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Evaluating Efficiencies in Preventive Medicine

Comparing Approaches Between the Services

by

Michael A. Palmer, Capt, USAF

A Research Report Submitted to the Faculty

In Partial Fulfillment of the Graduation Requirements

Advisor: Dr. Marcia Ledlow

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PREFACE

While working on the project to develop and publish the new Career Field Training and Education Plan (CFETP) for Bioenvironmental Engineering Officers, I began to peruse the Bioenvironmental Engineering Technician. In that document there is a claim that value in the career field is maximized for both the taxpayer and warfighter through a variety of product lines.[?] Remembering back to my first deployment, where I filled a Navy Environmental Health Officer position as an Air Force Bioenvironmental Engineering Officer, I noted the differences that I saw in the roles and responsibilities of myself, the other Air Force personnel I worked alongside, and the Navy personnel around us. It was at that point I truly questioned is there more value and efficiency in how the Air Force conducts its business versus the other branches of the military, or was this just a company line that we just accept as true?

The writing of this paper was a labor of love, but it was a labor none-the-less. It took many long hours that, combined with work and general military requirements, prevented me from giving my home life the full attention that it deserved at times. However, my family understood the importance of what I was trying to accomplish and provided me as much time as I needed to conduct my research. As a result I would like to extend my most sincere thanks to my wife and my daughter, for being so patient and understanding throughout this project. Their love and support provided me with the strength and determination to see this research through. Thank you and I love you.

I would also like to thank Dr. Marcia Ledlow for helping me shape and refine this paper. Without her inputs I would have had a very dry report with information displayed unclearly for the reader. Finally, I would like to thank my classmates for their efforts in providing me feedback on my research while simultaneously endeavoring to complete their own reports.

ABSTRACT

As the Department of Defense struggles against financial constraints and personnel shortfalls coupled with increasing mission requirements efficiency becomes paramount in all aspects of operations. While the preventive medicine mission is successfully completed in the Air Force, Army, and Navy, each branch has selected a different model for fulfilling the responsibilities associated with Occupational and Environmental Health (OEH), Health Risk Management (HRM), and Radiation Safety Officers (RSO). This paper asks the question, “Does the value of the Air Force Bioenvironmental Engineering model create more efficiency for the warfighter and taxpayer than more specialized approaches in the other branches of the military?” The evaluation framework is used to determine if the value of the Bioenvironmental Engineering model creates more efficiency for the warfighter and taxpayer than the more specialized approaches in the other Services.

The purpose of this research was to determine the efficiency of the Air Force, Army, and Navy models of fulfilling the OEH, HRM, and RSO roles and responsibilities. The different career fields were evaluated and compared with regard to training time and cost to fully qualify someone to work in that career field, manning usage to cover the different roles and responsibilities, and manning distribution between United States Active Duty facilities. The results of this research found that the Air Force model was most efficient at covering OEH, HRM, and RSO, but was the most inefficient when it came to training time and cost for qualified members.

INTRODUCTION

"I'm not asking you to do more with less. I think you'll have to do less with less, but not less well, and that's going to take some serious thinking about where to prioritize."

- General Martin Dempsey[2]

General Dempsey's words reflect a real concern with regard to how mission objectives are accomplished, with an emphasis on prioritization and efficiency. With today's fiscal constraints and personnel shortfalls combined with increasing mission requirements, it falls on the shoulders of current and future leaders and policy-makers to ensure Department of Defense (DoD) assets are employed in the most efficient ways possible. The DoD has embraced a broad range of continuous process improvement approaches to enhance process cycle times, resource consumption, quality, and other aspects of productivity.[3] For example, the Air Force has applied these concepts to reduce the repair cycle time for C-5 aircraft by 33 percent with an end goal of reducing the entire cycle over 50 percent.[4] As continuous process improvements are explored, the DoD can better utilize best practices and apply those practices to meet a wide range of operational requirements.[5]

The application of continuous process improvement tools and concepts carries over into all aspects of the DoD, to include preventive medicine units. The Air Force, Army, and Navy have all taken different approaches to how they accomplish the preventive medicine missions, though. The Air Force executes the Occupational and Environmental Health (OEH), Health Risk Management (HRM), and Radiation Safety Officer (RSO) roles through one career field. The Army and Navy, however, have split these roles between several career fields. While each of these approaches has merits, a deeper evaluation of which of these methods creates more efficiency for the warfighter and the taxpayer is warranted. With the continued focus on efficiency in the DoD, does the value of the Air Force Bioenvironmental Engineering model create more efficiency for the warfighter and taxpayer than more specialized approaches in the other branches of the military?

It could be posited that the Air Force Bioenvironmental Engineering model is more efficient to taxpayers and warfighters in comparison to the Army and Navy approaches, because it is able to encompass the responsibilities of OEH, HRM, and RSO into one career field. With the current pressures on the DoD, the use of resources must be evaluated to ensure maximum efficiency. Although Bioenvironmental Engineering arose from the Army Sanitary Corps, to date no other element of the DoD consolidates these focus areas.[6] While it could be argued that the Army and Navy's approaches produce more focused subject-matter experts, it could also be observed that their career fields receive less career-specific training than Bioenvironmental Engineers as well as perform duties that go outside the scope of OEH, HRM, and RSO.

Methodology

This research paper will use the evaluation framework to determine if the value of the Bioenvironmental Engineering model creates more efficiency for the warfighter and taxpayer than the more specialized approaches in the other branches of the military. To begin, common definitions for OEH, HRM, and RSO will be established to form a common background between the three Service branches. After a brief history of Air Force Bioenvironmental Engineering, an analysis of Army and Navy preventive medicine will follow. The evaluation criteria will be defined by how much time and money is invested in training a member to be a part of each career field versus their capabilities with respect to OEH, HRM, and RSO roles; how those roles are distributed between career fields; and availability at locations for these personnel/specialties. An analysis of the Air Force, Army, and Navy approaches will be conducted in reference to the above factors. The results of this study will be a recommendation for all services to adopt the most efficient preventive medicine practices. Through a careful evaluation of the Air Force, Army, and Navy's approaches, this paper will provide a way forward to maximize the efficient use of available resources to fulfill the OEH, HRM, and RSO duties.

