



**Natick Soldier Research,  
Development & Engineering Center  
Public Affairs Office**

**Year in Review  
2015**



# Table of Contents

## **Bright Ideas**

Natick pitches innovation in forum .....2

## **Soldier Sensors**

Knowledge is power on the battlefield .....3

## **Food for Thought**

Research team shapes future of combat rations.....4

## **What's in That MRE?**

New online Combat Rations Database can tell you.....6

## **'Speed Bag'**

Aerial resupply for troops on the battlefield.....8

## **Nobody's Foil**

Natick investigates materials for food packaging ..... 11

## **Test Case**

Evaluating protective eyewear and soft body armor ..... 12

## **Training for Your Brain**

Natick scientists investigate ways to help Soldiers recover from stress ..... 15

## **Better Fit**

3-D shape database improves clothing, equipment..... 16

## **Brain Domain**

Natick, Tufts team up to create new center ..... 18

## **Combat Menu**

Natick serves up new ration book .....20

## **'Cool Effort'**

NSRDEC helps warfighters with heat injuries.....22

## **Dry Run**

New technology could aid ration development .....24

## **À la Carte**

Combat Rations Database receives update .....25

## **Planting the Seed**

Combat Feeding tests hydroponic farming .....26

## **Eating at 'BK'**

Natick developing new Battlefield Kitchen.....28

## **Talking Turkey**

Natick researcher develops bacon, jerky .....29

## **Improving Soldier Capabilities**

Natick researcher collaborates with North Carolina State on textile technologies .....30

## **On the Mend**

Natick investigates self-healing protective clothing .....31


*Photo: Jeff Sison, NSRDEC Public Affairs*

# Bright Ideas

## Natick pitches innovation in forum

By Jane Benson, NSRDEC Public Affairs / NATICK, Mass. (Dec. 31, 2014)

The U.S. Army Natick Soldier Research Development and Engineering Center, or NSRDEC, has come up with a new way to spark out-of-the-box thinking, risk-taking, and employee participation. The center implemented the “Bootstrap Initiative and Pitch Day.”

The Bootstrap Initiative encourages innovation and creativity while streamlining processes and minimizing bureaucracy. The program accepts ideas from government civilian NSRDEC employees, who are allowed

to submit proposals for a new technology, research project, business process, or administrative process that supports NSRDEC’s mission, which includes researching and developing cutting-edge food, shelter, clothing and airdrop technologies and products.

Employee enthusiasm, participation and empowerment are at the heart of the initiative. Employees propose ideas and vote on which ideas receive funding.

NSRDEC’s Dr. Ken Desabrais, a research aerospace engineer, conceived the idea and led the Bootstrap Implementation Team.

“The Bootstrap Initiative was conceived of as a way to bring the crowdsourcing concept to NSRDEC, to find innovative and creative ways within our organization to solve a spectrum of problems, from technical challenges to improvements in our business and administrative processes and tools,” Desabrais said. “Our intent with the initiative was to encourage the sharing of ideas and help nurture a culture of collaboration amongst our colleagues to identify and find solutions to the problems we see in achieving our mission of helping the Soldier, while also empowering people to pursue and make decisions about those ideas.

“The Bootstrap Implementation Team did an exceptional job in pulling the initiative together in a very short time frame. We were able to implement and execute the initiative in about three months from start to finish, which is a testament to the dedication and commitment everyone put into the effort, including all the people (who) participated in submitting ideas and voting for proposals.”

Although Bootstrap is intended to encourage originality and ingenuity, there are still some submission restrictions. For instance, ideas must be able to be carried out for \$50,000 or less. Funding cannot be used to fund a contractor or external contract.

NSRDEC's Pitch Day provided a unique forum for both proposal creators and voters. During Pitch Day, proposers garnered employee voter support for their ideas by making posters, displaying prototypes, creating interactive displays and conducting show-and-tell sessions.

"This was a great effort to bring people together in a new and exciting way," said Donna Bulger, associate director for NSRDEC Operations and Outreach. "Giving the workforce an opportunity to have a voice in what efforts move forward generated some great discussion, and I am sure (it) will spark some new ideas for the next cycle."

Pitch Day showcased many project home runs, but not every project could be a winner. Funding was limited and the competition was steep, with 37 groundbreaking ideas being submitted.

In the end, there were 18 winning proposals, ranging from zero-waste cafeterias to a low-altitude, high-accuracy airdrop activation device.

"The workforce's response to the Bootstrap program far exceeded my expectation," said Dr. Charlene Mello, NSRDEC chief scientist. "It has brought together the business, administrative and technical communities to collaboratively execute our mission. I am eager to follow the progress of funded ideas and generation of new ideas for future Bootstrap submissions."

Megan Hoey, an NSRDEC research chemical engineer, submitted a Bootstrap project entitled "Friend or Foe in Fibers," which was one of the projects chosen by NSRDEC employee voters for funding.

"The Bootstrap Initiative has provided an avenue for me to start some work on developing fibers with specific optical additives in order to inform and prepare for a larger-scale 6.2 friend vs. foe identification effort that is on hold. If funding becomes available for that effort, Bootstrap will have enabled me to hit the ground running and effectively and efficiently transition into the full-scale Warfighter Improved Combat Identification Development 6.2 project."

# Soldier Sensors

Knowledge is power on the battlefield

By Jeff Sisto, NSRDEC Public Affairs / NATICK, Mass. (Jan. 6, 2015)

To the modern, dismounted warfighter, the saying "knowledge is power" is true, especially when making quick decisions based on limited information.

Scientists and engineers from the U.S. Army Natick Soldier Research, Development and Engineering Center, or NSRDEC, are working hard to make information assets a fundamental component of the Soldier's kit.

"The ability to collect, process and share battlefield information can greatly improve the chances of mission success and troop survival," said Dr. David Darkow, the Mission Information team leader with NSRDEC's Warfighter Directorate.

Army researchers are developing a fully-integrated, mobile platform that provide dismounted Soldiers at the squad level with organic and shared sensor information to enhance situational awareness on the battlefield.

During a November 2014 experiment at Fort Benning, Georgia, Natick researchers teamed Soldiers with unmanned vehicles and brought Full Motion Video, or FMV, sensing sources to the Nett Warrior system — a smartphone-based device that supports advanced navigation, friendly-force tracking, command and control communications, and other sensor-fed information portrayals to Soldiers on the ground.

The Natick team developed the components that integrated with Nett Warrior's software architecture. The system is scheduled to transition to the Army's Project Manager Soldier Warrior where it will be one step closer to fielding.

The Nett Warrior Future Initiatives Team was key to ensuring the experiment resulted in the successful integration and transition of the FMV information portrayal concept into the Nett Warrior system, Darkow said. "NSRDEC's role is to improve the Soldier experience," he said. "We provided support that helped transition the concept and we continue to support the NWFIT team with its development by focusing on the Soldier's perspective of the system."

The team's goal was to achieve full integration of various intelligence surveillance reconnaissance sensor feeds into the Nett Warrior platform to maximize the tactical information available, while supporting the broader objective of getting this capability into the hands of Soldiers at the squad level, he explained.

The NSRDEC Mission Information Team also linked video feeds from squad-organic sensors such as the Dragon Runner 20 Unmanned Ground Vehicle and the Cargo Pocket-Intelligence, Surveillance and Reconnaissance, as well as an overwatch capability from Raven unmanned aerial vehicles.

To do this, Darkow's team developed and incorporated into the Nett Warrior platform a mobile, plug-in software application, called the Tactical Video Viewer, which auto-populates what sensor feeds are available and links users to the source's live video feed.

In this way, Nett Warrior "acted as a full-motion video server that rebroadcast those video streams on demand to other Soldiers in the squad," Darkow said.

"Soldiers see a moving map application that displays blue (friendly)-force tracking, C2 (command and control) information, and full-motion ISR video feeds," Darkow said. "Instead of just following dots on a map, Soldiers at the small unit and company levels can be viewing the same emerging battle space picture."

More work is still needed to expand integration and control of battlefield sensors that will enhance the tactical information portrayal for viewing by dismounted Soldiers in austere environments, Darkow said.

"The team provided the first opportunity to put this emerging NSRDEC technology into a Soldier's hands at the squad level within an operationally relevant context," he said. "It went really well."

The Tactical Video Viewer is scheduled to transition to Nett Warrior and Project Manager Soldier Warrior, where the system will be optimized for Soldier performance.

# Food for Thought

## Research team shapes future of combat rations

By Bob Reinert, USAG-Natick Public Affairs / NATICK, Mass. (Jan. 21, 2015)

What kinds of rations might the military be using to feed its warfighters 15 years from now?

Seeking to provide a window into the future of combat feeding, the Consumer Research Team, or CRT, working on behalf of the Combat Feeding Directorate of the Natick Soldier Research, Development and Engineering Center, developed an online questionnaire for current and former military members.

A more detailed version of the questionnaire can be completed by Department of Defense personnel whose work involves military field feeding.

“This is a great opportunity,” said CRT’s Wendy Johnson. “It’s very unusual, in my experience, that we stop and we think 15 years ahead and say, ‘What can we do?’ Taking a look at the long term is very interesting, and I think it’ll be very beneficial in the long run.”

As Johnson pointed out, the Future General Purpose Operational Ration, or FGPOR, could take any form.

“We try not to say MREs (Meals, Ready-to-Eat) because we’re trying to think outside the box,” Johnson said. “It doesn’t have to be an MRE. They can look very, very different.

“Do we have to give them meals? Can we think about it in a different way? And can we give them a bunch of foods that maybe they can graze on?”

The CRT began its process about 18 months ago with a series of focus groups. The participants were told that rations could take on virtually any configuration.

“They were pretty interesting,” Johnson said. “There were a lot of things that came up. What we were looking for were things that came up maybe multiple times.”

Among the concepts that interested the focus groups were just-in-time delivery of rations, producing food with 3-D printers, and tailoring rations to parts of the world or missions.

Johnson said she was surprised by how much the groups focused on education.

“They’re talking about educating the Soldiers, for one thing, and also educating their chain of command, so that everybody is aware of the importance of nutrition and how the rations fit into that,” said Johnson, noting that this aspect of combat feeding is “not always fully understood.”

Jeannette Kennedy, a senior food technologist at Combat Feeding, added that field rations are about “performance fueling and performance nutrition.”

With data from focus groups in hand, four members of the CRT went to work fashioning the questionnaire.

