

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)

June 2001

BUDGET ACTIVITY

2 - APPLIED RESEARCH

PE NUMBER AND TITLE

0602786A - Warfighter Technology

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	25698	27901	27061	0	0	0	0	0	0	0
283 AIRDROP ADV TECH	2767	3170	4591	0	0	0	0	0	0	0
C60 AC60	1993	897	1467	0	0	0	0	0	0	0
H98 CLOTHING & EQUIPM TECH	16125	17317	15955	0	0	0	0	0	0	0
H99 JOINT SERVICE COMBAT FEEDING TECHNOLOGY	4813	6517	5048	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification:

PLEASE NOTE: This administration has not addressed FY2003-2007 requirements. All FY 2003-2007 budget estimates included in this book are notional only and subject to change.

This Program Element (PE) improves soldier survivability and performance by researching and investigating technologies for: combat clothing and personal equipment; combat rations and combat feeding equipment; and the air delivery of personnel and cargo. This program element supports the Army Transformation in the areas of improved dismounted soldier capabilities (project H98), logistics footprint reduction (project H99), and rapid deployment (project 283). The Clothing and Equipment Technology project (H98) funds cutting edge research and technologies for clothing, equipment, and high-pressure airbeam supported shelters. Technologies will enhance warfighter survivability from both combat threats (e.g., ballistics, flame, directed energy) and the field environment; enhance signature management and integration; provide alternative self-sufficient power; and significantly lighten the soldier's load. Human science is incorporated into modeling and analysis tools that will enable technologists and military users to trade-off potential warrior system capabilities and develop a human-centered warrior system design. The Joint Services Combat Feeding Technology program (H99) supports all Military Services, the Special Operations Command, and the Defense Logistics Agency with research and development of high impact/high payoff technologies for performance enhancing combat rations, packaging, and combat feeding equipment/systems. Research will enhance nutrient composition and consumption to maximize cognitive and physical performance on the battlefield; minimize physical, chemical and nutritional degradation of combat rations during storage; meet the needs of individual soldiers in highly mobile battlefield situations; and provide equipment and energy technologies to reduce the logistics footprint of field feeding while improving the quality of food service. Similarly, the Airdrop Advanced Technology project (283) supports all Services' requirements for air dropping larger combat and logistics loads while improving delivery accuracy, minimizing vulnerability of aircraft, and reducing life cycle costs. Investigation of technologies for safer, more combat efficient personnel parachutes addresses a critical capability for rapid deployment force projection, particularly into hostile environments. Contractors performing the work for this PE include: Alliant Technology, Inc., MN; General Dynamics, MI; South West Research Institute, TX; Ceradyne, Inc. CA; University of Virginia, VA; University of Rhode Island, RI; H.P. White Laboratory, MD; Irvin Aerospace, Inc., CA; and Vertigo, Inc., CA. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. It adheres to Tri-Service Reliance agreements on clothing, textiles, and operational rations and field food service equipment, with oversight and coordination provided by the Human Systems Reliance Panel, the

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Warrior Systems Technology Base Executive Steering Committee, and the Department of Defense (DoD) Food & Nutrition Research & Engineering Board. The program element contains no duplication with any effort within the Military Departments. Efforts are coordinated with those in PE 0603001A (Warfighter Advanced Technology). Work is performed by the Natick Soldier Center, Natick, MA.

<u>B. Program Change Summary</u>	FY 2000	FY 2001	FY 2002	FY 2003
Previous President's Budget (FY2001 PB)	25831	24659	26429	0
Appropriated Value	25971	28159	0	
Adjustments to Appropriated Value	0	0	0	
a. Congressional General Reductions	0	0	0	
b. SBIR / STTR	-413	0	0	
c. Omnibus or Other Above Threshold Reductions	-63	0	0	
d. Below Threshold Reprogramming	280	0	0	
e. Rescissions	-77	-258	0	
Adjustments to Budget Years Since FY2001 PB	0	0	632	
Current Budget Submit (FY 2002/2003 PB)	25698	27901	27061	0

Change Summary Explanation: Funding - FY 2001: Congressional adds were received for Combat Feeding (+1500), Affordable Guided Airdrop System (+1000), and Blisterguard Socks (+1000).

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- +1500 Combat Feeding - funds core technologies to produce rations that meet regulatory requirements for shelf stable products. - +1000 Affordable Guided Airdrop System - evaluates Guidance, Navigation, and Control and improved pneumatic technologies for airdrop systems. - +1000 Blisterguard Socks - evaluates textile technology for use in socks to reduce blisters and improve comfort.		

