

Submarine Assignment Policy Assessment

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Executive Summary

Introduction

In the FY94 Defense Authorization Act, Congress lifted the statutory prohibition against assignment of women to combat units. Following extensive review and recommendations by the Presidential Commission on Assignment of Women in the Armed Forces, each service identified new areas that would now be open to women.

On 29 April 1994 the Secretary of the Navy submitted the proposed Navy implementation plan to the Secretary of Defense. The Secretary of the Navy recognized the uniqueness of submarine duty by identifying submarines as the only career field to remain closed to women for reasons other than direct ground combat or collocation with direct ground combat forces. However, he directed the Chief of Naval Operations to conduct annual reviews with a view towards accommodating women in this field to the fullest extent practicable, in new and existing classes of submarines, consistent with cost and the distinctive elements of service that exist for this type of vessel.

The first report is due in April 1995 to the Standing Committee on Military and Civilian Women in the Navy.

Approach

The review effort consisted of: 1) assembling experts from the human resources, medical, sociological, submarine warfare, and submarine design fields to review the issues; 2) compiling a library of relevant reports, studies and documents, 3) contacting numerous government agencies, departments, commands and individuals with expertise that could contribute to the review; 4) using the experts to sort out the issues and identify considerations and conclusions based on the research.

The appendices contain a complete listing of references together with individuals and organizations contacted.

SUBMARINE ASSIGNMENT POLICY ASSESSMENT

Considerations

Today, more than 2700 women serve in a broad range of assignments in the submarine field; e.g., submarine staffs, tenders, bases, and training facilities. Until 1994, women were excluded from permanent assignment to submarines because of the statutory prohibition against assignment of women to combat units.

- ★ Consideration of mixed gender crews must be undertaken in the context of the combat effectiveness of the submarine. The Supreme Court has upheld that Title VII of the Civil Rights Act of 1964, which ensures all individuals are treated equally before the law with respect to civilian employment, does not apply to the military profession.

Submarines are unique. They are able to operate alone, -- submerged and unsupported -- undetected in a hostile environment for months at a time, limited only by food supplies and the endurance of the crew.

The vital characteristics of submarines generate competing design requirements, including safety of submerged operations, quieting, equipment accessibility and density. The final design is a trade-off that is dominated by operational effectiveness, engineering constraints and cost.

In parceling out available space, structure and equipment needed for submarine stealth, mobility, endurance and payload take priority over habitability. Non-essentials stay ashore. The crew must live in and around equipment. There is virtually no space for recreation.

Berthing and sanitary spaces are cramped. "Hot-bunking", wherein three crew members share two bunks in shifts, is standard operating procedure on attack submarines.

The total living area for more than 130 people is equivalent to a medium-size house. Unencumbered deck space in sleeping areas, toilets, and showers, is about one-half to one-third that afforded to a crew member on a small surface ship.

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Space and weight are critical to submarine design. Submarines do not have the flexibility of surface ships to accommodate large changes in payload. Submarine designers conserve precious weight and space margins for performance enhancements. In the new design submarine, the Navy is stripping out capability to arrive at a smaller, more affordable submarine.

In addition to personnel stress inherent in all combat vessels, submarine crews must endure long periods of submerged operations, unrelenting crowding, lack of privacy, infrequent communications with family and the outside world, no ability even to go topside for fresh air and a view. The recreational and other opportunities available on most naval vessels to relieve stress are largely absent in submarines. Any leisure time must be spent in the two dining areas with others, or in one's bunk.

Except for emergencies such as fire or flooding, the lesser upper body strength of the average female in relation to her male counterpart is probably manageable for routine operations although potentially problematic given the small crew size on a submarine. However, within the confines of a submarine, when a casualty strikes, any crew member may be immediately called upon to perform damage control actions requiring handling heavy equipment in cramped spaces and to perform other physically demanding tasks while wearing steam or fire protection suits and self-contained breathing apparatus.

Navy directives (OPNAV Instruction 9640.1, "Shipboard Habitability Program,") require separate and equivalent berthing and sanitary facilities for male and female officers, CPO and Crew. Existing submarines could not meet these standards without significant modifications.

The hostile undersea operating environment, together with the highly technical nature of the jobs aboard submarines, dictates extensive training requirements for officer and enlisted personnel. The lengthy training pipeline results in a crew with only a few enlisted personnel below the grade of petty officer and no line officers who have not completed 16 months of submarine and nuclear training.

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The range of skills required to operate and maintain the equipment, the small size of the crew, and the independent extended nature of submarine operations, dictates 100% manning of approved billets and makes unplanned losses significant. <

Both officers and enlisted crew members develop necessary skills in a prescribed progression of shipboard assignments of increasing responsibility. As a result, officer or nuclear enlisted personnel transfers from other communities are limited to junior personnel.

There is virtually no relevant data from the space program, Arctic and Antarctic expeditions, the biosphere experiment, or other known sources from which to predict the socio-psychological effect(s) of a mixed-gender crew in the close quarters of a submarine. The limited data that are available pertain either to events of relatively short duration or experiments conducted under conditions atypical to those that exist aboard submarines.

Statistically significant data from mixed gender crews on surface combatants will not be available for several years. These data will not be entirely representative either.

Of the four other nations operating nuclear-powered submarines (United Kingdom, France, Russia, China), none man them with mixed gender crews.

Conclusions

The extreme conditions on submarines -- submerged twenty-four hours a day for months at a time, in a crowded environment that affords almost no privacy - are a major factor that should drive submarine personnel assignment policy.

Introducing women into submarines is less a question of whether they can do the day-to-day work than it is a question of whether the added complications of a mixed gender crew will undermine the operational effectiveness of the ship. Therefore, the focus should not be on women, per se, but on the ramifications of having mixed-gender crews in the unique submarine environment.

There is no sound sociological and psychological data from which to predict the exact effects that gender mixing will have on group dynamics during normal and combat conditions in the unique submarine environment. The added complications inherent in a mixed-gender crew may well detract from the sharp focus on technical detail that has been the cornerstone of the impressive operational and nuclear safety record of the U.S. submarine fleet.

A mixed gender crew will complicate submarine life -- from simple things like shipboard supplies, watch bill, and bunk management to the far more complex areas of potential fraternization and harassment which would be difficult to deal with in the uniquely confining environment of a submarine. These added burdens could increase risk where the object has been to minimize unnecessary risk in order to provide the trained crew with the maximum advantage to cope with the stress and special demands of the submarine combat environment.

The need to keep submarines fully manned, coupled with the need to have enough people of the right gender to match with available living accommodations, would impose a burden not only on the ship but on those who would have to recruit, train, assign, retain, and ensure equal career opportunities for both male and female personnel.

Achieving habitability standards for mixed gender crews in existing classes of submarines will be extremely difficult. Although requirements can be waived, waivers concerning separate facilities for each gender will be either impractical with regard to societal standards or will cause unacceptable favoring of one gender.

Modifications to support mixed gender crews will impact other areas of ship capability. Final decisions to implement such modifications should be made only after the tradeoffs are considered in the context of overall cost and warfighting effectiveness. This is essential in a climate where the military capability of a new design has already been cut back to comply with funding limitations.

Although there is evidence that women have more illnesses and tend to use more health resources than men in the same age group, the increases are not significant, assuming that pregnant personnel are not allowed to remain onboard.

SUBMARINE ASSIGNMENT POLICY ASSESSMENT

It is unlikely that new information will become available at a pace that would warrant an annual review.

1.0 Introduction

Prior to 1994 women were prohibited by Federal statute from assignment to combat ships, and thus to submarines. Congress repealed the combat exclusion law in 1994 and each of the services was free to review their individual units with respect to the assignment of women. The United States Navy has determined that submarine duty is the only area which will remain closed to women for reasons other than direct ground combat.¹ The Secretary of the Navy has, however, directed the Chief of Naval Operations to conduct an annual review of the policy restricting the assignment of women to submarines. The Secretary directed that the reviews "...give full consideration to expanding opportunities for women into the submarine field as well as the cost effectiveness of the shipboard modifications necessary to facilitate mixed gender crews."²

The assessment which is reported here was undertaken to support the Chief of Naval Operations in responding to the Secretary of the Navy directives.

The United States Supreme Court has upheld the opinion that Title VII of the Civil Rights Act of 1964, which ensures that all individuals are treated equally before the law with respect to civilian employment, does not apply to the military profession.³ This ruling is important to this study and any others like it, in that it provides basis for the data to be evaluated with respect to the fundamental issue of combat effectiveness.

Combat effectiveness is dependent on readiness, the state of preparation of the personnel and equipment, and unit cohesion, the relationship which develops in a unit or group. The Presidential Commission on the Assignment of Women in the Armed Forces provided an expanded definition of cohesion but more importantly noted, "The evidence clearly shows that unit cohesion can be negatively affected by the introduction

¹ Secretary of the Navy Memorandum. Direct Ground Combat Definition and Assignment Rule, 29 April 1994.

² Secretary of the Navy Memorandum. Policy Review on Assignment of Women to Submarines, 29 April 1994.

³ Presidential Commission on the Assignment of Women in the Armed Forces, 1992. Report to the President.

of any element that detracts from the need for such key ingredients as mutual confidence, commonality of experience, and equitable treatment."⁴

The assessment was conducted primarily through the collection and review of relevant data along with interview of and discussion with experts in the various areas. The relevant issues and supporting data were reviewed by experts in the fields of submarine warfare, submarine design and construction, personnel management, and submarine medicine and psychiatry. In each of the assessment areas, the experts attempted to assess the data with the objective of determining if expansion of women's roles in the submarine community to actual submarine duty would have any effect on the combat effectiveness of submarines. Additionally, a top level personnel readiness model was developed to quantify some of the potential effects of assignment of mixed gender crews to submarines. The panel's assessments and conclusions are reported here.

The remainder of this report is divided into two sections. The first, "The Submarine - A Frame of Reference", provides an all important introduction to the physical configuration, operations, personnel requirements, and psychological environment of the submarine. Understanding the unique nature of submarines and submarine operations is essential to interpreting the assessments of the issues surrounding submarine assignment policies.

The second section, "Assignment Policy Assessment", provides assessment of assignment policy related topics in four key areas. The first of these, "Ship Configuration" discusses those submarine design issues which are directly relevant to supporting mixed gender crews. The topic of privacy in berthing and sanitary facilities is the one of most concern. The next assessment area is "Medical/Sociological". The focus is on the unique aspects of female medical care and physical condition as well as the potential psychological impacts of assignment of mixed gender crews to submarines. Pregnancy is at the forefront of the medical issues while the interaction between male and female crew members is the psychological topic of primary concern. In the next area, "Management", issues related to management of individual submarines and the overall submarine community are reviewed. Significant topics here are the effect of mixed gender crew assignment on shipboard management workload and the

⁴ Presidential Commission on the Assignment of Women in the Armed Forces, 1992.

ability to recruit and effectively manage the assignment and rotation of a small cadre of female personnel distributed over a wide rate and Navy Enlisted Classification (NEC) structure. Finally, in "Readiness", a quantitative look is taken at the effects of mixed gender crews on the personnel readiness of operational submarines.

2.0 The Submarine - A Frame of Reference

"A nuclear submarine embodies the highest form of integrated technologies in the world -- more complex than even space vehicles -- and must operate in a more hostile environment. U.S. submariners live and work under water for extended periods, coexisting with a nuclear reactor"⁵

This quote from a recent issue of NATIONAL DEFENSE provides a very vivid and concise description of the nuclear submarine and the environment it provides for its crew. Submarines are significantly different from other naval platforms and pose a collection of special challenges not encountered in other military or non-military endeavors.