“We went over every, single idea and talked it over and made sure that it was as clear and as concise as possible,” Johnson said. “That took up a lot of time. I think we’ve got a good set of ideas from that whole process.”

The basic questionnaire consists of 14 random questions and takes five to seven minutes to complete. The extended version, for subject-matter experts, asks them to rate 14 ration ideas, and they also have the opportunity to identify any obstacles they see to making each

of those ideas a reality. This version of the questionnaire takes seven to 10 minutes.

Johnson said the questionnaire will be online through March.

“We tried to streamline it and make it go as quickly as they wanted it to go,” Johnson said of participants. “Some people like to linger and think things over, and they’re free to do that.

“We hope they’ll be interested, and we hope that they take it seriously and they give us good, accurate answers.”

CAC users can access the questionnaire at <https://surveys2.natick.army.mil/Surveys/rations.nsf>. Those without CACs can find it at <https://surveys.natick.army.mil/Surveys/rations.nsf>.

Following data analysis on the completed questionnaires, CRT will deliver actionable requirements and concepts to Combat Feeding. These requirements will form the basis of future science and technology programs, which one day will lead to a FGPOR aligning with requirements projected today.

“This is another opportunity for us to gather information from our military customers on their requirements, in particular their future requirements,” said Kennedy, “so that we can focus our efforts on meeting those needs.”

---

*The Consumer Research Team at the Natick Soldier Research, Development and Engineering Center has posted an online questionnaire that will help the center’s Combat Feeding Directorate determine the direction it will take with future operational rations.*



*Photo: Michael Seppien, Combat Feeding Directorate*

# What's in That MRE?

## New online Combat Rations Database can tell you

By Bob Reinert, USAG-Natick Public Affairs / NATICK, Mass. (March 16, 2015)

**W**hen Soldiers rip open Meals, Ready-to-Eat in a combat zone, most probably are thinking more about flavor and filling their stomachs than about the nutrition.

That doesn't mean nutrition isn't important, however. The new online Combat Rations Database, or ComRaD, formally launched earlier this month by the Department of Defense's Human Performance Resource Center (HPRC), provides warfighters, military dietitians, food service officers and leaders the opportunity to learn more about the nutritional value of what's inside those packages. The interactive website can be found at <http://hprc-online.org/comrad/>.

ComRaD is the result of a collaborative effort between HPRC, the Natick Soldier Research, Development and Engineering Center (NSRDEC), and the U.S. Army Research Institute of Environmental Medicine (USARIEM) at Natick Soldier Systems Center. The database contains nutrition information about the MRE, First Strike Ration, Meal, Cold Weather, and Food Packet, Long Range Patrol.

Before ComRaD, military customers needed to contact experts at NSRDEC's Combat Feeding Directorate (CFD) to obtain accurate nutritional information. The lack of public access to this information has left customers to obtain nutritional information from alternate sources that are sometimes unreliable and inaccurate.

Today's increased emphasis on performance nutrition in the military provided the boost needed to get the website up and running. "Military dietitians expressed a need for publicly available nutrition information that could be used to help educate warfighters on how to properly fuel themselves before a mission, during a mission and post mission,"

said Julie Smith, senior food technologist with the CFD.

In the past, one had to rely on the Nutrition Facts Labels provided on the food component packages to have any idea what was in them. Holly McClung, a research dietitian at USARIEM, said those labels aren't always accurate.

"That's why the website's so important," McClung said. "That's where we want the warfighter and the dietitians to go to, because we know that the nutrition info is accurate and up to date."

How does McClung know this?

"The nutrition information that feeds into the database comes from actual chemical analysis of the food component," McClung said. "That's ... where USARIEM came in. We funded the chemical analysis of food components in the 24-menu MRE and other ration lines, which is difficult, expensive and time consuming.

"This is why it's taken us so long to complete the process. At this website, the user will be able to get nutrition on every individual component, the composition of complete ration lines, and individual MRE menus that are 100-percent chemically analyzed, so we feel confident in the nutritional data."

A quick look at the website would seem to reveal that warfighters are consuming too many calories and that their intake of ingredients such as sodium is too high. The numbers are deceiving, however.

"A civilian might look at what the energy needs are for a warfighter, or look at how much is provided in a ration, and think the rations are providing too many calories and/or fat, etcetera," McClung said. "What they have to realize is that the rations are con-

structed to meet the energy and nutritional needs of physically active warfighters. So, while there may be excessive energy available in the ration for a Soldier sitting at a desk, the ration may just meet the requirements of a physically active Soldier (who is) on (his or her) feet for a 12-hour patrol.

"That's why we hope the warfighter will use the website, as it will help them to figure out how many calories they need and guide them to make good decisions on what they should be choosing to eat," McClung said.

Combat Feeding developed the ComRaD website in collaboration with HPRC, but it's hosted by HPRC.

"Part of their mission is to educate the warfighter," said Smith of HPRC. "Their website provides warfighters and their families with a one-stop clearinghouse for evidence-based information and key resources in all aspects of performance to achieve total fitness and, ultimately, human performance optimization."

The ComRaD website will change over time, Smith said.

"We're already working on ... additional features to the website that will provide ComRaD users with Unitized Group Ration nutrition information, as well as a cart feature that will allow users to track what they have eaten by adding and removing ration components in order to view their overall daily nutritional intake.

"I think that it will be an evolving website (with) future improvements based upon the feedback that we get from users," said Smith, "which is really going to be invaluable."

For more information about ComRaD, email [usarmy.natick.nsrdec.mbx.nati-amsrd-nsc-adb@mail.mil](mailto:usarmy.natick.nsrdec.mbx.nati-amsrd-nsc-adb@mail.mil).

---

A Soldier digs into a First Strike Ration in the mountains of Afghanistan. Nutritional information about the First Strike Ration and other individual rations is now available at the online combat rations database.



Photo: Michael Stepien, Combat Feeding Directorate



The U.S. Army is streamlining efforts to provide squad- and platoon-level ground Soldiers operating in austere environments with an organic aerial resupply capability that will empower and sustain them on the battlefield.

The Enhanced Speed Bag System, or ESBS, fills this capability gap by drastically increasing the survivability rate of critical resupply items such as water, ammunition, rations and medical supplies, which must be air-dropped from helicopters to small units on the ground. The system includes a hands-free linear brake, rope, and a padded cargo bag that can hold up to 200 pounds and be dropped from 100 feet.

ESBS was originally developed by engineers from the Natick Soldier Research, Development and Engineering Center's Aerial Delivery Directorate and the Armament Re-

100-foot crane. They thoroughly inspected the rounds and conducted a live-fire to determine the ammunition system's effectiveness.

The results were a 98-percent survivability rating of ammunition dropped with the ESBS — a vast improvement from the 50-60 percent experienced with ad-hoc methods.

Subsequent evaluation at Army Expeditionary Warfighting Experiment Spiral I 2014, prompted ARDEC to "recommend the immediate fielding of ESBS to deployed Soldiers," Forrester said.

"What we have done is taken resupply to the lowest possible level — the squad and platoon

levels," Tabor said.

"Soldiers at unit level are trained how to get the system packaged, loaded in the aircraft, and delivered," Tabor said. "In this way, ESBS provides an organic resupply capability."

Advancement of the system gained increased momentum through the involvement of the U.S. Army's Rapid Equipping Force, or REF, an organization uniquely chartered to combine requirement validation, acquisition authority and flexible funding under one roof.

REF's mission to "harness current and emerging technologies to provide immediate solutions to the urgent needs and capability gaps faced by Soldiers deployed globally" led it to the ESBS.

"REF received a 10-liner requirement from a unit that needed a safe and reliable way to resupply water and other critical items to ground Soldiers, in a location where transportation

ditional resupply options, such as convoys, were not practical due to environmental factors and threats," said REF project manager Todd Wendt. "The unit was aware of NSRDEC's Enhanced Speed Bag System and identified it as a possible technology solution. Upon mission analysis and further market research, REF identified ESBS as a good candidate solution."

search, Development and Engineering Center's Logistics Research and Engineering Directorate to standardize the improvised airdrop methods used in theater to resupply units in remote locations where traditional resupply methods, such as truck convoys, are too impractical or threat laden.

"The goal was to standardize ad-hoc techniques used with body bags and duffle bags by providing a material solution and giving units enough knowledge and training to utilize it," said Dale Tabor, NSRDEC's Aerial Delivery Design and Fabrication team leader.

"We originally received this need from the field, specifically for emergency ammunition resupply," said Bob Forrester, an engineer with ARDEC's Logistics Research and Engineering Directorate at Picatinny Arsenal, New Jersey. "We received the requirements, found the funding, and teamed with Natick as the technical lead.

"Essentially, we worked the ammunition survivability piece, and NSRDEC worked the aerial delivery piece," Forrester said.

At an evaluation conducted in July 2013 at Fort A.P. Hill, Virginia, teams packed six ESBS cargo bags with 12,720 rounds of ammunition, each distributed based on a squad-level basic load, and dropped from a





Photo: Patrick A. Albrighi, U.S. Army

# *'Speed Bag'*

Aerial resupply for troops on the battlefield

---

By Jeff Sisto, NSRDEC Public Affairs / NATICK, Mass. (March 10, 2015)

---

## ‘Speed Bag’

The ability to directly engage with deployed units and access business practices across the Army’s functional areas allowed the REF to facilitate a comprehensive approach to ESBS validation.

“By leveraging an existing Army effort, REF is able to give deployed Soldiers solutions even faster than if we started a project from scratch. This also means we can help our friends at NSRDEC Aerial Delivery Directorate, by getting their design into the hands of Soldiers and collecting operational feedback. It’s just one example of how REF can address an urgent need, but at the same time, also help advance a technology and support a big Army solution,” Wendt said.

In December 2014, Tabor’s team led a Train-Up event at the Rhode Island Air National Guard base in Quonset Point, Rhode Island. The multi-organizational event included personnel from NSRDEC, ARDEC, U.S. Army Mountain Warfare School, Vermont National Guard, Rhode Island Air National Guard and the REF. The purpose was to train REF tiger teams and members of the Army’s MWS on the proper use and deployment of the ESBS.

The training focused on receiving the ESBS kit, unpacking it, setting up the rigging in the

aircraft and learning the packing procedures — skills that will be passed on to Soldiers who will use the system.

The ESBS training will provide the MWS instructors a period of instruction on small unit resupply that meets the needs of mountain Soldiers, while the REF trainers will take the knowledge they gained directly in theater to train units requesting the capability.