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BUDGET ACTIVITY 2 - APPLIED RESEARCH				PE NUMBER AND TITLE 0602786A - Warfighter Technology				PROJECT 283		
COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
283 AIRDROP ADV TECH	2767	3170	4591	0	0	0	0	0	0	0
A. Mission Description and Budget Item Justification: This project researches technologies to enhance personnel and cargo airdrop capabilities. These are key Army Transformation rapid deployment capabilities for force projection, particularly into hostile areas. Areas of emphasis include parachute technology for improved performance, precision offset aerial delivery, soft landing system development, airdrop simulation, and low altitude/high speed airdrop systems technologies. Efforts will result in increased personnel safety, more survivable and more accurate cargo delivery and reduced personnel, aircraft, and cargo vulnerability. This project will enhance the military's capability for global precision delivery and rapid force projection and supports the rapid deployment goal of the Army Transformation. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP). FY 2000 Accomplishments 2159 -Investigated smart airbag technologies for roll-on/roll-off cargo airdrop and transitioned to 0603001A (Project 242). -Researched advancement of soft landing of personnel by a combined parachute and pneumatic muscle system. -Researched a concept for a pneumatic muscle soft landing system for heavy cargo using subscale testing and modeling and simulation. -Investigated advanced, low-cost parafoil designs for improved flight and landing flare performance. 608 -Applied state-of-the-art airdrop system models to reduce (as much as 10%) the life cycle costs by: minimizing feasibility testing; providing predictions of system limitations; shortening development cycle times; and predicting the effects of system modifications. Total 2767										

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<u>FY 2001 Planned Program</u>		
• 1213	- Identify and analyze candidate concepts for a low cost, precision airdrop resupply capability for humanitarian and other one-time-use operations.	
	- Conduct market analysis for state-of-the-art technologies for decreasing rate of descent and automatic activation capabilities for personnel parachutes.	
	- Conduct feasibility experiments with candidate low cost precision airdrop concepts and advanced cargo airdrop mechanisms.	
	- Fabricate and conduct preliminary tests on miniaturized airdrop instrumentation package.	
• 900	- Incorporate additional advanced features into a second-generation three-dimensional high performance airdrop system model and validate with concurrent experimentation as part of a High Performance Computing (HPC) Grand Challenge program.	
	- Simulate airdrop systems of interest to DoD, transition results, and package software into a user-friendly Graphical User Interface (GUI) environment for use as an "airdrop virtual proving ground".	
• 1000	- FY 2001 Congressional add to further research an Affordable Guided Airdrop System (AGAS) to include Guidance, Navigation and Control (GN&C) and improved pneumatic control systems.	
	- Perform an integrated flight test utilizing AGAS technologies.	
• 57	- Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.	
Total 3170		
<u>FY 2002 Planned Program</u>		
• 1092	- Research additional components and technologies in support of the Precision Roll-on/Roll-off Air Delivery STO and transition to 6.3 STO programs.	
• 700	- Design automatic opening capability system prototypes and conduct systems integration/human factors analysis.	
• 799	- Utilize Airdrop System Modeling to simulate brassboards and prototypes in tech base and development programs (such as the Affordable Guided Airdrop System and the Advanced Tactical Parachute System) while validating the results with flight test data.	
• 2000	- Research concepts for, and feasibility of, developing a 20-ton, high altitude (25,000 ft), high offset (30 km) precision airdrop system to provide greater deployability and sustainability for the Objective Force.	
Total 4591		

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ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)								June 2001		
BUDGET ACTIVITY 2 - APPLIED RESEARCH				PE NUMBER AND TITLE 0602786A - Warfighter Technology					PROJECT H98	
COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H98 CLOTHING & EQUIPM TECH	16125	17317	15955	0	0	0	0	0	0	0
A. Mission Description and Budget Item Justification: This project supports the Army Transformation in the area of improved dismounted soldier capabilities by researching and investigating technologies to improve soldier survivability and performance. Areas of emphasis include: research to significantly lighten the soldier's load; lightweight materials for personal survivability (e.g., improved ballistic, flame, and directed energy protection, enhanced signature management); human science, modeling and analysis tools for optimizing soldier system clothing and equipment; three-dimensional textiles for achieving rapidly deployable wide-span airbeam supported shelters. These advanced technologies are being investigated to support the requirements of the Objective Force. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP). FY 2000 Accomplishments 4220 - Validated ability of virtual prototyping tools to analyze form, fit, function, and assist in infantry warrior system design; identified promising techniques to disperse nano-particles in a variety of polymer structures likely to be applied in the warrior system as the first step towards significant weight reduction of the heaviest components. - Investigated five battlefield scenarios to appropriately model the combat effectiveness of warrior systems and components in the Integrated Unit Simulation System (IUSS). 4490 - Researched technology for transition to the PM-Soldier Systems that reduces the system weight of the individual countermining protective system (fielded in FY96) by 30-35%, while providing equal protection; defined requirements for assessment criteria and test methodology to determine ballistic casualty reduction potential of emerging technology; evaluated novel materials/systems demonstrating concepts to increase protection and reduce weight of personnel armor, for both head and torso, against emerging ballistic threats. 2251 - Established quantitative relationships between the volume of a carried load and performance on an obstacle course as well as the forces exerted by these loads on the body; completed and successfully demonstrated the utility of passive dynamic gait models; supported integration of automated measurement and data extraction system for human-system interface analysis and military clothing sizing and issue. - Synthesized new conductive polymers that have shown potential for application in the development of lightweight, flexible and wearable power generating devices for soldier systems.										

