Women Ashore: The Contribution of WAVES to US Naval Science and Technology in World War II

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On 30 July 1947, US Navy (USN) women celebrated their fifth anniversary as WAVES: Women Accepted for Volunteer Emergency Service. In ceremonies across the country, flags snapped and crisp young women saluted. Congratulatory messages arrived from navy brass around the globe. The Commander-in-Chief (C-in-C) of the Atlantic Fleet, Admiral William H.P. Blandy, noted (perhaps too optimistically) that "the splendid services rendered by the WAVES...and their uncomplaining spirit of sacrifice and devotion to duty at all times" would never be forgotten by "a grateful navy."' Admiral Louis E. Denfeld, C-in-C Pacific, wrote more perceptively that "the vital role" played by the WAVES "in the defeat of the Axis nations is known to all and, though often unsung in peacetime, their importance has not decreased." Significantly, Admiral Denfeld added that he would welcome the addition of the WAVES "to the Regular Naval Establishment," an issue then hanging in the balance.' Indeed, for all the anniversary praise, the WAVES' contribution to wartime successes did not even guarantee them a permanent place in the navy once peace returned nor, until recently, has their "vital role" in the Allied victory received much scholarly attention. This article helps to round out the historical record by briefly surveying one aspect of the role of the WAVES: their contribution to naval science and technology.

The navy has always been a technical service but World War II was the first truly technological war. The demands of a two-ocean campaign placed enormous pressure on the USN to develop its scientific and technical capabilities and to train skilled operators for increasingly sophisticated technical devices. While it is widely agreed that "the scientific war was won in large measure by the Allies because they were more successful than their enemies in mobilizing their scientific, technical, and engineering expertise," until now no one has examined what part women played in that mobilization.'

In the last fifteen years there has been an encouraging increase in studies of American women at war. Some of these focus on the home front and the way in which women have coped in wartime, or they examine the traditional female role of nursing. Collections of wartime letters illuminate civilian and military women's varied personal experiences, and other accounts have analyzed the broad societal changes brought on by the war.' There are also some well-documented general works covering American military

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women in various wars and in each of the services, as well as accounts of Allied women in World War II. The US Army commissioned an official history of its women (WACS); in general, the WACS have received more scholarly attention than the WAVES. What is most conspicuously absent, though, is detailed information on women's scientific and technological activities.'

While there are some general institutional histories of women in the USN, these usually cover the whole span of American history, with only comparatively brief chapters on World War II. Most of these accounts give long lists of wartime jobs filled by women — including highly technical jobs but they seldom analyze WAVE occupations or give details of the specific skills and training their jobs required.' Lively WAVE memoirs also continue to appear in growing numbers; the best recent one is by former WAVE director Capt. Winifred Quick Collins. But though most memoirs provide colour and valuable anecdotal information, the genre is by definition personal and restricted in scope.' Scholarly military and naval journals have published very little on navy women, nor has there been much mention of women's war work in science and engineering journals. Female scientists barely appear in otherwise excellent accounts of American scientific developments in World War II, and none of the recent studies of naval technology or navy policy-making identify any specific contribution made by women.'

The military and scientific/technical/engineering professions have been dominated traditionally by men, and that was certainly true in World War H. But when men were sent to sea, the USN urgently needed people to take up the slack in every sort of shore operation, including the technical. Women filled that need and, though never more than two percent of the total naval forces, they played a valuable and perhaps surprising part in the navy's race for technological supremacy.

Because the navy's challenge in mobilizing women was significantly different from its traditional use of manpower, there is something to be learned from examining its ultimate success in this area. Women with scientific and technical skills had little incentive to join since, unlike men, they were never subject to compulsory military service. Indeed, the draft enhanced the civilian careers and earning power of many women, stiffening the competition faced by the USN. Moreover, the pool of technically-skilled women was much more limited than that of men. Before the war, few women graduated with technical degrees of any sort; fewer than a dozen per year in engineering, for example. The navy was further handicapped in its effective use of women by a pervasive institutional (and societal) skepticism about women's technical aptitude and ability. In the end, however, wartime necessity overcame many of these constraints. Vigorous publicity campaigns encouraged women to volunteer and effective training programmes remedied deficiencies in skills, confounding contemporary expectations. Women ultimately proved essential to the vast expansion of US naval science and technology in World War II.

My definition of activities affecting the naval scientific war is broad, though I exclude nursing, both because it was a well-established field considered suitable for women and because it has been well-covered already. I include the use of technical skills, work with technical equipment, scientific research, development and use of technological devices, and training of others in each of these fields. In this overview I will examine how the navy obtained the women it needed, how they were trained to fill scientific and

technical positions, and how they functioned in jobs for which many believed they were mentally and temperamentally unsuited. The results demonstrate the breadth, depth and significance of the WAVES' contribution to naval science and technology during the conflict.

In early 1942, a generally reluctant navy was driven to consider unorthodox sources of personnel, especially when the newly-created War Manpower Commission declared itself unable to supply a sufficient number of men to satisfy the needs of the projected naval expansion. As Dean Virginia C. Gildersleeve of Barnard College expressed it later, "if the Navy could possibly have used dogs or ducks or monkeys, certain of the older admirals would probably have greatly preferred them to women." But the admirals were pressured by Congresswoman Edith Nourse Rogers of Massachusetts, who sponsored a bill to admit women to the army and who then cast her eye on the navy. Uncertain how to proceed, the navy directed Gildersleeve and a select group of academic women with no knowledge of naval affairs to draw up the initial plans for a women's naval force. This would be a costly abdication of responsibility on the part of the navy, leading to unnecessary confusion and inefficiency during the WAVES' early days.9 Gildersleeve was appointed to chair the Advisory Council for the Women's Reserve United States Navy, and her national reputation attracted a remarkable group of very able women to head the proposed new force. Among them was Mildred McAfee, at forty-two the still youthful president of prestigious Wellesley College, who soon became the first director of the WAVES. Interviewed after the war, McAfee ruefully acknowledged that it might have saved the navy some confusion "had the supervision of the admission of women been put in the hands of an experienced naval officer." [10] On the other hand, initial weaknesses in operational procedures were offset by the calibre of the women Gildersleeve's academic connections attracted, and by the high standards these women established for all WAVES. While the Advisory Council received little guidance from the navy, it did have a precedent to follow. A small number of enlisted women — the so-called Yeomanettes — had served in the USN in World War I. But the loophole making that possible had been plugged, and the Naval Reserve Act of 1938 confirmed the restriction of reserve service to "male citizens of the United States." Congressional action would be required to reverse this.