“The initial info seemed complex, but today, I definitely feel sufficient to train Soldiers on this system,” said Dusty Hunt, training consultant, Rapid Equipping Force, Tiger Team, at Fort Benning, Georgia. “With the old methods, they were losing 50 to 60 percent of the supplies. Finally, there is a good solution in the ESBS, which we will take to Afghanistan to train the unit’s trainers.”

“We rehearsed on the ground, and conducted a final check for rigging and spotting,” said Jason Miller, training consultant, REF, Tiger Team, at Fort Bragg, North Carolina. “From the aircraft, we looked at how the bundles fell and responded to the drop.”

In an after-action review, or AAR, the REF trainers had positive and insightful comments about the system.

“We learned that rigging the system is key to a successful drop. So attention to detail in how it’s rigged is important,” Miller said.



Photo: Patrick A. Albrighr, U.S. Army

“Also, more elaborate communication with the pilot and the aircrew should be explored.”

“There were weather limitations, but the job went well,” Miller said. “We lost only one water bottle out of more than 240 and additional five-gallon jugs dropped. It was an outstanding result — we had no issues.”

“The benefit is the simplicity of it,” Hunt said. “You can take a regular Soldier and train them on ESBS, as long as they are comfortable in the aircraft.”

“Aerial resupply also means one less convoy needed on the road, and that’s a good thing,” Tabor said.

The ESBS will undergo further testing throughout 2015. If the system is selected for fielding, a formal program of record, or POR, will be established, and the REF will have met the immediate need.

# Nobody's Foil

## Natick investigates materials for food packaging

By Jane Benson, NSRDEC Public Affairs / NATICK, Mass. (July 28, 2015)

Scientists at the U.S. Army Natick Soldier Research, Development and Engineering Center, or NSRDEC, are investigating high-barrier, non-foil materials, which have the potential to be lighter in weight, less expensive, and more environmentally friendly than foil-based packaging.

The non-foil materials – which are based on nanotechnology – could be used for military ration packaging and for food packaging that supports deep space missions for NASA. The Advanced Materials Engineering Team, or AMET, part of NSRDEC's Combat Feeding Directorate, or CFD, is working on the nanocomposite materials, which are an ideal packaging choice for shelf-stable processed foods.

Nanocomposite films can improve the barrier, mechanical and thermal properties of non-foil food packaging films.

“The incorporation of nanotechnology into barrier films has proven to be a critical ingredient in our packaging design that will allow us to achieve food protection properties only seen before through the use of foil-based systems,” said Dr. Christopher Thellen, a materials engineer in NSRDEC's CFD.

Nanocomposite packaging can be lighter in weight and less expensive than foil pouches and can potentially reduce the amount of

solid waste, enhance the quality of the rations and reduce the warfighter's logistical burden.

The technology is based on the incorporation of nano-clay particles into thermoplastic resins. These materials are 1,000 times smaller than conventional composite material fillers.

The high-barrier, non-foil material will decrease the permeation of oxygen and water molecules through packaging materials, thus better preserving food freshness and better ensuring safety. The packaging will comply with the meal, ready to eat, or MRE, requirement of maintaining a three-year shelf life. The packaging will maintain up to a five-year shelf life for space applications.

Food sterilization techniques, in combination with proper packaging, play an important role in providing this extended shelf-life protection. Retorting is the food industry's most common commercial sterilization process for pre-packaged, low-acid foods.

This process exposes food packages to high moisture and high temperature conditions. In some cases, the long retort process causes severe thermal impact to the food and the package, leading to a reduction in food quality and limiting the types of packaging materials that can be used.

Dr. Jo Ann Ratto, team leader, AMET, NSRDEC CFD, said that the implementation of a non-foil structure into food packaging will provide the ability to consider novel sterilization methods, such as microwave-assisted thermal sterilization, or MATS, and pressure-assisted thermal sterilization, or PATS.

MATS and PATS are desirable alternatives to retort sterilization as these methods reduce the time needed to raise the product temperature to that required for the thermal lethality of target bacteria. A shorter process time can improve food quality and nutrient retention, which is one reason these methods are so attractive for both the U.S. military and NASA.

AMET is exploring polymeric packaging for these novel methods in collaboration with CFD's Food Processing Engineering & Technology Team. The two teams are also studying the effect of the various processing methods on vitamin stability, in an effort to not only preserve freshness and food safety, but also prevent nutrient loss.

“The nanocomposite research and development work has been challenging and rewarding for the Advanced Materials Engineering Team. After further demonstration and validation work, we will know if these materials have acceptable performance to be considered for incorporation into ration packaging for the warfighter,” Ratto said.

Nanocomposite packaging can be lighter in weight and less expensive than foil pouches and can potentially reduce the amount of solid waste, enhance the quality of the rations and reduce the warfighter's logistical burden.





# Test



Photo: Department of Defense

## Evaluating protective eyewear and soft body armor

# Case

By Jane Benson, NSRDEC Public Affairs / NATICK, Mass. (June 9, 2015)

Researchers, at the Natick Soldier Research, Development and Engineering Center, or NSRDEC, have devised new, more operationally-relevant ways to evaluate protective eyewear and soft body armor. These new test methods and apparatus are transitioning to the Aberdeen Test Center, or ATC, and will be incorporated into standardized test operating procedures.

The quick transition to ATC has been enabled by the Science and Technology, or S&T, Objective, or STO, Force Protection Soldier and Small Unit program, formerly TeCD 1b, which focuses on aligning and transitioning science and technology projects to programs of record and various customers.

“STO Force Protection: Soldier and Small Unit comprises 77 projects that are delivering knowledge products, materiel, and test methods — all aimed at understanding and increasing Soldier performance and protection in an operationally relevant environment,” said Jaclyn Fontecchio, STO lead, NSRDEC Warfighter Directorate. “New and relevant test methods are critical to the ability to accurately assess products or systems during their S&T development. As new products emerge through research and development, the use of standard test methods, as is or modified, are not always applicable particularly when dealing with revolutionary or novel products and materials. In many cases, new test methods are required to measure parameters of interest and require an upfront investment. Failure to do so can lead to non-conforming products, shortened product service life, and increased testing costs.”

Natick’s new test methods for protective eyewear and soft-armor protection were needed to evaluate

evolving, state-of-the-art protection and new materials/designs, in situations where previous methods were incapable of testing the new materials/designs accurately.

The new test methods include a soft-armor flexibility test, a soft-armor durability test, an eyewear abrasion test, and an eyewear anti-fog test. The new NSRDEC-developed tests are consistent, accurate, reliable, repeatable, and most important, operationally relevant, to ensure that equipment better meets the needs of Soldiers.

### SOFT ARMOR TESTING

Previous test methods, which existed for evaluating soft armor flexibility and durability were written based on woven fabric constructions. These methods were inapplicable to new, higher-performance materials, which were not made of woven construction.

NSRDEC developed a flexibility test for soft armor, which consists of a spherical bend procedure that characterizes the flexibility of multilayer, soft armor ballistic panels.

“Previous soft-armor tests didn’t really translate to someone wearing it in a real environment,” said Robert DiLalla, ballistic and blast thrust area manager. “There was no means to say, was this too hard or too soft? So, we came up with a study that took soft armor panels that were comprised of materials of varying stiffness and put them on Soldiers and had them do a set series of tasks. We asked them how the overall comfort was and took goniometer and reach measurements. We then developed a method by which we could take a



## Test Case

sample of that soft armor, plunge it through an eight-inch-diameter hole, and we measured how much force it took to plunge it two inches through. We took all that data of all those designs and compared it to the human-factors assessment. And believe it or not, as you got panels that took more force to plunge, you could see that the Soldiers would say it was too stiff or prohibited range of motion. We found the threshold where Soldiers didn't like it. We also found a lower threshold where they started to say that it was too soft."

Thus, the new test methods are a standardized way to evaluate soft armor based on direct Soldier input.

"It is very simple, reliable and repeatable," DiLalla said. "The apparatus provides an accurate way to test current armor and future designs. The reason that this test is better is that we can actually test a system level, multi-layered system unlike the previous method of measuring the fabric stiffness of a single ply. We wanted to come up with a method that was operationally relevant and that reflected what the Soldiers would think, and at the same time not prohibit new materials/constructions from being used."

The second new test method measures wear durability with an apparatus that subjects an armor sample to load conditions that replicate physical movements used frequently by warfighters — including squatting, bending and twisting — in a single mechanical stroke.

"In this case when we say durability, we are trying to predict wear life or say that the system will at least last for some period of time. If Soldiers are in theater and wear this every day for a year — will the protection hold up to wear over 12 months? We don't want a system that will degrade in performance from normal, expected field use. We developed a test method to measure that. We came up with an apparatus that can mechanically work an armor sample in one stroke, and it's repeatable. Previously, there was no test method available to show how long the ballistic protection would last with typical use."

### PROTECTING EYEWEAR TESTING

Previous testing methods for eye protection, including goggles and spectacles, did not adequately test for real-world conditions, including the desert conditions that have been prevalent in many Soldier operations.

"Our eyewear must be scratch resistant, fog resistant, and protect from dust and sand infiltration," said Michelle Markey, NSRDEC science and technology researcher. "This can be accomplished through design and specialty coatings. More ventilation can mean less fog, for example, but it can also mean more dust and sand gets in. It's a challenging balance that continuously needs to be looked at."

Previously, there wasn't a very reliable, effective test method for the laboratory. So, researchers had to rely on user field test data, which is time consuming and expensive. NSRDEC developed a new fog test and apparatus that measures anti-fog performance and provides quantifiable measurements that apply to real scenarios.

"Instead of having to test products in the field or a large chamber, we can now do it at a laboratory scale," Markey said.

Eyewear for Soldiers also needs to work, as part of a system and in conjunction with a helmet, which made private industry test methods inapplicable.

"Wearing eyewear with a helmet can affect air flow," Markey said. "The existing test methods didn't account for design, style, how it is worn, and the various environmental conditions the eyewear is used in. So, Natick came up with a test methodology to look at all these different considerations.

"A heated moisture bath in the head form is used to simulate heat and moisture from the eyes. Mounting on a head form also allows the space factor between the eyewear and the head to be considered, as well as the effect of other equipment, such as helmets. The environment is also a factor. Is it cold? Is it warm? What is the relative humidity and what effect does it have? The test apparatus addresses all of this, and is enclosed in a chamber, basically creating a miniature controlled environment for consistent test conditions."

### SERVICE

This type of testing will improve Soldier safety because Service members will be more likely to keep their protective goggles and spectacles on if they do not have problems with fogging.

