THE WARRIOR

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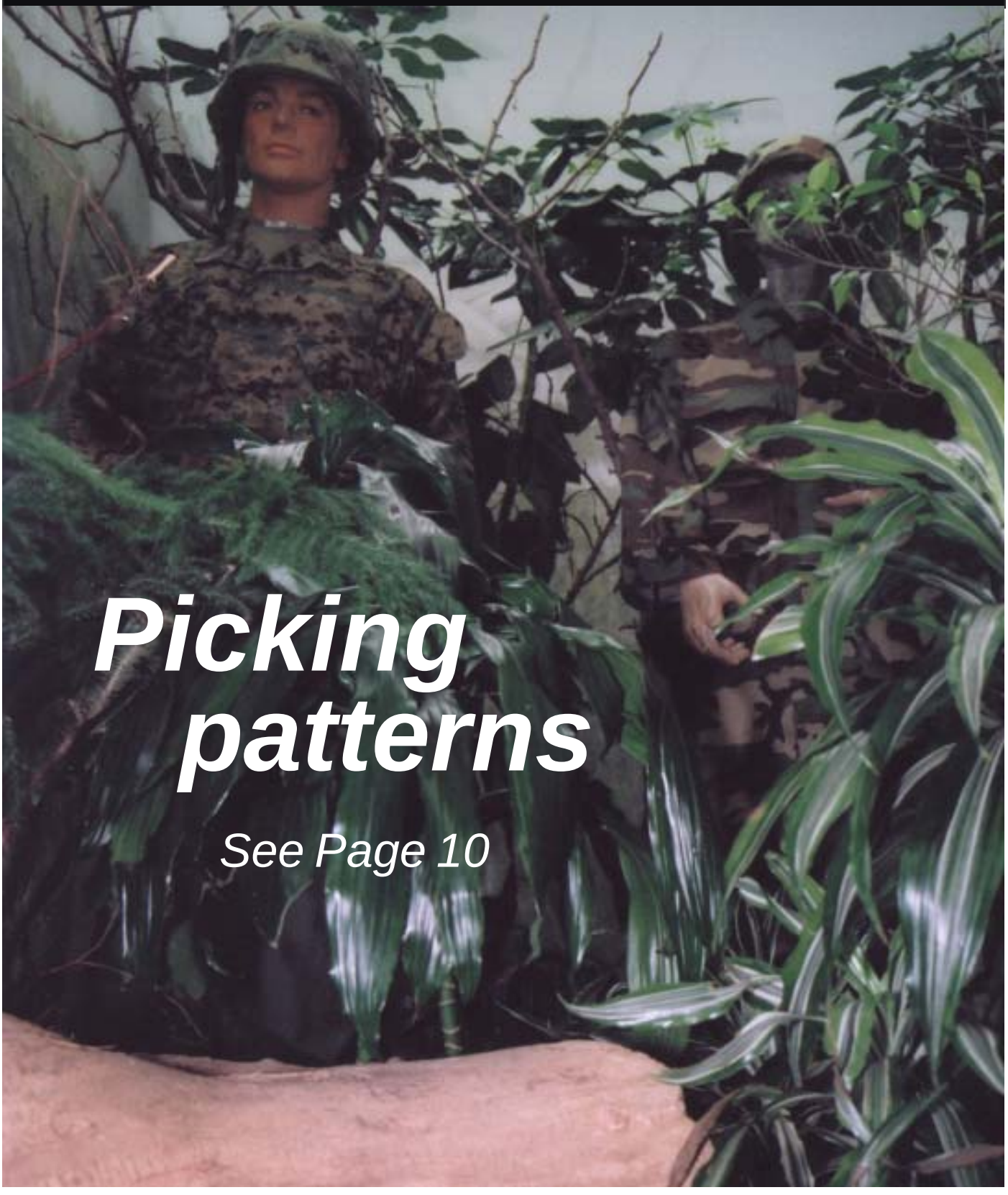

