English	non-metric	1.005 liter
United States (USA)	FSR	full ration	SP	2832	NATO	1589	432	included	not required	not required	not required	no	not included; may use PE bag	English	non-metric	0.710 liter

Notes, Abbreviations and Acronyms:

AUS - Australia
B, L, D - Breakfast, Lunch, Dinner
CAN - Canada
cm - centimeters
Euro - European
FB - Fiber Board
FRH - Flameless Ration Heater
GP - General Purpose
ISO - International Organization for Standardization
m - meters
NS - Not Supplied
PE - Polyethylene
SP - Special Purpose
* The CAN pallet is specifically designed for out-of-country shipments.
** The USA LRP is a restricted use ration and is issued one meal per soldier per day.

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14. Abstract

This report summarizes a three-year study carried out by NATO RTG-154/HFM-154 Research Task Group on "Nutrition Science and Food Standards for Military Operations" to examine the current state of alliance nation's individual and special purpose combat rations including their nutritional value. This effort was conducted within the context of supporting the most stringent requirements of a fully operational NATO Response Force (NRF) land component. The NRF is equipped with forced entry capability and designed to be mobilized within 5 days and engaged in a self-sustainable, high intensity mission of 30 days without resupply. This report is focused on assessing current ration systems and providing science based recommendations to develop standards for nutrition, packaging, and combat rations that support the NRF to ensure nutrition, combat feeding and performance are optimized. The report considers four major areas of interest: 1) nutrition; 2) behavioral and psychological factors; 3) interoperability; and 4) collateral issues of significance but beyond the scope of the RTG mandate. The report concludes that designing one universal combat ration which suits all NATO forces would represent a great challenge. A major outcome of this RTG effort is the common understanding of needed research leading to future improved combat ration design.

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