NSRDEC also developed a new standard test method for abrasion resistance. The method incorporates the use of rapidly blowing sand to replicate real-world conditions. None of the previous methods could accurately replicate this type of damage. In fact, eyewear that performed well under previous methods sometimes performed poorly when exposed to the blowing sand test mechanism.

"Abrasion resistance is always a key concern with eye protection," Markey said. "It's a challenge because of the nature of the impact-resistant material we use. It is soft and has to be coated to keep it from scratching. The durability of those coatings must be tested, ideally with something similar to what is experienced in the field. In a desert environment, blowing sand can be quite abrasive."

---

**"People tend to focus on just the products, but they don't realize that behind the scenes we are working diligently to develop new methods to better assess the performance of these products."**

Robert DiLalla, NSRDEC

---

### CONCLUSION

"People tend to focus on just the products, but they don't realize that behind the scenes we are working diligently to develop new methods to better assess the performance of these products," DiLalla said. "In many cases, old-test methods can't be applied to the new products. So, we need to be the lead, not only in developing these new products, but in developing operationally relevant methods to assess them.

"TECD Force Protection Soldier and Small Unit has been committed not only to developing new material solutions and knowledge products, but also to the development of improved test methods, which is one part of providing better capabilities to the Soldier. The program is set to wrap up at the end of FY2016 with numerous products transitioning to multiple stakeholders."

*Photo: Dr. Caroline Davis, NSRDEC Cognitive Science Team*


# Training for Your Brain

**Natick scientists investigate ways to help Soldiers recover from stress**

**By Jane Benson, NSRDEC Public Affairs / NATICK, Mass. (Sept. 2, 2015)**

Soldiers can't avoid stress, but researchers at the Natick Soldier Research, Development and Engineering Center, or NSRDEC, are leading a study to investigate ways to help Soldiers increase their cognitive resilience under stress.

NSRDEC is working in collaboration with the Human Research and Engineering Directorate, or HRED, at the U.S. Army Research Laboratory, or ARL, located at Aberdeen Proving Ground.

"A Soldier who is out in the field in a battle-type context is under very high demands – mentally, emotionally and physically," said Dr. Marianna Eddy, a research psychologist on NSRDEC's Cognitive Science Team. "They can be emotionally and physically fatigued. Cognitive resilience is the ability to perform well under those stressors. Perform-

ing well can mean a variety of things, such as making a good decision. For instance, deciding whether to call for reinforcements or making a split-second shoot or not-to-shoot decision."

"We are interested in characterizing individual differences in the way that cognitive processes can break down under stress," said Dr. Caroline Davis, who has a background in emotion, stress and anxiety research and is a research psychologist on NSRDEC's Cognitive Science Team. "During an acute stressor, some people are able to maintain peak performance much better than others. Our goal is to identify metrics that predict such individual differences, and to use this information to develop training strategies that will allow all Soldiers to maintain optimal cognitive performance both during and immediately following extreme stress."

NSRDEC and Tufts University, which jointly created the Center for Applied Brain and Cognitive Sciences, are also conducting a parallel effort examining cognitive resilience in the civilian population.

"The work at the center can be used as a foundation for the work we are doing in collaboration with ARL-HRED," said Eddy.

"The studies we are conducting at the Center for Applied Brain and Cognitive Sciences are being conducted in a lab where we have tight experimental control," said Davis. "Our collaboration with the Cognitive Assessment and Simulation Engineering Laboratory at ARL-HRED allows us to move these laboratory-based studies into a somewhat more realistic, Soldier-relevant environment."

Stress affects a Soldier's memory and decision-making as well as the ability to act and react.

"We want to know what it is that allows some people to overcome these challenges and perform well," said Eddy. "People can tell us about their coping mechanisms, but we are also interested in what is going on in their brains. To do this, we are running an electroencephalography (EEG) study in collaboration with the Translational Neuroscience Branch at ARL-HRED. We outfit the Soldiers with an EEG cap and some other sensors that measure physiological responses to emotional stimuli, such as changes in breathing patterns, sweat responses and facial muscle activity."

"We are also looking at the way that personality traits, such as impulsivity or emotion-regulation style, interact with an individual's biological stress response to promote resilience," said Davis.

Finding ways for Soldiers to become more cognitively resilient may help increase Soldier performance and possibly improve decision-making, effectiveness and survivability.

"We have a unique ability to impact the Soldier," said Davis. "I am excited to be entering this rapidly growing field that has recently started to attract a lot of attention, and I think that we have real potential to improve life for the Soldier."

"It's rewarding to interact with Soldiers and see that they are excited about what we are doing," said Eddy.



# Better Fit

## 3-D shape database improves clothing, equipment

By Jane Benson, NSRDEC Public Affairs / NATICK, Mass. (April 17, 2015)

A new database at the U.S. Army Natick Soldier Research, Development and Engineering Center, or NSRDEC, is a perfect fit for America's Soldiers.

The ANSUR II 3-D Shape Database uses three-dimensional shapes and contour data to improve the fit of clothing and equipment for warfighters. It incorporates the latest Army anthropometric survey data and 3-D whole body scans, providing a searchable platform for the data and the 3-D shapes.

The center completed the latest comprehensive anthropometric survey of Soldiers, called ANSUR II, in 2012. The previous survey was completed in 1988. The 2012 survey set out to address changes in Army personnel body size and shape, and the resulting data showed that Soldiers have increased in overall body girth since 1988. The new study also set out to document the sizing needs of the increasing number of women serving in the military.

The 2012 data collection included 3-D scans of the head, foot and entire body. This innovation provided geometric and morphological data on military personnel that could not be obtained through traditional body measurement techniques.

Dr. Peng Li, a computer scientist on NSRDEC's anthropology team, is working on a novel approach to use all of the 3-D scan information to define common shapes for items, such as body armor and helmets. Scans provide contour information that is essential for proper fit.

"Peng has been working on tools to make the body scans more accessible and more usable," said Steve Paquette, a research anthropologist and team leader for NSRDEC's anthropology team.

"We developed our own shape descriptor and query method for 3-D body scans," Li said. "It will help determine different shapes for body armor and protection and gear for heads and faces."

"The anthropology team's primary mission is to maintain 'the' data base on Soldier body size," Paquette said. "This has been true since Natick opened. Most of the data over the years have been traditional measurements that you take with calipers and tape measures. With the 2012 study, we also took body scans, and it's those 3-D scans that Peng has been working with. He is actually developing tools for searching 3-D shapes.

"Say if you want to search for someone with a narrow head, or a wide head, Peng has been working on a shape searching tool. We not only collect data on Soldiers, we also develop tools to better use the data."

"The ANSUR II 3-D Shape Database is an integrated database that provides access to both traditional measurements and 3-D scans collected in ANSUR II survey," Li said. "It allows a user to search or query body dimensions and shapes, and to download search results in spreadsheet and 3-D surface files."

The goal was to acquire data from males and females to help Army engineers, scientists and designers develop equipment, clothing, shelters, kitchens, airplane cockpits, and vehicle crew stations that best serve the dimensions of the Soldier. The study included 7,435 men and 3,922 women.

Based on their access to data of body measurements and their ability to analyze the data, Paquette's anthropology team, which includes Li, a computer scientist, and Brian Corner, a 3-D morphologist, played a key role in the design of female body armor.

Women's body dimensions are very different from their male counterparts, and they need equipment designed for them specifically. Smaller versions of items developed for males do not fit female Soldiers properly. Team members devised eight new sizes based on the female anatomy data. They provided statistics based on those theoretical sizes.

"We worked with team leader Annette LaFleur and the design, pattern and prototype team, and they started making patterns based on that data," Paquette said. "Then we took those patterns and got prototypes made of those patterns. And then we put armor on actual women and tested it. Sometimes, you need to adjust the sizes or add an additional size."

Peng's work with 3-D shapes will help researchers to better use the shape data to solve problems of sizing and human interface.

"We work closely with human factors and biomechanics," Paquette said. "It's not just what size they are, but how the human interfaces with the environment or work station. Can they reach? Can they see? Anthropometry is just one piece of the whole picture."

3-D shape data has become an integral part of the product design process.

"First, the database allows the designers to more easily check population distribution with multiple range restriction," Li said. "For example, a designer can check how many subjects in the database fit into a box in three or five dimension ranges such as chest circumference, waist circumference and stature. Secondly, the designers can also look at a real 3-D shape of those subjects. Finally, if a user has advanced CAD (computer-aided design) systems, she or he can transfer 3-D whole body data to a CAD system as a model to be fit with a product's prototype design."

The shapes captured by the scanner help with the design of items where close, accurate fit plays an important role in providing optimum protection, as is the case with body armor, helmets and goggles.

"Comfort, performance, safety and fit—that's what it's all about," Paquette said. "If it doesn't fit right, you don't even want to wear it."

# Brain Domain

## Natick, Tufts team up to create new center

By Jane Benson, NSRDEC Public Affairs / NATICK, Mass. (June 29, 2015)

Army researchers have teamed up with the Tufts University School of Engineering to create the Center for Applied Brain and Cognitive Sciences, or Center for ABCs.

The center is co-directed by Dr. Caroline Mahoney, team leader for the U.S. Army Natick Soldier Research, Development and Engineering Center, or NSRDEC, cognitive science team, and Dr. Holly A. Taylor, a professor of psychology in Tufts' School of Arts and Sciences who also has an appointment in mechanical engineering at Tufts.

"The new partnership between Tufts and NSRDEC will allow NSRDEC scientists opportunities to partner with Tufts faculty and students and utilize unique center resources," Mahoney said. "It will also afford the opportunity for Tufts faculty, undergrad and grad students to gain further real-world experience working collaboratively with NSRDEC scientists to solve Soldier problems in specialized NSRDEC facilities, such as the climatic chambers, that are not available to them at the university."

"This partnership will also extend the expertise available for innovative, collaborative projects for Tufts researchers and graduate students by involving the NSRDEC researchers," Taylor said. "Interdisciplinarity is highly valued at Tufts already, and this center fits that emphasis."

By bringing together experts in engineering, neuroscience, psychology, linguistics, computer science and robotics, the collaboration aims to advance researchers' understanding of

how people think, respond and perform in demanding, real-world situations. The center will ultimately provide insight into how Soldiers think in response to ever more complicated and challenging environments.