Picking patterns

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Cover photo: Manikins dressed in camouflage uniforms are displayed in the woodland setting in the Camouflage Evaluation Facility. (Warrior/Biberdorf)

THE WARRIOR
U.S. Army Soldier Systems Center

Installation Commander
Col. David J. Bongi

Garrison Manager
John Manning

Chief, Public Affairs
Jeremiah A. Whitaker

Editor
Curt Biberdorf

Staff Photographer
Sarah E. Underhill

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U.S. Army Soldier Systems Center
Public Affairs Office
ATTN: AMSSB-OPA(N)
Bldg. 45, Kansas Street
Natick, MA 01760-5012
(508) 233-4300/5340
DSN 256-4300/5340
AMSSB-OPA@natick.army.mil

U.S. Army Soldier Systems Center
Internet link
http://www.natick.army.mil

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Filtered in

Membrane pouch changes dirty water into purified drink

By Curt Biberdorf
Editor

Contaminated water can go in, but only pure water seeps through the self-hydrating membrane pouch in development at the Department of Defense Combat Feeding Directorate at the U.S. Army Soldier Systems Center in Natick, Mass.

Based on the vinyl commercial X-Pac hydration pouch technology developed by Hydration Technology Inc. (HTI) in Albany, Ore., Combat Feeding is aiming to modify HTI's current membrane to incorporate a forward osmosis membrane into military packaging.

The prototype pouch is designed to take water from any available freshwater source—rivers, lakes, ponds or puddles—to hydrate beverages or dry ration foods to reduce combat weight and logistics of potable water.

"With Future Force Warrior, (researchers) are looking at ways to reduce weight and volume," said Andre Senecal, a senior food technologist and project officer for the membrane pouch. "Food is what troops usually like to sacrifice when paring down their load weight. They're also not carrying enough water."

Based on hydration requirement data, a physically active soldier requires about 10 liters per day in a hot environment, he said. Soldiers now carry about 5 liters.

Drinking water can be purified using reverse osmosis (RO), where it is forced by a powered pump through a semi-permeable membrane to remove contaminants from a solution within 15 minutes. The same membranes are used in the self-hydrating pouch in a process called forward osmosis (FO).

Both filter more than 99.9999 percent of the bacteria that might be found in non-potable water, but FO works by pulling water through the membrane. Although slower, it requires no power and does not foul the filter even with muddy water.

Ingredients in the beverage powder or food that have charged ions, such as salts, sugars and amino acids, energize the osmosis, drawing water in like a sponge. The process takes three or four hours to completely hydrate a 12-ounce beverage, according to Senecal.

"We want something consumable, so we have to balance these ingredients with the osmotic components that actually drive the process," he said. "The toughest piece is to rehydrate beef stew or some other entrée. There's no great osmotic potential. We'll have to work out a design, maybe separating the components or reformulating the ration."

Senecal said interest in a self-hydrating membrane pouch started in the 1980s, but the break came in the 1990s when Combat Feeding met with HTI. Combining their sturdy membrane technology and the packaging expertise of another Combat Feeding industry partner, Pactech in Rochester, N.Y., a prototype membrane pouch was introduced this year.

The prototype has the same multilaminate foil used in the Meal, Ready-to-Eat, a resealable plastic zipper at the water intake side of the inner pouch and an outer membrane pouch holding the food or beverage. Water is filled into the inner pouch and sealed to begin the osmosis. When ready, warfighters tear off the outer pouch end and open the zipper to consume the hydrated contents.

With the look and feel of a waxed textile, the membrane has a robustness not demonstrated during previous attempts to develop the technology, Senecal said. However, durability in rough handling tests must still be done with food ingredients already incorporated into the pouch to simulate military field handling to ensure they don't tear under stress.

Not its own ration, he said the pouches are intended to become a part of existing and future rations. Possibilities include the Meal, Cold Weather/Long Range Patrol ration, survival food packets and the developmental First Strike Ration.