To put some of these differences in perspective, this report section describes the submarine, their operations, their crews, and the psychological environment in which the crews must perform.

It is important in reviewing the remaining sections of the assessment that the discussion of each of the issues, findings and recommendations be considered in light of the unique submarine environment. The descriptions provided are intended to assist the recipients of this report, especially those who are not intimately familiar with submarines, in maintaining this important perspective.

2.1 The Submarine

War Fighting Characteristics

A U.S. submarine provides stealth, mobility, and firepower and the mere suspicion of its presence dramatically changes the military equation for enemy commanders. U.S. submarines are able to operate alone, unsupported, and undetected -- even in enemy waters -- for months at a time, limited only by food supplies and the endurance of the crew. There are no onboard maintenance personnel; the operating crew must handle

⁵ Gwinn, Richard H. and Tanquin, Don 1994. Submarine Base Viability Relies on Interim Program. NATIONAL DEFENSE November 1994:22.

any emergency, including repairs to even the most sophisticated equipment. The submarine carries an array of precision weapons that can strike targets ashore, on the surface, or other submarines. It requires no escorts; no tankers; no air cover; no supply ships; and there are no manufacturers' representatives on board. It is the platform of choice for many Special Forces operations.

Ship Design and Arrangement

Submarine designers strive to minimize the size of the ship. This is important to achieve maximum performance within a reasonable power plant design and to avoid unnecessary construction costs.

Submarine designers try to take advantage of every cubic foot of space. Living spaces are integrated with electrical and mechanical operating systems. The crew lives in and around the submarine weapon systems.

Most submarine spaces are served by a single central passageway on each level. These passageways are about 27" wide and do not permit the passage of two people without each turning slightly sideways, a movement which becomes second nature to a submariner. This arrangement precludes traditional surface ship traffic management with respect to fore and aft and up and down movement. All movement, in all directions, occurs in the central passageways.

The severe constraints on submarine size dictate the intimate living conditions characteristic of submarine duty. Living accommodations aboard most Navy ships are less than generous. Living conditions aboard submarines are much more constrained than for other types of Navy ships. Table 2-1 provides perspective.

Table 2-1
Comparison of Standards

Standard	Submarine ⁶	Surface Ship ⁷ (150'-300')
Unencumbered deck space in sleeping areas [square feet per person]	Officer -- 6 ft ²	Officer -- 20 ft ²
Unobstructed passage width between rows of crew bunks	18"	24"
Drawer/locker storage space per person (cubic feet)	Officer -- 15 ft ³ CPO -- 10 ft ³ Crew -- 3 ft ³	Officer-19.75 ft ³ CPO -14 ft ³ Crew 7.5 ft ³
Size of messing facilities (% seated)	Officer - 75% CPO+Crew - 35%	Officer - 100% CPO - 100% Crew - 65% (Assumes 20 officer/20 CPO/200 Crew)
Additional day room space	None required	Space, in addition to dining facilities, for 1/3 of the crew. Topside space is also available.
Showers	1/50 Enlisted	1/25 Enlisted

As a practical matter, submarine designs usually provide less than one bunk per crew member. Having about one-third of the crew on watch at all times makes it possible to manage watch bills and bunk assignments so that three junior enlisted people can share two bunks. This is called "hot bunking".

Efforts continue to be made to minimize hot bunking, however the reality is that hot bunking is still required to accomplish at sea missions. To reduce the number of crew required to hot bunk, commanding officers will often grant the option of laying down mattresses in the torpedo room where there is some unencumbered deck space. Generally, crew members prefer the inconvenience and lack of privacy involved in these sleeping arrangements to sleeping in shifts on permanent bunks. Extra riders; for

⁶ OPNAV INST 9640.1 Shipboard Habitability Program. Encl (1).

⁷ Ibid.

example shipyard personnel on sea trials, inspectors, VIPs, and technical observers; increase the requirements for hot bunking and berthing in operating spaces.

Within the crew berthing areas:

- Each bunk is about six and a half feet long, two and one-half feet wide. It has a reading light, an individually controlled ventilation outlet, and 18" of clearance from mattress top to the bottom of the next bunk.
- Each bunk is hinged so it can be lifted to provide access to a mattress sized pan locker which is the individual's primary storage for all personal gear. Each individual usually has one additional locker near his bunk. These are small and not uniform in size. They are often difficult to access and may have ship cables or piping systems running through them.
- A curtain along the side of each bunk, when pulled, creates the only individual private space on ship, other than a commode or shower stall.
- Typically, bunks are stacked three high and line each side of a narrow (18-inch) passageway -- not much more than shoulder-width apart.
- In this small area the inhabitants enter and leave their bunks, extract clothing and possessions from the locker underneath each mattress, and dress.
- This same area frequently doubles as the main compartment passageway to the lavatories/heads.
- Except during "all hands" evolutions, crew members sleep in the living compartments at all times of the day and night because of watchstanding requirements.

The heads are designed for efficiency. The main crew berthing area on the SSN 688 class (second platform) has 72 bunks, served by a single head consisting of two showers, three toilets, one urinal, and four wash basins. All must be used

simultaneously during peak times. A second head provided in the lower level, adjacent to the 21 person bunk room, has a single shower and toilet. These are common facilities with no privacy, other than partial doors on the toilets.

Except for the commanding officer and the executive officer, submarine officers generally bunk three to a stateroom. Approximately twelve to fourteen officers share one shower, one toilet, and one urinal. There is one drop-down wash basin in each officer stateroom and one additional basin in the common head. The staterooms also serve as the primary office space for each of the officers, with three officers sharing two desks.

The wardroom and the mess decks are also small. Together, they can accommodate only a fraction of the crew at a time. After meals, the mess areas are used full-time for administrative work, crew training, testing, study, and recreation. Additional limited, and small, recreation areas are available in some submarines.

The 688 Class, the current class with the largest number of ships, has more than 75% of the interior space devoted to operating spaces (propulsion plant, auxiliary systems, sensors, weapons, etc.). The submarine is designed to be a weapons system with only minimal accommodations for personnel.

To a different perspective, Figure 2-1 shows a comparison of the living spaces in a submarine to the passenger compartment of a Boeing 747 aircraft. The spaces shown include all non-operational areas. In submarines, over half of non-operational space is occupied by berthing and sanitary facilities. The total living area for more than 130 people is equivalent to a medium size house.

2.2 Submarine Operations

The unique aspect of submarine operations, as compared to surface ships, is that even in peacetime, submarines operate unsupported in an inherently hostile environment -- the oceans of the world. When submerged, even a small breach in a seawater piping system can threaten the ship and all aboard. The closed atmosphere of a submarine creates physical risks. In case of fire, for example, a submarine must quickly get to the surface to evacuate smoke or toxic fumes.

The United States Navy operates two types of submarines, strategic submarines (SSBNs) and attack submarines (SSNs). Although different in mission and operating schedule, both types of ships face the same challenge -- operating submerged, stealthy and unsupported for months at a time.

The SSBN is a key element of strategic deterrence. TRIDENT submarines deploy on patrol, individually, for about 75 days -- cruising, undetected, at slow speed with 24 long-range, strategic nuclear missiles capable of reaching any potential target.

- These submarines are characterized by a predictable operating schedule and long uninterrupted periods in port between patrols.
- To increase time-on-station without overextending personnel, the Navy assigns two crews to each SSBN. When the Blue crew returns from patrol, they are relieved by the Gold crew and the ship undergoes a quick refit and returns to sea.

Some attack submarines deploy as part of a carrier battle group to provide battle group support and for forward reconnaissance. Others operate independently, submerged for 60 to 90 days at a time for reconnaissance, special operations, anti-submarine and anti-surface warfare, or under-ice operations in the Arctic. They are offensive weapons.

- Attack submarines are the quick response element of the submarine force. Their schedules are dynamic, with frequent changes to respond to world situations, and their operating tempo can be intense.
- They are manned by a single crew.
- They deploy for six months out of every 15-18 months.

- In home port, between deployments, the SSN operating schedule is about the same as that for surface ships -- generally out for a few days or weeks at a time but spending about 50% of the time in the ship's home port.

2.3 Submarine Personnel

Operating and maintaining the very sophisticated combat, navigation, and propulsion systems aboard our submarines requires highly educated, well-trained, and motivated personnel who carry out the mission with maximum teamwork.

The U.S. submarine service relies on volunteers, selected early in their Navy careers for rigorous training in submarine duty and in the equipment they will operate and maintain.

A career in submarines is arduous and demanding. This is reflected in the effort the Navy expends in retaining experienced officer and enlisted personnel in whom the Navy has invested so much. Special bonuses have been authorized to compensate for duty that can be particularly stressing on service members and their families.

Submarine personnel spend their entire sea-going careers, and most of their shore duty, in the submarine business. Both officer and enlisted begin at the most junior levels and progress through training, experience, and a rigorous program of submarine specific testing and requalification to earn promotion to the higher levels. Lateral transfer from other communities is infrequent and is generally restricted to junior personnel. Lateral transfer of senior personnel would put inexperienced personnel in supervisory positions which would be disadvantageous to the individual and create potential safety problems for a submarine.

Input for officers comes primarily from the Naval Reserve Officers Training Corps, the Naval Academy, Officer Candidate School, and other special programs designed to attract college graduates. Those who aspire to command, must be qualified by training and experience in nuclear propulsion. Newly commissioned officers are selected based on careful review of academic and extra-curricular performance, in-depth interviews with several senior headquarters technical personnel, and a personal interview by the Director, Naval Nuclear Propulsion.

For enlisted personnel involved in nuclear propulsion, there is also a careful screening and selection process for entry to Nuclear Power School.

Officers and enlisted undergo extensive education and training in classrooms and on actual reactors dedicated to training. Once qualified ashore, they go to sea where they begin a lengthy process of qualification on the submarine and reactor type to which assigned. Because preparation for submarine duty involves lengthy training, there are significantly fewer enlisted personnel below the level of E-4 assigned to submarines than to other ships.

For submariners training is a way of life and never stops. Officers and enlisted personnel, at all levels, must repeatedly prove their skills, formally qualifying and re-qualifying through a system of qualification manuals, periodic examinations, inspections, and tests. This emphasis on training, knowledge, attention to detail, and advancement requires those who serve to study hard and apply themselves.

2.4 The Psychological Environment

For many, submarine duty offers much in the way of job satisfaction, camaraderie, and an overall feeling of being a vital part of a very professional unit. On the other hand, confinement in such cramped quarters for such long periods, can be the source of increased stress in an environment where many of the normally accepted stress relievers are not available. The following summarizes the psychological environment:

- Unlike surface ships, submarines offer no place to be alone, except in the bunk with curtain drawn.
- There are no windows or any connection with the outside -- no opportunity to walk topside, to look at the ocean, to watch sunrise or sunset; to observe weather changes.
- There is no sensation of speed or depth, except for an occasional gauge, a sharp turn, or when the ship takes an angle to change depth. Submerged, the platform is almost always steady.

- Temperature is constant.
- Physical proximity to and contact with shipmates is unavoidable and frequent.
- Except for when the mess decks are free, there is virtually no place to sit down -- except for those standing watch at their equipment.
- At sea, there is no mail, in or out; except for a 50-word family gram received approximately twice a month, and these are not private.
- Any negative personal news from the outside is provided directly to the commanding officer who must decide when and how the information will be delivered.
- The crew stands watch in six hour shifts. A three-section watch bill converts submarine life to an 18 hour day with six hours on watch and the remaining twelve hours divided between training, maintenance, professional duties, eating, and sleeping.
- The eighteen-hour rotation means that crew members cannot sleep at the same time every day. This disrupts the body's circadian rhythm.
- To accommodate watchstanding, submarines, like other ships, serve four meals a day. To the individual arising from sleep, the next meal may be dinner, not breakfast.
- All drills are all-hands evolutions and handled as actual emergencies. "This is a drill", is not used on submarines. Drills are frequently conducted several times each day. This provides further disruption of any "normal" routine.

