Sharing the Burden:

Women in Cryptology during World War II

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Cover Photo: Women cryptologists at work at Arlington Hall. At the right front is Ann Caracristi, who would later become deputy director of NSA.

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Setting the Stage

The cryptanalysts working for the Signals Intelligence Service[1] (SIS) of the U.S. Army knew how crucial it was to decipher and read Japanese secret messages. But this new code, "Purple," wasn't breaking.

For eighteen months the team struggled with this difficult Japanese diplomatic code. Then, one day in September 1940, Genevieve Grotjan made a discovery that would change the course of history. By analyzing and studying the intercepted coded messages, she found a correlation that no one else had yet detected. This breakthrough enabled other cryptanalysts to find similar links.[2] Shortly thereafter, SIS, along with the U.S. Navy, built a "Purple" analog machine to decode the Japanese diplomatic messages.

Almost sixty years later, Frank Rowlett, a cryptologic pioneer and head of the "Purple" team, remembered that historic day: "What [Genevieve] Grotjan did was a big step forward and was very significant in the solution of the 'Purple'."[3] Her discovery, and the work of other team members, allowed the United States to read secret Japanese diplomatic messages and to continue reading them throughout World War II.

Genevieve Grotjan's contribution to the Allied victory cannot be measured. Nor can the contributions of the thousands of women serving their country through cryptography. Like

Genevieve, many women working in cryptology during World War II were civilians; thousands of others were in the military.

Volunteering for Duty

President Franklin Roosevelt signed the bill establishing the Women's Army Auxiliary Corps (WAAC) on May 15, 1942.[4] A few months later, on July 30, he signed a similar bill for the Navy which created the Women Accepted for Voluntary Emergency Service, more commonly known as the WAVES.

Women across the country volunteered for military duty. The *New York Times* stated that 10,000 women reported to Army recruiting stations the first day the WAAC accepted applications for officer training.[5] The applications had to be returned in only one week; even so, the Army received over 35,000 applications. They had fewer than 1,000 officer positions available.[6] Likewise, the Navy began receiving hundreds of requests each day for applications, even before the forms were available. They received nearly 25,000 requests for only 900 officer commissions.[7]

Women who joined the military relieved men by working in noncombatant positions. These men were desparately needed to fight the battles overseas. One observer described the situation this way:

> As the war got under way the drain upon manpower brought the Signal Intelligence Service into keen competition for personnel with industry and other government agencies. Not only was it difficult to obtain deferment for male civilian employees, but it was almost impossible to keep many of the younger officers qualified for overseas assignments, but badly needed at Headquarters, from being put on orders for shipment to theaters of operations. In view of this 'uncopasetic' situation the Signal Intelligence Service turned its attention to the procurement of (1) military personnel, particularly Wacs, (2) female civilians, and (3) males who had been given deferred status by Selective Service.[8]

Cryptography was one of the most vital of these "sit-down" jobs. The Army and Navy had sizeable cryptographic offices; however, even they were small compared to their eventual size at the height of the war. The Army's Signal Intelligence Service had 331 people, military and civilian, when Pearl Harbor was attacked on December 7, 1941. The Navy's communications security section (OP-20-G) had 730 people, Navy personnel and civilians who worked in radio intelligence, cryptography, and security. Their work involved cryptanalysis, cryptographic development and security, and laboratory work for photographic services and special inks. The SIS worked closely with the Second Signal Service Battalion, which provided radio intelligence.[9]

Only those women meeting higher qualifications were admitted into cryptologic work. Women in the Army had to meet officer qualifications, as well as have strong mathematics or language skills. The Navy competed with the Army for women with similar qualifications and offered officer status for cryptographers.[10]

However, both services placed a higher value on a woman's integrity than on her skills. A woman with the right qualifications, but not trained in cryptography, could learn the skills. But a woman whose loyalty was in question, no matter how qualified, could not be selected for this highly classified work. In a memo from the Navy's cryptologic office, OP-20-G, Captain Laurance Safford responded to a query concerning the recruitment of women:

> In view of the confidential nature of the work done in this section, it is essential that all personnel be especially selected for integrity. Individual qualifications are of secondary concern, and used only as a basis for assignments after integrity has been established.[11]

Anyone working in the field had a thorough background investigation. This delayed the acceptance of personnel into cryptography, but could not be avoided. The security of the work required trustworthy people.