Depending on what rations are used, water weight savings can range from 4-12 pounds. It also can be joined with new generation hydration systems for Future Force Warrior, especially helpful when Soldiers wear a self-contained suit.

Initial evaluation of prototype packages is scheduled for next year, with a larger-scale evaluation set for 2007. Besides food, Senecal said the technology has interested the Air Force for medical intravenous solutions and Navy for sea survival kits to purify salt water.

Warrior/Underhill

A prototype self-hydrating membrane pouch is dipped into a lake.

Warrior/Underhill

Peter Stalker (left), team leader at the Parachute Prototype Facility, is jumpmaster-inspected by Sgt. 1st Class Mark Bleuze, parachute rigger at the facility, while Dean Rogers, Aerial Delivery Engineering Support Team leader, watches. Stalker marked the 51st anniversary of his airborne school graduation with a jump at Fort Benning, Ga., May 25.

Employee reaches airborne milestone

By Curt Biberdorf
Editor

Peter Stalker first jumped out of an airplane as a 19-year-old Soldier in 1953 and today still jumps out of military aircraft as a Department of the Army civilian employee.

The team leader for the Parachute Prototype Facility at the U.S. Army Soldier Systems Center in Natick, Mass., joined eight civilian employees and Soldiers from the Natick Aerial Delivery Life Cycle Team for a static line parachute jump at Fort Benning, Ga., May 25 to commemorate the 51st anniversary of his airborne school graduation.

"It was marvelous. The C-17 (airplane) is as nice as your living room," Stalker said, who's recorded more than 3,000 jumps in his lifetime. "It doesn't seem to bother me physically. I like the impact. I enjoy the bang."

Back in his Army days, make that also a punch.

The Massachusetts native enlisted in 1952 as an infantryman in a heavy weapons platoon and decided to go airborne for the extra pay. At airborne school in Fort Benning, he was selected to become an instructor, but during a parachute entanglement with another student in the jumpmaster course, he broke his foot.

During his recovery, an opportunity opened to join the post boxing team, which led to assisting the boxing team at the U.S. Military Academy at West Point, N.Y. He kept his jump status with a small airborne unit.

Leaving the Army in 1955, he pursued a professional boxing career that he ended after five fights. He also trained to become a private pilot and remained involved with parachuting, this time skydiving with a school he opened in Pepperell, Mass., and barnstorming at local fairs around New England. Their performances were years before the establishment of military jump teams, such as the Golden Knights.

"I needed the money, anything for $100," Stalker said, which supplemented income as a toolmaker to support him and his family. "There was nothing you could read about (skydiving). We learned it after about a year of beating ourselves up. We made more tree landings than field landings."

Once an updraft carried his parachute from about 2,000 feet to 16,000 feet before he was able to break out of it and land at a country club during an armed forces day in New York. On another occasion, he modified his canopy to be able to get extra lift. Instead, he zoomed straight down.

"I was told that it looked like I bounced 10 feet," Stalker said, describing his landing. "My pants split open. The next day I hurt all over, but I didn't break any bones."

Parachuting became more than a side job when Stalker fulfilled a longtime desire for employment at Natick Laboratories, as it was called then, in 1968 when he was hired as a fabric worker at the Parachute Prototype Facility.

The facility fabricates prototype personnel and cargo parachutes, harnesses and accessories, modifies

equipment and provides quick-response production.

He continued to jump out of airplanes as a skydiving instructor after work, but it wasn't until the 1980s that Stalker was able to return to jumping for the military. For the first time, civilians responsible for research and development of parachutes were authorized to attend jump school. After a refresher course, Stalker returned to his paratrooper roots.

"This teaming between military and civilians was the brightest decision. It helps give the engineers and designers credibility with the troops," he said. "(Returning) was like I never missed a day. It was a different aircraft but the same feeling. Regardless, there's always a tension. There's a closeness, a feeling that you overcome that fear. If I ever thought my equipment couldn't do the job, I'd be the last person off the plane."