In World War I the Yeomanettes filled mostly navy yeoman's jobs ashore as clerical workers, telephone operators; translators, stenographers, and typists. Thereafter, many legislators (and naval officers, too) believed that any clerical expansion required by war could be met by hiring more civil service personnel. They failed to anticipate both the coming shortage of civilian employees generated by the military build-up and the rapidly increasing sophistication of warfare and weapons requiring not only clerical workers but also technically-trained personnel. While women with clerical skills would remain indispensable to the navy in the Second World War, the additional demand for technical and scientific skills grew quickly. In the absence of sufficient men, women would have to supply those skills»

This was far from apparent to most of the naval establishment. The WAVES' haphazard beginnings reflected the general dislocation of a service which grew from around a quarter of a million in 1941 to well over three million by 1945; 100,000 of these were women. Yet in December 1941, when the Bureau of Navigation (BuNav, soon the

Bureau of Naval Personnel) questioned naval commands around the country on their need for navy women, the answers were almost unanimously negative. [12] Even Assistant Secretary of the Navy James Forrestal clearly indicated his belief that "the Navy had no place for a women's corps."13

Only the Bureau of Aeronautics (BuAer, the youngest and most technical branch of the navy) and the Chief of Naval Operations (CNO) responded enthusiastically to the BuNav query. BuAer recognized "the educational and social changes which have taken place between the two periods of service," and quickly determined they could employ women "in a wide variety of technical and skilled positions."[14] Also looking ahead, CNO foresaw an increasing need for communications personnel under military discipline and control to reduce security risks and to be available for work around-the-clock. To fill these needs, CNO advised that an adequate Women's Reserve be begun without delay. Less than two years later, on 30 September 1943, 776 WAVE officers and 3262 enlisted personnel worked for the Vice Chief of Naval Operations (VCNO) in all communications areas, including cryptanalysis and hydrographics. On 2 January 1942 BuNav, ignoring the pervasive myopia of respondents to its survey, advised the Secretary of the Navy to request legislation permitting the employment of women in a naval reserve for duty ashore.15

Advocates of women in the military, with no coherent plan and facing stiff opposition, took almost eight months from the outbreak of war to persuade Congress to establish the WAVES. Top navy officials accepted the idea of bringing women into the service once they began to feel the personnel crunch and to note the lack of other options. After strong opposition from conservative senators led by Naval Affairs Committee chairman David Walsh, a bill was finally passed on 30 July 1942 accepting women into the naval reserve, albeit with limitations. They would be temporary emergency personnel only, signed on for the duration of the war plus six months, and restricted to serving ashore within the forty-eight states. No numerical limits were set, but Rear Adm. Randall Jacobs, Chief of Navy Personnel, had told the Senate that he thought numbers "will probably go up around 10,000 before we get through with it." There was a cap on promotions, however; Mildred McAfee was to hold the top post with the rank of lieutenant commander; only thirty-five WAVE lieutenants were authorized; and no more than thirty-five percent of the remaining officers could be lieutenants (junior grade). These narrow restrictions reflected a failure of strategic vision among legislators, and Senate debates emphasized their parochial concerns. Instead of galvanizing the nation for all-out war, Senator Charles Andrews of Florida wanted to be reassured that "there would not have to be another Annapolis, would there?"16

When a representative from the Bureau of Ordnance informed the Senate committee that his bureau already employed some civilian women engineers, quite a few women draftsmen, and some other women in technical and professional positions, several senators expressed disapproval. Far from being reassured, they insisted that women were really only suited to clerical work or nursing. Admiral Randall Jacobs explained to the legislators that navy women were needed not only for clerical work but also for communications of all sorts, coding work, "cryptoanalysis," photographic interpretation, radio and electronics, and as laboratory technicians. But Senators Harry Byrd (Virginia), Allen Ellender (Louisiana), Charles Andrews (Florida), and David Walsh (Massachusetts)

still wanted to be assured that such jobs would involve only "desk work." A cornered Admiral Jacobs was finally driven to respond "Yes; in some instances."17

Legislators were not the only ones, though, who did not seem to grasp the nature and dimension of the wartime personnel problem. The navy was also hobbled by service-wide, patronizing cultural attitudes towards women. But the navy's deeper weakness was strategic, part of a general "slipshod planning system." Throughout the war the USN remained unable to establish a reliable method of estimating manpower requirements. In early 1944, for example, there was still no comprehensive manpower plan for the summer of 1945. Small wonder, then, that in 1942 the Bureau of Personnel (BuPers) estimated it would need only 10,000 WAVES in total. When BuAer immediately requested 20,000 women, BuPers hastily revised its estimate upwards. Ultimately, as noted before, more than 100,000 women served in the wartime WAVES.18

When even a ninety-seven-year-old woman volunteered for coast watcher duty, it was evident that women were prepared to tackle unconventional occupations during the national emergency. As soon as rumours started that Congress was considering establishing a women's naval auxiliary, queries arrived at the Navy Department from interested individuals and groups. Typical was the telegram from the Chairman of the National Women's Council of the Navy League, which noted that the Council had "at least twenty candidates, all college graduates, for the women's reserve of the navy. We are eagerly awaiting to hear where they may apply and when. "[19] At a time when university degrees were still rare in America, this is indicative of the high educational calibre of many women attracted to the USN. Fewer than five percent of all men in the Army had sixteen or more years of education at that time, and only twenty-eight of the ninety-six Marine Corps generals on active duty during the war had college degrees.20

In spite of promising early signs, women did not flock to the navy and vigorous recruiting began at once, particularly among women scientists from college faculties and student bodies. Eventually, strenuous publicity campaigns using newspaper and radio ads were also required to attract sufficient numbers. The limitations on rank and the restrictions of military discipline undoubtedly deterred many well-qualified women who held more responsible positions at higher salaries than lieutenants in the navy.[21] In Britain, too, the armed forces had trouble attracting sufficient numbers of women, even after March 1941 when all women between the ages of nineteen and forty had to register at employment exchanges so that the Ministry of Labour could direct them to essential war work.22

In August 1942, the week after the formation of the WAVES, *Newsweek* reported that engineering, astronomy, metallurgy, statistics, and physics were "especially desired" skills in WAVES recruits. The navy, however, faced stiff competition for scientific women, including from companies with navy contracts like Du Pont, Bell Labs, Grumman Aircraft, GE, Kodak, Raytheon, and Sperry. Unlike the navy, civilian corporations had no mandated caps on salaries or promotions, and by December 1942 the *New York Times* quoted a corporate director of engineering admitting "we'll give an aeronautical engineer any job in the place she wants." The story is not simple, though. While Raytheon hired a woman engineer in 1943, it also began losing technically-trained women to the WAVES, SPARS (coast guard women), and Women Marines. [23] Indeed, as a group women in the US military were better educated than their male counterparts, nearly twenty

percent of whom were found to be functionally illiterate. All military nurses were nursing school graduates, of course, while seven percent of other female personnel were college graduates; fifteen percent more had some college; an additional forty-one percent had completed high school; and only six percent had never been to high school. [24] At the same time, only 13.6 percent of the armed forces as a whole had some college; twenty-four percent were high school graduates only; while thirty-five percent had only an elementary education.[25] In fact, though there were few women with formal academic scientific or technical qualifications, there were many more with technical skills than degree statistics suggested. The war brought many of these women to the navy. More significantly, this number was greatly enhanced by the rapid acceleration of technical training both outside the navy and within.