"Our objective at the cooperative center is to identify innovative, interdisciplinary approaches to monitoring Soldier physiological and mental states, predicting how those mental states influence operational behavior, and optimizing behavior via adaptive, multimodal interfaces and robotic platforms," said Dr. Tad Brunyé, center program manager and member of NSRDEC's cognitive science team. "This objective is accomplished through fundamental and applied interdisciplinary research to inform the design and development of next-generation support and augmentation systems, enhancing future Soldier capabilities and performance during kinetic operations."

The center's research will be divided into four areas.

The first area will examine the principles, which govern interactions between people and intelligent supporting systems.

"These include hand-held and person-borne devices (smart phones, head-mounted displays and tablets) and autonomous robotic platforms aimed at augmenting and optimizing human cognition, effect, and/or physical capabilities in mixed initiative teams," Mahoney said.



The second area involves monitoring, characterizing and optimizing cognitive and non-cognitive states.

"Research efforts will focus on establishing and testing multimodal — physiological, neurophysiological, behavioral, hormonal — measures and metrics for monitoring and characterizing relevant cognitive and non-cognitive states such as frustration, mental workload, stress, readiness for problem-solving, fear, uncertainty and fatigue — cognitive and physical," Mahoney said.

The third area involves studying ambulatory human performance of cognitive and physical tasks. The area will examine warfighters on



Photo: Dr. Todd Brumby, NSRDEC

the move engaged in environments based on real-world conditions and demands.

The fourth area of study will focus on applying cognitive science findings to team-based situations, which require interaction, communication and cohesiveness among team members.

Mahoney is excited about the center's possibilities.

"The Center for Applied Brain and Cognitive Sciences is a tremendous opportunity for NSRDEC human sciences to pioneer a truly innovative environment that brings together

a multidisciplinary group of world-renowned experts in the fields of cognitive science, psychology, neuroscience, computer science, robotics, engineering, linguistics, and nutrition to push the state of the science on measuring, predicting and enhancing cognitive capabilities and human-system interactions for individuals and teams working in naturalistic high-stakes environments," Mahoney said. "The research focus for the center is the dismantled Soldier, but certainly data and knowledge products developed will have the potential to make a significant impact on law enforcement, emergency first responders, and the medical community, as well."

---

*Scientists at the Center for Applied Brain and Cognitive Sciences collect data on the efficacy of administering targeted brain stimulation on memory and navigation performance in novel environments.*

The Tufts School of Engineering is one of the eight schools and colleges that make up Tufts University. The school, located in Medford/Somerville, Massachusetts, offers undergraduate and professional degrees in several fields of engineering and computer science.

# Combat Menu

## Natick serves up new ration book

By Bob Reinert, USAG-Natick Public Affairs / NATICK, Mass. (May 12, 2015)

Let's call it the American military's latest combat menu.

That might be easier to swallow than its official name: "Operational Rations of the Department of Defense." Either way, it boils down to the offerings of the DoD Combat Feeding Directorate at the Natick Soldier Research, Development and Engineering Center.

In its generous serving of 72 pages, the 10th edition of Combat Feeding's ration book dishes out a history of combat rations and their present state. Maybe they are not four-star restaurant quality, but Combat Feeding's 24-menu options include everything from the familiar Meals, Ready-to-Eat, or MREs, to such special purpose rations as religious meals and those used in humanitarian situations.

"We want the warfighter to know what is out there and what's going to be coming their way," said Michael Stepien, Combat Feeding program marketing analyst. "Our team works very hard to provide a wide variety of rations to accommodate the diverse members of the military. This book showcases the amount of dedication our directorate has to constantly upgrading the variety and quality of rations available to the warfighter. We can also use the book for different outreach events to tell the story of the amazing work going on within Combat Feeding."

If, as Napoleon Bonaparte famously observed, an Army marches on its stomach, the ration book is a road map to the destination of satisfying a voracious organization that has been eating military rations since the American Revolutionary War. The book debuted in 1950 and was last published in 2012.

"Moving forward, the goal is to publish it annually as the menus change," said Stepien, pointing out that the 2015 version is currently available online.

The current ration book has compelling imagery and feature stories about Combat Feeding to accompany the usual information about available items. Philip Fujawa of NSRDEC Strategic Communications, who provided art direction for the publication, designed it to be easily digested.

"It ties in the work that goes on and how it applies to the menus," Stepien said. "There's an enormous amount of work that goes on behind the scenes here that most people aren't aware of. Our project officers deserve

---

**"It's important to us now to build upon that flavor of the MRE and incorporate more things into it ... to make the Soldier perform more effectively on the battlefield, whatever we can do to ensure that the Soldier has a decisive advantage."**

**Michael Stepien, Combat Feeding program marketing analyst**

---

a great deal of credit for constantly focusing on innovative methods to improve our rations and increase the quality of life for our warfighters. Featuring highlights of their work helps tell the story of what it takes to build a combat ration."

Combat Feeding strives to give warfighters a taste of home in some of the most inhospitable places on Earth.

"Soldiers work in such harsh and extreme environments, and they require the right nutrition," Stepien said. "We wanted to make sure that this book discusses the nutrition

aspect and we're able to convey through the imagery the challenges that our Soldiers face throughout their deployments and how we, as Combat Feeding, work to supply them with the rations they need to ensure they're able to continue to fight."

Toward that end, each new ration book contains new items craved by warfighters, and omits others that proved unpopular with them. Among notable additions to the Combat Feeding inventory are creamy spinach fettuccine and pasta and tomato sauce.

Eliminated items include spicy penne pasta and ratatouille.

The hope is to offer something for every palate. The best way to accomplish that is to regularly survey warfighters in the field to obtain their preferences.

"The feedback from Soldiers certainly demonstrates that our continuous product improvement program has been effective," Stepien said. "It's very rare that you find a Soldier saying anything really negative about the rations.

"We have been able to identify entrees that warfighters aren't particularly fond of, and we've been able to remove them and replace them with rations that have received high ratings from field tests."

As Stepien pointed out, Combat Feeding's job extends beyond the taste buds to nutritional value.

"The taste of the MREs is very good," Stepien said. "It's important to us now to build upon that flavor of the MRE and incorporate more things into it ... to make the Soldier perform more effectively on the battlefield, whatever we can do to ensure that the Soldier has a decisive advantage."

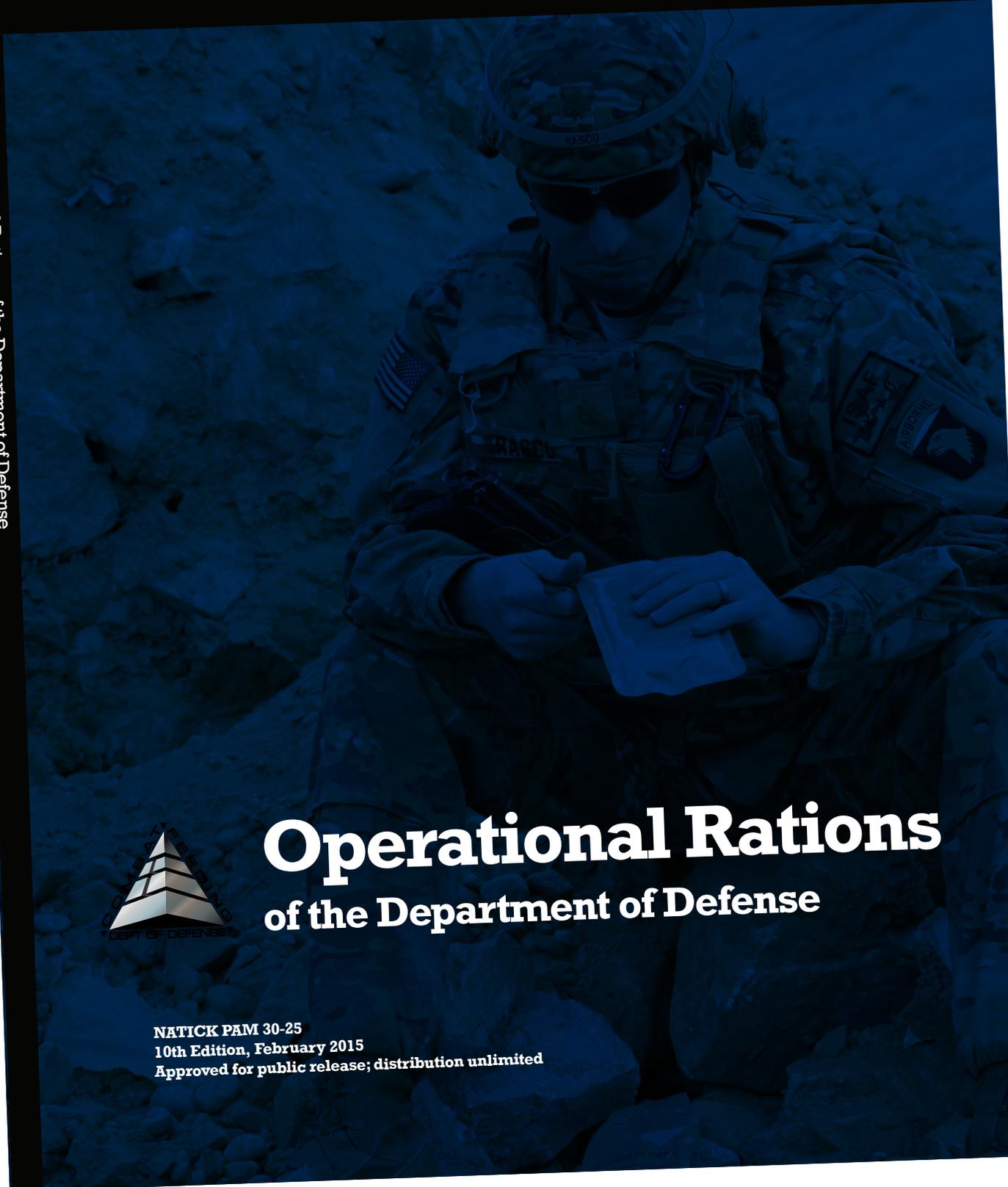
2015



Combat Feeding Directorate



Operational Rations of the Department of Defense



# Operational Rations of the Department of Defense

NATICK PAM 30-25  
10th Edition, February 2015  
Approved for public release; distribution unlimited



Photo: Sgt. Duncan Brennan, U.S. Army

# 'Cool effort'

## NSRDEC helps warfighters with heat injuries

By Bob Reinert, USAG Natick Public Affairs / NATICK, Mass.  
(June 26, 2015)

In hopes of bringing medical treatment to Soldiers on remote battlefields in warm climates, the folks at Natick Soldier Research, Development and Engineering Center, or NSRDEC, recently put forth a “cool effort.”