> Since most of the operating personnel of the Signal [Intelligence Service] were entrusted with SECRET and TOP SECRET cryptographic and cryptanalytic matters affecting the security of the nation as a whole, the Agency in all its recruiting of personnel sought individuals:
>
> 1. of excellent character who were citizens, preferably native born, of the United States;
>
> 2. who had no intimate connection with foreigners in the United States or foreign countries;
>
> 3. whose loyalty, integrity, discretion, and trustworthiness were unquestioned; and
>
> 4. whose financial status and/or habits were such as to render unlikely their succumbing to any temptation that might endanger national security.[12]

Due to the secret nature of the work, recruitment was difficult. The Signal Intelligence Service conducted several recruitment drives for both civilians and Wacs. However, the type of positions for which they needed people could not be adequately advertised. An article in the *New York Times* described assignments as "highly confidential work of great tactical importance, closely connected with the safety of our forces on the fighting front."[13]

The Navy had its own recruiting concerns. Many women performing cryptologic duties were already working for the Navy as civilians. For these women, and the Navy, there were benefits to their remaining civilians. From the women's point of view, they worked during the day, received vacations, and could quit if they chose. OP-20-G civilians could not be absent from their work attending the Navy's indoctrination school. However, there were also benefits for the Navy if the women joined the service. As WAVES, they would do communications work for the duration of the war, and they could be assigned to the less desirable shifts, such as nights and weekends. So it was a mixed message the female civilians received from Commander

John Redman, head of OP-20-G, when Congress considered a Women's Naval Reserve:

> We encourage and advise our women employees to apply for the Corps but we assure them that the existing SP and P Civil Service program is expected to continue indefinitely.
>
> ... Yet they must expect a rather long transition period extending well into 1943. It would be an unbearable hardship on the Section to attempt an immediate universal change; the work the women are now doing is too important to the war effort to risk a period of absence and disorganization.[14]

Indoctrination and Training

Fifty-nine women from OP-20-G were approved as officer candidates. OP-20-G submitted their names along with a request that their indoctrinations be staggered in order to avoid the loss of their services at one time. However, they were informed that the first six women would report for indoctrination school on October 6, 1942, and that the remaining candidates would report during November. This meant that a majority of the women would be gone from the section for at least a month and that the efficiency and production of the office would be seriously affected. OP-20-G again requested the WAVES' indoctrinations be staggered by sending three smaller groups every six weeks. They explained that delaying each goup would ensure "that no serious disruption of very important work of a secret nature would occur as a result of the simultaneous detachment of 35 young women."[15] Although the groups were not separated by the desired six weeks, they were staggered by several weeks, alleviating some of OP-20-G's concerns.

The Army handpicked the men and women enrolled in their cryptographic course. Initially, the training was provided at Fort Monmouth, New Jersey, but was later transferred to Vint Hill Farms Station in Virginia. Those students who demonstrated the necessary skills within the first six weeks of cryptanalysis training continued on. They learned "cryptographic security,

Army and staff organization from a signal intelligence viewpoint, elementary and advanced cryptography, IBM theory and operation, code compilation, and the preparation of cryptanalytic work sheets. The more advanced course also covered ... language instruction in Japanese, German, Italian, French, Spanish, and Portuguese,...and military cryptanalysis."[16]

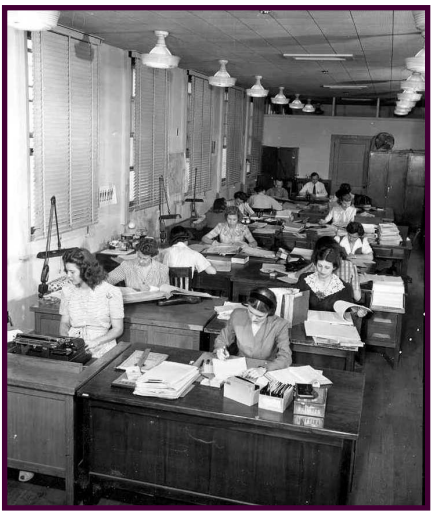
A classroom inside Arlington Hall Station

The Navy provided cryptology classes in several colleges prior to the war in order to create a pool of trained personnel. Baltimore's Goucher College trained a small group of Navy students. English professor Ola Winslow taught the secret cryptology classes in a locked room on the top floor of Goucher Hall. After graduating, most chose to join the WAVES and went to Smith College or Mount Holyoke for additional Navy indoctrination. At least one graduate joined the WAC, and some chose to continue in cryptology, in a civilian status.[17] Other WAVES received their code training in a three-month course at Smith College. However, hundreds of positions in OP-20-G did not require cryptanalysis training. WAVES whose loyalty and test scores indicated an ability for these jobs went straight from Hunter College boot camp to work in Washington, D.C.

Getting Down to Work

The Army and Navy assigned the cryptographic graduates to their respective cryptanalysis offices. The Army made its SIS headquarters the Munitions Building in Washington, D.C. (Genevieve Grotjan made her break into the "Purple" code while stationed there.) But the growing demand for signals intelligence throughout the war required more personnel and more space. In 1942 the SIS moved to a junior college for girls in Arlington, Virginia. It became known as Arlington Hall and was the largest message center in the world. The Navy also needed larger spaces as it grew throughout the war. In February 1943 it relocated its cryptographic offices from the Navy Department building in Washington, D.C., to Mount Vernon Seminary just five miles away. This facility had also been a girls' school. It became known as the Naval Communications Annex.