Many women (and men also) acquired skills specifically recommended by the army, navy, and defence industries in specially-designed courses offered to the public at participating colleges across the country. As early as October 1940, Congress appropriated $9,000,000 for the cost of condensed college-level engineering courses designed to meet the shortage of engineers trained in fields essential to the national defence. The Federal Security Agency of the US Office of Education administered the programme known as ESMDT (engineering, science, and management defense training), and in 1941 over 2300 ESMDT-sponsored courses were offered in 144 engineering schools in the United States and Puerto Rico. The following year Congress voted an additional $17,500,000 to expand the program to include training for chemists, physicists and production supervisors. Once the war began, the program accelerated, changing its name to ESMWT, for war training. While courses had educational prerequisites, there were no restrictions on participants regarding their "age, sex, race or color."26

Barnard College for Women at Columbia University established its own Faculty National Service Committee to examine the contents of all courses which might be of value as "war minors" to students majoring in the various departments. As far as possible, such courses were to be related to "requirements of Civil Service, Army, Navy, or other war works demands," to help prepare students to join the war effort. Barnard's geology department identified meteorology, geological survey work, work in photogrammetics, and courses in topographical drafting as suitable war minors. For each of these a good foundation in mathematics and physics was required. As well, Columbia University's School of Engineering contributed to the ESMDT and war minors programs with such courses as "Chemistry of Powder and Explosives," intermediate and advanced courses in electronics and radio frequencies, and a course in photo-micrography. On 19 February 1942, professor of engineering Frank Lee suggested to Dean Gildersleeve, who headed the Faculty National Service Committee effort, that they institute an ESMDT course in statistical drafting. This was in response to "a request...by the Navy Department for chartists for immediate employment by the navy."27

Similar ESMDT/ESMWT and war minor courses were offered at many women's colleges, including Bryn Mawr, Manhattanville, New Jersey College for Women, Sweet Briar, Goucher, Pembroke, Skidmore, Radcliffe, and Wellesley. The Committee on College Women Students and the War, under the American Council of Education, was also active in promoting "significant plans or programs for the higher education of young women to prepare them to meet the specific needs already developed in the war period."

One of the most successful of these programmes was the joint NYU-Vought-Sikorsky venture, which was specifically instituted to train women as aeronautical engineers. Vought-Sikorsky Aircraft Division of the United Aircraft Corporation produced, among other navy items, shipboard fighter planes such as the F4U-1 Corsair.28

Women also attended night schools set up in cities and towns to provide training in such essential fields as radio and electronics. Many graduates of these programs applied for the USN with their newly-acquired credentials. Among these women was Sue King. Realizing early on that war was likely, King took a course in aeronautics at Louisiana State University and then a preflight course at Centenary College. Already holding a master's degree from the University of Texas, she completed a course in higher mathematics at Columbia, and when the navy opened to women she signed on. In 1943, Ensign King went to the Naval Air Navigation School at Hollywood, FL, for training. In March 1944, she was assigned to the Aviation Training Division of the Office of the CNO where she worked on research and development of carrier navigation procedures, and wrote a training manual entitled "Mark III Plotting Board Instructions for Use and Problem Portfolio." After fifteen months, King went to Quonset Point, RI, for research on navigating by radio, radar, loran, altimetry, dead-reckoning, and pilotage. In January 1947, after a short stint at the Naval Aeronautical Laboratory at Banana River, FL, Lieutenant King was assigned to the Air Branch of the Office of Naval Research to develop an air navigation research program. Sue King represents the combination of education, prewar experience and specialized training in the naval service at the heart of the WAVES' contribution to the scientific war.29

After haphazard beginnings, WAVE recruitment, training, and job assignment soon settled into a well-organized and effective routine. Boot camp for enlisted women became centralized at Hunter College in New York City, and WAVES officers received indoctrination training at the Naval Reserve Midshipmen's School (WR) on the Smith College campus in Northampton, MA. The efforts of McAfee, Gildersleeve, and the Advisory Council attracted many exceptional women to the navy in spite of the irksome restrictions. There were four college deans in the initial classes at Smith, and more degrees than there were WAVES. Of the professional and business women, some were specialists in technical fields, such as engineering, radio, and meteorology. [30] Enlisted women also sustained the WAVES' reputation for quality. Many were unsophisticated young women from rural America attracted by hopes of adventure, although in general most WAVES seem to have come from middle-class backgrounds, and strict chaperoning and social codes carefully maintained an impression of gentility. [31] This was even more true of the British WRENS (Women's Royal Naval Service), whose all-volunteer force was widely regarded as the most socially select of the women's services. [32] US WAC recruiting, on the other hand, was persistently hindered by "slanderous, mocking rumors" of general loose and immoral behaviour in the corps. [33] Many enlisted WAVES were college graduates qualified to become officers but initially unable to obtain commissions because of the tight numerical restrictions. Among this group was Emily B. Saltonstall, daughter of the governor of Massachusetts. Though pronounced eligible to join the next available officer class, Emily Saltonstall chose instead to accept immediate service in the navy. She was sworn in as apprentice seaman on 2 September 1942, even though she already held the rank of major in the Women's Defense Corps, where she was in charge

of all communications. By fall 1944, the majority of WAVE officers were chosen from enlisted ranks.34

Soon WAVES were serving in every bureau of the Navy Department and in every naval district in the continental US. At first, the congressional mandate allowing WAVES only to replace men for sea duty was adhered to strictly. This led to some peculiar assignments that often did not make best use of WAVES' skills and training. But with the rapid expansion of the USN, women were moved into many new positions, often gaining real scope for their particular skills. Eventually WAVES replaced 50,000 men for sea duty, and filled almost 50,000 new jobs.35

After basic training, some enlisted women were assigned to duty as seamen 2nd class, while most were selected by aptitude tests for specialist schools. It is no surprise that a majority of enlisted women ultimately served as yeomen and storekeepers. The next largest group, however, were medical specialists in the Hospital Corps, where they worked in the wards and offices, clinics, laboratories, and therapy departments. A report issued in 1951 showed that during World War II there had also been 390 WAVE officer medical specialists serving as laboratory technicians, dental hygienists, and occupational and physical therapists. Forty-one of the women were doctors, two were dentists, and two more were civil engineers.[36] Many of these women — enlisted and officers — like Elisabeth Gaskill from Belmont, MA, were trained by the Bureau of Medicine and Surgery in much needed specialties.