2.5 Summary

The preceding section describes the uniqueness and complexity of the submarine, its operations, and its environment. These features define a unique physical and psychological environment that mandates the need for stringent selection, training, and performance standards for the officers and crew. Recognition of the special responsibility to operate safely in this environment is at the root of the strict discipline designed to focus attention clearly on the tasks at hand.

Since NAUTILUS first went to sea -- January 17th, 1955 -- U.S. submarines have logged millions of miles of undersea operations while executing difficult and dangerous missions throughout the world. The unrelenting stress, absence of tension relievers, constant danger, continuous close contact, and demanding operating schedules make submarines unique and place a premium on the morale and cohesion of the crew.

Assignment policies that affect any element of this proven framework of success must be reviewed with appropriate consideration for the uniqueness of the submarine platform and the long term impact of those changes which might be considered.

3.0 Assignment Policy Assessment

This assessment is based on the review and analysis of a large volume of assembled material, interviews with Navy personnel and other experts, and modeling of submarine readiness based on personnel events. More than thirty people who are either directly involved in the policy issue or who are experts in or involved with research in the relevant fields were contacted. These people and their affiliations are listed in Appendix B. Almost 200 reference documents were collected, catalogued, and reviewed for relevance. Appendix C provides a bibliography of these documents. The results, presented in this section, are discussed in four topical areas: Ship Configuration, Medical/Sociological, Management, and Readiness.

Numerous individual issues were identified during the course of the assessment. The review team spent considerable time debating the merits of each with a view toward determining those that were of significance in addressing the policy issue in question. The topics most relevant to assessing the assignment policy for submarines are reflected in the following discussions. The review team specifically excluded from consideration topics which had previously been reviewed in the overall discussion of women in the military unless they were determined to have additional or different considerations when applied to submarine assignment.

3.1 Ship Configuration

Section 2 of this report introduced a general description of the submarine's basic design and physical configuration. Existing configurations on all current and planned classes of submarines do not provide facilities which meet the standards of privacy⁸ for mixed gender crews. The design of the New Attack Submarine is in progress. This section discusses the nature of modifications which would be required to meet standards. A discussion of the alternatives to modifications and their impact is also included.

3.1.1 Background

"The Navy's primary mission is to be prepared to conduct prompt and sustained combat operations at sea in support of U.S. national interests and the national military strategy. The Navy is dependent upon shipboard personnel to accomplish this mission and therefore must provide them with living and working conditions which will result in levels of crew morale, safety, health and comfort, adequate to sustain maximum personnel effectiveness and to support optimum personnel retention."⁹

This excerpt from the Navy's Shipboard Habitability Program instruction demonstrates clear understanding by the Navy's senior leadership of the critical role played by the shipboard environment.

Modifications to Navy ships, required to accommodate female service members, should be implemented in a fashion which does not create inequities that negatively affect crew members of either gender. For instance, in a ship with two heads, a simple solution which has been suggested is to make necessary changes and assign one of them to women. This satisfies the requirement for a women's head but results in a disproportionate reduction of facilities for male crew members. In another example, the problem of separate berthing and sanitary facilities for CPOs, the proposed simple solution is to have female CPOs share facilities with female E1-6. Again, it provides a

⁸ OPNAVINST 9640.1.

⁹Ibid.

place for female CPOs to sleep but creates a situation which may be viewed as a loss of stature and be unacceptable to the CPOs.

The impact of the shipboard environment on morale and performance is significant. Studies of contained environments within a hostile environment, the ocean in the case of a submarine, have shown that "...any specific effects of the hostile environment from which a group is protected are small in comparison to the effects of being confined in the contained environment."¹⁰ This raises the nature of the contained environment to the forefront. The physical arrangement of the submarine must be properly designed if it is to support successful integration. The success of integrating women, if undertaken, can only be determined over the long term and must consider morale/crew cohesion, readiness, and warfighting effectiveness and not just the ability and willingness to provide the physical accommodations for women in the submarine environment. Adding emphasis to this point, the habitability instruction also states, "A warship cannot be designed around optimum habitability factors alone, but conversely, habitability factors cannot be progressively sacrificed to other readiness elements without eventual detriment to mission readiness. The habitability standards must be attained and maintained in order to preserve positive morale and the effectiveness of the mission readiness equation."¹¹

3.1.2 Assessment

3.1.2.1 Description of Required Modifications

The habitability standards for surface ships and submarines require that officer, CPO, and crew be accommodated in separate berthing compartments and that female officers, CPO, and crew accommodations be separate from those of their male counterparts. These same separations are also specified for sanitary facilities. These privacy items are mandatory for new classes of ships and for existing classes. Deviation from these standards requires approval by the Chief of Naval Operations (CNO) in accordance with OPNAVINST 9640.1.

¹⁰Blair, S.M. 1986. *Adaptation to a Contained Environment-The Antarctic Experience Applied to Chemical Warfare*. Bethesda, MD.:Uniformed Services University of the Health Sciences

¹¹ OPNAVINST 9640.1.

Current submarines were designed with the presumption of an all male crew. The major modifications required to accommodate women onboard these submarines are those which involve providing the required level of privacy for both men and women. These privacy modifications involve berthing compartments and sanitary facilities and are accompanied by lesser requirements including the labeling of male and female spaces, installation of privacy barriers to prevent unobstructed viewing of spaces from public passageways, and the closure/blocking of all openings to these spaces (pipe runs, cableways, ventilation) which could allow visual access (intentional or unintentional). There are other required changes such as provision of the necessary medical examining facilities and storage of additional unique medical equipment and supplies.

To aid in understanding the magnitude of the effort required, the modifications required to accommodate a mixed gender crew on MHC 51 Class ships were reviewed. In this relatively simple case, berthing and sanitary facility modifications were required only for the CPO living spaces. Nonetheless, to accommodate a complement of 19 women (2 officers, 2 CPO, and 15 crew) more than 15 arrangement changes, along with numerous other minor modifications, were required to comply with the standards. In comparison, submarine modifications are likely to include changes in CPO and enlisted berthing spaces and the creation of, as many as, three new sanitary facilities, one each for officers, CPOs, and enlisted.

Assuming a female component of approximately 10-15%, each of the current classes (Los Angeles, Ohio, and Seawolf) was examined. This examination was not an attempt to design modifications but rather to establish the condition of each class relative to the standards.

- In each case, berthing for female officers can be provided by dedication of an existing two or three person stateroom. There is no easy solution to separate berthing for CPOs in any of the classes. The current arrangements do not support allocation of existing space as for the officers, and division of the spaces is difficult, if not impossible.
- Separate sanitary facilities would have to be added in all classes for officers and CPOs since there is currently only one facility for each group. The addition

of new sanitary spaces with the accompanying major piping modifications is a significant change and not merely a redesignation of usage.

- The Los Angeles and Ohio classes present some options for enlisted berthing which would require minimal modification. Los Angeles has a nine person bunkroom which could be dedicated and a twenty-one person bunkroom which could be dedicated if a significantly larger fraction of females was planned. Ohio class has enlisted berthing arranged in nine person bunkrooms and therefore females could be added in multiples of nine. Berthing arrangements in the SEAWOLF class are much more difficult since enlisted berthing is provided in two large, Pullman style compartments. There are no smaller rooms and division would not be easy.
- Significant sanitary facility modification would be required for enlisted personnel in all classes. These are complex modifications as has been previously noted.
- The large sanitary facilities which exist could not be reallocated between the sexes without imposing an inequitable burden on the male crew.

Current submarine designs have little to no margin for expansion or addition of new spaces. Modifications required to attain the specified levels of privacy and separation will require reallocation of space within the living compartments. New spaces, particularly sanitary facilities, can only be accommodated at the expense of some existing function. This requires a set of modifications. Simply partitioning existing spaces would result in a ratio of facilities to crew which did not meet the required standards. New sanitary facilities require more piping modifications in submarines, and may in some cases require additional seawater piping or hull penetrations. These are not insignificant modifications. While the construction aspects of berthing facilities are not complex, the reallocation of space is a major challenge. Both berthing and sanitary facility modifications require corresponding electrical system changes as well. The scope of the total modification package is the sum of the berthing/sanitary facility modifications plus those modifications which result from the reallocation of space and relocation of existing functions. In the case of both the Los Angeles and SEAWOLF

classes, modifications which attain compliance with the standards may not be possible without lengthening the ship. This is impractical for Los Angeles due to the lack of margin and SEAWOLF because of the small number of ships planned.

The New Attack Submarine (NSSN) is in the design stage. Designers are tasked with responding to the Secretary of the Navy's directive to "...give due regard to accommodating the assignment of women...".¹² A top level review of the NSSN design indicates that compliance with the standards will be difficult, even in the case of this new submarine. Some preliminary work performed by the Naval Sea Systems Command suggested that additional facilities for women would require an increase in length from the baseline design and even then, the facilities were not fully compliant with the standards.

3.1.2.2 Alternatives to Modification

While waivers to the specified minimum habitability standards are possible, the review team is unaware of any which have been granted relative to the separation of officer, CPO, and crew sanitary and berthing facilities. Any modification or compromise that would require a waiver must be evaluated in terms of its impact on the fabric of morale, good order, management, and discipline.

Sharing of sanitary spaces by significant numbers of the opposite sex (more than a few) on either a scheduled or on-demand basis would result in male-female inequity and create a potentially serious morale problem. Casual sharing of facilities is common in homes and small offices and generally works except in cases of heavy loading or peak demand. The submarine, however, operates on a schedule which creates a peak demand period every six hours, concurrent with watch relief, and following any drill or all hands evolution. At these times about two thirds of the crew will use the sanitary facilities in a period of about one to one and one-half hours. An even more stressing scenario is created in the submarine when it enters port and the entire crew wants to use the sanitary facilities at virtually the same time. Even with an all male crew, the lack of facilities can be a cause of friction during peak demand periods.

¹² Secretary of the Navy Memorandum, Policy Review on Assignment of Women to Submarines, 29 April 1994.

3.1.3 Summary

Current classes of submarines will be difficult, if not impossible, to modify to standards to accommodate mixed gender crews. There is insufficient space to support the addition of separate facilities which are required by standard and believed to be necessary by the review team. The design of the NSSN is ongoing.

Sharing of sparse facilities by mixed genders has a low probability of success in the submarine environment where sharing concepts, whether by time or demand, result in allocating about one half, or all in the case of officers and CPOs, of the sanitary facilities to a group expected to be about 10% of the users of the facilities. Such a significant mismatch is not equitable, not efficient, and has the high probability of creating friction in the crew. *

3.2 Medical/Sociological

This section examines the medical, physiological and psychological implications associated with the assignment of women to submarines and assesses the potential effect on operational readiness.

3.2.1 Background

The medical aspects of submarine duty are significantly influenced by the uniqueness of the submarine environment, and the associated special operating conditions required for a successful mission.

The submarine environment creates a stressful situation in which the crew must live for prolonged periods beneath the sea, encapsulated in very close quarters, with limited accommodations and minimal privacy, while adapting to an 18-hour day and work cycle. Also, the absolute inviolate first priority of submarine operations, to remain undetected, forces a restriction on all personal communications to and from the crew while deployed. This adds to the crew's stress by heightening their sense of total isolation and loss of control of issues outside of their closed environment. The crew's ability to endure the rigors of submarine duty entails a combination of proper motivation, high morale, good physical and mental health, and a capability to adjust to the stressors associated with the unique environment and operation of the submarine.