BACKGROUND

To begin this analysis it is essential to find the commonalities between the Service branches. To do this, common definitions will be established. Once the similarities are evaluated, then the differences will be looked at through the perspective of the history of Bioenvironmental Engineering and a brief look at how the Army and Navy conduct preventive medicine missions.

Definitions

Common definitions and language to understand OEH, HRM, and RSO must be established. These common definitions will provide a foundation for the comparison of duties and responsibilities between the three Service branches.

The definition of OEH is all activities related to preventing OEH-related illnesses for DoD personnel.[7] These OEH-related illnesses can further be defined as a suspected or confirmed adverse health event, including biological changes indicative of overexposure to a hazard, caused or aggravated by employment as described in Occupational Injury and Illness Reporting Guidelines for Federal Agencies.[8] Therefore, a combined definition for OEH that covers the three branches' understanding is all activities related to preventing suspected or confirmed adverse health effects in DoD personnel, to include biological changes indicative of overexposure to a hazard, caused or aggravated by one's job.

Next, to understand HRM one must first understand risk management in general. The Army and Navy both define risk management as a "process for assisting organizations and individuals in making informed risk decisions in order to reduce or offset risk, thereby increasing effectiveness and the probability of mission success."[9, 10] The Air Force, however, defines it as "a decision-making process to systematically evaluate possible courses of action, identify risks and benefits, and determine the best course of action (COA) for any given situation."[11] Despite these slight differences in definition, all three branches follow the same five step process: identify hazards, assess hazards, develop controls and make decisions, implement controls, and supervise and evaluate.[12, 13, 14] The other shared tenets include decisions being made at the appropriate level and accepting no unnecessary risks.[15,16,17] The combined definition of HRM based off of these definitions is a decision-making process for assisting the appropriate level of leadership in making informed health risk decisions through identifying and assessing health hazards, developing controls and making decisions, implementing those controls, and supervising those sections while evaluating the results.

A RSO is defined as the person that the commander designates, in writing, as the person responsible for the installation, organization or unit radiation safety program.[18, 19, 20] Typically this is with regard to ionizing radiation, but will be expanded for purposes of this report to include non-ionizing radiation sources such as infrared radiation, ultraviolet radiation, lasers, and electromagnetic frequency radiation. By including all forms of radiation exposure on the various installations in the RSO responsibility coverage, there is the potential to show that there is a crossover of responsibilities between career fields.

These three criteria form the backbone of preventive medicine efforts. Preventive medicine itself went through several changes as time marched on.

Brief History of Air Force Bioenvironmental Engineering

Early traces of preventive medicine can be found in the recorded efforts toward military medicine that supported the Roman legions through the functions of advising leaders, educating unit members on hazards and prevention, ensuring compliance, investigating non-compliance, and intervening to protect the unit from unsafe conditions.[21] While there was historical evidence of a prevention mindset, it was forgotten in the annals of time. The importance of preventive medicine was highlighted further during the Civil War, where there were 1.6 disease, non-battle injuries (DNBI) to every 1 combat casualty.[22] This rate remained steady until the stage was set for the birth of Bioenvironmental Engineering.

On 30 June 1917, the Army Surgeon General created the Army Sanitary Corp to address the issue of non-combat diseases and injuries by leveraging the skills of Sanitary Engineers, Industrial Hygienists, Clinical Laboratory Officers, Entomologists, and Aviation Physiologists.[23] Following World War II, Environmental Sanitary Engineers were instrumental in the efforts rebuilding Germany's infrastructure and establishing installations overseas.[24] Furthermore, maintenance on aircraft was conducted more at operational Air Force Bases, as opposed to the previous practice of maintenance primarily being done at depots.[25] This coupled with upgrades in weapons system technology drove more hazardous operations, to include noise, radiation, and chemical usage.[26] As a result, commands incorporated Industrial Hygienists into their manning documents.[27] Before the Korean War, the Air Force Environmental Sanitary Engineers and Industrial Hygienists were merged into one career field, renamed Bioenvironmental Engineering in 1964.[28]

From the 1960s until 1983, Bioenvironmental Engineering officers at every installation worked alongside Environmental Health Nurses and Preventive Medicine Technicians in a preventive medicine function called Environmental Medicine.[29] Environmental Medicine fulfilled multiple roles by tracking communicable diseases, training members on disease prevention, as well as monitoring industrial workplaces, environmental sanitation, and disease vectors.[30] Meanwhile, the Air Force had Veterinary Services that treated military working dogs and inspected food processing plants, purchases, and preparation areas to prevent potential illnesses sources.[31] When the Air Force Veterinary Corp was discontinued in 1983, its preventive medicine functions were absorbed into Environmental Health Services and Bioenvironmental Engineering, separating the two career fields from one another and doing away with Environmental Medicine.[32] Environmental Health Services, later called Public Health in 1992, took on the food safety programs and communicable disease prevention, while Bioenvironmental Engineering shifted more to industrial hygiene, environmental quality, and radiological health.[33] This set the stage for both career fields to be more involved in Nuclear, Biological, and Chemical agent detection and defense, expanding preventive medicine beyond non-combat casualties to preventing combat casualties as well.[34]

Brief Analysis of Army and Navy Preventive Medicine Specialties

Despite facing similar challenges in industrial hazards and preventing DNBI, the Army and Navy have developed different approaches to preventive medicine. This is in part is due to their organizational structures.