On 2 September 1942, Gaskill was sworn in to the navy as apprentice seaman 2nd class. Because she had just graduated from Smith College with a pre-med major, Gaskill was soon assigned to the Hospital Corps for training; she made pharmacist's mate 2nd class early in 1943. After studying at the Massachuse tts General Hospital in Boston, Gaskill received a certificate from the Bureau of Medicine and Surgery as a qualified assistant in electroencephalography. By June 1943, Gaskill was head technician at the Brain Wave Laboratory at the US Naval Hospital in Chelsea, MA, where she made tests on epileptic, seasick, and psychoneurotic patients, and those suffering from brain tumours or head injuries. She also gave electroencephalographic tests to all applicants for the Aviation Cadet Corps in the First Naval District who had a history of head injuries. As a result of her good work in the Brain Wave Lab, Gaskill was recommended for officer training, receiving a commission as ensign on 14 December 1943. By March 1944 Ensign Gaskill was on her way to the Naval Air Training Center in Pensacola, FL, where she was instructed in the operation of low-pressure chambers. WAVE officers took the two-month course in low-pressure chamber technology in groups of ten, working closely with the navy's Altitude Training Unit to gain practical experience. Gaskill then put this training into practice at the Naval Air Station (NAS) at Quonset Point, RI, where she, twenty-six other women, and two men comprised the low-pressure chamber personnel.37

A number of WAVES in the Bureau of Medicine and Surgery (BuMed) were also involved in devising tests and outlining procedures for the assignment of navy women to appropriate billets. This included establishing requirements for such medical specialties as clinical training in occupational and physical therapy. WAVES also devised aptitude tests for women assigned as control tower and Jam Handy operators, cryptographers, and others thought to require specific personality and ability profiles.38

Almost alone in the navy, the Bureau of Aeronautics had correctly anticipated its wartime expansion. In the course of the war one-third of all WAVES were assigned to this rapidly-growing field in which many were yeomen and storekeepers, bakers, mailmen and cooks, but many others had technical jobs in aerology departments, parachute lofts, control towers and hangars. Enlisted women were sent to Naval Training Stations in Norman, OK, and Memphis, TN, where they learned to become aviation machinist's mates and aviation metalsmiths. They took radio operator courses at the University of Wisconsin and trained to be Link Trainer Instructors to operate blind flying equipment at the US Naval Reserve Aviation Base in Atlanta, GA. They also went to NAS Lakehurst, NJ, for training as parachute riggers or as aerographer's mates to do technical work with weather instruments, charts and weather obse rvations. Once trained themselves, WAVES were used as instructors to pass on their new skills to male fliers and future air crews; 1000 WAVES taught instrument flying to 4000 men a day, while two WAVE officers and an enlisted woman were awarded the French Cross of Lorraine for training French pilots at Pensacola, FL. WAVE aviation mechanics serviced and repaired planes and engines for which they needed practical mathematics and a knowledge of simple blueprint reading. Women were trained as degaussers to demagnetize ships. For this a "knowledge of physics and/or electrical engineering [was] desirable." WAVES with a knowledge of telegraphy became Land Line supervisors handling single-traffic telegraph lines. A background in amateur or professional photography was necessary to strike for Photographer's Mate, and a knowledge of developing, printing, sorting, and splicing was helpful. Aspiring Licensed Radio Operators should have had experience in coding and in operating a radio set, and if possible should have a knowledge of electricity. "Any person whose past hobby has been operation of a `ham' sho rt wave set [is] especially desirable."39

Virginia Scott Potter of Kansas City was just the so rt of person the navy needed. Enlisting in the WAVES in 1942, Potter already had a short-wave radio operator's license. Through hard work and skill, Potter rose from apprentice seaman to chief petty officer (CPO), becoming the first WAVE chief radioman. In June 1945, CPO Potter was supervisor of sending and receiving messages in the communications department at NAS Floyd Bennet Field, New York. She also wore the navy dark blue ribbon of expe rt pistol shot. CPO Potter out-rated two of her se rvice brothers and had levelled with the third, a navy chief storekeeper.40

A look at the Hydrographic Office (HO), responsible for producing naval navigation charts, gives some idea of the magnitude of the navy's training task. The HO's peacetime organization included about 200 officers, all male, and civilians who produced about 2,000,000 charts annually. By October 1944, the Hydrographic staff had grown to 1600 officers, enlisted personnel (mostly WAVES) and civilians, generating more than 42,000,000 charts annually. Rear Adm. George S. B ryan, the Hydrographer, admitted that "the training of hundreds of unskilled personnel in the highly technical a rt of chartmaking was a tremendous job, but we still got our work out without loss of valuable time." Among other things, WAVES in this activity compiled and drafted air charts for combat areas in the South Pacific.41

Under the guidance of Dr. Ma ry Sears, the HO during the war also took on a variety of critical new responsibilities. Dr. Sears, later an internationally famous oceanographer and planktonologist, held a PhD in Zoology and Oceanography from

Harvard University. In 1938, as well as instructing at Harvard, Sears joined the Department of Zoology and Physiology at nearby Wellesley College. In 1939, in recognition of her accomplishments in marine biology, Sears became the second woman to receive an appointment to the staff of the Woods Hole Oceanographic Institution. After Pearl Harbor, Sears put her extensive scientific skills at the disposal of the navy, receiving a commission as Lt.(jg) in the WAVES in 1943. At first, Sears was assigned to Naval Intelligence, where she wrote oceanographic intelligence reports. Later, she organized and headed what was to become the Oceanographic Division of the HO, where she served until 1946. Sears coordinated the navy's oceanographic research conducted by scientists at Woods Hole overseeing, among other important projects, the study of smoke at sea and the ocean's thermal layers to help submarines avoid detection. After the war, Sears remained active in the naval reserves until 1963, retiring as a commander. But while she became eminent in oceanographic circles, Dr. Mary Sears' valuable contribution to the navy's scientific war effort has remained little known.42

For the most part, the navy succeeded in obtaining WAVES with required skills by a judicious and practical combination of selection and training. This policy is indicated at the top of a list of billets dated 1 December 1942 stating that:

> which billets will be filled by WAVES is presumed upon the qualification of a good, all-round education, not necessarily specifically or technically directed toward the duty to be assumed. Where training and experience prior to Navy enlistment is considered either *necessary* or especially *desirable,* such notation is made. In other classifications, experience is as a rule *helpful,* and of course where candidates with specific training are available, such training whenever practicable will be a basis for further instruction and assignment. But willingness and interest in the type of work, plus adaptability as shown in aptitude tests, will most frequently be relied upon to determine special technical training and assignment of the individual.43

Even without specialized training, WAVES often contributed to technically significant projects by fulfilling routine and boring assignments with scrupulous care. When vivacious, outgoing, twenty-year-old WAVE seaman 2nd class Terry Wiruth arrived at China Lake Naval Ordnance Testing Station, California, in December 1944, she was sent straight to Harvey Field. She thought this was probably because of her service with the civil air patrol back home in Dubuque. "They had the airplanes at Harvey Field," she recalled fifty-two years later,

> and they would have the ordnance on the planes, and then they had sailors giving the numbers off the hardware, and the sailors thought this work was beneath them so they would put down any old numbers. So when there was a flight and there was a bad batch of rockets or something, the scientists had no idea which batch it was, and this messed up all their calculations. So they decided, well let's try a WAVE. And

> my job was to get the right information off of the rockets and the information off of the airplane, and everything that was necessary.[44]

There was no more confusion of batch numbers once Seaman Wiruth took over. As Rear Adm. W.A. Buck, chief of the Bureau of Supplies and Accounts, later pointed out, "In performance of work which consists of a repetitive and, therefore, monotonous task... [women] are more capable since they tire less easily and retain enthusiasm for that type of work longer than do male personnel."[45] Terry Wiruth agrees with the admiral's observation about job performance, although the reason for her enthusiasm might have surprised him. When she arrived at Harvey Field, Wiruth notes, "there were sixty-five guys and me. I had a ball." Certainly, the generally greater maturity of the WAVES also affected the care with which they undertook even monotonous tasks. WAVES had to be at least twenty years-old to sign on, whereas men could enlist at seventeen with parental permission.