In determining the medical feasibility of assigning women to submarine duty, a review of the available research data on pertinent medical issues of clinical, physiological and social-psychological nature in relation to women at sea and in contained environments was conducted.

3.2.2 Assessment

3.2.2.1 Clinical Conditions

General Health Care Requirements

Women consistently have been found to use more health care services than men (Andersen & Andersen, 1967¹³; Briscoe, 1987¹⁴, Cleary, Mechanic, & Greenley, 1982¹⁵, Hankin, 1974¹⁶; Kohn & White, 1976¹⁷, Nathanson, 1975¹⁸; Tessler, Mechanic & Diamond, 1976¹⁹, Verbrugge, 1979²⁰; Verbrugge, 1985²¹, Verbrugge & Depner, 1980)²². In the United States, for example, women in the reproductive age group use physician services at almost one and a half times the rate of men in that age group, exclusive of utilization associated with pregnancy.

Many sex differences in health care utilization have been attributed to the fact that, despite women's biological and behavioral advantage with regard to mortality, women appear to have a greater morbidity than men (Gove & Hughes, 1979²³; Rodin & Ickovics, 1990²⁴; Woods, 1981)²⁵. In a review of morbidity figures, Wingard (1984)²⁶ reported most

¹³ Anderson, R. and Anderson, O.W. 1967. A decade of health services. University of Chicago Press.

¹⁴ Briscoe, M.E. 1987. Why do people go to the doctor? Sex differences in the correlates of GP consultation. *Social Science and Medicine*. (25):507-513.

¹⁵ Cleary, P.D., Mechanic, D. and Greenley, J.R. 1982. Sex differences in medical care utilization: An empirical investigation. *Journal of Health and Social Behavior*. (23):106-119.

¹⁶ Hankin, J. 1974. Psychological distress and the use of medical services. Unpublished doctoral dissertation, University of Wisconsin, Madison.

¹⁷ Kohn, R. and White, K. 1976. Health care - An international study: Report of the World Health Organization/International Collaborative Study of Medical Care Utilization. London: Oxford University Press.

¹⁸ Nathanson, C.A. 1975. Illness and the Feminine Role: A Theoretical Review. *Social Science and Medicine*. (9):57-62.

¹⁹ Tessler, R., Mechanic, D.L. and Diamond, M. 1976. The Effect of Psychological Distress on Physical Utilization: A Prospective Study. *Journal of Health and Social Behavior*. (17):353-364.

²⁰ Verbrugge, L.M. 1979. Female Illness Rates and Illness Behavior: Testing Hypotheses About Sex Differences in Health. *Women in Health*. (4):61-79.

²¹ Verbrugge, L.M. 1979. Gender and Health: An Update on Hypothesis and Evidence. *Journal of Health and Social Behavior*. (26):156-182.

²² Verbrugge, L.M. and Depner, C.E. 1980, August. Sex Differences in Health: Testing Sociological Hypothesis. Paper presented at the Meeting of the American Sociological Association, New York.

²³ Gove, W.R. and Hughes, M. 1979. Possible Causes of the Apparent Sex Differences in Physical Health: An Empirical Investigation. *American Sociological Review*. (44):126-146.

²⁴ Rodin, J. and Ickovics, J.R. 1990. Women's Health: Review and Research Agenda as we Approach the 21st Century. *American Psychologist*. (45):1018-1034.

categories of self-reported chronic conditions and all acute conditions---with the exception of injuries---were more common for women than for men. Similarly, health and morbidity statistics in the United States show that women have higher illness rates than men; they report more days of illness and disability and a greater incidence of morbidity (Verbrugge, 1985)²⁷.

A Navy study (NHRC 90-2)²⁸ on the health requirements of men and women aboard U.S. Navy ships documents that shipboard women use more health care services than men and that the differences are greatest in occupational specialties that traditionally have not been open to women. The nontraditional occupational categories for women include: electronics and instruments; deck; engineering and hull; supply; store and mess; and ordinance. Within traditional occupations, (administrative and medical) the female to male ratio of clinical visits was 1.38 to 1; within nontraditional occupations, the ratio was 1.54 to 1²⁹. The primary reasons for the increases in female health care utilization between traditional and nontraditional occupations included injuries and--to a lesser extent--the effects of exposure (e.g., skin disorders or irritations, eye inflammation) or stress (e.g., migraines & tension headaches).

An inspection of the data indicated that women in nontraditional occupations exhibited significantly higher sick-call visit rates for injuries, nervous or sensory organs, skin disorders, mental disorders, and neoplasms. These five diagnostic categories accounted for 89 percent of the differences in the sick-call rate between women in traditional and nontraditional occupations. The leading factor was injury, which accounted for 44 percent of the difference. These injuries were primarily unspecified disorders of the back, burns, open wounds, soft tissue injuries, and internal derangement of the knee. Injuries were followed by nervous and sensory organ disorders (17%), which were predominantly migraines, disorders of the external ear, and inflammation of the eye

²⁵ Woods, N.F. 1981. Women and Their Health. In: C.I. Gofel and N.F. Woods (Eds.), Health Care of Women: A Nursing Perspective. 3-26. St. Louis: Mosby.

²⁶ Wingard, D.L. 1984. The Sex Differential in Morbidity, Mortality and Lifestyle. Annual Review of Public Health. (5):433-458.

²⁷ Verbrugge, L.M. 1979. Gender and Health: An Update on Hypothesis and Evidence. Journal of Health and Social Behavior.

²⁸ Nice, D.S. and Hilton, S.M. 1990. Sex Differences in Health Care Requirements Aboard U.S. Navy Ships. Report Number 90-2. San Diego: Naval Health Research Center.

²⁹ Nice, D.S. and Hilton, S.M. 1993. Sex Differences in Occupational Influences on Health Care Utilization Aboard U.S. Navy Ships. Military Psychology 6(2):109-123.

and eyelid. Skin disorders (13%) included ingrown toenails, dermatitis, and pruritus (itching). Mental disorders (10%) focused on tension headaches and psychological counseling. Neoplasms (5%) were primarily of an unspecified nature (i.e., mole). Among men, by contrast, the difference between the age-adjusted visit rates in administrative or medical occupations (318/1,000) and the visit rates in all other occupations (362/1,000) was not statistically significant³⁰.

Navy experience has shown that the rank order of reasons for patient visits as aggregated within seventeen major diagnostic categories of clinical conditions is quite similar for both men and women. In general, women report more depression and are treated more frequently for physical ailments such as genitourinary tract infections, headaches, dizziness and stomach upsets; while men have a higher incidence of, and more treatments for skin disorders and accident injuries.

When compared against the health statistics published by the U.S. Department of Health and Human Services of January 1994³¹, the pattern of sex differences in health care utilization aboard Navy ships is very similar to that of the nation as a whole.

Navy shipboard women use physician services at almost 1.44 times the rate of men in the same age group, and at 1.21 times the rate of men when all sex-specific diagnoses are excluded. The Navy study demonstrated that there is a fairly linear relationship between the number of females assigned to a ship and the number of additional sick call visits per month; for every 100 women, there will be 33 additional sick call visits.

The assignment of women to submarine duty would increase the scope of the clinical conditions ordinarily seen with an all male crew by the addition of female specific clinical entities such as disorders of menstruation, pregnancy, and diseases of the female breast and genital tract. However, the majority of the female specific conditions are non-emergency in nature and could be handled by a nuclear submarine medical technician with the proper training.

³⁰ Nice, D.S. and Hilton, S.M. 1993.

³¹ U.S. Department of Health and Human Services 1994. Vital and Human Statistics From the Centers for Disease Control and Prevention/National Center for Health Statistics: Current Estimates from the National Health Interview Survey, 1992.

The tendency for a greater incidence of occurrence of all acute clinical conditions in women increases the probability for a slightly higher number of medical evacuations and transfers. A review of the medical evacuation and transfers from SUBLANT tenders for a six month period in 1993, noted a medevac rate of 4/1,000 women per quarter as compared to 3/1,000 for men in that same period.

Based on the NHRC 90-2 study, it is likely that similar female to male morbidity ratios and health care requirements seen for men and women assigned to Navy surface ships would be seen for those assigned to submarines.

The health care requirements of women for all acute, non emergency type conditions, as noted in the Navy study, exclusive of pregnancy, can be accommodated aboard a submarine provided that the nuclear submarine medical technician receives appropriate training in the recognition and treatment of common gynecological problems and neuropsychiatric conditions of women. The ship's authorized medical allowance list must be modified to include additional female specific medications and supplies for the treatment of the female crew members.

In addition, careful physical screening of female submarine candidates for any disease or condition that causes chronic or recurrent disability, increases the hazards of isolation or has the potential of being exacerbated by the environment or nature of submarine duty would lessen the potential health risk to the individual and reduce the excessive medical burden on the command. This is consistent with the pre-selection process now in use for male volunteers, and could easily be incorporated within that system.

Pregnancy Risks

The medical problems sometimes associated with pregnancy, such as ruptured ectopic pregnancy, spontaneous hemorrhagic abortion or septic abortion would be significantly magnified in the submarine environment.

The occurrence of a ruptured ectopic pregnancy is a life threatening emergency that requires a correct diagnosis and a prompt medevac to a medical treatment facility with

an obstetrical surgical capability³². In the U.S., there is one ectopic pregnancy for each 60 diagnosed pregnancies. Eighty percent of ruptured ectopic pregnancies occur between four to eight weeks after the last menstrual period with the peak distribution at six and a half weeks from the last menstrual period³³.

A review of the SUBLANT medical statistics for ectopic pregnancies for a 6 month period during 1993 revealed a rate of 3.8 ectopic pregnancies per year per 1000 women. Fortunately, all of SUBLANT cases were correctly diagnosed, received prompt surgical treatment and survived. Without immediate surgical treatment, ruptured ectopic pregnancy is usually fatal. The death rate for ruptured ectopic pregnancy in the U.S. is estimated at 1/826.

The urine tests for pregnancy are very sensitive and will reliably detect any pregnancy that is at least 10 to 14 days old, i.e., 4 weeks after the last menstrual period³⁴. But, testing all women for pregnancy will not remove the risk because the tests may not be positive in very early stages of gestation when ectopic pregnancy poses a problem.

The medical department of a submarine is not physically or professionally capable of handling obstetrical surgical emergencies on board, nor is it likely that the command could guarantee a prompt medical evacuation in every instance.

Pregnancy and its associated complications are incompatible with submarine deployments because they pose significant risks to the morbidity and mortality of the mother, and thus to the operational readiness of the unit.

A revised Navy pregnancy policy would need to address the medical issues related to the assignment of women to submarine duty and provide specific guidance on the diagnostic testing for pregnancy at specific times and intervals as a condition of service.

³² Hughey, M.J. Surgical Emergencies in Obstetrics and Gynecology: The Surgical Care of Women in Operational Settings. Washington, D.C., Department of the Navy, Bureau of Medicine and Surgery.

³³ Nederlof, K.P., Lawson, H.W., Saftlas, A.F., Atrash, H.K. and Finch, E.L. 1990. Ectopic Pregnancy Surveillance, United States, 1970-1987. In: CDC Surveillance Summaries, December 1990. MMWR 1990. 39 (no. SS-4):9-17.

³⁴ Hughey, M.J. Surgical Emergencies in Obstetrics and Gynecology: The Surgical Care of Women in Operational Settings. Washington, D.C., Department of the Navy, Bureau of Medicine and Surgery.