Here men and women, civilian and military, worked to break the coded messages. Many had a background in mathematics. College graduates recruited locally and around the country applied their mathematical skills to the science of cryptology. The Navy's Enigma Office (OP-20-G) was known as the "Office of College Professors" because many of the officers were Ph.D.s and teachers.[18]



B branch inside Arlington Hall Station

One of the best cryptanalysts of the time, Agnes Meyer Driscoll, worked for the Navy as a civilian. Known to some as "Miss Aggie," she too was a math teacher before joining the Navy in 1918. The Navy introduced her to her life's work in cryptology. Following World War I, except for a few years in the 1920s when she worked for another cryptographic pioneer, Edward Hebern, Agnes continued in cryptology with the Navy and other organizations (including NSA) for the rest of her career. She is credited with making breaks into most of the Japanese naval codes OP-20-G worked on.

> In the navy she was without peer as a cryptanalyst. Some of her pupils, like Ham Wright, were more able mathematicians but she had taught cryptanalysis to all of them, and none ever questioned her superb talent and determination in breaking codes and ciphers... Among her uniformed naval colleagues, she was held in the highest esteem throughout her long career, which continued from the Office of Naval Communications to the Armed Forces Security Agency, and then to the National Security Agency, before she retired in 1959.[19]

Women accepted into the cryptologic field were sworn to secrecy. The penalty for discussing the work outside of approved channels could be death, as it was considered an act of treason during a time of war. One Wac still recalled more than fifty years later, the first lecture she received: "Don't talk." The Army informed her and her fellow Wacs that no one was to know of their work. Anyone caught discussing it would be treated as a spy and shot.[20] The Navy gave their WAVES the same warning. Elizabeth Allen Butler, stationed at the Naval Communications Annex, wrote home in 1943, "As far as my telling you about my work. I can't. It's very secret, one of the most in the Navy. You have a terrible time getting into the place even with a uniform on and then you have to wear two badges and show them to the Marines who are on guard at the front of the building."[21] Constance McCready Rush described it this way: "Everything going on in our airless attic was so secret–more so than in some other

areas of the building except the actual codebreaking room–that only four or five high-ranking officers were allowed to enter."[22]

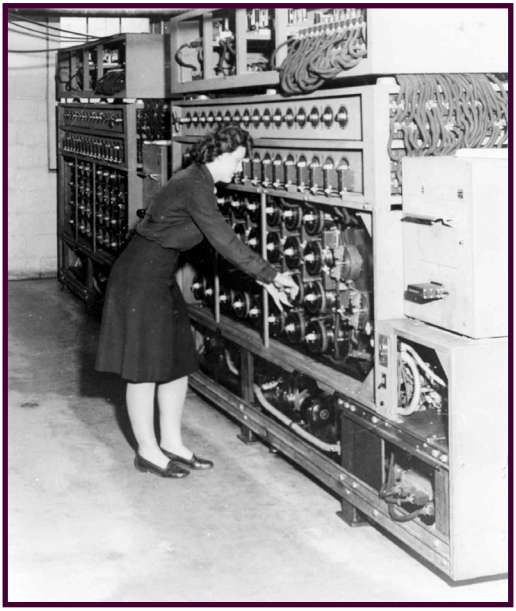
To help maintain the secrecy, neither the Army nor the Navy told the women how their work fit into the whole. WAVE Georgia Ludington explained, "We weren't supposed to know anything. We just did something and it didn't all fit in. We didn't know the big picture."[23] The actual cryptanalysts knew how their achievements aided the men overseas, but the Wacs in the Second Signal Service Battalion intercepting coded messages and the WAVES operating the cryptanalytic machines rarely learned the results of their efforts.

Women assigned to the Second Signal Service Battalion received training on radio intercepting and morse code transcribing of katakana, a syllabic form of Japanese writing. The training emphasized that they couldn't make mistakes. If they didn't understand or hear a portion of the code, they were not to guess. It was better to have a blank, indicated by three dots (...), than to have an incorrect letter. A wrong guess could affect the cryptanalyst's ability to break the message. The Wacs' transcriptions were forwarded to Arlington Hall for analysis, decryption, and translation. But the intercept operator never knew the details of the messages she copied, nor if she had somehow helped a mission or a soldier.