WAVE officers — who had to have a college degree or two years of college combined with suitable job experience — were drawn from a wide variety of occupational backgrounds. Among the 185 WAVE officers assigned to the Third Naval District (New York) in March 1943, one had been a postal censor, thirty-nine had held secretarial positions, eight had sales experience, seven were librarians and twenty-seven had been teachers. Five women had research backgrounds, and there were nine statisticians, one physiologist, one chemist, one lawyer, one botanist, and one clinical psychologist.[46] After indoctrination training, some of these women went directly to their assignments, while others, like the enlisted WAVES, went on to specialized training.

Advanced training for many WAVE officers took place in coeducational classes. Some women were selected to take the nine-month meteorology course at the Massachusetts Institute of Technology or at the University of California in Los Angeles, and others took radio courses there (see figure 1). Other colleges offered training in chemical warfare or general ordnance. More than 100 WAVES went to the University of Chicago for a nine-month course in aerological engineering, and then ran aerological operations studying the atmosphere, including its upper layers, at various naval facilities. WAVES officers trained at the Naval Aviation Training School in Hollywood, FL; the Navy Pre-Radar School at Harvard; and the Naval Technical Training Command School in Corpus Christi, TX.[47]

Additional training programs were established to keep up with the navy's rapid expansion. As the CNO had predicted, the need for communications officers grew exponentially, so a special communications training course was set up at Mount Holyoke College, a few miles from Smith. Graduates of this course and enlisted WAVE radiomen were essential to the smooth flow of information and orders. Until the last two or three months of the war, for example, Radio Central in Jacksonville, FL, was run entirely by WAVES with the exception of one male Chief. WAVES also comprised three-quarters of the personnel at "Radio Washington," the nerve center of the entire navy communications system.[48]

Massachusetts Institute of Technology

This is to certify that

Charlotte Ann Potter

has satisfactorily completed the special full-time course given for

RADIO SPECIALIST OFFICERS
of the United States Navy

during the period
May 1, 1944 – August 30, 1944

CAMBRIDGE, MASSACHUSETTS
AUGUST 30, 1944

Robert S. Williams
DEPUTY DEAN OF ENGINEERING

HARVARD UNIVERSITY

CAMBRIDGE · MASSACHUSETTS

This certifies that

Charlotte A. Potter, W-V(S)

Ensign United States Naval Reserve

has completed satisfactorily a course of instruction for officers of the United States Navy and Marine Corps on the subject of

ALTERNATING CURRENTS, ELECTRONICS, AND CATHODE-RAY TUBES

given in the Graduate School of Engineering during the period from December 1, 1943, to April 28, 1944 at an average rate of forty-two hours in session per week.

E. L. Chaffee

Director of Cruft Laboratory
In Charge of the Course

Harold M. Westergaard

Dean of the Graduate School of Engineering

From its founding in 1867, the navy's Civil Engineer Corps (CEC) had been open to men only. But in September 1943, Ensign Kathleen F. Lux became the first woman admitted to the Corps. Ensign Lux, who had an engineering degree from Purdue University, had been commissioned the previous March and had been on duty in the Bureau of Yards and Docks for several months before being granted her CEC status.49

The navy sent a number of WAVES, like Ensign Charlotte Potter, for diplomas in electricity, magnetism, alternating currents, electronics, cathode-ray tubes, and radar to Harvard University's graduate school of engineering (see figure 2). Lt. (jg) Rose Nudo, who had a mathematics degree from Penn State, was assigned to NAS Norfolk, VA, in May 1944, where she taught celestial navigation in the Celestial Link Trainer. Nudo flew in PB4Ys for additional training and experience in sun line approaches and radar jamming techniques. She was one of a select group who qualified as Air Navigation Instructors, received flight pay, and wore Technical Observer wings — the precursor to the present Naval Flight Officer.50

Officers of the Women's Reserve also held many demanding and responsible positions in laboratories doing research, taking tests, and compiling scientific information. At the Indian Head, MD, rocket power plant early in 1945, WAVES operated the laboratory, completely staffed one of the firing bays, and did approximately half the ballistics calculations. By August 1945, sixty WAVE officers and 200 enlisted WAVES were among the 2555 uniformed personnel engaged in scientific and technical work at the Naval Research Laboratory (NRL) in Anacostia. In September 1944, five WAVE officers arrived at the NRL together. They had just spent six months at Harvard and three months at MIT studying radio and radar engineering in a class of over 100 men from various branches of the military. Four of the women were assigned to radio and radar work but one of them, Marie Klein, had worked for Southern Bell before the war doing statistical work. So she was assigned to a civilian scientist and "spent all day punching a calculator, working on air-to-air missile trajectories. "[51] WAVES were not alone, of course, in doing significant scientific work for the war effort. Among the 400 WACs assigned to the Manhattan Project to produce the atom bomb there were cryptographers, chemists, metallurgists, electronics technicians, and photographers.52

Perhaps the most notable American woman scientist of World War II was the WAVE who ran calculations for the USN on the Mark 1 computer. With a PhD in mathematics from Yale University, Dr. Grace Murray Hopper taught at Vassar and Barnard before joining the navy. After graduating first in her class at the Northampton Midshipmen's School in June 1944, Lt. Hopper was sent directly to the navy's Bureau of Ships (later the Bureau of Ordnance's) Computation Project at Harvard University. There she was one of a team of five officers and four enlisted men who operated the navy's only computer, the Mark 1. Throughout the war this team (including one other woman, WAVE ensign Ruth Brendel) ran the Mark 1 around the clock, making complex calculations for navy guns, acoustic and magnetic mines, self-propelled rockets, and eventually, the atomic bomb. Hopper's wartime experience in the WAVES shaped her lifelong commitment both to the new field of computer science into which she had been plunged, and to the USN, which had done the plunging. The convergence of these forces led to Hopper's highly-productive career from which both the navy and the computer industry profited. After the war, Hopper became a pioneer in the development of

computer programming languages. In 1949 she went to work as a senior programmer for the Eckert-Mauchly Computer Corporation where, with Betty Holberton, she developed the original software for the UNIVAC 1. In the late 1950s she achieved renown as one of the creators of COBOL, a programming language still in use today. In 1966, Hopper returned to work for the USN. Her first project was to develop the Navy Tactical Data System (NTDS) for atomic submarines. After the war, Hopper continued in computers and later achieved renown as one of the creators of COBOL, a programming language still in use today. "Amazing Grace," as her colleagues fondly called her, remained an active naval reservist working on numerous programming languages which were used in the American space programme and for communication within the NATO military command structure. Esteemed both for her giant intellect and for her unceasing energy, when she finally retired as a rear admiral in 1986, Grace Hopper, then seventy-nine, was the oldest active officer in the USN.53

Hopper was well know in her later years, and she received considerably more popular attention than did Mary Sears. But apart from one juvenile biography and a number of specialized articles, there has been little scholarly examination of her career, particularly of her wartime contribution to the USN at the Harvard Computation Lab. Yet the story of the WAVES is significant not only for its star performers but also because of what it says about the high general level of competence achieved by navy women in World War II. And in spite of deep initial reservations, assessments of WAVE performance by those in a position to know were ultimately favourable.