The Heat Ailment Recovery Pack, or HARP, is being developed by the Joint Foodservice Engineering Team, or JFET, of the Combat Feeding Directorate at NSRDEC. It will help personnel maintain

medical supplies at the proper temperatures and keep potable water cool until medical attention can be administered to Soldiers with heat-related injuries.

“They don’t have this capability at all,” said Ben Williams, a mechanical engineer with JFET. “It’s never been done before. It’s a brand-new concept.”

Medical supplies, such as IV solution bags, will be kept cool on the way to treat heat injuries by the Heat Ailment Recovery Pack, or HARP, developed by the Natick Soldier Research, Development and Engineering Center.



Williams was approached about a year ago by deployed Joint Special Operations Command U.S. Africa Command, or JSOC AFRICOM, personnel about developing something to cool water and medical supplies to treat individuals, who are suffering from heat-induced medical conditions. Together, they approached the Rapid Equipping Force, which approved the funds to produce four of the bags for testing and evaluation.

“I love working directly with people in the field because it makes your job easier,” Williams said. “You’re not trying to develop products in a vacuum, and you’re not making products that people don’t want. It makes your life easy.”

Williams had already helped Soldiers in the field cool water with the Beverage Cooling Unit and maintain water temperature with the Insulated Container for Bottled water. JSOC AFRICOM wanted Williams to combine the two concepts, providing a means to not only maintain the temperature of medical supplies and bottled water, but to cool them on demand, when necessary.

“Being able to provide Soldiers on the ground with medical supplies and water at the proper temperature after an extended, or even an indefinite, period of time in remote locations is a major challenge,” Williams said. “The state-of-the-art technology before the HARP for this application was just your standard portable, plug-in refrigerator. The HARP is a completely new concept, which can either maintain the contents’ temperature or drop it to acceptable levels within minutes, depending on what the user requires.”

Williams and Brian Grady, an equipment specialist with the NSRDEC Aerial Delivery Design and Fabrication Team, got to work making the concept a reality.

“We have to actually make this from scratch,” Grady said. “We’re not production; we’re prototype. But to build four of these? It’s a production process, and we tackle it and get it done.”

“Obviously, it’s not a parachute, but its fabric. We have a lot of these items that we take in, too. Who else will build this?”

The result was a 23-inch-wide, by 26-inch-long, by 20-inch-high pack, which weighs up to 60 pounds when fully loaded with medical supplies and water. Its micro-refrigeration unit is powered by a BB-2590 lithium-ion battery, which can be run continuously for three hours in 120-degree temperatures.

“You can drag an IV bag or medical supplies down to 50 degrees off of one battery from 120 degrees, if you just let it run,” Williams said.

An integrated flexible solar panel can also be used to recharge batteries and extend the HARP’s runtime while acting as a solar shade for the system.

“It needs to be a self-sufficient system, capable of running indefinitely,” said Williams in explaining the solar panel.

The HARP, coated with a newly developed infrared-reflecting material, can cool its contents down from 120 degrees to a usable temperature of 98 degrees in a mere 15 minutes. Using its remote control and monitoring system, the HARP can keep an IV fluid bag constantly usable (below 98.6 degrees) for 100 hours in 120-degree temperatures, all while being monitored and controlled from a distance of up to 100 feet.

“Remote monitoring and control is an absolute necessity, especially when the system is stored on the outside of the vehicle or in a cargo area,” Williams said.

The HARP is also capable of being broken down and configured for man-transportable use within minutes, while still maintaining its cooling capability. Modular Lightweight Load-carrying Equipment, or MOLLE, features with integrated shoulder straps added to its backside allow the bag to be worn like a backpack or attached to and carried on another pack.

“It’s actually a two-bag system,” Grady said. “The challenge was (working with) the fabric ... and how unforgiving the fabric was. There’s no room for error with the fabric.”

Most of the work on the HARP was done at NSRDEC, but four other Army agencies and two outside companies ultimately were involved in the process.

Eight months after the need for the HARP was determined, four were sent to the REF, May 20. Another four systems are scheduled to be fielded to the U.S. Army Medical Materiel Agency for user evaluation aboard MEDEVAC aircraft.

“I think we did a great team effort on this one, because we got everyone involved and leveraged all of the necessary skills to get the job done,” Williams said. “We have the capability here at Natick to take a Soldier’s need and turn it into a reality. It’s a cool effort.”

Natick Soldier Research, Development and Engineering Center scientists are looking to vacuum microwave drying, or VMD, technology to create new, quality items for rations that may also reduce the warfighter's carrying load.

NSRDEC researchers hope to acquire the pilot scale equipment to develop items that meet the stringent requirements of military rations that must be shelf stable for years in extreme climates with no access to refrigeration.

The rapid drying technology would enable the creation of lightweight, nutritious, inexpensive shelf-stable foods, including cheese, fruits, vegetables and meats. Such items could be incorporated into the following rations: Meal, Cold Weather; Food Packet, Long-Range Patrol; and Meal, Ready-to-Eat.

"Some of the conventional drying methods are not efficient," said Dr. Tom Yang, a food technologist in NSRDEC's Combat Feeding Directorate, or CFD. "For example, sun drying takes a long time and is dependent upon Mother Nature. And it is not very sanitary. Another method is mechanical drying, which involves using a hot oven with hot air to remove moisture. But drying foods at a high temperature can affect quality, taste and texture. It is edible, but it can be hard like a rock. Drying foods can also take away nutrients. The food can shrink and the color can become dark. Not very appetizing."

VMD combines vacuum and microwave technology, heating foods uniformly through a quick, gentle process.

"Since you combine vacuum technology with microwaving to remove water, you can do so at a lower temperature," said Yang, who is part of CFD's Food Engineering and Analysis Team. "You maintain nutrients since the rapid drying process doesn't destroy heat-sensitive nutrients. The colors remain appetizing and the texture doesn't become hard and brittle."

In addition to producing higher-quality foods, the process takes less time than conventional air drying or freeze drying. Yang explained that freeze drying, which was pioneered at Natick years ago, is effective and retains good food quality but has some drawbacks.

"VMD takes freeze drying to the next level," said Yang. "It is much less expensive and uses much less energy."



# Dry Run

## New technology could aid ration development

By Jane Benson, NSRDEC Public Affairs / NATICK, Mass. (Aug. 5, 2015)

Foods created by VMD are nutritious and pleasing to the palate. The technology also fits into NSRDEC's mission to lighten the warfighter's carrying load.

"It is low weight. It is very easy to eat on the move," said Yang. "You don't need to store it anywhere."

The Food Engineering and Analysis Team, led by Lauren Oleksyk, hopes to obtain its own VMD machine for its Food Innovation Lab, where it will be used to create new foods for the warfighter and improve existing offerings.

"Our Soldiers deserve the best," said Yang. "Soldiers do so many important missions. They are under a lot of stress. They need to be well fed. Their physical and mental state needs to be in top shape. We are hoping to get a (vacuum/microwave) unit so that we can use it as a tool to try out many ingredi-

ents and recipes that we know Soldiers would like to have."

Yang said he thinks it is important to create some favorite foods for Soldiers far away from home.

"I have an idea for a shelf-stable cheeseburger with a layer of dried cheese, a layer of dried meat, and a layer of dried bread," Yang said. "A regular cheeseburger would be highly perishable, but this one would be shelf stable for three years. This is one of the concepts I want to explore."

"I like to explore new technology and new products. I like to see technologies that work, save money, and produce great rations that get into the hands of Soldiers."

Updates to the Combat Rations Database will make the website even more useful to warfighters seeking nutritional information about what they eat in the field.

The Combat Rations Database unveiled earlier this year is already receiving updates designed to make the website more useful to warfighters, military dietitians, food service officers and leaders.

The database — ComRaD, for short — debuted in March with accurate nutritional information about combat rations. It was the result of a collaborative effort between Department of Defense’s Human Performance Resource Center, the Natick Soldier Research, Development and Engineering Center, or NSRDEC, and the U.S. Army Research Institute of Environmental Medicine at Natick Soldier Systems Center. The database contains information about the Meal, Ready-to-Eat; First Strike Ration; Meal, Cold Weather; and Food Packet, Long Range Patrol.

Later this month, a cart feature will be added to the site that will allow users to track what they have eaten by adding and removing ration components in order to view their overall daily nutritional intake. In September, information on group rations will follow.

ComRaD provides public access to accurate information at a time of increasing emphasis on performance nutrition in the military. Military dietitians want warfighters to better understand how to fuel themselves before, during and after missions.

“It will be interesting to see how the individual warfighter actually uses it,” said Julie Smith, senior food technologist with the Department of Defense Combat Feeding Directorate at NSRDEC. “We haven’t received that feedback yet.”

Early analytics from the website (<http://hprc-online.org/comrad/>) showed that it was receiving heavy use, however. From Jan. 1 to April 30, ComRaD had 10,051 page views. Visitors had spent an average of 2 minutes, 28 seconds on the site.