Compared to the T-7 parachute of 1953, the current T-10 is gentler and more forgiving, according to Stalker. Decades of refinement on the T-10 make it a tough parachute to replace, but with heavier combat loads, a replacement to slow the rate of descent is on the way.

He now works closely with industry as a "contractor's troubleshooter," where he can apply his broad expertise that expands outside shop foremanship, said Edward Doucette, director of Airdrop and Aerial Delivery, who's worked with Stalker for 19 years.

"He's really a testament of how smart he is with production. He has a rare skills set," Doucette said. "He's enjoying himself. He loves jumping. I don't think he'd stay if he couldn't jump."

Stalker jumps at least once a quarter to stay qualified, gaining experience with a variety of static-line parachutes, and has a physical every other year to calm any fears of his fitness.

"You don't grow old if you stay with it. We have a jump schedule, and I look forward to it," Stalker said, who has no immediate plans of retiring. "It's been the thrill of my life working here for the Soldier. I just love 'em. Because of that I can't seem to let go."

Peter Stalker, team leader of the Parachute Prototype Facility, descends to the drop zone at Fort Benning, Ga., (above) and recovers his parachute after landing. (Warrior/Underhill)

Burn to learn

Military thermal, flame testing consolidated in future on-site facility

By Curt Biberdorf
Editor

Construction of a joint-use thermal test facility at the U.S. Army Soldier Systems Center in Natick, Mass., is scheduled to begin January 2005 and open in 2006.

The state-of-the-art 12,500 square-foot facility will house a propane fuel cell and laboratories for evaluating the effect of flame or thermal threats, and assist in the development of improved clothing, materials and equipment to protect individual warfighters.

The 2004 Defense Appropriation Act authorized the installation's Natick Soldier Center $5.4 million to build the facility, which will include a conference room and commons, and enable for the first time testing of complete clothing ensembles in a consolidated location.

"We have always had a need for this type of test facility," said Joel Carlson, a research chemist on the Materials Science Team, who along with Calvin Lee, an aerospace engineer on the Airdrop Technology Team, are overseeing the building project. "Flame and thermal threats are increasing, and it's more cost-effective to have everything in one facility."

Thermal and fire testing is now accomplished with equipment at facilities in North Carolina and Massachusetts, and the new facility will combine some testing equipment already on-site.

The Air Force transferred all fire testing responsibilities to the Soldier Systems Center five years ago, and other organizations will be encouraged to use the new facility, according to Lee.

"I have no doubt we can generate (Cooperative Research and Development Agreements) and testing contracts with fabric clothing companies," Carlson added.

Environmental controls are painstakingly detailed to prevent pollution.

"Environmental concerns are a No. 1 priority," Carlson said. "When testing is done, we want to make sure the air and water are as clean as before we do the testing."

Propane fueled

Filling the largest test space, researchers will evaluate burn injury protection and thermal characteristics of clothing systems, materials and equipment in the propane fire cell. Propane is the industry standard fuel used in flame testing and safe for the environment, Carlson said.

The Navy Clothing and Textile Research Facility, also located at the Soldier Systems Center, will provide a thermal oven to assess convective heat transfer of clothing and a new articulated walking thermal manikin.

The manikin, developed by Physical Sciences Inc. in Andover, Mass., contains 122 skin heat sensors and simulates a person walking near or through a flame. The walking manikin will join an American Society of Testing and Materials stationary manikin, also equipped with 122 skin heat sensors, to test the effect of flash fires on clothing systems.

A propane fire pit 6 feet by 10 feet can test tents and individual equipment. The pit offers extra flexibility for testing future equipment.

"We wanted to put the pit in there to meet future mission requirements," Carlson said.