Toxicological Considerations

One of the more serious problems involved with life in sealed environments, such as in submarines, is the continual contamination of the atmosphere by small quantities of toxic materials. Any agent produced will be cumulative, and in time will give rise to a toxic level.

The Submarine Atmosphere Control Manual of the U.S. Naval Sea Systems Command³⁵ notes that there are several thousand organic trace contaminants in submarine air due to a number of known sources within the submarine. More than two hundred of the potentially toxic chemicals in the submarine environment have been evaluated by the Subcommittee on Submarine Air Quality of the National Academy of Sciences, National Research Council³⁶. A review of the Subcommittee's findings indicated there are no demonstrable gender differences to the potentially hazardous substances that are known to be present in trace quantities under normal operating conditions in a submarine that would indicate a greater risk to women, as long as they were not pregnant. The fetus is most sensitive and at the greatest risk in terms of the toxicological effects of the environment during the first three months of gestation^{37,38}.

The major gases present and routinely monitored aboard submarines include: carbon monoxide, (CO); carbon dioxide, (CO₂); hydrogen, (H₂); oxygen, (O₂); fluorocarbon-12 and fluorocarbon-114.³⁹

With regard to toxicological considerations, carbon monoxide (CO) present in the closed environment of the submarine can have an adverse effect on the development of the fetus⁴⁰. Cigarette smoking, smoldering fires, overheated insulation, and snorkeling

³⁵ Nuclear Powered Submarine Atmosphere Control Manual. Compounds Quantitatively Identified in Submarine Atmosphere Ch 3. NAVSEA S9510-AB-ATM-010.

³⁶ National Research Council 1988. Submarines Air Quality: Monitoring the Air in Submarines. 1-73. Washington, D.C. National Academy Press.

³⁷ Rosenstock, L. and Cullen M. 1986. Clinical Occupational Medicine. W.B. Saunders Company.

³⁸ Barlow, S.M. and Sullivan, F.M. 1982. Reproductive Hazards of Industrial Chemicals. New York. Academic Press.

³⁹ Nuclear Powered Submarine Atmosphere Control Manual. Compounds Quantitatively Identified in Submarine Atmosphere Ch 3. NAVSEA S9510-AB-ATM-010.

⁴⁰ National Research Council 1988. Submarines Air Quality: Monitoring the Air in Submarines. 1-73. Washington, D.C. National Academy Press.

can produce CO in submarines. While normal adults have a reserve capacity and compensatory response that enable them to handle moderately high carboxy-hemoglobin concentrations without irreversible effects, the fetus under normal situations can be functioning close to a critical level with respect to tissue oxygen supply, so even moderate carbon monoxide exposure could decrease the oxygen transport capacity of maternal and fetal hemoglobin and result in interference in fetal tissue oxygenation during important developmental stages⁴¹.

Radiation Effects

Ionizing radiation exposures inherent with being a nuclear submariner are not a bar to women serving in submarines unless they are pregnant.

In the case of occupational radiation exposure of pregnant service members, the embryo-fetus is considered to be a member of the general population that, perforce, must accompany its mother to work and thus receive incidental radiation exposure. There is a minimal risk as long as the dose equivalent limit to the embryo and fetus from occupational exposure of the expectant mother is no more than 50 mrem per month and 500 mrem (.5 rem) for the entire gestational period.⁴²

3.2.2.2 Physiological Considerations

In general, the most quantitative values for women--such as muscle strength, pulmonary ventilation, and cardiac output, all of which are related to the muscle mass--will vary between two thirds and three quarters of the values recorded for men. The hormonal differences between men and women account for a large part of the differences in heavy work physical work performance. Testosterone, secreted in the male testicles, has a powerful anabolic effect, which means that it causes greatly increased deposition of protein everywhere in the body, especially in the muscles. In fact, even the man who participates in very little physical activity but who nevertheless is well-endowed with testosterone will have muscles that grow to size 40 percent or

⁴¹ National Research Council, 1984. Emergency and Continuous Exposure Limits for Selected Airborne Contaminants. Washington, D.C. National Academy Press.

⁴² National Council on Radiation Protection and Measurements. 1986. Review of NCRP Radiation Dose Limit for Embryo and Fetus in Occupationally Exposed Women. NCRP Report No. 53.

more greater than those of his female counterpart and with corresponding increase in strength.⁴³

The greatest physiological disparity between men and women is in upper body strength. That finding is clearly demonstrated in studies performed by the Navy Personnel Research and Development Center, San Diego, in 1981^{44,45}. These studies measured the performance of damage control and other tasks by a group of male and female recruits both before and after training. The results, after training noted: Stretcher carry, level: 38 percent of the women failed, and zero males. Stretcher carry, up and down ladder: 88 percent of the women failed, and zero men. P250 Pump, carry down: 99 percent of the women failed, and 4 percent of the men failed. Start the pump: 75 percent of the women failed, and zero men. Remove SSTG Pump: 99 percent of the women failed and zero men. Torque an engine bolt to a 90 pound pull: 47 percent of women failed and zero men. Similar differences were noted in other tests.

These findings are significant since they show that women lack sufficient upper body strength to satisfactorily complete basic damage control tasks, and would require some sort of preferential treatment in the event that any of those tasks or other type of heavy exertional work would be required in the normal course of duty. That situation can pose an added burden for the male crew members during emergencies when all hands would normally be required, as well as being perceived as grossly unfair with regard to the equal distribution of work tasks among the crew. The latter point is important because it relates to the ability of the men to resign themselves to the hardships of submarine life. A key factor in that resignation is in the knowledge that all aboard are being treated fairly and equally without any preferences due to gender.

⁴³ Guyton, A.C. 1985, Sport Physiology. Chapter 84. In: Textbook of Medical Physiology. Philadelphia: W.B. Saunders, Publisher.

⁴⁴ Robertson, D. 1982. Development of Occupational Strength Test Battery (STB). NPRDC-TR 82-42. San Diego: Naval Personnel Research and Development Center.

⁴⁵ Robertson, D.W. & Trent, T. 1985. Documentation of Muscular Demanding Jobs and Tasks and Validation of an Occupational Strength Test Battery (STB). MDLTN 86-1. San Diego. Naval Personnel Research and Development Center.

3.2.2.3 Psychological Factors

Submarine Environment Stressors

Duty in a submarine is associated with exposure to a number of stressors directly related to the submarine environment. These include: unrelenting close personal contact, the lack of privacy due to limited space and living accommodations, the continuous and nonvarying auditory, olfactory and thermal sensations, the feeling of being isolated from the rest of the world due to the nature of the mission and the imposed restriction of all personal communications, coupled with having to adjust the rhythmic 24 hour biological cycles of the body to conform with the 18-hour day work and sleep schedule, and the constant physical and mental demands associated with submarine qualification procedures⁴⁶.

To successfully endure the rigors of submarine duty requires a combination of proper motivation, good physical and mental health, self-confidence, strong personal discipline, and a willingness and a capability to adjust to the submarine environment, its inconveniences, and its subculture. Adaptation to submarine duty can best be described as an ongoing process of emotional, work, and social adjustment.

Male submariners have developed a number of psychological defenses and social interplays that have enabled them to cope effectively with submarine duty. Gender mixing of the crews will change the social dynamics of the submarine environment. Both groups will need to develop gender neutral, socially acceptable psychological defenses and interplay that allow an outlet for their respective emotions without being demeaning of each other or interpreted as a form of sexual harassment⁴⁷.

3.2.2.4 Social Psychological Factors

In addition to the environmentally related stress, women submarine crew members are likely to face problems during the transition phase that include: lack of appropriate female submariner role models; unfamiliarity with the all male subculture; sexual

⁴⁶ Harvey, C.A. 1985. *Women on Submarines Letter*. New London: Naval Submarine Medical Research Laboratory.

⁴⁷ Ibid.

harassment to some degree; over-close scrutiny of performance and behavior which may cause a tendency to overcompensate or to withdraw; overt hostility from some of the male crew and/or their spouses or girlfriends; complaints from their spouses or boyfriends about their assignment to a submarine; and, handling the interpersonal social relationships associated with having to live not only with the men but also with other women in close proximity⁴⁸.

Conversely, problems faced by the male majority would include: lack of familiarity with working with women as fellow submariners; the reactions of perceived reactions of their wives or girlfriends; disruption of previously established relationships, styles of conversation and subculture; and, changes in the use of space in the submarine⁴⁹.

In no other institutions, including schools, prisons, as well as other military operational units, are men and women forced to live in such unrelenting close personal contact with minimal privacy and in less than satisfactory accommodations for extended periods.

Technical competence of women should not be a problem on a submarine. As with men, women with mature emotional composure, good motivation and strong personal determination could successfully handle the environmental stressors of a submarine. What remains uncertain is the effect gender mixing of submarine crews will have on group dynamics under routine, emergency, and combat conditions.

In a Roper survey⁵⁰ concluded during the Persian Gulf War, 64 percent of the military surveyed reported that sexual activity had taken place in their unit. With the assignment of women, it would not be unreasonable to believe that in the enforced confines of the submarine, romantic relationships will develop between some men and women in the crew. Any special relationships of that sort, or the even the perception that they exist, could be problematic and damaging to the morale and unit cohesion of the crew, which are critical elements for operational readiness and combat effectiveness.

⁴⁸ Thomas R, J. 1981. Women in the Military: Gender Integration At Sea. NPRDC-TN 8-13. San Diego: Naval Personnel Research and Development Command.

⁴⁹ Ibid.

⁵⁰ Roper Study Survey 1990.

This is likely to happen when exclusive sexual pairing is perceived by the group to be associated with some resulting favoritism or unfairness.^{51,52}

Gender mixing of the crews will require a greater effort by command leadership to achieve good order and discipline in the crew with regard to issues involving fraternization, displays of personal affection, and sexual harassment. Education, training, and clear enforceable rules will have to be developed for practical use aboard submarines with gender mixed submarine crews.

Unit effectiveness and cohesion are far more the result of socio-psychological bonding than anything else. Without this crucial bonding, units disintegrate under stress no matter how technically proficient or well equipped they may be. The key variable in the effectiveness of a military unit like a submarine is not just technical abilities, although a certain level of technical competence is necessary, but the ability of the crew to maintain cohesiveness under fire and in the attack. Therefore, it is essential that every effort be made to identify any factors that can adversely affect unit cohesiveness and morale.

What is clear about the socio-psychologic aspects of this issue is that there is not sufficient or reliable data founded on experience to make a recommendation with any great certainty. To offer advice without having any sound sociological and psychological research from which to predict the results of the proposed organizational restructuring risks tinkering with the very foundation and success of the U.S. Submarine Force. Any changes in the existing highly effective operating units of the Submarine Force must be based on scientific facts rather than speculation.

3.2.3 Summary

The medical aspects of submarine duty are significantly influenced by the unit environment of the submarine and its characteristic mission requirements. Women are

⁵¹ Holmes-Johnson, E. 1985. Debriefing Report, McMurdo Station, Ross Island, Antarctica, Winter-over 1985. In: S.M. Blair. Adaptation to a Contained Environment. The Antarctic Experience Applied to Chemical Warfare. Port Hueneme: Naval Support Forces Antarctica.