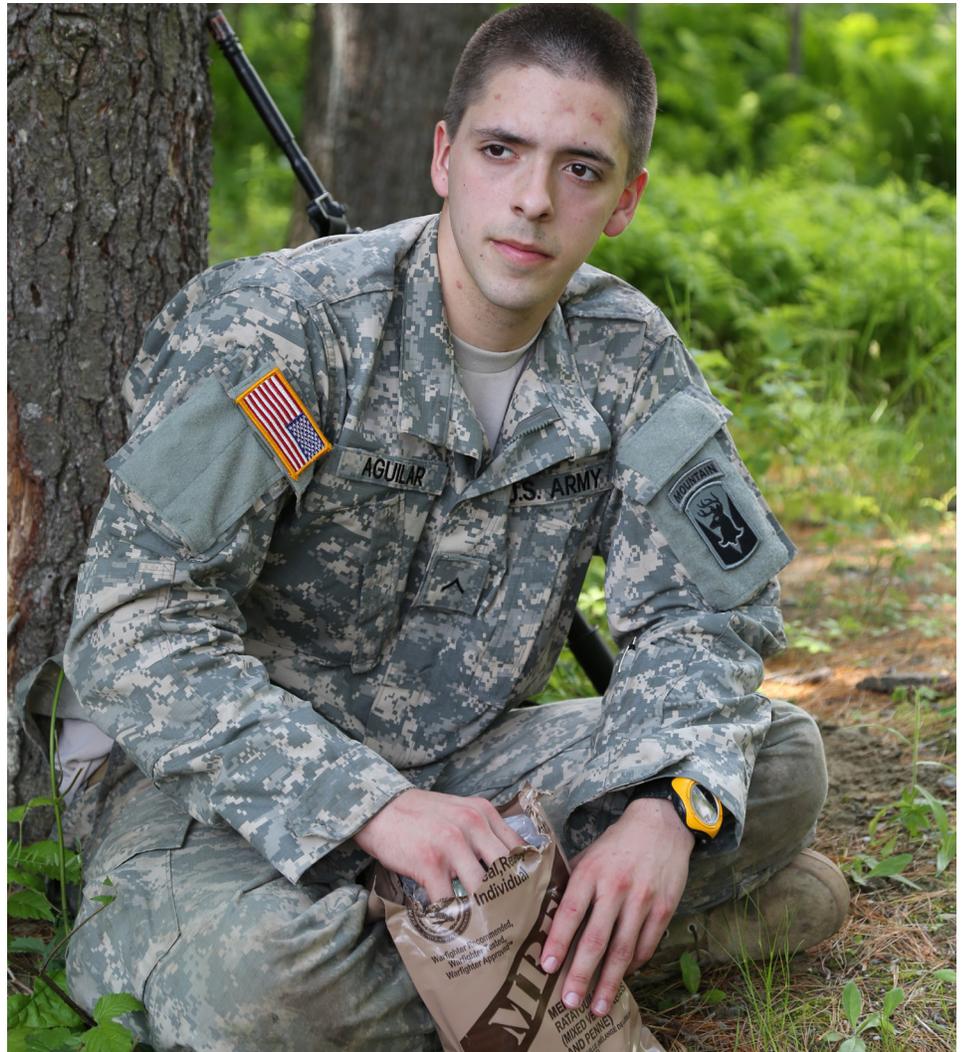


Photo: Michael Sepien, DoD Combat Feeding Directorate

## À la Carte

### Combat Rations Database receives update

By Bob Reinert, USAG Natick Public Affairs / NATICK, Mass. (Aug. 10, 2015)

“For now, I think we’ve delivered what the customer wants,” said Smith, “and I’m excited to be a part of the website development and launch.”

Smith pointed out that adding group rations to the database was a bit more complicated than it was with the individual rations.

“Because we do have to change some of the features,” Smith said. “The way that the (group ration) menus are planned are for added variety. In group rations, there’s a lot of split menus that enable an individual to choose one entrée or choose the other entrée.”

“It’s actually more difficult for warfighters to learn about group rations, because the nutri-

tion facts label is not in front of them when they eat it. They don’t have easy access to nutrition information.”

As ration menus change in the future, items will be added or dropped from ComRaD.

“I think as people use it, I’ll be excited to get feedback,” Smith said. “I think that will really drive if additional work needs to be done.”

“But we know as time goes on, there might be new features that people would want.”

For more information about ComRaD, email [usarmy.natick.nsrdec.mbx.nati-amrsd-nsc-ad-b@mail.mil](mailto:usarmy.natick.nsrdec.mbx.nati-amrsd-nsc-ad-b@mail.mil).

# Planting the Seed

## Combat Feeding tests hydroponic farming

By Bob Reinert, USAG Natick Public Affairs / NATICK, Mass. (Oct. 15, 2015)

**D**on Holman was raised on a farm in Michigan and served 30 years in the Navy, which makes him a perfect fit to help test whether American warships could one day grow their own fresh vegetables.

Inside a re-purposed former refrigerated shipping container tucked behind the Combat Feeding Directorate at Natick Soldier Research, Development and Engineering Center, Holman has been growing lettuce since August in a climate-controlled, 40-by-8-foot “hydroponic farm.” What will be a year-long effort has been undertaken for the Navy, which aims to explore the capability of growing produce at sea utilizing hydroponics technology.

“I want to see what can grow and what can’t grow,” said Holman, an engineering technician with the Joint Foodservice and Engineering Team at CFD and a retired command master chief. “We want to experiment with all varieties of vegetables and see how much produce we can produce.”

“The end goal is to provide the Navy a technical report detailing the test results of the equipment, its possibilities and limitations.”

Currently, ships on long deployments receive fresh fruit and vegetables by helicopter or by tensioned cable between ships with pulley system.

“Much of it comes from locally procured overseas sources,” Holman said.

The hydroponic farm is growing produce from seeds without using soil. Seeds germinate and grow first in peat moss plugs placed in trays and then are transferred into vertical “towers.” Through each step, the seedlings and, later, plants are moistened with nutrient-enriched water that is pH balanced.

“All functions are instrumented and automatically controlled, which simplifies data collection,” Holman said. “The Wi-Fi allows one to monitor the farm from an iPhone at home, to ensure the farm’s operating correctly.”

The current hydroponic farm runs efficiently, consuming approximately 6.8 kilowatt-hours of electricity during daytime operations and 1.2 kWh at night.

---

**“I want to see what can grow and what can’t grow. We want to experiment with all varieties of vegetables and see how much produce we can produce.”**

Dan Holman, Combat Feeding Directorate

---

“You can grow more plants in a vertical arrangement, rather than a horizontal configuration,” Holman said. “It takes up very little floor space when it’s hung vertically. There is more growth in less area.”

The space is illuminated with light-emitting diode lights, and the 24-hour operation simulates daytime and nighttime conditions and accelerates plant growth. The container has Wi-Fi and Bluetooth capability and is equipped with an infrared camera.

“The power requirements are minimal,” Holman said. “We’re still collecting power consumption data, as well.”

Only 10 of the 280 gallons of water circulating through the farm’s vertical towers are consumed daily.

“You can’t do that on a dirt farm,” Holman said. “It’s going to take a lot more water than that. The manufacturers estimate a 90-percent reduction in water consumption.”

As Holman pointed out, there are other advantages over outdoor farming.

“There are no insects,” Holman said. “We do not have the diseases normally associated with a dirt farm. The atmosphere is controlled for temperature and humidity as well as the nutrients and pH levels of the water — an obvious advantage over a dirt farm.”

The first lettuce crop was harvested Oct. 14. After it’s thoroughly tested by a Combat Feeding microbiologist, the produce may be used in the Natick Soldier Systems Center dining facility.

“We continued for several weeks planting lettuce to learn the farm and to make necessary modifications,” Holman said.

Broccoli, Brussels sprouts and bush beans – currently growing in trays – will move to the towers next.

“Now that we’ve learned how to operate the farm, we’re going into full test mode, to determine the farm’s production output,” Holman said.

According to the manufacturer, the farm will produce the equivalent of an acre of land.

“It remains to be seen,” Holman said. “That’s why we’re testing.”

Does an old salt such as Holman believe that hydroponic farming technology will translate well to today’s warships?

“Space is always a premium aboard ship,” said Holman, “but once that issue is resolved, I don’t think the challenges are going to be that great.”

Holman went even further than that.

“If the farm tests well, its potential wouldn’t be limited to just the Navy,” Holman said.

“The Army and Marine Corps would benefit greatly from reduced produce costs, shipping costs, and the logistics of moving produce on the battlefield. I think the applications for all the services are great.”

# By the Numbers

## Hydroponic Farm



90%

*Percentage reduction over water consumption used on an acre of land*

24 Hours a day that it operates



10

*Days it took to get the farm up and running*

12

*Heads of lettuce in each grow tower for first harvest*





# Eating at ‘BK’

## Natick developing new Battlefield Kitchen

By USAG Natick Public Affairs / NATICK, Mass. (Sept. 30, 2015)

Mention “BK” to some people, and a certain fast-food establishment might come to mind. At the Natick Soldier Systems Center, however, those two letters refer to the latest in field feeding technology.

The Battlefield Kitchen, or BK, being developed in a cooperative effort between the Natick Soldier Research, Development and Engineering Center, or NSRDEC, and Product Manager Force Sustainment Systems, or PM FSS, is a self-contained, efficient mobile kitchen that can provide up to three hot meals daily to as many as 300 Soldiers during military operations. The BK can serve a full range of individual and group rations.

“It’s like walking into a restaurant. It’s like walking into a real kitchen as opposed to a piece of military equipment,” said Joe Jordan, team leader, Food Service Equipment Team, PM FSS/Combat Feeding Directorate, NSRDEC, who added that the BK would provide “a better ability to provide good meals to the Soldiers.”

A trailer-mounted system, the BK can be towed by a truck and can be transported by sea, rail or air. It will replace the Mobile

Kitchen Trailer, or MKT, which was introduced in the 1970s and uses inefficient open-flame combustion appliances that also vent burner exhaust into the kitchen. The BK features closed-combustion, thermostatically-controlled appliances that will make roasting, grilling, boiling, frying and baking food a cooler, cleaner and quieter process.

“In hot ambient conditions, it gets very, very hot inside of the current kitchens,” said Tim Benson, program integrator, field services and field feeding, PM FSS. “(The BK is) going to be a healthier environment for the cooks and the customers, not having the burner exhaust going into the kitchen.”

The process also becomes significantly more energy efficient, according to Benson.

“We’re looking for at least a 20-percent improvement in fuel efficiency over the current set of appliances, with an objective of 40 percent,” Benson said. “But the main benefit of the appliances is that they’re closed combustion. The current appliances are open combustion, which means that all the heat and the exhaust and the noise from burners

*The BK features closed-combustion, thermostatically controlled appliances that will make roasting, grilling, boiling, frying and baking food a cooler, cleaner and quieter process.*

goes into the kitchen environment, and less (heat goes) into the food.”

“Using heat from combustion to directly heat the appliances is so much more efficient than using electrically powered appliances,” Jordan said. “A kitchen this size can use a 3kW generator as opposed to a 30kW or 60kW generator required by electric appliances. That allows the kitchens to be truly expeditionary, carrying the generator right onboard the kitchen while still providing a quiet and quality product.”

The BK appliances aren’t only more efficient, they produce better results.

“The appliances are designed with heat exchangers that better distribute the heat so that you get more uniform, better quality cooking, on average,” Benson said. “You’re capturing all that heat that used to escape into the environment, (and) putting it (where) it needs to go.”

The Army expects to acquire about 1,500 of the systems, which also include running water, refrigeration and on-board power generation. Development should take place in fiscal years 2016-18, and production is planned to begin in FY 2019.

Natick researcher Dr. Tom Yang wants to talk turkey.

Yang is a food technologist in the Combat Feeding Directorate at the Natick Soldier Research, Development and Engineering Center, or NSRDEC. He is working on healthier forms of jerky and bacon made from turkey that he believes Soldiers will gobble up.