In July 1943, a survey was conducted among fourteen representative activities to obtain a cross section of opinion on how WAVES handled their communications duties. In general, the comments were favourable, although it was suggested that WAVE officers, in particular, needed to have more practical, rather than just theoretical, training before being assigned. The District Communication Officer for the Fifth Naval District wrote on 10 August that "it might be of interest to you to know that two of the original WAVE officers who reported here in January are standing `top watch' as CWO's [Communication Watch Officer] and also are handling the job of Staff Duty Officer for ComFive." The chief of BuShips, replying to the survey in September, noted that there were eighty-three WAVE officers on duty at the Bureau in administration, maintenance, and the radio and shipbuilding divisions. In addition, there were ninety-six officers on duty throughout the country at the offices of the supervisors of shipbuilding and the inspectors of machinery. "The most cogent proof of their efficiency," wrote the chief, "is the continuous demand for more WAVES, not only from divisions which have already had some assigned to them, but also from divisions which previously did not consider them as potential replacements for male officers." Even Senator David Walsh had partly come around by 1943. "I see some of the charming young ladies who represent the WAVES here," he gushed during a Senate hearing. "We are pleased to note that we have got very excellent reports from naval officers as to the very excellent work you are doing."54

Unfortunately, some other legislators proved incapable of moving beyond their own prejudices. Soon after the end of the war, the House Naval Affairs Committee debated an initial proposal to establish the women's reserve on a permanent basis. Congressman Carl Vinson, Committee chair and long time opponent of women in the military, said he had "seen some comments in the newspapers saying that the women were

going to run the navy." His resistance did much to prevent an early favourable resolution of the issue. In fact, by 1947 the final dissolution of the WAVES was imminent, and the navy had to launch a vigorous campaign to save them. A Navy Department Press Release of 27 June 1947 urged the retention of women, even admitting that "in certain specialized fields the performance of WAVES was superior to that of men."55

Acrimonious congressional debates on the permanent admission of women to the regular navy and the naval reserve dragged on into 1948. In February of that year, Admiral Louis Denfeld, by then CNO, told the House Armed Services Subcommittee on Organization and Manpower that it was essential to provide careers for women in the regular navy in order to secure the strength and resources of "womanpower." The last war had shown that "this is particularly applicable to problems of medical and technological development...which must continue during peacetime." In a House committee debate in June 1944, Congressman Frederick Bradley, though objecting to most WAVES going overseas, had not minded the idea of WAVES in the Medical Department doing so because "that is a natural function of a woman — to take care of the sick." But this was not at all the kind of work Admiral Denfeld praised in 1948. And his view was supported by the testimony of Rear Adm. H.L. Pugh, the Deputy Surgeon General, who described the "wide scope of the usefulness of the Women's Reserve to the Medical Department in the technical and clinical fields." They had been, and would continue to be "needed in technical specialties allied to medicine, in the laboratory, in research, in rehabilitation..." Finally, Rear Adm. Earl E. Stone, the Chief of Naval Communications, made his pitch to the House committee to admit women to the regular navy. He stressed that during the war WAVES showed themselves particularly well fitted for work in coding rooms, for message traffic handling, for linguistic assignments, for cryptanalytic work, and for all phases of naval communications.56

On 2 June 1948, Congress finally passed the Women's Armed Services Integration Act after more than a year of debate. This act saved the WAVES, making them for the first time an integral part of the regular navy. But in spite of testimony about their varied capabilities, they were finally retained mostly to perform clerical functions and as a nucleus for expansion in case of a future emergency. As before, the terms of admission were grudging, numbers were limited to two percent of regular naval strength, and there was a lid on promotions.57

Often boosted by the warm support and confidence of navy men, and sometimes facing daunting opposition, the cumulative accomplishments of the WAVES were important in winning the USN's scientific war. Yet recognition of their contribution to naval science and technology still lags far behind awareness of their achievements in more traditional female roles, such as nursing. Perhaps, in part, this is because prewar resistance to scientific and technical careers for women was reasserted once the men returned and wanted their jobs back. Anecdotal evidence shows that unlike Mary Sears and Grace Hopper, most women who had performed technical and scientific work in the navy during wartime never used, nor indeed even spoke of, those skills once peace was restored. In general they returned to civilian life and participated in the new national prosperity as housewives. Their technical and scientific prowess was quickly forgotten.

NOTES

* Kathleen Broome Williams teaches at Bronx Community College of the City University of New York. The author of *Secret Weapon: U.S. High-Frequency Direction Finding in the Battle of the Atlantic(Annapolis,* 1996), Dr. Williams is currently conducting research into the role of women in the development of naval technology.

I. Naval Historical Centre (NHC), Operational Archives (OA), Records of the Assistant Chief of Naval Personnel for Women (ACNP[W]), 1942-1972, Women in Regular Navy, Official Correspondence (1946-1948), roll 13, series I, Statement by Adm. William H.P. Blandy, 30 July 1947.

2. NHC, OA, ACNP(W), Women in Regular Navy, Official Correspondence (1946-1948), roll 13, series I, Statement by Adm. Louis Denfeld, USN, US Navy Press Release, 30 July 1947.

3. David Zimmerman, *Top SecretExchange: The Tizard Mission and the Scientific War* (Montréal, 1996), 4.

4. See, for example, Sherna Berger Gluck, *Rosie the Riveter Revisited: Women, the War and Social Change* (New York, 1988); Judith Bellafaire, *The Army Nurse Corps: A Commemoration of World War II Service* (Washington, DC, 1993); Judith Barret Litoff and David C. Smith (eds.), *We're in This War Too: World War II Letters from American Women in Uniform* (New York, 1994); D'Ann Campbell, *Women at War with America: Private Lives in a Patriotic Era* (Cambridge, MA, 1984); and Peter A. Soderbergh, *Women Marines: The World War II Era* (Westport, CT, 1992).