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PROJECT

H98

FY 2000 Accomplishments (Continued)

- 2240 - Designed a dismounted soldier system signature evaluation and analysis plan to determine the total system baseline signature (i.e., visual, near-, mid-, and far-infrared, acoustic, electromagnetic); designed low cost breadboard to help mitigate experimental soldier system signature issues; analyzed experimental thermal signature reducing facepaint formulations to provide safe and effective means to manage the thermal signature of exposed skin.

- Increased the level of achievable laser eye protection using polymer-based limiters to support all soldiers, both mounted and infantry, in the Objective Force.

- Established test methodologies for flame resistant textile material systems for soldier protection.

- Investigated advanced helmet technology design concepts and prioritized potential capabilities for integration into a future headborne integrated system for use by decision-makers to complete a complex tradoff analysis required in the next step of integrated headgear maturation/development.
- 2924 - Optimized wide span airbeam textile construction and demonstrated technologies through the fabrication and testing of representative prototypes. Completed the full-size shelter design (80 ft x 132 ft) and validated critical features with sub-scale models.

- Advanced the reliability, affordability and safety of airbeam technology through the incorporation of new continuous manufacturing technologies and processes.

Total 16125

FY 2001 Planned Program

- 5661 - Evaluate technology for virtual prototyping tools to develop warrior system designs, with a focus on integrated load carriage, helmet design, and component/capability placement on the torso and head; demonstrate the feasibility of incorporating nano-scale materials in soldier system components to reduce weight and/or enhance performance.

- Determine required level of human system data points to enable quantitative measures of soldier system performance, validation of small unit combat analysis models, and development of soldier system virtual prototyping and design tools; begin focused effort to collect required human system data to accomplish those tasks.
- 5721 - Extend the IUSS individual/small unit combat model to provide the initial ability to assess the effects of restricted terrain (e.g., rooms, hallways, trenches) on warrior system performance.

- Transition improved test methodology/assessment criteria for personnel armor systems to the acquisition community to enable the trade-off of protection, weight, mobility and affordability; mature novel concepts to increase protection and decrease the weight of personnel armor components.

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PROJECT

H98**FY 2001 Planned Program (Continued)**

- 2305 - Determine effects of varied topographic and terrain conditions on soldier performance through biomechanical evaluations; extend the passive dynamic gait model to encompass terrain data; augment 3-D anthropometric scanning capabilities to include tools for applications supporting human-based modeling/simulation and novel uniform and equipment virtual prototyping and design concepts.
- Investigate and process electronic and photonic materials using electrospinning and electrostatic layer-by-layer deposition techniques into novel, high surface area nano-structures; assess energy density and conversion efficiency potential for future power generating devices for soldier use.
- 2293 - Show a 30-50% cost decrease compared to the cost of existing flame-resistant combat clothing systems while maintaining multiple threat protection levels.
- Modify the breadboard design of millimeter-lens arrays for laser eye protection devices to decrease the length of the optical assembly to make them more compatible with human factors criteria. This technology will support all soldiers, including mounted and infantry, in the Objective Force.

- Demonstrate the ability of an airbeam-supported structure to span a cross section exceeding 60 feet in width to enable the development of a rapidly deployable large weapons platform maintenance shelter.
- 1000 - FY 2001 Congressional add to investigate technology used in Blisterguard Socks to reduce blisters and improve comfort.
- 337 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 17317

FY 2002 Planned Program

- 7363 - Enhance the capabilities of virtual prototyping tools, focusing on the head and torso areas, to advance the state-of-the-art in designing body worn soldier clothing and equipment.
- Produce breadboard prototype panels or system components made with nanomaterials for performance testing to determine the potential for significant system weight reduction and/or enhanced performance.
- Continue focused effort to collect required human system performance data to support soldier system design decisions.
- 6100 - Develop close combat/small arms data and algorithms to assess warrior survivability and lethality at distances less than 25 meters.
- Complete an improved personnel armor casualty assessment model that will permit evaluation of personnel armor systems against conventional and emerging ballistic threats.