⁵² McCullah, R.O. 1977. Debriefing of Winter-Over Personnel at South Pole Station, 1975-1976. In: S.M. Blair. Adaptation to a Contained Environment - The Antarctic Experience Applied to Chemical Warfare. Port Hueneme: Naval Support Forces Antarctica.

physically capable, with the exception of some damage control tasks, of serving aboard a submarine as long as they are not pregnant, or suffering from any disease or chronic condition that may be adversely affected by the rigors of isolation or the effects of the submarine environment. The female to male morbidity ratio for all acute medical conditions likely to occur in both groups indicates that women have more illnesses and tend to use more health resources than men in the same age group. However, the increases are not that significant, assuming that pregnant personnel are not allowed to remain onboard, and can be accommodated with only some minor modifications of the existing submarine medical department capability. Training of the hospital corpsmen would be necessary to achieve a basic proficiency in the recognition and treatment of female specific conditions, and a change in the ship's authorized medical allowance list to include the appropriate medications and supplies needed for the treatment of women would be required.

Women in the Navy have shown that they have the capacity to rise to professional challenges and deal effectively with stressful situations. The record of successful performance of this group suggests, that if given the opportunity to serve, women would adjust to the submarine environment and develop their own psychological mechanisms to deal with the stress.

What is most concerning about the prospect of assigning women to submarines is the uncertainty about the exact effect gender mixing will have on group dynamics during normal submarine operations and under combat conditions. Submarines and submarine duty are unique. There are no good comparisons when considering all of the environmental conditions of the submarine and its mission. Unfortunately, there is no available sociological or psychological research on this particular issue. Therefore, any recommendation about the efficacy of a gender mixed submarine crew would be more speculative than factual. When considering that unit cohesiveness, morale and combat effectiveness of the U.S. Submarine Force and the strategic defense of the country is in the balance, it would be prudent to avoid making a hasty decision before having all of the facts.

3.3 Management

3.3.1 Background

Management involves the full range of efforts necessary to conduct the business of the Submarine Force. At the unit level, the Commanding Officer must ensure the ship is properly manned and trained and is materially and operationally ready to meet the commitments assigned by the ship's operating schedule. The actions taken to manage the ship must comply with the policies and guidance provided by higher echelons in the chain of command.

At the Submarine Squadron, Group and Force (Type Commander) level, management involves increasingly larger numbers of units, and the oversight broadens accordingly. The larger number of ships at each echelon allows increased flexibility in resolving emerging or unforeseen requirements by permitting resources from one area to be shifted to satisfy personnel, materiel or maintenance requirements in another. While each of these levels has the authority to provide policy and guidance as required, they also ensure compliance with the policies and guidance from higher levels in all areas, from personnel and administration to operations and safety.

The management demands on every Commanding Officer in the Navy are significant, but few would argue that the submarine Commanding Officer's job is one of the toughest. The technical demands and strict standards of training, qualification and safety, the severely constrained ship's habitability and work environment, the small crew size and independent multi-mission ship operations in an unremittingly dangerous, remote and unforgiving environment for long periods combine to make this so. The submarine Commanding Officer is not supported by a staff and must, as a result of independent operations, routinely make operational decisions made at much higher levels in other warfare specialties.

The right range and depth of skills in the crew is of critical importance if the submarine's combat effectiveness and safety are to be maintained. Personnel training, qualification and performance are an integral part of the submarine culture and are critical elements in the periodic examinations, inspections and certifications related to reactor operations and safety, weapons system safety and performance, operational readiness, and deployment preparations. The submarine's independent operations,

often in remote areas, means that access to replacement personnel or assistance from others only occurs in the case of extreme emergencies. If such outside assistance is required, it can be obtained only at the expense of mission readiness or mission performance. Thus, personnel management in submarines receives extra attention at all levels of command before the ship gets underway because the right mix of experience and skills is so essential to the ability of the submarine to operate successfully, even at the most basic level, and because there are so few opportunities to make adjustments without an impact on mission readiness or performance after the submarine deploys.

The management load on officers and petty officers in all Navy fields is widely recognized and a matter of continuing concern, so this section focuses on the management requirements and issues associated with mixed gender submarine crews. The change in the management workload can then be considered with the assessment results from other areas to determine the aggregate effect(s) on combat effectiveness.

3.3.2 Assessment of Management Issues

This assessment assumes that women assigned to submarine crews will be eligible for all rates and NECs, that established Navy standards of privacy⁵³ in berthing and sanitary facilities will be maintained, that co-mingling of the facilities of officers, CPOs and other enlisted will not be allowed as a means to achieve mixed gender crewing, and that space and other standards for women crew members will be essentially equivalent to those for male crew members. Equal standards for all crew members are deemed essential, since separate standards would be an additional and unacceptable source of stress and friction in the crew. The socio-psychological aspects of mixed gender crews on submarines were discussed in Section 3.2 of this report.

3.3.2.1 100% Manning

Because of the highly technical nature of submarining, the range of skills required to operate and maintain submarines, the small size of the crew and the independent, extended nature of submarine operations, operational submarines are manned at 100% of allowance as a matter of policy. Submarines depend upon 100%

⁵³ OPNAVINST 9640.1

manning to provide the proper number of crew members of the right skills to fight and maintain the ship, and to man all watch stations for day-to-day operations with adequate watch rotation, usually three sections. Because of routine personnel turnover during inport periods and the need to operate to qualify watchstanders, many submarines start operational deployments with some watch stations on port and starboard until additional watchstanders can be qualified to allow a three section rotation.

3.3.2.2 Unplanned Losses

Paygrade defines the level of seniority of an individual and implies a corresponding level of experience; enlisted rating refers to a particular occupational field such as Machinist's Mate or Radioman; and Navy Enlisted Classification codes (NECs) are four digit numbers assigned to a sailor who has acquired a particular skill through technical training (schooling) and, in some cases, practical experience. The proper distribution of skills and experience (personnel with the required rating, NEC, and paygrade) among the crew is critical to effective operation and maintenance of the ship and its equipment. Although efforts are made to maintain some depth in NEC skills; i.e., more than one crew member with a particular NEC, it is not unusual in the case of an unplanned loss, to insist the replacement have not only a particular paygrade and rating but also a particular NEC. The particular combination required must be found within the personnel available to the various echelons of command. If necessary, the individual will be reassigned from shore duty or a non-deployed ship to fill the requirement for a deploying or deployed ship.

Unplanned personnel losses impose additional management burdens on the command. An analysis of the effects of unplanned losses is addressed in the personnel modeling results discussed in Section 3.4.

3.3.2.3 Hot Bunking

Hot bunking in submarines is a fact of life — always on SSNs and periodically on SSBNs, although SSBNs on patrol almost always operate on a "one person, one bunk" rule with all bunks filled. On SSNs, as many as 40% of the crew may be hot bunking for the duration of a deployment. Crew members are assigned to hot bunks based on

seniority. Extra riders or VIPs on board will usually increase the percentage of the crew who have to hot bunk.

To reduce hot bunking, some submarines allow temporary bunks (air mattresses or regular bunk mattresses placed on flat surfaces) in the "open spaces" in the torpedo room (SSNs and SSBNs) or the missile compartment (SSBNs only). These temporary bunks are used primarily during sea trials or when there are extra riders, but regular crew members may opt for these temporary bunks on deployments, if they are available, to avoid having to hot bunk.

Assignment of females to a submarine crew will require separate female berthing areas with appropriate privacy and sanitation facilities. Female crew members would be expected to hot bunk at approximately the same rate as the male component of the crew. Once berths providing the requisite privacy are designated for females, use of those berths by male crew members would not be possible. Therefore, any unplanned loss of a female crew member would normally require replacement in kind (gender, paygrade, rating and NEC) in order to maintain crew skills and experience levels and to maintain male-female hot bunking balance.

3.3.2.4 Replacement in Kind

Without replacement in kind, replacing an unplanned loss with a sailor of the opposite gender could cause a significant ripple effect in the crew, since replacement of a female with a male would lessen the hot bunking burden on females and increase it for males, and vice versa. It also might require movement of more than one crew member to reacquire the proper skills and maintain the "hot bunk balance" between male and female crew members. So, in addition to the 100% manning rule, a gender specific replacement in kind rule for unplanned losses would be necessary, although some flexibility in rate/paygrade/NEC would be possible based on the NEC depth of the crew.

3.3.2.5 Impact of Privacy Considerations

Calling the oncoming watch is part of the routine for watchstanders. This is accomplished by using a watchstander whose roving duties allow the freedom of

movement necessary to wake the oncoming watch, both officer and enlisted. Navy privacy standards do not permit male members of the crew to enter female berthing spaces except under controlled conditions, and vice versa, so mixed gender crews will require management to make arrangements for the watch to be called in ways that maintain privacy standards. Likewise, it is certain that a variety of watchstanders or duty personnel will require routine access to all spaces to take gage readings, make routine inspections, rig for dive, blow sanitary tanks, obtain stores or spare parts and perform other routine duties required by the watch responsibilities or in connection with ship evolutions, such as diving, surfacing, deep submergence, housekeeping operations at periscope depth, etc.. As previously discussed in Section 2.0, the 18 hour watch cycle on submarines means that some personnel are sleeping at all hours, day and night. In some surface ships, privacy in female spaces is maintained by establishing a female watch in the berthing space to wake the oncoming watch and perform whatever routine functions would impact privacy considerations. Such a watch in submarines is not feasible without the assignment of additional personnel since all personnel are assigned to the watchbill or other full time duties.

Also, because of privacy considerations, crew members of one or the other gender would be precluded from assignment to the periodically used temporary, "open space" bunks discussed in paragraph 3.3.2.3 above. This preclusion would be perceived as inequitable by some, and the privacy issue in this situation is further complicated by the fact that these temporary bunks are in operational spaces subject to periodic inspection or manned full time by a watchstander. It is essential that mixed gender crews not impose gender restrictions on submarine watches and duties.

3.3.2.6 Force Structure Changes

With the current force of SSNs and SSBNs (each of the latter with two crews), the submarine enlisted personnel pool is approximately 29,000. This includes approximately 18,000 at sea and 11,000 assigned to shore duty. The submarine officer community consists of approximately 4,100 officers of which approximately 2,000 are at sea.

The planned decline in the number of ships in the Submarine Force is an important factor. Absent significant change in the defense budget, the Submarine Force

structure will be reduced to approximately 50 SSNs and 14 SSBNs. This will reduce enlisted submariners at sea by approximately 6000 personnel. As the Submarine Force structure declines the management required to maintain 100% manning with gender specific personnel of appropriate NEC and paygrade will become increasingly difficult.

For illustrative purposes, if the female cadre of submariners is assumed to be approximately 10% of the total number of submariners, then the number of enlisted female submariners in a 68 ship submarine force would be approximately 2300. The small size of this cadre and the range of paygrades and NECs required may prove to be difficult to recruit and manage. The specific size of the required female cadre must be determined accurately to support recruiting projections and the development of community management plans. Analysis of this issue is beyond the scope of this assessment but warrants careful study to determine how best to grow and manage a small group in a fully gender-neutral assignment environment.

3.3.2.7 Building a Cadre of Volunteer Female Submariners

Volunteers for Submarine Duty

If there is to be a cadre of female submariners, it is essential that, like their male counterparts, they all be volunteers for submarine duty and not be limited in the types of submarine duty they can pursue; i.e., limited only to SSBN duty. This is necessary to avoid a two-tiered approach to submarine careers for females, especially female officers. There is little question that submarine duty for females would attract at least an initial group of volunteers; however, the unique nature of submarine duty may make it difficult to attract sufficient females to sustain the required pool of female submariners. Surveys of enlisted recruits have shown that 21% of female recruits are definitely interested in assignment to combat ships. An additional 34.5% stated that they would probably be interested in this type of duty. Specific surveys related to interest in submarine duty have not been conducted but could be completed in 3-6 months⁵⁴. There is unanimity in the assessment that it would be unacceptable to assign non-volunteers to submarine duty, so building and maintaining the female personnel pool of volunteer submariners must be both carefully planned and successful. Commander,

⁵⁴ Commander, Naval Recruiting Command, 1994. COMNAVCRUITCOM Ltr 1300 Ser 22/001010 of 20 Dec 94.