5. See, for example, Jeanne Holm (ed.), *In Defense of a Nation: Service Women in World War II* (Washington, DC, 1998); Martin Binkin and Shirley J. Bach, *Women and the Military* (Washington, DC, 1977); C. Kay Larson, *'Til I Come Marching Home: A Brief History of American Women in World War 11* (Pasadena, MD, 1995); Mattie E. Treadwell, *The Women's Army Corps: The U.S. Army in World War II* (Washington, DC, 1954); Mary V. Stremlow, *Free a Marine to Fight: Women Marines in World War II* (Washington, DC, 1994); and Gail Braybon and Penny Summerfield, *Out of the Cage: Women's Experiences in Two World Wars* (London, 1987). For the broadest range and scope of articles on women and war, see the journal *Minerva,* a quarterly review of women and military published in Pasadena, MD.

6. See, for example, Jean Ebbert and Marie-Beth Hall, *Crossed Currents* (Washington, DC, 1993); and Jeanne Holm, *Women in the Military: An Unfinished Revolution* (rev. ed., Novato, CA, 1992).

7. Winifred Quick Collins, *More Than A Uniform: A Navy Woman in a Navy Man's World* (Denton, TX, 1997); Joy Bright Hancock, *Lady in the Navy(Annapolis,* 1972); Helen Clifford Gunter, *Navy Wave: Memories of World War 11* (Fort Bragg, CA, 1992); and Josette Dermody Wingo, *Mother Was a Gunner's Mate: World War II in the Waves* (Annapolis, 1994).

8. See, for example, Montgomery C. Meigs, *Slide Rules and Submarines* (Washington, DC, 1990); Joel R. Davidson, *The Unsinkable Fleet: The Politics of U.S. Naval Expansion in World War II* (Annapolis, 1996); Kenneth Poolman, *The Winning Edge: Naval Technology in Action, 1939-1945* (Annapolis, 1997); and Zimmerman, *Top Secret Exchange.* An exception is Susan H. Godson, "The WAVES in World War II," United States Naval Institute *Proceedings,* CVII, No. 12 (1981), 46-51.

9. For the quote, see Virginia C. Gildersleeve, *The "Waves" of the Navy: How They Began* (New York, 1956), 267. See also NHC, OA, ACNP(W), roll 4, series I, Letters/Memorandum to District/Air Command Directors (1943-1948).

10. US Naval Institute, Oral History Office, Mildred McAfee Horton, interview by John T. Mason, Jr., typescript of tape recording, August 1969. For a concurring view, see US Department of the Navy, Bureau of Naval Personnel, "History of the Women's Reserve" (2 vols., Washington, DC, 1946) (WAVES History), 37. This official history of the wartime WAVES notes that lack of professional indoctrination and guidance caused difficulties lasting fifteen months.

11. "WAVES History," I, 1-2 and 8; and Lillian Budd, "Yesterday's News — World War I," *The* Register[Newsletter of Women in Military Service for America Memorial Foundation, Inc.] (Winter 1996-1997), 8.

12. "WAVES History," I, 4.

13. Ibid., I, 4-6.

14. Ibid., I, 6-7. Women in the US Army had a similar experience; forty percent of all WACs eventually served in the Army Air Corps. See Judith Bellafaire, *The Women's Army Corps: A Commemoration of World War II Service* (Washington, DC, 1993), 12.

15. 'bid, I, 7-8.

16. Rear Admiral Jacob's quote is from NHC, OA, ACNP(W), Hearings on WAVE Legislation and Public Laws, 1942-1948, roll 19, series III, Senate hearings on S 2527, 19 May 1942. See also Hancock, *Lady in the Navy,* 55-56; "WAVES History," I, 10-12, 15 and 361.

17. NHC, OA, ACNP(W), Senate Hearings on S 2527, 19 May 1942.

18. Davidson, *The Unsinkable Fleet,* 128-131; "WAVES History," I, 235; and Hancock, *Lady in the Navy,* 61. Limitations on rank and restrictions on promotion were eased somewhat on 25 November 1943 with the passage of Public Law 441; see Hancock, *Lady in the Navy,* 69.

19. New York Times, 9 May 1942; National Archives (NA), BuPers, Record Group (RG) 24, folder QR8-5-79, box 2329, Mrs. Robert Weeks Kelley to R. Adm. Randall Jacobs, telegram, 24 June 1942; and NA, RG 19, BuShips, folder QR8, box 1197, Miss Hy Lee Small to Lt. Comdr. Charles Bittenger, Navy Department, 24 June 1942.

20. Campbell, *Women at War with America,* 22-23; and Albert A. Nofi, *The Marine Corps Book of Lists* (Conshohocken, PA, 1997), 18.

21. NHC, OA, ACNP(W), Esso Recruiting Drive, 1944, Shelf File box 1, Lt. Comdr. J. Harrison to Director of Public Relations, on the recruitment of WAVES, 27 May 1944.

22. Braybon and Summerfield, *Out of the Cage,* 157-160.

23. Raytheon Archives, Lexington, MA, Monthly Payroll Book of Chapel St. Branch, Receiving Tube Division, Raytheon Corp., Margaret Bassett, hired 9 July 1943. See also *Raytheon News,* 16 July and 5 November 1943.

24. James F. Dunnigan and Albert A. Nofi, *Dirty Little Secrets of World War II* (New York, 1994), 122.

25. James F. Dunnigan and Albert A. Nofi, *Dirty Little Secrets of the Vietnam War* (New York, 1998), forthcoming.

26. Radcliffe College (RC), Schlesinger Library (SL), Elizabeth Reynard Papers (Reynard Papers), file 127, box 8, A-128, US Office of Education, "Information Bulletin," February 1942.

27. Ibid., Faculty National Service Committee, Report of Progress, 13 March 1942; and School of Engineering to Dean Gildersleeve, 28 January and 19 February 1942.

28. New York University Archives, RG 3.0.5, Harry Chase Administrative Papers, folder 5, box 16, series I, Margaret S. Morriss, Chairman, Committee on College Women and the War, to Chase, 19 February 1943; and Chancellor Harry W. Chase to Dr. Francis T. Brown, American Council on Education, 25 February 1943.

29. RC, SL, Reynard Papers, file 127, box 8, A-128, "ESMDT Courses," undated memo; and NHC, OA, ACNP(W), Women in Regular Navy, Official Correspondence (1946-1948), roll 13, series I, "Eight WAVES Hold Important Posts in Office of Naval Research," Navy Department press release, 27 July 1947.

30. Among the distinguished women were Deans Margaret Disert of Wilson College, Dorothy Stratton of Purdue, Elizabeth Crandall of Stanford, and Louise Wilde of Rockford College. See Ebbert and Hall, *CrossedCurrents,40;* and "History of the Naval Reserve Midshipmen's School (WR), Northampton, MA," in "WAVES History," I, 242.

31. Respondents to author's questionnaires, for example Hazel Sides. Born on a homestead in

Wyoming, Sides had her first streetcar ride and saw her first elevator on the day she enlisted in the navy. See also NHC, OA, Marie Bennett Alsmeyer Personal Papers (Alsmeyer Papers), folder E-H, series III, box 3: "I too came from a small town and it was the first time away from home," Alice Kinman Eubanks to Marie Alsmeyer, 27 October 1982. See also Dunnigan and Nofi, *Dirty Little Secrets of World War II,* 122.