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<u>FY 2002 Planned Program (Continued)</u> • 2492 - Provide design guidance for load carrying equipment that enhances mobility performance across squad positions by 15%. - Improve energy density and conversion efficiencies of photovoltaic nanostructures to promising levels for soldier system use through unique materials, modeling, processing and fabrication strategies. Total 15955		

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BUDGET ACTIVITY 2 - APPLIED RESEARCH				PE NUMBER AND TITLE 0602786A - Warfighter Technology					PROJECT H99	
COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H99 JOINT SERVICE COMBAT FEEDING TECHNOLOGY	4813	6517	5048	0	0	0	0	0	0	0
A. Mission Description and Budget Item Justification: The Joint Services Combat Feeding Technology project researches and applies combat feeding and food system technologies to revolutionize the manner in which we sustain and support the Armed Forces, ensuring optimal nutritional intake. This project supports the Army Transformation in the areas of sustainability and reduced logistics footprint. Thrust areas include: applied research of combat rations, packaging, and combat feeding equipment/systems. Near-term goals include: enhancing nutrient composition and consumption to maximize cognitive and physical performance on the battlefield; reducing ration weight/volume and food packaging waste to minimize the logistics footprint; tailoring rations to the combat situation and radically improving mobility; reducing replenishment demand by extending shelf-life, permitting more extensive prepositioning of stocks, while maintaining initial quality; and providing equipment and energy technologies to reduce the logistics footprint of field feeding while improving the quality of food service. The work in this project supports all military Services, the Army's Objective Force, Special Operations Command, and the Defense Logistics Agency. The Army has Executive Agency responsibility for this DoD program. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP). <u>FY 2000 Accomplishments</u> 2139 - Downselected competing reformer/fuel cell and cogeneration approaches. Matured and tested concept for Superheated Liquid Injected Cogeneration (SLIC) that provides electrical power and mix of high and low temperature heat ideal for field kitchens, reduces number of subsystems and moveable parts and increases efficiency and reliability. Transitioned SLIC to Advanced Technology Development. - Researched and tested passive cold storage system for safe handling of perishable subsistence in a field environment. - Designed, fabricated and tested breadboard 4 oz. Pocket Stoves to provide warrior light weight capability to rehydrate dehydrated rations, heat beverages, and provide personal hygiene. - Completed long term experimental testing and maturation of a thermal fluid heat transfer and cogeneration system prototype to improve reliability and maintainability of field kitchens. - Created concepts for a Self-Heated Group Ration (SHGR) to support the Objective Force. SHGR will provide group feeding without the logistics burden associated with field kitchens (90% reductions in manpower, weight, and cost). - Completed front end analysis of food and packaging field waste management methods.										

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PROJECT

H99

FY 2000 Accomplishments (Continued)

- 1408 - Completed prototype development and matured technology for microwave sterilized rations through a commercial contract to improve nutritional/sensory quality.
- Completed studies on enhancers/antioxidants, packaging models, and methodologies/carriers for smart food components for combat optimized ration components to enhance cognitive/physical performance.
- Conducted in-house evaluations on items produced by novel dehydration technologies in combat ration products, demonstrating significant reduction in weight and cube of combat ration components.
- Conducted research and testing of engineering processes for production of carrier matrices for bioengineered protein systems to enhance nutritional value for optimized future combat rations.
- 1266 - Researched the feasibility of accelerating the osmotic dehydration of fruits by sugar solutions and by employing both single and repeat cycles of high pressure to reduce processing cost of these ration components.
- Researched the feasibility of incorporating nano-sized fillers into commercially available packaging materials optimizing barrier properties to extend ration shelf life.
- Identified technologies for the conversion of native cellulose to foodstuffs for revolutionary survival ration; conducted a market survey to assess current conversion/digestion systems.
- Investigated the production of volatile compound(s) that are unique to specific food-borne pathogens and the effects of food composition on chemical volatile distribution to provide the basis for handheld biosensors to quickly determine ration quality and safety in the field.