In the Army specialized preventive medicine personnel are integrated into the various divisions, armored cavalry regiments, and higher-level medical functions throughout the force.[35] Even though individual and unit-level preventive medicine measures are a command responsibility it first falls to the individual soldier to perform basic measures such as maintaining physical and mental fitness, and protecting themselves against various physical injuries.[36] The medical personnel and unit field sanitation team assists these efforts.[37] The scope of the responsibilities for these assets depends on their assignment to the unit-, division-, or above division-level.[38] At their core, though, they advise commanders on measure to reduce DNBI while ensuring appropriate field sanitation facilities and effective controls are established and maintained.[39]

Although the Marines are not explicitly being evaluated in this research, the Navy's preventive medicine services provide support to both Navy units and Marines.[40] Similar to the Army having preventive medicine personnel assigned at different levels working organically with the various organizational echelons, the Navy provides support in three different ways: direct support from Navy medical personnel assigned to Navy ships, squadrons, or units; direct support from Navy medical personnel assigned to Marine units; and support to Navy and Marine units from hospital, clinical, and preventive medicine units.[41] Also similar to the Army, the Navy service's goal is to lower DNBI rates through advising leaders and sanitary assessments concerning the prevention of foodborne and waterborne illnesses, heat injuries, communicable diseases, and occupational injuries and illnesses.[42]

EVALUATION RESEARCH FRAMEWORK

The research conducted to complete this paper outlines the differences between Air Force, Army, and Navy approaches to fulfilling the OEH, HRM, and RSO missions.

Criteria for Efficiency

Efficiency in terms of the warfighter and taxpayer has several measurable criteria. These criteria are how much time and money is expended to initially qualify a member in each career field; how many career fields it takes to fulfill the OEH, HRM, and RSO duties in each branch; and whether these personnel available at every installation. The cost element is the greatest concern for the taxpayer, as they are providing the revenue to make everything possible. The amount and availability of the career fields is paramount to the warfighter because while these functions and capabilities may exist, it could provide mission stoppage or frustration if they cannot be accessed immediately or if it takes questioning too many wrong sources to achieve the true answer.

Training Time/Cost. This will be a combination of the number of calendar days spent in training for the specific career fields, the pay for the Active Duty member at expected ranks during these trainings, and the lodging and per diem costs to simulate the cost to house and feed trainees. The following equation will be used to calculate the results for each career field:

$$C = [(T_d/31) * P_{rank}] + \Sigma_n [(T_d * L) + (T_d * P_{diem})]$$

C: Cost in dollars

T: Time allocated for training in days

P_{rank}: Pay for the expected rank in dollars per month

L: Lodging cost for the training location in dollars per day

P_{diem}: Per diem (meals and incidentals) for the training location in dollars

Σ_n: Add together the results of all necessary temporary duties

An assumption that will be made for calculation purposes involves the time aspect. For training durations that are not listed in months, the assumption will be that a month is 31 days long.

Manning Usage. This criterion will be evaluated in terms of the differing career fields fulfilling OEH, HRM, and RSO roles. While it has been stated that Air Force Bioenvironmental Engineering is the only career field that encompasses all of these roles simultaneously, it is important to determine how many career fields in the other branches are being utilized for the same purposes to examine efficient use of personnel. Additionally, an analysis of duties could show overlap in duties and, thus, inefficiency of personnel use.

Manning Availability. This will be a yes or no concerning the career fields existing at the different active duty, enduring installations across the United States to fulfill the duties in question. This represents if the specialties that cover the OEH, HRM, and RSO duties are readily available to commanders and personnel at the various bases or if there is a wait time to these services being covered. For example, the wait could be a result of there being a regional specialist that covers several locations simultaneously with a large work queue.

ANALYSIS OF THE AIR FORCE APPROACH

The Air Force approach to fulfilling the roles of OEH, HRM, and RSO is accomplished through the Bioenvironmental Engineering career field. The career field can be further broken down into Bioenvironmental Engineers, the officer force, and Bioenvironmental Engineering Technicians, the enlisted force. The function of both factions may vary, with the officers taking more of a management role and the enlisted members conducting more of the field work, but at their core they provide five capabilities:[43]

- Provide health surveillance
- Plan, prepare for, and provide real-time Chemical, Biological, Radiological, and Nuclear response
- Ensure safe potable/non-potable water
- Reduce vulnerabilities
- Reduce health risks

Bioenvironmental Engineering Officers/Technicians

As with most military careers, Bioenvironmental Engineering officers have a minimum education requirement to even qualify being placed in the career field. Potential Bioenvironmental Engineers are required to have at least a Bachelor of Science in an Engineering field from a college accredited by the Accreditation Board for Engineering and Technology (ABET).[44] Through this, a member would be commissioned as an Air Force Second Lieutenant in Bioenvironmental Engineering. A member could join at a higher rank, First Lieutenant to potentially Captain, through obtaining a Master's degree, previous work experience that is related to Bioenvironmental Engineering, prior service in a different branch of the military while performing similar duties, prior service as an enlisted Bioenvironmental Engineering technician, or any combination of these reasons.