Simulated sun

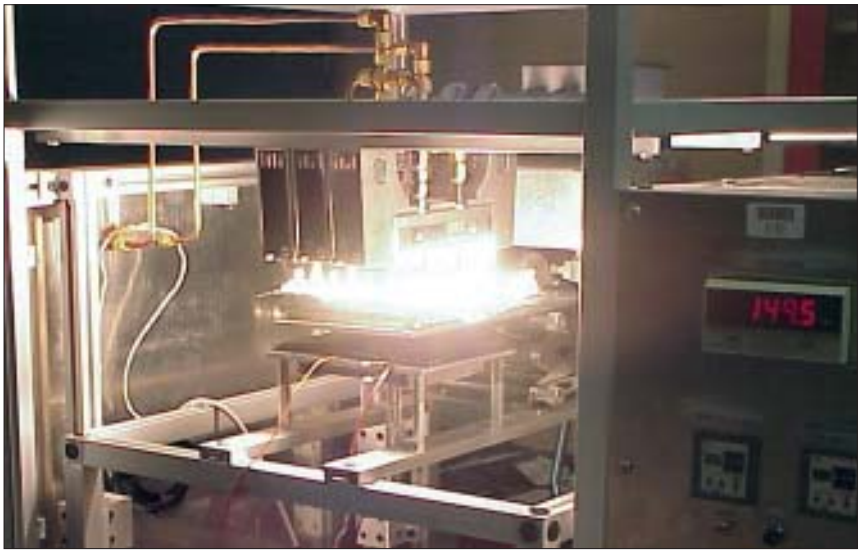
The thermal radiation testing cell will provide the technology to irradiate areas of uniform systems 1 square foot or smaller to study the interaction of uniform layers and components, such as flaps, closures and linings, on the systems' ability to protect against flame and thermal energy.

This capability provides a transition between swatch testing and production of prototype garments. An electric arc provides ultraviolet, visible and near-infrared radiation with a spectral distribution similar to that of the sun.

Broad wavelength range, irradiation exposure times of milliseconds to hours, and flexibility to vary the intensity and area of exposure permits thermal radiation testing equipment also to be used to study and develop material coatings and application techniques.

Lasing heat

Existing and candidate uniform materials will be evaluated for their ability to protect against flame, laser and thermal radiation in the car-



Courtesy photo

The thermal test barrier apparatus performs bench-scale testing on fabric and will join the thermal protection testing laboratory.

bon dioxide laser cell. Energy associated with this type of laser is absorbed by most materials, resulting in rapid heating.

Furthermore, the carbon dioxide laser can be used to study materials processing methodologies.

The ability to concentrate a laser beam into a small area, deliver it precisely to a given spot, and control both the intensity and duration of the beam, provides a method of localizing the heating of a material. A semiconductor, for instance, can be lased to modify its electronic properties without changing the overall mechanical properties.

Under control

Centered around the three test cells is the control room. It will allow direct viewing and operation of the walking manikin, stationary manikin, tent test pit, thermal radiation testing and carbon dioxide laser.

The room will house four cameras for the test laboratories, data acquisition and control systems, waste gas and heat flux measuring devices, propane warning apparatus, propane delivery control, air and fuel mixing equipment, thermal radiation testing control and fire suppression equipment all under computer control.

Lab work

Before any testing in the cells begins, materials and equipment are examined in the five supporting laboratories.

"The lab work helps us do an initial screening with bench-scale testing before conducting full-scale manikin tests," Lee said.

■Getting materials ready for testing is the function of the materials preparation laboratory. It also has space necessary for future mission requirements.

■The flammability testing laboratory will help study burning characteristics and thermal barrier properties of materials and equipment through a collection of bench-scale testing equipment, such as a vertical flame tester and radiant protective performance tester.

■The combustion monitoring laboratory tests, evaluates and analyzes thermal processes and combustion by-products of field kitchen burners, tent heaters, water heaters and other support equipment for safe and efficient performance that meet joint service requirements. Testing equipment will include a vapor combustion furnace, drop tube furnace and porosometer.

■The materials analysis laboratory will chemically analyze waste gases from the combustion of military fabrics and material through a gas-chromatograph mass spectrometer and other pieces of equipment.