Naval Recruiting Command estimates based on the current female enlisted recruit accession rate (20-25%), indicate a sufficient number of qualified enlisted volunteers. The volunteer aspect is based on the data from the previously discussed "interest" survey. The estimated number of submarine accessions could change significantly if the interest in "combat ships" does not extend to submarine duty⁵⁵.

Full Manning Essential

Once the female berthing space in a submarine is established, there is little flexibility to increase or decrease the size of the female component of the crew. Any increase in the number of females will exacerbate the hot bunking situation among female crew members, and any decrease will result in reduced female hot bunking or empty female bunks. If a female shortfall is compensated for by assigning additional males, it would create an imbalance in hot bunking percentages between males and females or lead to empty female bunks. If the female cadre cannot be kept fully manned, reversion to an all male crew would become necessary.

Commander, Navy Recruiting Command reported that it might be possible to achieve a female officer input of about 16% that of the current male input. This is based on analysis of statistical data and does not include any survey data on volunteer likelihood. Input about this level would require additional market expansion⁵⁶. This level may be inadequate if female manning were determined by the allocation of submarine officer staterooms. In this latter case the percentage of officers below the CO/XO levels rises to 25-30%.

Two-Tiered Career Paths

Assignment of female personnel to only Ohio Class submarines has been suggested as one option for introducing women to submarine duty.

Creating a two-tiered system that separates the career paths of female and male submarine officers would be unacceptable because of increased management requirements and the career limitations it would impose; viz., female submariners

⁵⁵ Commander, Naval Recruiting Command, 1994.

⁵⁶ *Ibid.*

would not have the opportunity to serve in both types of submarines and the availability of SSBN billets for male officers would be reduced. This approach would also be viewed, correctly so, as tokenism and not true acceptance of mixed gender submarine crews.

Building a Female Cadre

The "how-to" of building a cadre of female submariners has not been addressed, by the Navy, but the management difficulties of doing so should not be underestimated. Some of the issues involved have been discussed in relation to Navy Recruiting Command data discussed in previous sections. Currently, there are age and paygrade limitations placed on entry into nuclear power and submarine programs. Cross-decking senior (age and rate/grade) personnel into nuclear power or submarines has acceptability, performance and safety implications. As a result, building a cadre is best done from the bottom up. Any implementation plan for assigning females to submarines should take the approach to start at the bottom and "grow our own" pool of female submariners with the range and depth required. This means that it will require a number of years to develop the experience and seniority for women submariners to qualify for senior positions, both officer and enlisted. The impact on sea-shore rotation for both male and female submariners will also need to be factored in; sea-shore rotation for males and females will have to be the same to avoid male-female inequities.

3.3.2.8 Male-Female Relationships, Fraternalization and Sexual Harassment

Male-female relationships have been discussed in the Medical-Sociological section of this report, but the implications for management will be addressed here.

While it is difficult to predict the degree to which male-female relationships will develop between members of a mixed gender submarine crew, there can be little doubt that they will develop, and there is virtually no possibility that such relationships can be kept from knowledge of the entire crew because of physical proximity and the way the crew operates. Also, there is virtually no possibility that such relationships will be able to avoid the kind of public displays of affection (PDA) that are unacceptable because of the problem they present for morale and discipline.

On the other hand, the strength of submarine officer and enlisted leadership means that relationships and arising problems will be recognized almost immediately. The problem for management is how such problems are to be resolved when they affect crew morale or violate the Navy's fraternization or sexual harassment policies. For such cases, the management and disciplinary rules are well-established, but the submarine Commanding Officer has few options other than transferring one or both parties off the ship since separation of the parties on board the submarine is simply not feasible. Such transfers in port are one thing; underway or deployed, they are quite another because the submarine usually operates independently and is remote from other Navy units and because at-sea transfers are high risk operations. Because of the risk, such transfers usually take place in sheltered areas such as bays, coves or in the lee of land. The resolution of onboard male-female relationship disciplinary problems occurring while deployed or operating clearly involves additional management actions and an adverse impact on the submarine's operational readiness.

3.3.2.9 Pregnancy

A revised Navy policy on management of pregnant service members (PSM) is pending. There is little doubt that pregnancies will occur among females assigned to submarines. Use of pregnancy, or the appearance of using pregnancy, to avoid operational commitments or any other aspect of submarine duty (shipyard overhaul, refit or maintenance periods, pre-deployment workups, etc.) is likely to be a major source of friction between male and female crew members as well as a management problem for the command. Additionally, a pregnancy that occurs or is discovered while the ship is underway will, in almost every case, require the PSM to be evacuated/transferred and replaced. As discussed above, such evacuations/transfers degrade mission readiness and are a personnel management burden. The extra effort to train and qualify the replacement for a PSM may result in a return to port and starboard duty/watch rotation until a new watchstander is qualified.

It is difficult to assess accurately the impact of pregnancy among female submariners. The effect on readiness of unplanned losses due to pregnancy can be estimated (see Section 3.4). In practical terms, it is likely that female submariners will need to time any pregnancies extraordinarily carefully or forego pregnancy altogether to avoid negative perceptions among male crew members. Sensitivity training can

mitigate these feelings, but the additional training and its periodicity are yet another management task.

Involved in this issue, because of fetal health considerations (see Section 3.2), is mandatory pregnancy testing, how it will be used and whether such testing can be effective enough to avoid the management and readiness difficulties associated with PSMs on submarines. An effective way to avoid these problems is essential, and the full extent of the management load associated with mandatory pregnancy testing remains to be determined.

3.3.3 Summary

Several management issues and an increased management load are associated with implementation of mixed gender submarine crews. Management issues requiring further study include:

- Building a cadre of female submariners (recruiting, growing and managing the community) of the right paygrades, ratings and NECs to meet 100% manning and replacement in kind requirements.
- Establishing a Navy policy on pregnancy of personnel assigned to sea duty and determining how its implementation would affect female submariners, especially if mandatory pregnancy testing is required.
- How to manage gender privacy and gender neutral duties/watches when routine duties, inspections and evolutions require access to every part of the submarine at all times day and night.
- Whether or not the submarine environment can provide an acceptable degree of privacy for female crew members without creating operational problems, gender specificity in watches and duties, disadvantages to male submariners and/or degraded mission effectiveness.

3.4 Readiness

This section presents quantitative results from a top level personnel readiness model developed to support this assessment. The development and use of the model also provided valuable insight into the statistical categorizations of male-female differences and the complexity of the mixed-gender personnel management process. The model looked only at submarines themselves.

3.4.1 Background

The ultimate point of evaluation is the ability of the submarine to perform its assigned mission(s) under all conditions. Combat effectiveness is dependent on 1) readiness - the state of preparation to execute the assigned mission (includes manning, training, material condition and logistics) and 2) unit cohesion. The Presidential Commission defined cohesion as "... the relationship that develops in a unit or group where: (1) members share common values and experiences; (2) individuals in the group conform to group norms and behavior in order to ensure group survival and goals; (3) members lose their personal identity in favor of a group identity; (4) members focus on group activities and goals; (5) members become totally dependent on each other for the completion of their mission or survival; and (6) members must meet all standards of performance and behavior in order not to threaten group survival". The Commission went on to say "The evidence clearly shows that unit cohesion can be negatively affected by the introduction of any element that detracts from the need for such key ingredients as mutual confidence, commonality of experience, and equitable treatment."⁵⁷

While there is no means to accurately predict the exact quantitative contribution of these factors to combat readiness, there are some factors that can be counted. Among these are the estimated differences in the level of manning and training of deployed submarines and the increase in detractors such as hot bunking or emergency evacuations because of the introduction of mixed gender crews on submarines. This section discusses an analysis to estimate these differences.

⁵⁷ Presidential Commission on the Assignment of Women in the Armed Forces 1992.

3.4.2 Readiness Modeling

In our review of the issues surrounding the assignment of women to submarines, an issue frequently raised was that of decreased readiness due to an increase in the unplanned loss rate. Increases in the loss rate were attributed primarily to medical causes, including pregnancy. The potential problems cited included a significant increase in MEDEVACS and unplanned losses which could not be immediately filled, thus resulting in a potential reduction in capability. Some numerical data was available but a detailed assessment had not been performed.

A top-level personnel readiness model was developed as a way to start to assess the significance of the various factors over the long term. The model, The Submarine Assignment Policy Model (SAPM), is an event-driven Monte Carlo simulation. The effects of assignment of about 10% and 20% female crew members were evaluated.

3.4.2.1 The SAPM Model and Inputs

The SAPM model is an event-driven Monte Carlo simulation of submarine crew composition over long periods. It includes a squadron of attack submarines and ashore based component of possible crew replacements. The model was developed utilizing personnel management rules and operational information provided or concurred by the Bureau of Naval Personnel and/or the Staff of Commander Submarine Force, U.S. Atlantic Fleet as appropriate. Both commands assisted in providing personnel data on unplanned losses and other statistics required to represent the Submarine Force personnel.

The SAPM model utilizes a squadron of ten 688 Class submarines which are supported by a shore force which has been scaled in proportion to projected submarine force manning levels in the year 2000. The ships operate on a nominal 18 month deployment cycle which is patterned after the COMSUBLANT CVBG/JTF deployment cycle. The ships are manned in accordance with the authorized billet allowance for an actual 688 Class ship and the Paygrade/Rate/NEC structure is reflected in the shore component.

Female crew are assigned in each category (Officer, CPO, and Enlisted) and a specific number of bunks are designated for female occupancy with the females hot bunking in

the same ratio as the males. Enlisted females are randomly distributed across the authorized billets and throughout the shore force at the beginning of each model run to reflect gender neutral assignment policies. Officers are treated in a similar manner.

Table 3.4-1 summarizes the personnel events, data, and rules which are considered in the model. Actual statistical data are utilized and, where necessary, corrected for submarine demographics. For instance, the composite Navy pregnancy rate is heavily influenced by the E1-E3 community. Submarines have virtually no personnel in these categories and the pregnancy rates are adjusted to consider only personnel in the paygrades assigned to submarines. The model utilizes these events and rules to simulate the coming and going of personnel throughout the operating cycle and calculates output over several thousand deployment cycles.

Table 3.4-1
SAPM Model Considerations

<u>Category</u>	<u>Comment</u>
Disqualification Rate	Combined rate for all causes. Same for male and female.
Sick Days	Individual rates provided for male and female. This rate reflects non-availability and not merely visits.
MEDEVAC Rate	Based on COMSUBLANT and NHRC data.
Pregnancy Rate	1992 NPRDC data adjusted for demographics
Officer Management Rules	Reviewed by BUPERS. Included prioritization and allowable gapping based on time in operating cycle
Enlisted Management Rules	Same approach as officers with the addition of slightly more complex rules for dealing with the mix of Sex/Rate/NEC/Paygrade. Management effort to maintain equal hot bunking simulated.

Submarine disqualification data was obtained from the Submarine Type Commanders. Since there are no female submariners the data is based on a male population. The disqualifications are broken down into a number of categories but in the absence of information to identify male-female differences a single composite disqualification number was used and applied to both men and women.

The issue of work days lost due to illness and injury required more careful assessment. Data from the Naval Health Research Center^{58,59} and the U.S. Department of Health and Human Services were reviewed.⁶⁰ While both showed a consistently higher utilization of health care services by females, both also showed an insignificant difference in work days lost when conditions related to pregnancy were separated. The model used an equal number of days missed by male and female personnel and treated pregnancy as a separate issue.