Once commissioned, the new officer will go to Commissioned Officer Training (COT) at Maxwell Air Force Base in Montgomery, Alabama.[45] The training is a five-week program that educates Air Force judge advocates, chaplains, health professions officers, and medical scholarship recipients through physical conditioning, leadership training, and classroom studies.[46] Upon completion, the new officer is at the entry skill level with an Air Force Specialty Code (AFSC) of 43E1A.[47]

This is just the beginning of the new officer's training, though. The member proceeds to their first duty station to gain experience before attending technical school. Additionally, this period before technical training provides time for the student to complete prerequisites that set them up for success in the course. When ready, the officer attends the Bioenvironmental Engineering Officer (BEO) course at the United States Air Force School of Aerospace Medicine (USAFSAM) at Wright-Patterson Air Force Base, Ohio.[48] This course lasts approximately 3 calendar months and emphasizes the protection of personnel through operational health risk assessment, communication, management, and casualty prevention from a wide array of hazards in varying environments.[49] After successful graduation from the BEO course, the officer is awarded an intermediate skill level with an AFSC 43E2A.[50]

Although still in development, officers in this career field will soon have to participate in upgrade training to be considered "qualified." The upgrade training will be a two part process made up of upgrade training back at home station and attending a 4 week long Bioenvironmental Engineering Officer Advanced Course, again at USAFSAM.[51] After 6 to 18 months from completion of the BEO course the member should have the upgrade requirements completed, resulting in the member being considered at the qualified skill level and a AFSC 43E3A.[52]

A fully qualified Bioenvironmental Engineering officer has a wide array of expertise and responsibilities. Bioenvironmental Engineers apply engineering and scientific principles to anticipate, recognize, and evaluate OEH hazards.[53] The OEH hazards include chemical, biological, radiological, nuclear, and physical hazards which may compromise Force Health Protection.[54] In coordination with these hazard evaluations, as a subject matter expert the officer serves as the RSO.[55] Once these threats are evaluated the officer also has a hand in recommending and, at times, designing control measures that enable command and staff agencies to make effective HRM decisions.[56] Moreover, the officer has the overall responsibility of directing and supervising technicians conducting base Bioenvironmental Engineering activities.[57]

These technicians have their own prerequisites and education to accomplish. Bioenvironmental Engineering technicians entering the career field must have a GED with 15 college credits or a high school diploma with completion of Algebra I, chemistry, biology, and English composition.[58] On top of the educational requirements, physical requirements include the ability to wear a 40-pound self-contained breathing apparatus with an additional 40 pounds of equipment in a totally encapsulating chemical protective suit without signs of claustrophobia.[59] This is to ensure that any potential technicians will be able to face the rigors of an emergency response while still maintaining their composure throughout the event.

After signing to join the Air Force, extensive training follows for the enlisted member. First, they must complete 7.5 weeks of Basic Military Training followed by Airmen’s Week at Joint Base San Antonio – Lackland, Texas.[60] Following basic training, the enlisted members destined to become Bioenvironmental Engineering technicians attend a 68 work day long technical training at USAFSAM.[61] Upon completion of this training, the enlisted member is awarded the AFSC of 4B031, apprentice level, and is sent to their first base level assignment.[62]

Next the member is put into upgrade training, a period of 12 to 24 months where a combination of six volumes of a Career Development Course and on the job training (OJT) is conducted to ensure the new technician is trained and certified on core tasks of the career field as defined in the CFETP.[63] Additionally, after 48 months of Total Active Federal Military Service or selection to the rank of Staff Sergeant, the member will attend Airmen Leadership School.[64] This sets the technician up to receive their journeyman level, AFSC 4B051.[65]

The end goal is a fully qualified member at the craftsman level, AFSC 4B071. To achieve this another period of 12 to 24 months of OJT with other core tasks for certification as defined by the CFETP.[66] The final step to achieve the AFSC 4B071 after the home station upgrade training is completed is the technician successfully completes the Occupational Health Measurements course at USAFSAM.[67] As a fully qualified technician a member is expected to perform and manage OEH-related activities in garrison and deployed, perform health risk assessments, and communicate health risks to provide commanders appropriate information when decision-making.[68]

Manning Availability

The Air Force recruiting website was used to determine that there are 64 installations located in the United States.[69] Bioenvironmental Engineering Officers and Technicians are present at 95 percent of these Air Force bases.

ANALYSIS OF THE ARMY APPROACH

While the Air Force approach to covering the OEH, HRM, and RSO responsibilities is taken by the Bioenvironmental Engineering officers and technicians, the Army has taken a division of labor approach. These roles in the Army are covered by the following career fields: Environmental Science Officers, Nuclear Medical Science Officers, Health Physicists, Preventive Medicine Officers, and Preventive Medicine Technicians.

Environmental Science Officer

In the Army, Environmental Science Officers supervise research with regard to environmental health and industrial hygiene to prevent illness and injury for military personnel.[70] They take part in identifying and evaluating potential health hazards in weapons, equipment, clothing, and material systems and recommending controls for those hazards.[71] Moreover, they develop environmental health and industrial hygiene criteria and standards as well as uphold measures to prevent DNBI.[72]

To qualify for this career field, an officer candidate must have completed a Bachelor's degree in environmental science, industrial hygiene, environmental health, epidemiology, toxicology, or safety management from a school acceptable to the Surgeon General.[73] After their college education, a qualified member in this career field completes an Officer Basic Leadership Course, 4 weeks of Direct Commissioned Officer Training at Fort Benning, Georgia followed by 6 to 15 weeks of branch-specific functional training at Fort Sam Houston, Texas.[74, 75]

Nuclear Medical Science Officer

Nuclear Medical Science Officers also play a role in Army preventive medicine capabilities. They are responsible for chemical, biological, radiological, and nuclear defense operations, nuclear elimination missions, and radiation safety programs.[76] Nuclear Medical Science Officers identify, evaluate, and recommend controls against radiation hazards.[77] Not only do they serve as a subject matter expert on emergency response teams, they also advise on radiation related fields to the general public as well as OEH.[78]

Members of this specialty require a Master's degree in health physics, reactor physics, nuclear physics, nuclear engineering, radiobiology, radiochemistry, applied nuclear or atomic physics, laser or microwave physics, or medical physics.[79] The program must be accredited and deemed acceptable by the Surgeon General.[80] Otherwise, the member has to attend the Officer Basic Leadership Course and complete annual Force Health Protection training requirements.[81]