32. Braybon and Summerfield, *Out of the Cage,* 198.

33. Holm (ed.), *In Defense of a Nation,* 47.

34. Boston Herald, 2 September 1942; and NHC, OA, ACNP(W), Speeches, Statements and Articles of Captain M.M. [McAfee] Horton (1943-1945), roll 12, series I, Captain Mildred H. McAfee, "Article for Army Navy Journal," October 1944.

35. NHC, OA, ACNP(W), Women in Regular Navy, Official Correspondence (1946-1948), roll 13, series I, Secretary of the Navy James Forrestal, press and radio release, 30 July 1946.

36. NHC, OA, Alsmeyer Papers, folder "Memorabilia, Misc.," series II, box 3, "Enlist in the WAVES, Serve in the Hospital Corps," US Government Printing Office pamphlet, 1943; ACNP(W), Bureau of Naval Personnel, Various Status of Women Reports (1951-1964) roll 13, series I, "The Utilization of Womanpower in Navy Billets, Officer and Enlisted," May 1951.

37. Papers in the personal collection of Elisabeth Gaskill Coombs, including copies of orders, certificates of training, her Officer Qualification Questionnaire, a biographical sketch, photographs, and a certificate of honourable discharge. See also NA, RG 52, Bureau of Medicine and Surgery (BuMed), folder A21/F49-1, box 33, Commander, Naval Air Training Station to BUPers, 30 May 1944.

38. "Jam Handy" operators were film projectionists. The Jammison Handy Corp. made an enormous number of films for commercial and industrial operations from the 1930s into the 1950s. Apparently they had a special simplified projection system, which is where "Jam Handy operator" derived. NA, RG 52, BuMed, folder A18-1/EN, box 33, BuMed to Capt. John B. Farrier, 18 September 1943; BuMed to BuPers re: Establishment of requirements for clinical training, 19 July 1944; Request from BuAer for development of aptitude tests, 15 February 1943; and folder P16-3/QR8, box 28, BuPers memo to Vice Adm. McIntire re: WAVE corpsmen, 27 June 1944.

39. NHC, OA, ACNP(W), Policies for the Administration of Women's Reserve (1943-1969), roll 9, series I, BuPers memorandum list of specialties open to WR, 20 March 1945; Holm (ed.), *In Defense of a Nation,* 73; and RC, SL, Reynard Papers, file 35, box 2, A-128, "Women Reservists Rapidly Relieving Men for Sea Duty," Navy Department Press Release, 23 December 1942. "I asked an ensign about the Mechanical Corps, and the blueprinting. She said enlisted WAVES don't make the blueprints, just build the airplane motors etc. from the blueprints available:" OA, NHC, Alsmeyer Papers, folder May 1943, series I, box 1, Marie Bennett to her parents, 10 May 1943.

40. All Hands, June 1945.

41. Ibid., October 1944. For Adm. Bryan's quote, see NHC, OA, ACNP(W), Speeches, Statements and Articles of Captain M.M. [McAfee] Horton (1943-1945), roll 12, series I, Captain Mildred H. McAfee, speech, "Recruiting for North Carolina," 9 February 1944.

42. All the above information on Sears is from the files in the Wellesley College Archives, Wellesley, MA. Materials include a biographical file with press releases and clippings; the appendix to the President's Report, 1938; a letter from the Department of Zoology and Physiology to College Recorder, 28 September 1939; and *The Wellesley Magazine* (December 1939), 98.

43. RC, SL, Reynard Papers, file 44, box 2, A-128, "List of Billets," 1 December 1942.

44. Author's interview with Terry Wiruth, 30 December 1996, Ridgecrest (China Lake), CA.

45. NHC, OA, ACNP(W), roll 19, series III, House Armed Services Committee Subcommittee No. 3, hearings on S 1641, 18 February 1948.

46. RC, SL, Reynard Papers, file 124, box 8, A-128, "General Statistics Concerning Women Reservists Assigned to the Third Naval District," 7 March 1943.

47. See, for example, Harvard University Archives, HUE 61.3145, "A Chronological Record of the Naval Training School (Pre-Radar) Harvard University, 23 June 1941-31 March 1945," 1 April 1945.

48. Ebbert and Hall, *CrossedCurrents,53-55.* For Jacksonville, see response to author's questionnaire from Dorothy Wells Black. See also *BuPers: The Story of Navy Manpower, U.S. Bureau of Naval Personnel(Washington,* DC, 1949), 37.

49. All Hands, October 1943.

50. NHC, OA, ACNP(W), Speeches, Statements and Articles of Captain M.M. [McAfee] Horton (1943-1945), roll 12, series I, "Script for New Year's Day Broadcast by Captain Mildred H. McAfee," 1 January 1944; and responses to author's questionnaire from Charlotte A. Potter and Rose Nudo Clement, 1996.

51. BuPers, 37. "War History of the Naval Research Laboratory" (Unpublished ms. No. 134), 1 November 1946, 108; and response to author's questionnaire from Marie Klein Lemlein, 1996.

52. Holm (ed.), *In Defense of a Nation,* 44.

53. Howard H. Aiken and Grace M. Hopper, "The Automatic Sequence Controlled Calculator," Electrical *Engineering* (August-September 1946), 1-4; Smithsonian Institution (SI), Grace Hopper Papers, files 1-22, box 6, Miscellaneous newspaper clippings; Carmen Lois Mitchell, "The Contribution of Grace Murray Hopper to Computer Science and Computer Education" (Unpublished PhD thesis, University of North Texas, 1994), 1-11, 24-37, 50-51 and 63-64; Charlene W. Billings, *Grace Hopper: Navy Admiral and Computer Pioneer* (Hillside, NJ, 1989), 30, 36-38, 47-53, 111 and 115; and author's interview with Ruth Brendel Noller, 23 December 1996, Sarasota, FL.

54. "WAVES History," I, 281 and 300; and NHC, OA, ANCP(W), roll 19, series III, Senate Naval Affairs Committee hearing on H.R. 2859, 29 September 1943.

55. NHC, OA, ACNP(W), roll 19, series III, House Naval Affairs Committee hearing on H.R. 5915, 9 May 1946; and roll 13, series I, Women in Regular Navy, Official Correspondence (1946-1948), Navy Department Press Release, 27 June 1947.

56. NHC, OA, ACNP(W), roll 19, series III, Hearings on WAVE Legislation and Public Laws, 1942-1948, House Armed Services Subcommittee No. 3, Hearings on S 1641, 18 February 1948; and House Naval Affairs Committee, 22 June 1944.

57. Once again it was Congresswoman Edith Nourse Rogers, along with Congresswoman Margaret Chase Smith, who fought for the survival of women in the American military. Eventually, separate titles of the Integration Act created a permanent place for women in each of the military services, including the new US Air Force. Holm, *Women in the Military,* 113-122.