■The thermal protection testing laboratory will evaluate flame-retardant fabrics based on their flame and thermal protective performance at a heat flux simulating battlefield flame and thermal hazards.

The performance is measured using skin sensors that can predict temperature changes and burn injuries on the human skin surface resulting from heat penetrating a fabric sample.

The thermal barrier test apparatus performs bench-scale testing using single or multiple layers of fabric samples 5 inches by 7 inches that are exposed to the heat flux of a flash fire for a specific exposure time.

The apparatus employs modern components and concepts such as an electro-mechanical shutter and linear position actuator to improve its operational precision and accuracy.

The portable flammability test apparatus is the most advanced fully automated and compact bench-scale system, Lee said. An unusual feature is that it can burn fabrics at multiple angles.

Heat flux level, burn time and air gap between fabric and skin are computer-controlled, and skin temperature and burn injury prediction are fully displayed immediately after the test.

Lee said these capabilities provide information for efficient scientific research as well as quick procurement approval of military protective fabrics.

Courtesy photos

Thermal manikins are used by the Navy (left) and Army to test the effect of fires on clothing systems. A new articulated walking manikin and a stationary manikin will be housed in the propane fuel cell at the Thermal Test Facility.

Balanced

Nutrition study to guide protein content for future ration

By Curt Biberdorf
Editor

Video games and movies play inside the "Doriot Dorm," a classroom in the Doriot Climatic Chambers facility at the U.S. Army Soldier Systems Center in Natick, Mass., converted into the main living and data collection area for a study that will help determine the protein content for a new individual military ration.

The activities help pass time for human research volunteers participating in the "Exercise and Nitrogen Balance" study, the most intensive on-site nutrition study conducted by the U.S. Army Research Institute of Environmental Medicine's (USARIEM) Military Nutrition Division, according to Lt. Col. Ann Grediagin, a registered dietician and principal investigator of the study.

Research is specifically measuring the effect of fitness level, caloric intake and protein intake on short-term nitrogen balance during a 1,000-calorie increase in daily energy expenditure. The goal is to determine if fitness level affects a person's requirement for protein and to see if extra protein helps promote a more positive protein balance when energy expenditure exceeds energy consumption during a sudden increase in exercise.

It's the type of situation warfighters find themselves in combat, and the reason why the First Strike Ration ("The Warrior" May-June 2003) will benefit from the recommendations once the study is complete.

"The First Strike Ration is not designed to match Soldier energy expenditure, and we know they have a caloric deficit," Grediagin said. "In a deficit, we want to minimize the loss of lean body tissue and also physical, cognitive and immune function. With the right balance of proteins, carbohydrates and fats (in a calorie-limited ration), maybe we can affect the type of tissue lost, fat vs. muscle."

Warrior/Biberdorf

Pvt. Andres Bohorquez plays a video game in the "Doriot Dorm" connected to a machine to measure his caloric expenditure.

Nitrogen gains and losses are tracked because the element is found only in proteins.

It is a building block in amino acids, a string of amino acids making a protein. When protein from food or muscle is broken down, nitrogen is excreted through waste products and sweat.

More nitrogen consumed than excreted causes a positive nitrogen balance or muscle-building state. More nitrogen excreted than consumed brings a negative nitrogen balance or muscle-losing condition.

"Nobody in the civilian population has been able to definitively answer the question of what the impact is of exercise on protein requirements," Grediagin said. "Recommended amounts of protein for a sedentary population may be adequate, but we want to know protein requirements for athletes. Soldiers are athletes."

Started in July 2003 and about halfway finished, the study is composed of three physically fit groups and one sedentary group with seven volunteers in each group.

Sedentary individuals making up Group A are tasked with eating and increasing energy expenditure 1,000 extra calories per day through exercise to see how exercise alone affects protein breakdown.

Fit Group B follows the same conditions as Group A, and was set up to examine how fitness level affects protein breakdown.