Health Physicist

Related to Nuclear Medical Science Officers, Health Physicists are also Army specialists when it comes to radiation. Health physics is a profession devoted to protecting people and the surrounding environment from radiation, while ensuring radiation can be used to meet our society's ends.[82] Army Health Physicists provide a broad range of services in support of the Army's use of radiation in its operations. They assess the radiation doses and health risks for soldiers and the general public.[83] Health Physicists evaluate the radiation protection programs at installations and with specific organizations like medical facilities or research laboratories.[84] These evaluations can lead this professional to be included in historical site assessments and surveys to decommission Army facilities.[85] Furthermore, Health Physicists advise commanders during radiation and radioactive material incidents and act as responders during these incidents.[86] Finally, the Health Physicist's expertise is vital in developing guidance documents and doctrine concerning the use of radiation.[87]

At a minimum Health Physicists require a Bachelor's degree in health physics, physics, environmental science, or a related science field.[88] The new officer will also need to complete the Officer Basic Leadership Course.[89]

Preventive Medicine Officers/Preventive Medicine Specialists

Army Preventive Medicine is composed of two parts: Preventive Medicine Officers and Preventive Medicine Specialists. These two career fields represent the officer and enlisted sides respectively.

Preventive Medicine Officers have oversight on planning, coordinating, and directing programs to maintain health, improve physical fitness, and prevent DNBI.[90] They conduct and supervise direct patient care while planning and executing disease prevention and health promotion programs.[91] In their planning, Preventive Medicine Officers conduct research on diseases of concern while training other medical personnel to help maintain the availability of a well-rounded medical system.[92] Finally, they perform special staff functions in support of commanders and exercise command of medical units as provided by law and regulation.[93]

Individuals hoping to enter this career field require a doctor of medicine or osteopathy degree from an accredited United States school of medicine or osteopathy.[94] Moreover, the individual needs a current license to practice medicine in the United States, District of Columbia, or Puerto Rico; board certification eligibility; and completion of at least one year in an approved graduate medical education internship as well as a training program in preventive medicine.[95] It is also acceptable for physicians just starting out to receive aid from the Army in completion of first-year graduate medical education, residency, and fellowship programs.[96] The potential Preventive Medicine Officer will also have to complete Officer Basic Leadership Course and a 2 week preventive medicine specialization course at Fort Sam Houston, Texas.[97, 98]

Enlisted technicians of the same field have slightly different responsibilities that contribute to the preventive medicine mission. Preventive Medicine Specialists conduct preventive medicine inspections, surveys, and control recommendations for various hazards.[99] Additionally, they assist with preventive medicine laboratory procedures.[100] These actions all contribute to ensuring OEH on the installation and in particular workplaces as well as ensuring proper information is present as commanders make decisions.

Preventive Medicine Specialists require an Armed Services Vocational Aptitude Battery (ASVAB) score of 101 to qualify for this career field.[101] Next, the new recruit must complete 10 weeks of Basic Combat Training at one of five locations: Fort Jackson, South Carolina; Fort Knox, Kentucky; Fort Leonard Wood, Missouri; Fort Sill, Oklahoma; or Fort Benning, Georgia.[102] This is then followed by 15 weeks of Advanced Individual Training at Joint Base San Antonio, Texas.[103]

Manning Availability

The Army recruiting website was used to determine that there are 79 installations located in the United States.[104] Environmental Science Officers are present at 46 percent of the facilities, Nuclear Medical Science Officers are present at 23 percent, and Health Physicists are present at 19 percent.[105, 106] At the time of this report, representatives from the Army could not be reached for comment on Army Preventive Medicine Officers and Technicians.

ANALYSIS OF THE NAVY APPROACH

Like the Army, the Navy has also divided the OEH, HRM, and RSO roles between several career fields. In this case, the Navy has Environmental Health Officers, Industrial Hygienists, Preventive Medicine Technicians, Radiation Health Officers, and Radiation Health Technicians.

Environmental Health Officers

Environmental Health Officers focus on food service sanitation and safety, drinking water surveillance, disease investigations and prevention, and combating biological agent threats.[107] In addition, they support a variety of other programs like public health sanitation, controlling thermal stress hazards, sanitation of water used for recreational use, wastewater sanitation, stopping diseases by evaluating potential vectors, and preventive medicine.[108] With this broad range of expertise, Environmental Health Officers aid and advise commanders in assessing threats and providing risk communication.[109]

A member wanting to pursue this career field would need a Bachelor's or Master's degree in environmental health from a National Environmental Health Science and Accreditation Council accredited program or a Master's degree in Public Health with a concentration in environmental health from a Council on Education for Public Health accredited college.[110] Preferentially it may be required to have either a Registered Environmental Health Specialist or Registered Sanitarian certification through the National Environmental Health Association, or a state level equivalent.[111] After completing their education, personnel attend a five-week Officer Development School in Newport, Rhode Island to prepare them as officers in the Navy.[112]

Industrial Hygienists

Industrial hygienists serve as Naval station subject matter experts with regard to hazardous material assessment and disposal, biohazards, safety, respiratory protection, hazard controls, and ergonomics.[113] Moreover, they are responsible for the detection, assessment, and monitoring of threats in wartime and natural disaster contingencies.[114] Industrial hygienists' responsibilities take them to the various industrial and operational settings in the Navy to conduct inspections and training for personnel.[115] In turn, this makes them prime advisors for OEH issues and reducing DNBI.[116]

Navy Industrial Hygienists must have either a Bachelor's or Master's degree in industrial hygiene, public health, environmental sciences, chemistry, industrial engineering, or industrial safety.[117] It is preferred that the Master's degree in industrial hygiene be from an Accreditation Board for Engineering and Technology accredited program.[118] Industrial hygienists also need to complete Officer Development School.[119]

Preventive Medicine Technicians

Preventive Medicine Technicians are unique in how they become qualified. They begin their careers as Hospital Corpsmen where they assist with direct patient care.[120] They complete 7 to 9 weeks of Recruit Training at Great Lakes, Illinois. Following "Boot Camp" the member then goes to school for 19 weeks at Fort Sam Houston, Texas.[121] Upon completion of course work with corresponding examinations and holding at least the grade of E-3, the member can be upgraded to a Preventive Medicine Technician.[122, 123]