Total 4813

FY 2001 Planned Program

- 1590 - Integrate and test subsystem prototypes for Liquid-Injection Cogeneration, optimizing waste heat conversion and user safety, and transition to Advanced Technology Development for field kitchens.
- Design packaging prototypes for SHGR including integration of food and heaters, and heat transfer modeling and testing to ensure environmental compliance and optimum performance at lowest cost.
- Complete prototype development of Soldier Pocket Stove technology and transition to Advanced Technology Development to validate/demonstrate revolutionary non-powered combustion technology.
- 2136 - Mature technology and test combat optimized ration components to include engineered carrier matrices for bioengineered proteins, encapsulation technology for smart food ration components, and new delivery systems (i.e., gels) to increase cognitive/physical performance.

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<u>FY 2001 Planned Program (Continued)</u>		
	- Complete field test of products produced with advanced dehydration technologies which reduce ration weight, volume and total logistics costs; transition to fielded individual/group ration improvement programs.	
	- Fabricate prototype ration quality status indicators that can be monitored externally by military logistics personnel to ensure least fresh, first out and design totally integrated Class I supply/requisition/distribution concepts that support DoD/Department of Army logistic initiatives and minimize Class I logistical impacts and theatre stockpiles.	
	- Research and design ration packaging system prototypes that: will respond to the environment to provide a single packaging system for all rations with reduced signature; will prevent lipid oxidation, minimize undesirable odors, and help prolong quality retention of shelf stable ration items; and will use intercomponent films for multi-component ration items to increase product quality and menu variety.	
• 1200	- Evaluate pressure effects on texture mediated by activation/release of native enzymes in fresh vegetables (pectin esterases) or meats (proteases) as a pretreatment to reduce dehydration or thermal processing requirements for ration components, while maintaining initial quality.	
	- Conduct processing trials to determine feasibility of utilizing and/or modifying existing methods and techniques; optimize processing parameters to enhance orientation of nanocomposite fillers, such that gas diffusion will be minimized, extending barrier protection for combat rations.	
	- Explore the feasibility of non-enzymatic hydrolysis techniques, such as acid or alkaline hydrolysis, alone or as a pretreatment to enzyme hydrolysis for potential conversion of biomass to foodstuff that would support soldiers in survival situations.	
	- Conduct tests with mixed culture samples to evaluate the potential and time for detecting and differentiating specific volatile compounds from food pathogens for use in easy-to-use, lightweight, field biosensor.	
• 1493	- Explore innovations in food preservation technologies (thermal and non-thermal); evaluate the feasibility of novel nutrient delivery systems; research foundations for enhancing human performance in stressful situations through nutritional initiatives; exploit material sciences for advanced food packaging systems and pursue food safety detection and intervention methodologies for countering both bioterrorism threats and natural microbial pathogens in military feeding operations.	
• 98	- Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.	
Total 6517		

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<u>FY 2002 Planned Program</u> • 1960 - Evaluate technologies and functional compounds to prevent/minimize ration component degradation and freezing in extreme temperatures. - Conduct validation testing of selected carriers for "smart" food ration components. Transition to Advanced Technology Development. - Identify pathogen specific Volatile Organic Compounds (VOCs) and initiate exploratory development of recognition elements for incorporation into a surface scanning biosensor for ration contamination assessment. - Evaluate sensors and other components of the computer-based externally monitored ration quality system. - Optimize formulations, identify suitable packaging and perform in-house comparison studies of microwave sterilized and radio frequency sterilized ration components. - Investigate ration packaging technologies, including nanocomposites, ultra-high barrier polymers, barrier films and films with chromatic pigments, to extend quality/shelf-life of combat rations and reduce their weight and signature. • 1267 - Complete evaluations of pressure accelerated ration processing and transition to Advanced Technology Development. - Complete investigation of mixed culture samples and develop strategy for implementation of bacterial volatile compounds with field biosensors for ration contamination assessment. - Design and assess methodologies for indexing the satiety value of military rations. - Investigate feasibility of transdermal nutrient delivery systems and identify candidate nutrients based on bioactivity and physical/chemical properties. • 1821 - Complete technical demonstration of Solid-state Thermo Electric Power (STEP) cogenerator prototype. Transition to Development: Mobile Kitchen Trailer (MKT) Improvement Program. - Complete work on heater, activator, and heat transfer mechanisms for SHGR. Transition to Advanced Technology Development. - Design and fabricate thermoacoustic refrigerator prototype and test concepts for safely tempering frozen meats in a field environment. - Design and fabricate experimental filtration and distillation for water conservation and re-utilization program for field kitchens. Test and evaluate non-stick coatings and sanitizing solutions for future waterless sanitation system for field kitchens. Total 5048		

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