Fit Group C receives no extra food, but exercises their normal

Warrior/Biberdorf

Pvt. John Wild waits in the kitchen for an important part of his meal.

amount plus an additional 1,000 calories daily and was designed to learn what happens to protein stores during an exercise-induced energy deficit.

Fit Group D retains the same criteria as Group C, but is the only group to double protein intake to discover if loss of body protein stores can be minimized.

The percent of dietary carbohydrate is consistent for all four groups. This is important because the body's preferred source of energy during exercise is carbohydrate, and if carbohydrate varied, the amount of protein used for energy may be altered, Grediagin said.

For 11 days, research volunteers are strictly monitored as they live in a room packed with exercise equipment, bunk beds to sleep overnight and electronic entertainment. Their diet, customized to them based on preliminary measurements and a three-day survey, consists mostly of liquid protein shakes along with solid foods such as carrots, popcorn and low-protein cookies served on a strict schedule by the Diet Team in an adjacent room.

"I control every detail," Grediagin said. "I've scripted every part of the day. I have to know how many calories are used so I can achieve energy balance or create the 1,000 calorie deficit."

Once their diets are stabilized during the first four days, exercise is increased to burn 1,000 calories for the designated groups for each the remaining seven days. On Days 1, 5 and 9, each time the volunteers start a new activity they are hooked up to a machine that measures exhaled gases to determine calories expended. Precision is so high that it makes a large number of volunteers unnecessary, according to Grediagin.

Warrior/Biberdorf

Diet Team members Holly Lehmann and Christina Falco prepare meals for the human research volunteers in a study session.

Exercise is performed on equipment including a treadmill, stationary bike and an arm ergometer to simulate energy expenditure of weight resistance. Other measurements are taken while bouncing on an exercise ball, playing video games and even sleeping.

Body fat is measured twice during the study. The biological samples team in a separate room collects blood samples two times over four days to assess physiological response to exercise. Research volunteers collect their own waste products for analysis and wear a patch daily to collect sweat to measure lost nitrogen.

Their opportunity to leave the installation is to travel to Tufts University in Boston for tracer studies used to determine the rates of protein breakdown and synthesis.

"(Tracer studies) explain the end result of nitrogen balance. It answers a basic science question," Grediagin said.

Study sessions are scheduled monthly with two to four volunteers until 28 research volunteers in total are tested. If enough research volunteers are recruited, Grediagin said the study could end as soon as this December.

Qualified volunteers still being recruited for study

Participation in USARIEM's Exercise and Nitrogen Balance study is still open to qualified military and civilian candidates.

Volunteers must be non-smoking males 18-35 years old, able to participate in strenuous exercise, and a normal weight that's been stable within 5 pounds for at least two months before the start of the study. They are categorized as sedentary (less than 30 minutes per day of light exercise) or very fit (minimum of 45 minutes of high intensity exercise five days per week).

Disqualifying factors are medications or disease that affects their ability to use nutrients; heart problems, including abnormal EKG and elevated blood pressure; alcohol or drug abuse; and nutritional supplement or caffeine use during or three weeks before starting study.

Volunteers will visit the Soldier Systems Center on four separate occasions for an informational briefing, medical clearance, aerobic fitness test and food activity records before spending 12 consecutive days and nights for the actual study. Candidates must provide the name of their primary care physician and sign a medical records release. Leaving the site except for study-related activities is disallowed.

Upcoming study dates are Sept. 19-Oct. 1, Nov. 7-19, Dec. 5-17, Jan. 23-Feb. 4 and Feb. 27-March 10. Compensation is up to $1,250 for completion of the study.

Those who meet the criteria and are available during one of the study dates can e-mail USARIEM.proteinstudy@na.amedd.army.mil or call 508-233-4353 to be scheduled for a study briefing.

Concealed

Facility quickly sifts out camouflage design duds

By Curt Biberdorf
Editor

Patterns for military camouflage developed in-house or collected from other sources can efficiently be tossed out or retained for further review after scrutiny in the Camouflage Evaluation Facility.