As a Preventive Medicine Technician the member will assist Medical Department officers in executing preventive medicine and OEH programs.[124] This will lead the technician into inspections of food service facilities and storage areas, berthing spaces, childcare facilities, recreational facilities, potable water and wastewater disposal systems, solid waste systems, vehicles, and transport containers.[125] Food and water inspections include testing for bacteria in food, water, and ice samples.[126] In addition, to prevent DNBI the technician conducts epidemiological investigations, interviews and counsels patients with communicable diseases, conducts monitoring to control vector-borne diseases, and administers mass immunization programs.[127]

Radiation Health Officers/Technicians

Radiation Health Officers plan, direct, and administer radiation protection programs to include providing training in radiation programs and recommending control measures.[128] In this role they serve as liaisons between the Navy and other agencies, federal and state.[129] Outside of their preventive medicine scope Radiation Health Officers assist physicians in diagnosis and treatment.[130]

Radiation Health Officers must have a Bachelor's degree in chemistry, engineering, physics, applied physics, or mathematics.[131] Members may also have degrees in biological sciences, but they must also have course work in modern physics and vector analysis mathematics.[132] Similar to the other officers in this section, Radiation Health Officers must complete Officer Development School.[133]

Radiation Health Technicians represent the enlisted side of this career field. They begin their careers as Hospital Corpsmen with training and upgrade requirements similar to Preventive Medicine Technicians.[134, 135] Once completed, Radiation Health Technicians perform radiation monitoring to include dosimetry, various radiation surveys, analysis of radiation samples, and inspections of areas where radioactive materials are in use.[136] Their expertise is also leveraged in emergency situations where the technicians direct decontamination efforts of personnel and equipment.[137]

Manning Availability

The Navy recruiting website was used to determine that there are 121 installations located in the United States.[138] At the time of this report, representatives from the Navy could not be reached for comment on the disposition of any of the Navy preventive medicine assets.

ANALYSIS OF RESEARCH

With all of the data collected, the different service approaches can be weighed against the previously defined criteria of training time and cost, manning usage, and manning availability.

Training Time/Cost

Taking the data collected on each career field, the cost of training a member to "full qualification" can be calculated. This will include any lag times between trainings, such as Bioenvironmental Engineering officers reporting to base level before attending technical school. Calculations can be found in the Appendix of this report.

Table 1 – Career Field Training Costs

	Qualified Member Cost (Time)	Qualified Member Cost ($)
AIR FORCE		
Bioenvironmental Engineering Officer	34.2 months	$159,163.44
Bioenvironmental Engineering Technician	72 months	$176,819.60
ARMY		
Environmental Science Officer	4.3 months	$36,021.32
Nuclear Medical Science Officer	4.3 months	$36,021.32
Health Physicist	4.3 months	$36,021.32
Preventive Medicine Officer	4.8 months	$40,083.52
Preventive Medicine Technician	5.7 months	$40,151.33
NAVY		
Environmental Health Officer	1.2 months	$12,351.88
Industrial Hygienist	1.2 months	$12,351.88
Preventive Medicine Technician	60 months	$142,759.00
Radiation Health Officer	1.2 months	$12,351.88
Radiation Health Technician	60 months	$142,759.00

Considering these career fields could all be trained simultaneously, the Army comes out on top in both training time and dollar cost when producing fully qualified members.

Manning Usage

Based off of the definitions established for OEH, HRM, and RSO and the descriptions of the differing career fields, a parallel can be drawn to see which career fields cover the various responsibilities examined in this report. The following table sums up how the career fields assessed in this report cover OEH, HRM, and RSO duties. Any space marked with an "X" covers the responsibility. Any space marked with a "/" partially covers the responsibility either, usually limited due to subject matter expertise. Any space left blank is not covered by the career field.

Table 2 – Career Field Responsibilities

	OEH	HRM	RSO
AIR FORCE			
Bioenvironmental Engineering Officer/Technician	X	X	X
ARMY			
Environmental Science Officer	X	X	/
Nuclear Medical Science Officer	/	/	X
Health Physicist	/	/	X
Preventive Medicine Officer/Technician	X	X	/
NAVY			
Environmental Health Officer	X	X	
Industrial Hygienist	X	X	/
Preventive Medicine Technician	X	X	/
Radiation Health Officer/Technician	/	/	X

Each branch is able to cover the OEH, HRM, and RSO responsibilities, but only the Air Force fulfills these roles with Bioenvironmental Engineering. It is also noteworthy that the career fields in the other branches have overlapping responsibilities or areas of expertise, which could create redundancies. This has a two-fold effect. First, inexperienced commanders may not know the exact specialties of each career field resulting in confusion of which agency does what during times of stress. This could be magnified in joint environments, where one branch may not know the capabilities and responsibilities of the other branches' preventive medicine assets. Second, during times of stress new personnel may not fully be aware of their own responsibilities and, with the overlaps, may mistakenly think that someone else is fulfilling a role.

Manning Availability

While not wholly conclusive due to the data gaps, it is interesting enough to note that the subject matter experts for the Army are not present at every installation. Even with the overlaps in responsibilities between career fields, this could potentially yield knowledge gaps for leaders as they make decisions. In other words, commanders might not have all of the necessary information to make decisions that contribute to mission success while factoring in personnel health and safety.