The rate of expected medical evacuation (MEDEVAC) in a ship with a mixed gender crew, as compared to an all male crew, is predicted to be higher by both the Naval Health Research Center⁶¹ and Commander Submarine Force, U.S. Atlantic Fleet (COMSUBLANT). The NHRC data is based on surveys of various Navy commands and the COMSUBLANT data is based on evaluation of mixed gender crews assigned to submarine tenders. The projected increases in MEDEVAC from the two sources are comparable and this increase is reflected in the model. The increase is equivalent to an average of less than one additional evacuation per ship per 18 month deployment cycle. The all male rate is 1.3 evacuations per year and the mixed gender rate is about 1.5.

The model assumes that a pregnancy testing policy is in effect and that pregnant service members are transferred from shipboard duty at the time pregnancy was detected. The pregnancy rates are obtained from NPRDC and adjusted to the submarine population.

3.4.2.2 Analysis of Results

The quantitative results of the model are clearly limited to the differences which arise from pregnancy. In the case of the 10% female fraction crew an individual submarine experiences about 12 unplanned losses per 18 month deployment cycle. About 1 in 8 of these is pregnancy related and these, on the average, result in less than one additional MEDEVAC during the deployed period. The results for the 20% case are proportional.

⁵⁸ Naval Health Research Center 1990. Sex Differences in Health Care Requirements Aboard U.S. Navy Ships:Report Number 90-2

⁵⁹Naval Health Research Center 1990:Health Care Requirements for Women Aboard Combat Logistics Force (CLF) Ships:Final Briefing

⁶⁰HHS 1992. Vital and Health Statistics - Current Estimates From the National Health Interview Survey, 1992

⁶¹Naval Health Research Center 1990. Sex Differences in Health Care Requirements Aboard U.S. Navy Ships:Report Number 90-2

The remaining unplanned losses are evenly distributed among male and female personnel. While no statistical difference is seen, observation of the model in operation showed a clear impact of the unplanned loss of female personnel. The model ran slower and took longer to solve these problems. This is directly related to the difficulty in managing a very small cadre of personnel distributed over a broad rate/NEC structure complicated by the need for a same sex replacement due to bunk management requirements; i.e., a bunk is always dedicated to one sex.

3.4.3 Conclusions

The primary difference in personnel readiness of mixed gender crews is the result of pregnancy. The actual number of pregnancies per deployment cycle is small and a corresponding increase in the probability of MEDEVAC while deployed is noted. A different detailed analysis would be required to assess the significance of these potential decreases in personnel readiness on combat/mission effectiveness.

The increased management effort cannot be quantified within the scope of this project but may be significant. A more detailed simulation with new and possibly more complex rules would be required to model the full complexity of the submarine mixed-gender personnel management process. The observations suggest that the size of the female component and the size of the component in specific rate/NEC elements must be carefully considered if a mixed gender submarine force is pursued.

The results and observations are considered to be worst case. The data used is all Navy data and does not account for the effects of attitudes of volunteers and more highly educated/trained personnel. Numerous studies by military and civilian medical experts strongly suggest that highly motivated and better educated personnel require less medical care, have fewer medical absences, and in the case of pregnancy, a much lower rate of unplanned pregnancies appears to occur. In the absence of supporting data, there is also no credit taken for areas of disqualification and unplanned losses where the addition of female personnel might result in improvement.

The conclusions presented are applicable only to operational submarines. The impacts of female submarine assignment on the rest of the submarine infrastructure (training,

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pipeline, shore commands, etc.) has not been assessed. New personnel models may be required to conduct a complete assessment.

APPENDICES

- A. Secretary of the Navy Memoranda
- B. People/Agencies Contacted
- C. Bibliography

Appendix A



THE SECRETARY OF THE NAVY
WASHINGTON D C 20350-1000

29 April 1994

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE (PERSONNEL AND
READINESS)

SUBJ: Direct Ground Combat Definition and Assignment Rule

In response to your request (Tab A), I recommend full adoption of Marine Corps plans for implementing the Direct Ground Combat Definition and Assignment Rule as outlined at Tab B. These plans would open 33 additional Military Occupational Specialties and nine units currently closed to women. This represents a major increase in opportunities for women in the Marine Corps, particularly in light of the fact that ground combat is their primary mission.

I recommend adoption of Navy plans for implementing the Direct Ground Combat Definition and Assignment Rule, as outlined at Tab C. It should be noted that submarine warfare is the only career field we recommend remain closed to women (officer and enlisted) for reasons other than direct ground combat or collocation with direct ground combat forces. While opening submarines to women is considered cost prohibitive at this time, I have directed the Navy to review this assignment policy on an annual basis. The following specific guidance applies:

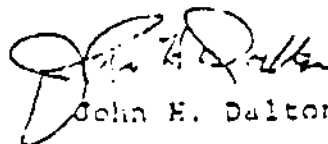
- Submarines will remain closed to women at this time.
- The design of new classes of submarines shall give due regard to accommodating the assignment of women to the fullest extent practicable in view of the distinctive elements of service that exist for this type of vessel.
- Review of designs of new classes of submarines will not preclude ongoing examination of current classes of submarines for possible accommodation of women.

The Navy's plans, as outlined here, do not open any additional positions or units to women that had not previously been opened as a result of the Secretary of Defense's 28 April 1993 assignment policy change and November's repeal of the combat exclusion. Currently, over 96% of all ratings and designators and over 94% of all positions are open to Navy women.

These recommendations have been coordinated with the Army and the Air Force at the Service and Secretariat level.

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I am confident that we have conducted a comprehensive review that meets all of the Secretary's criteria and demonstrates our commitment to expanding opportunities for women in the Department of the Navy.



John H. Dalton

Tab A - SECDEF memo of 13 Jan 94
Tab B - USMC Implementation Plans
Tab C - USN Implementation Plans

SUBMARINE ASSIGNMENT POLICY ASSESSMENT



THE SECRETARY OF THE NAVY
WASHINGTON, D. C. 20380-1070

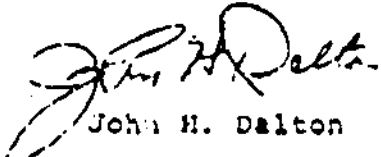
29 April 1994

MEMORANDUM FOR CHIEF OF NAVAL OPERATIONS

SUBJ: Policy Review on Assignment of Women to Submarines

I have forwarded your proposed plans for implementing the Direct Ground Combat Rule to the Under Secretary of Defense (Personnel and Readiness) with my recommendation that they be adopted. I have also advised the Under Secretary of Defense (P&R) that submarines will remain closed to women at this time. However, in considering the design of new classes of submarines we will give due regard to accommodating the assignment of women to the fullest extent practicable consistent with cost and other considerations for this type of vessel. In addition, our review of designs of new classes of submarines will not preclude ongoing examination of current classes of submarines for possible accommodation of women.

Please conduct reviews of the policy restricting the assignment of women to submarines as outlined above. These reviews should be conducted annually, with your first report due to the Standing Committee on Military and Civilian Women in the Department of the Navy in April 1995. Your review should give full consideration to the importance of expanding opportunities for women into the submarine field, as well as the cost effectiveness of the shipboard modifications necessary to facilitate mixed gender crews.


John H. Dalton

Appendix B
List of Agencies and People Contacted

This appendix provides a complete listing of all agencies and personnel officially contacted and the subject matter/purpose of each contact. In addition to these contacts, the members of the review team as well as many of the personnel contacted had informal discussion with numerous personnel who provided additional insight into the topic and associated issues and concerns.

<u>Name</u>	<u>Position/Affiliation</u>	<u>Area of Discussion</u>
BAISDEN, Denise	Physician, Flight Medicine Johnson Space Center	Studies of mixed gender groups in confined environments
BILGORE, Beverly	Inspector General COMSUBLANT Staff	Submarine force data and interpretation
BLAIR, Sidney	Capt., MC, USN Chief of Psychiatry National Naval Med. Cen.	Performance factors in confined environments. Dr. Blair has written extensively on the Antarctic experience.
BLANCO, Thomas	Division Head Assignment Systems Naval Personnel Research and Development Center (NPRDC)	General Personnel Research Issues
BYMAN, Mike	LCDR, USN Bureau of Naval Personnel	Submarine Officer Data
CAVEY, Bruce	CAPT, USN COMSUBLANT Staff (N1)	Submarine Force personnel issues and experience with women on tenders
DEAN, Larry	CAPT, MC, USN Commanding Officer Naval Health Research Center (NHRC)	Medical Research Issues
ENGLISH, Rocky	CAPT, USN COMSUBLANT Staff (N3)	Submarine Force Readiness and Operations
FLYNN, Chris	Major, USAF Human Systems Center Brooks AFB	Psychiatric Screening for mixed gender groups

SUBMARINE ASSIGNMENT POLICY ASSESSMENT

FRENCH, William	CDR, USN Bureau of Naval Personnel	Submarine Officer Data
HALL, Molly	LCOL, USAF 645th Medical Group	Psychology of Mixed Gender Groups in Confined Spaces
HENRY, Joseph	CAPT, USN Bureau of Naval Personnel	Submarine and Nuclear Propulsion Personnel Matters
JORDAN, Roy	Naval Personnel Research and Development Center	Manpower Modeling
JOSEY, Carl	LT, USN Bureau of Naval Personnel	Enlisted Personnel Matters
MAHONEY, Will	National Archives	Records of the Presidential Commission
MARSH, Roy	Physician Johnson Space Center	Bio-Behavioral Studies
McCARTHY, James	General, USAF (Ret.) Professor, USAF Academy	General Topics. General McCarthy teaches a course on women in the military.
NICE, Stephan	Scientific Director NHRC	Medical Research Projects and Results
OOSTERMAN, Carl	CAPT, USN NAVSEA (08)	Naval Reactors and Ship Studies information
QUESTER, Aline	Ph.D. Director, Resource Analysis Center for Naval Analysis	Review of previous work on women in the Navy
RATTE, James	CDR, USN Bureau of Naval Personnel	Enlisted personnel matters and data
SACK, David	CDR, MC, USN COMSUBLANT Staff	Submarine Medical Matters
SANTY, Patricia	Ph.D. University of Texas	Psychological aspects. Doctor Santy is an expert on the psychological aspects of space flight and crew selection
SCHLICHTING, Chris	Physician Sub. Med. Research Lab.	Psychiatric and psychological performance and screening
SCHULTE, J.J.	MAJ, USAF 645th Medical Group	Psychiatric/psychological implications of long term confinement

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SEGAL, Mady	Ph.D. Professor of Sociology University of Maryland	General topics on sociological aspects of mixed gender assignment. Dr. Segal is an expert in military sociology
SHAKE, Caron	LT, MSC, USN Navy Medical Research Inst.	Experiences in mixed gender groups (divers) and work in submarine related topics
SPISHOCK, Patricia	CAPT, USN Commanding Officer NPRDC	General Personnel Research Issues
THOMAS, Marie	Pers. Research Psychologist NPRDC	General Personnel Research Issues
THOMAS, Patricia	Director, Women/Multi-cultural Research NPRDC	Previous and ongoing assessments of women in the Navy
WEYBREW, Benjamin	Retired	Mr. Weybrew is an expert on the psychiatric screening and evaluation of submarine personnel
WHITE, Sarah	MSgt ,USAF Reserve	General issues. Ms White was a Commissioner on the Presidential Commission on the Assignment of Women in the Armed Forces

Appendix C
Bibliography