Since its setup in the 1980s, the facility at the U.S. Army Soldier Systems Center in Natick, Mass., has provided a controlled environment to view domestic, foreign and experimental camouflage in simulated daytime and nighttime conditions to provide clothing and equipment to help warfighters operate unseen by the enemy.

"The requirements we have are different from hunting camouflage," said Richard Cowan, a chemist on the Materials System and Integration Team. "Animals are not out there looking through passive night vision devices. We also have to protect people in a wide variety of terrain."

Still, he said researchers look at all designs they receive because they never know if they will work. Unsolicited samples of camouflage designs come from any number of places.

"Camouflage is a funny thing. It's subjective and personal to a lot of people, but it's becoming a much more scientific endeavor because of the advances in electro-optical devices," Cowan said. "One guy was working on his design for six years. I looked him up later and found out he worked at an auto shop in Louisiana. (Designing camouflage) was a hobby."

Regardless of its origin, the facility provides a standardized baseline to check against. At the far end of the airy main room are four zones simulating a desert, urban, woodland and arctic setting, giving the backdrop where camouflage patterns are clipped to board, dressed on a manikin or worn by a person. Walls are painted to match the scene. Live trees and plants, bark, soil and sand are used because they give the correct reflectance level essential in checking night vision, according to Cowan, and these components can be adjusted as desired.

Full fluorescent lighting from the high ceiling helps simulate daylight conditions. Calibrated lighting along the sides produces nine night-sky settings from "moonless overcast" to "twilight maximum."

Camouflage patterns are first measured with a spectrometer for reflectance and then compared with visual screenings from various distances up to 50 feet away under every level of lighting. From a balcony at the facility's entrance, researchers look at the patterns through night vision goggles to determine near-infrared and shortwave infrared camouflage protection.

"Numbers will give you a good idea, but visually we can find out how bad it is by looking at how well it blends into the environment," Cowan said.

Buckles, webbing and commercial items out of catalogs have been recent items of interest. Other prod-

Warrior/Biberdorf

The digital inkjet textile design and printing system avoids the expense of screen production, print pastes and large yardage requirements in creating experimental camouflage fabrics.

ucts evaluated range from face paint, battle dress uniforms, ghillie suits and backpacks to collective protection items such as solar shades and tarps.

Foreign military uniforms, dozens of them already available in storage, and commercial hunting uniforms are typically studied and compared to discover any advantages, according to Cowan.

If a manufacturer has a new material or if there's a question about existing quality, the facility provides the resources to easily inspect it.

Beyond existing designs, the Materials System and Integration Team investigates new camouflage assisted by a digital inkjet textile design and printing system, located in a side room, that avoids the expense of screen production, print pastes and large yardage requirements.

It scans fabrics or photographs into the system, or directly from digitized pattern files or digital photographs; measures samples with a spectrometer; and saves existing colors to the library or creates new colors from the color wheel.

"You can take a photograph of a specific terrain and then design a camouflage to blend in," Cowan said. "It's for a quick visual demonstration. The pattern can be called up on-screen and evaluated on-screen."

Once the desired pattern is electronically created, the inkjet printer rolls out 60-inch-wide pre-treated textile fabrics with reactive or acid dyes.

Standard or experimental fabrics can be printed, and all fabrics are steamed and washed following printing to fix the colors. An average print run is 5 linear yards, much cheaper than in the past when the cost could reach $5,000 just to obtain a minimum yardage rotary screen print trial from a manufacturer, Cowan said.

The inkjet system and facility helped in downselecting designs for the Marine Corps Utility Uniform, and contributed to the design of the new Army Combat Uniform and Future Force Warrior.

"This is where we take the first swipe at it," Cowan said. "We still need to go to the field and area of operation to complete the evaluation, but the facility is a money-saver. If it doesn't work here, chances are it isn't going to work in the field."

(Clockwise from top) Settings for arctic, urban and desert camouflage in the Camouflage Evaluation Facility are used as backgrounds to quickly view and downselect patterns. (Warrior/Biberdorf)