Yang has been experimenting with osmotic meat technology, which was originally developed in France, to develop the new turkey jerky and turkey bacon products that taste great but are much lower in salt and fat.

The turkey, osmotic version of jerky stays moist and avoids the texture problems of commercial jerky, which can become brittle. It is also higher in protein. The turkey version of bacon allows all Soldiers to enjoy bacon anywhere in the world because it does not contain any pork.

“This is new technology, and it is very energy efficient and is inexpensive,” Yang said. “The technology uses a principle called osmosis. So what we have now is a semi-dried meat. It has much less salt and stays moist.”

During the process, the meat is ground and made into a paste. It is then extruded onto a sheet, sandwiched between two layers of paper and put through a conveyor.

“The conveyor will take the sheet into an osmotic tank, which contains a high concentration of non-sugar solution,” Yang said. “Ninety-two to ninety-five percent of moisture will migrate from the meat into the solution. The whole process takes place at refrigeration temperature so any heat-sensitive nutrients will not be destroyed.”

In addition to turkey, this process can be used on beef, pork, chicken and seafood. The meat’s texture is somewhat moist, resembling the texture of prosciutto.

“The French eat the meat as is,” Yang said. “It’s safe. But Americans are used to a cooked-meat type of texture. So we toast it. We can then, according to the recipe, make a jerky or a bacon. The toasting is for two or three minutes at 350 degrees.”

Yang’s recipes add omega-3s and use lean, turkey breast. He sees applications beyond bacon and jerky.

“You could also use the meat as a wrap by wrapping the meat around vegetables,” Yang



# Talking Turkey

## Natick researcher develops bacon, jerky

By Jane Benson, NSRDEC Public Affairs / NATICK, Mass. (Nov. 23, 2015)

said. “This type of wrap would have a lot of protein as opposed to carbohydrates. And because the meat is lean, it is not greasy at all. It is a very healthy alternative. Soldiers need more protein as opposed to carbohydrates.”

In addition to working on healthier forms of bacon and jerky, Yang is also working to improve hash browns with bacon, a very popular item in the meals, ready-to-eat, or MREs. The new, healthier version has osmotic meat that tastes like bacon. It is pork-free.

“So Soldiers will be able to have the hash brown and bacon that they like without pork,” Yang said. “It is healthier. There is no

grease from bacon, and it is a good source of beef protein.”

It is important to Yang to develop cost-efficient, good-tasting, nutritious food for the warfighter. He plans to continue to find new uses for the osmotic technology and to continue improving his recipes.

“To see Soldiers eat and like something that you have developed and see that it improves their morale and helps them perform their mission better—I think that is the most fulfilling my job as a researcher can get,” Yang said. “My mission is to know they are well-fed and well-nourished.”



## Improving Soldier Capabilities

### Natick researcher collaborates with North Carolina State on textile technologies

By Jane Benson, NSRDEC Public Affairs / NATICK, Mass. (Oct. 15, 2015)

Army researchers are partnering with universities to improve Soldier capabilities and protection.

At the U.S. Army Natick Soldier Research, Development and Engineering Center, or NSRDEC, senior research biologist Kris Senecal collaborates with North Carolina State University, which has resulted in the development of nonwoven, multifunctional materials. Senecal partnered with NC State's Nonwovens Institute, or NWI.

In a separate effort, she is developing novel textile coatings using atomic layer deposition, or ALD, with Dr. Gregory Parsons, director of the NC State Nanotechnology Initiative.

"NC State University is one of the largest textile colleges in the United States," Senecal said. "The fact that Natick has a significant textile focus makes it very important that we continue to interact with NC State."

NWI is a consortium that encourages cooperation among government, private industry and academia. Senecal will be the chair of the consortium's Industrial Advisory Board's Executive Committee in 2016.

"Companies, such as Nike and Kimberly Clark, are involved," she said. "It's really a special consortium that is getting national attention."

Rather than being knitted or woven, nonwoven fabrics are made by connecting fibers with adhesives or by entangling fibers mechanically, chemically or thermally.

"Nonwoven materials include felt, cleaning wipes, filters for cars and air conditioners, or brake pads for your car," Senecal said. "As more demands come up for the warfighter, nonwoven materials could help solve certain needs. The institute is investigating nonwoven topics that we have a lot of interest in, including conductive textiles and antimicrobial textiles."

Through the institute, NC State graduate students are involved in research work on projects selected by the companies involved.

"The students love the chance to do Soldier research," Senecal said. "The students are very well trained, and the work gives them real-world experience. We give them input and provide feedback, and we interact with the main professors, as well. In return, it gives us fresh perspective, and we can leverage the research that is accomplished through the NWI."

As part of her own research, Senecal will be working with nonwoven materials supplied from member companies associated with the Nonwovens Institute on textile capacitors. The goal is to provide lightweight materials for wearable energy storage.

"Soldiers will have extra power capabilities built into the uniform, with no added weight penalty," Senecal said.

Senecal's collaboration with Parsons on ALD textile coatings will increase capabilities on existing fabric systems. In addition to

being the director of the NC State Nanotechnology Initiative, Parsons is an Alcoa professor in the department of Chemical and Biological Engineering.

"This research area applies a deposited conformal coating that is in the nanometer range," Senecal said. "You can tailor fabric properties specifically for differing environments by applying metal oxides and/or organic coatings using this coating technology, yet not increase fabric weight."

Research indicates that coatings could be used to improve Kevlar protection, she said.

"I was looking at putting the coatings on Kevlar, to improve cut- and puncture-resistance, and at the same time not degrade ballistic protection capabilities," Senecal said. "Initial results using ALD coating showed improvement on both cut- and puncture-resistance on Kevlar."

Coating technologies allow for the creation of multifunctional capabilities for the Soldier.

"The multifunctional capabilities include flame resistance, antimicrobial protection, and additional cut protection, as well as other capabilities," Senecal said. "You can tailor the coating technologies depending on what you need. The coating technologies can be added directly to an already existing uniform fabric."

"Working with Kris Senecal has been tremendous," Parsons said. "She is a highly energetic and highly creative researcher dedicated to new technology to promote Soldier safety and well-being. By sharing her passion with our group at NC State, she inspired us to find new solutions to protect Soldiers in the field from physical harm. She has helped teach students in my group the importance of DOD basic and applied research, and her insights push my students to address problems and create solutions well beyond the obvious next steps."

"It is great when something theoretical becomes everyday use," Senecal said. "I love to do the research, but I actually love to see that it has an impact. If it can make the Soldier safer, more comfortable, without adding any weight, that's rewarding."

"Kris is an excellent research partner who is willing to take on and solve the most challenging problems," Parsons said. "Her skills in personal engagement and enthusiasm for her work make her a tremendous asset for our research group and for the Army in general."

# On the Mend

## Natick investigates self-healing protective clothing

By Jane Benson, NSRDEC Public Affairs / NATICK, Mass.  
(Nov. 19, 2015)

Army researcher Quoc Truong wants to fill in the gaps in Soldier protective clothing — literally.

Truong is a physical scientist at the U.S. Army Natick Soldier Research, Development and Engineering Center, or NSRDEC. He is collaborating with other researchers at NSRDEC, the University of Massachusetts Lowell, and Triton Systems, Inc., on the technical development of self-healing coatings that contain micro-capsules of healing fluid, which will be used to mend chemical-biological, or CB, protective clothing.

“When Soldiers are wearing a chem-bio protective garment, they are basically isolating themselves from their environment and any harmful agents, such as nerve gases, viruses and bacteria,” Truong said. “Soldiers are very active and can encounter thorny bushes or other things that could result in pin-hole-sized damage to their chem-bio garment while carrying out their missions. The damage may not be visible to the human eye, but it is there.”

The self-healing technologies will enable cuts, tears and punctures in fabrics to quickly repair themselves. This means that the protective qualities of the garments will be far less apt to become compromised by tears and punctures. The technology will be incorporated into both the Joint Service Lightweight Integrated Suit Technology, or JSLIST, garment, and the Joint Protective Aircrew Ensemble, or JPACE, garment.

“The self-healing coatings can be a spray-on coating or a continuous coating — depending on the type of protective clothing they are applied on,” Truong said. “The idea is just like when a scratch breaks open the skin. Our body has the ability to heal and mend, make a scab and heal. The same idea applies to the self-mending fabric; when the fabric containing these self-healing materials gets cut, it comes back together and heals. It forms

something very much like a scab on the skin except it is on the fabric.”

The technology combines innovative approaches to gap-closure with healing micro-capsules that are activated when torn to repair cuts and punctures. The self-healing layer contains reactive agents to deactivate dangerous threats, including deadly chemicals, and also acts to reform the physical barrier to bacteria and viruses. When integrated into a CB protective garment, the self-healing technologies help ensure that the CB protection is uninterrupted.

The JPACE’s protective mechanism is based on a selectively permeable membrane; therefore, the microcapsules are embedded into the selectively permeable membrane and/or in a supporting reactive selectively permeable membrane layer, which will act as a self-healing supporting barrier material. When the membrane breaks, these microcapsules open and mend the tear in about 60 seconds, filling the gap with the aid of the gap-closure technology.

“This helps preserve the capabilities of the fabric,” Truong said. “The idea is to support chemical-biological protective clothing. The self-healing textile would have the ability to neutralize the chemical agents. The selectively permeable membrane structure acts like a barrier to agents, but allows warm/hot body sweat, i.e., moisture vapor, to be transported from the body to the environment outside of the protective clothing.”

The JSLIST chemical protective overgarment is based on a non-woven material that carries



activated carbon spheres. Thus, it is air permeable and doesn’t lend easily to the use of microcapsules. So, the JSLIST suit configuration has to be sprayed with microcapsules and a foaming agent.

Truong is dedicated to continuously improving safety for the Soldier.

“Ideas to help the Soldier come to me all the time,” Truong said. “It makes me feel good to know that some of these ideas can be transformed into protection for the Soldier.”

The technology also has commercial applications.

“For instance, this technology could be used to develop self-mending tents to ensure protection against the elements since holes would be repaired quickly,” Truong said. “It could also be used for commercial workers who handle chemicals, work in the rain, or work in extreme cold. Their protective clothing would be self-mending to keep them safe, dry and protected from the elements.”



## **Natick Soldier Research, Development & Engineering Center**

General Greene Avenue  
Natick, MA 01760  
[www.natick.army.mil](http://www.natick.army.mil)