RECOMMENDED COURSE OF ACTION

The question now becomes what should be done with this information. In terms of training time and cost, the Army model is more efficient by having the shortest training times and monetary costs to fulfill the OEH, HRM, and RSO missions. Meanwhile, the Air Force is more efficient with Bioenvironmental Engineering Officers and Technicians covering all of the OEH, HRM, and RSO duties and the other branches requiring four different career fields to cover the same duties and subject areas. Recommendations from this point on will reflect the tenets of continuous process improvement to apply world-class, best-of-breed practices to meet the wide range of operational requirements that preventive medicine unit's shoulder.[139]

As the DoD requires more joint operations in the future, it would be in the best interest for the Service branches to reach an agreement upon what division of labor is required to fulfill the OEH, HRM, and RSO responsibilities. For example, there could be an OEH unit and a RSO unit at each facility, with each of them contributing to HRM recommendations to commanders with regard to their subject matter expertise. This would allow greater interoperability between the Services as their preventive medicine assets would be interchangeable with little variation between roles, responsibilities, and terminology. Additionally, if all of the Services are training there personnel to the same standards, then a single technical school or standard can be developed to ensure the members are all trained equally. Until such a time comes and decision is made, however, the following interim conditions should be implemented to enhance efficiency.

Air Force Bioenvironmental Engineering's biggest detriment to winning the efficiency argument is the amount of time and money required to fully qualify a member. One issue that fuels the amount of training time required, and the cost as a result, are the prerequisites to the officer and technician career fields. As it stands right now, officers are required to have an

ABET accredited Bachelor's degree in any Engineering field. The problem with this is this includes Engineering aspects that have nothing to do with OEH, HRM, or RSO. Take, for example, someone with a Bachelor of Science in Computer Engineering or Electrical Engineering. While this member might have the analytical mind and knowledge of the scientific method necessary to perform in the career field, they do not possess the base knowledge. They could potentially be steered toward the Bioenvironmental Engineering career field without having a foundation in a related field. It can be observed that the Army and Navy officer career fields require either a higher level degree or degree paths that are more related to the occupations themselves. Therefore, the Air Force may want to consider scoping down the field of degrees to those that are more applicable to the Bioenvironmental Engineering career field. This would include degree programs in Industrial Hygiene, Occupational Safety and Health, Health Physics, Environmental Science, and Environmental Engineering to name a few. By bringing in members that already have a rudimentary knowledge in the areas of expertise required in Bioenvironmental Engineering, the amount of initial and upgrade training time could be condensed.

Another measure that could be taken to reduce the time and cost of qualification of Bioenvironmental Engineering Officers is the amount of lag time the members potentially have at base level. A new officer could very well sit at base level for a year before attending the BEO course. Albeit a time period this large is the result of class cancellations, usually due to not having enough students scheduled for attendance. New officers go to base level first to gain an understanding of the career field in which they have been placed. This same courtesy is not extended to the technicians, though. While it could be argued that officers will have oversight over various programs and should have eyes on before training, it could be called into question what is the benefit of having eyes on something if one does not fully comprehend what they are looking at? The paradigm shift for this issue could be sending officer students straight to the BEO course after completion of COT, or other method of entering the operational Air Force such as the Air Force Academy. Prospective Bioenvironmental Engineering Officers could be scheduled to attend COT at certain dates out of the year, coinciding with the dates when other acquisitions, such as United States Air Force Academy graduation, would be coming in to the operational force. Then, the officers could attend the BEO course immediately following and receive their base assignments while in school. This would shave 12 months off of the training time and $50,738.40 off of the training cost calculated in this report. Furthermore, this would increase the importance of the upgrade training following the BEO course. The upgrade training could be used to reiterate and expand upon what the member learned while in technical training.

The Army and Navy, on the other hand, have different factors to consider to increase the efficiency of their preventive medicine efforts. The dispersal of responsibilities could be viewed as both an advantage and a disadvantage. The advantage to this is that the Army and Navy can attract subject matter experts with a great depth of knowledge on a particular subject rather than the jack-of-all-trades approach the Air Force has taken with Bioenvironmental Engineering with a greater breadth of knowledge. The problem lies in that several of these subjects are interconnected and can cross lanes into one another. This can lead to confusion of mission capabilities, especially in joint environments where the different forces may not be familiar with the roles and responsibilities of one another. For example, in the Army Nuclear Medical Science Officers and Health Physicists have the potential to advise commanders during emergency responses involving radiation. At this point it could be argued that more information coming in to the commander could be beneficial. However, in the off chance that the two subject matter experts have differing opinions on correct courses of action or there is a delay in time because the commander does not know who to consult, this confusion could weigh in on the health and safety of personnel. Therefore, it is recommended that the Army and Navy attempt to consolidate the overlapping roles and responsibilities into single career fields.

CONCLUSION

In a time of measuring efficiency and making sure every dollar yields the greatest result, leaders must weigh all factors in how America's Armed Forces continue from here on out. While the Air Force does an excellent job of covering the OEH, HRM, and RSO roles and responsibilities under one umbrella, they do not conduct this in the most cost efficient manner. Perhaps it was premature to state in the Bioenvironmental Engineering Technician CFETP that "value is maximized for both the taxpayer and warfighter" through the career field's fulfillment of multiple product lines.[140] The distribution of responsibilities may be simpler for Air Force commanders and personnel to know who to turn to as subject matter experts, especially during times of emergency. Taxpayers would be more concerned with the bottom line of how their tax dollars are spent, though.

As it stands right now, Bioenvironmental Engineering is a great asset to the warfighter as a one-stop shop for OEH, HRM, and RSO requirements. This comes at a cost, though. It takes more time and money for the Air Force to attain fully qualified Bioenvironmental Engineering Officers and Technicians than it does for the Army and Navy to train personnel to fulfill the same roles. This is in part due to new members coming from a variety of Engineering backgrounds that may have no bearing on the subject matter they will be working with and the potential for lag time at home stations before attending formal training. Moreover, the breadth and depth of knowledge required to be in Bioenvironmental Engineering requires a wider array of training topics. In finding the way forward, leaders will need to consider what prerequisites, training requirements, and distributions of duties are truly important to achieving mission success in the most efficient way possible. It is owed not only to the warfighter who defends this great nation, but to the taxpayers who fund these efforts as well.

APPENDIX - CALCULATIONS

Below are the calculations for each career field with explanations for why certain values were chosen. All military pay values were based off of the January 1, 2016 values.[141] All of the lodging and meal cost estimates were generated based off of the training locations from the U.S. General Services Administration per diem rates.[142]

Air Force Bioenvironmental Engineering Officers

For worst-case calculations in this career field the O-3 paygrade was selected because that is the highest rank with which a new member can enter. It was averaged over the 2 years or less and over 2 years pay rates to reflect potential pay raises that occur during the training time. All of the times are calculated off of worst-case scenario amount of time to complete the trainings, to include lag times at home station and upgrade training.

Table 3 – Air Force Bioenvironmental Engineering Officer Training Time and Cost

Base Pay (Average of O-3 2 years or less and over 2 years pay for Worst-case Scenario)	34.2 months * $4,228.20/month	$144,604.44
Officer Training School at Maxwell AFB, AL	(35 days * $89/day) + (35 days * $51/day)	$4,900.00
Bioenvironmental Engineering Officer Course at Wright-Patterson AFB, OH	(93 days * $90/day) + (93 days * $59/day)	$5,487.00
Bioenvironmental Engineering Officer Advanced Course at Wright-Patterson AFB, OH	(28 days * $90/day) + (28 days * $59/day)	$4,172.00
		$159,163.44

Air Force Bioenvironmental Engineering Technicians

All of the times are calculated off of worst-case scenario amount of time to complete trainings, to include upgrade training time at home station and maximum time to achieve appropriate rank.

Table 4 – Air Force Bioenvironmental Engineering Technician Training Time and Cost

Base Pay (Average of E-1 2 years or less and E-5 over 4 years pay for Worst-Case Scenario)	72 months * $2,090.55/month	$150,519.60
Basic Military Training and Airmen's Week at Joint Base San Antonio-Lackland, TX	(60 days * $120/day) + (60 days * $64/day)	$11,040.00
Bioenvironmental Engineering Apprentice Course at Wright-Patterson AFB, OH	(95 days * $89/day) + (95 days * $51/day)	$13,300.00
Occupational Health Measurement Course at Wright_patterson AFB, OH	(14 days * $89/day) + (14 days * $51/day)	$1,960.00
		$176,819.60

Army Environmental Science Officers, Nuclear Medical Science Officers, and Health Physicists

The following calculation reflects the time and cost of training one member for one of these career fields. The O-1 pay grade was selected because there was no evidence to the contrary on what rank a member in any of those career fields enters.

Table 5 – Army Environmental Science Officer, Nuclear Medical Science Officer, or Health Physicist Training Time and Cost

Base Pay for O-1 2 years or less	4.3 months * $2,972.40/month	$12,781.32
Direct Commissioned Officer Training at Fort Benning, GA	(28 days * $89/day) + (28 days * $51/day)	$3,920.00
Branch-specific functional training at Fort Sam Houston, TX	(105 days * $120/day) + (105 days * $64/day)	$19,320.00
		$36,021.32

Army Preventive Medicine Officers

The O-1 pay grade was selected because there was no evidence to the contrary on what rank a member in any of those career fields enters.

Table 6 – Army Preventive Medicine Officer Training Time and Cost

Base Pay for O-1 2 years or less	4.8 months * $2,972.40/month	$14,267.52
Direct Commissioned Officer Training at Fort Benning, GA	(28 days * $89/day) + (28 days * $51/day)	$3,920.00
Branch-specific functional training at Fort Sam Houston, TX	(105 days * $120/day) + (105 days * $64/day)	$19,320.00
Preventive medicine specialization course at Fort Sam Houston, TX	(14 days * $120/day) + (14 days * $64/day)	$2,576.00
		$40,083.52

Army Preventive Medicine Specialists

The E-1 pay grade was selected because there was no evidence to the contrary on what rank a member in any of those career fields enters.

Table 7 – Army Preventive Medicine Specialist Training Time and Cost

Base Pay for E-1 2 years or less	5.7 months * $1,566.90/month	$8,931.33
Basic Combat Training at Fort Knox, KY (most expensive of the five locations)	(70 days * $111/day) + (70 days * $59/day)	$11,900.00
Advanced Individual Training at Joint Base San Antonio, TX	(105 days * $120/day) + (105 days * $64/day)	$19,320.00
		$40,151.33

Navy Environmental Health Officers, Industrial Hygienists and Radiation Health Officers

The following calculation reflects the time and cost of training one member for one of these career fields. The O-1 pay grade was selected because there was no evidence to the contrary on what rank a member in any of those career fields enters.

Table 8 – Navy Environmental Health Officer, Industrial Hygienist, or Radiation Health Officer Training Time and Cost

Base Pay for O-1 2 years or less	1.2 months * $2,972.40/month	$3,566.88
Officer Development School in Newport, RI (highest rates of the year)	(35 days * $192/day) + (35 days * $59/day)	$8,785.00
		$12,351.88

Navy Preventive Medicine Technicians and Radiation Health Technicians

The following calculation reflects the time and cost of training one member for one of these career fields. The 60 month time limit represents the high year tenure of a member at the grade of E-3.[143]

Table 9 – Preventive Medicine Technician or Radiation Health Technician Training Time and Cost

Base Pay (Average of E-1 2 years or less and E-3 over 4 years pay for Worst-Case Scenario)	60 months * $1824.45/month	$109,467.00
Recruit Training at Great Lakes, IL	(63 days * $89/day) + (63 days * $51/day)	$8,820.00
School at Fort Sam Houston, TX	(133 days * $120/day) + (133 days * $64/day)	$24,472.00
		$142,759.00

END NOTES

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

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