The BOMBE

The Navy also told their WAVES as little as possible in order to maintain secrecy. They sent some 600 newly inducted WAVES, along with 200 men, to Dayton, Ohio, to help build and train on the cryptanalytic Bombes. These machines were to be used to help break German messages enciphered on an Enigma machine. Each Bombe required sixty-four rotors to be wired to match the rotors actually used in the Germans' Enigma. WAVES performed this task. Each woman was given a wiring diagram for one side of the two-sided rotor. She spent her eight-hour shift soldering wires to rotors. Another WAVE sol-

dered the other side. This arrangement maintained the secrecy of the rotor wirings. No WAVE would have knowledge of both sides of any rotor.



The N-530 Bombe, located on the second deck of building 4 (Photo dated 15 May 1945)

Eventually, the Navy built 120 Bombes and sent them to the Naval Communications Annex. Here, women began operating the machines. Three shifts of women ran them twenty-four hours a day. The work was noisy and hot, but the Navy had impressed upon them the importance of their work, without ever explaining how their work fit into the whole cryptanalytic effort. Commander Gilman McDonnell, a supervisor on the Bombe deck, recalled an incident in which a rotor solution, known as a jackpot, was accidentally thrown out. The resulting delay made it apparent to the chief of the Bombe operations, John Howard, that some kind of explanation was necessary.

> Eventually we got the answer and then they realized that the wheel order had already been run and should've been a jack-

> pot. Well, it had obviously been thrown in the burn bag by mistake. So John got permission from his superiors to tell the girls something to give them some sense of how important the work was.
>
> We shut down operations for about ten minutes and he got up on a chair in the middle of the operations area. He didn't tell them specifically what they were doing, but said they were attacking an enemy cipher and it was a very important job.... And that's all they knew.[24]

The Second Signal Service Battalion

Unlike many occupations women entered during the war, cryptology was never a traditionally male job. Since the beginning of permanent cipher bureaus following World War I, women civilians had worked in the Army and Navy code rooms. There were other positions in the intelligence field, however, that had always been filled by men, such as the radio intercept operators. Women proved repeatedly that they could do the work as capably as, and sometimes better than, the men they replaced. A WAC staff director, reporting on the Wacs in the Second Signal Service Battalion, said, "It was proven over and over again that women were far better equipped than men for routine but detailed work."[25]

Women in the Army's Second Signal Service Battalion worked as high-speed radio operators, teletype operators, switchboard operators, cryptographic code clerks, cryptanalysts, and route clerks. They intercepted and forwarded coded enemy messages to SIS headquarters where other Wacs, soldiers, and civilians worked to break them. Arlington Hall analyzed, decoded, translated, interpreted, and distributed these messages. They were also responsible for the security of American communications and had a branch devoted entirely to that endeavor. The Second Signal Service Battalion monitored the U.S. Army radio transmissions looking for poor communica-

tions practices which would make it easier for the enemy to decrypt U.S. messages.

Operations trick, and Signal Service Battallion (soldiers and Waves), approximately 1943. The battalion was located in Vint Hill Farms Station, Virginia. (Note the barn in the background.)

Travel and Working Conditions

The Signal Corps sent Wacs to various countries in Europe and North Africa: England, Italy, France, Algeria, and others. Female Signal Corps personnel in Europe reached over 1,700. This number accounted for nearly one quarter of the Wacs stationed in that theater, though not all were involved in cryptographic work.[26] Considerably fewer women specializing in communications were assigned to the Pacific Theater. However, Signal Intelligence Service assigned Wacs to New Guinea, Australia, the Phillipines, and other locations as the Americans gained control of the South Pacific.[27] The Boyce Report described these 120 Wacs with the SIS in the Southwest Pacific

area as "highly skilled technicians" and their work to be of a highly secret nature.[28]

Even though many WAVES expressed a desire to go, the law did not allow WAVES to be stationed overseas, not even in Hawaii. OP-20-G male personnel were stationed throughout the world, but only a handful of women were assigned outside the contiguous United States. Most WAVES working in cryptography were assigned to the Naval Annex on Nebraska Avenue in Washington, D.C. By February 1944 nearly 3,000 WAVES were stationed there.[29] Some WAVES worked in cryptanalysis, communication security, or translation. However, the majority of the women operated the cryptanalytic Bombes.

Life was not always easy for the women. Shift work duties interrupted regular sleeping and eating habits, which led to health-related problems. Women working the midnight to 8:00 A.M. shift found it difficult to sleep while their barrackmates conducted normal daytime activities. For the Wacs, only Arlington Hall managed to arrange cubicle housing, placing four women in a cubicle rather than in barracks.[30] The Navy's WAVE Quarters "D," across the street from their communications facility, had several barracks to house more than 4,000 WAVES. Each of the four original buildings housed over 100 women on two floors. Eighty-four women shared one large room. They slept in bunk beds and kept their belongings in a steel locker. Realizing that morale was highly dependent on living conditions, the Navy built cubicle-style housing as Quarters "D" expanded.[31]

> One of our biggest problems was that of shift workers...we had to watch their health carefully. There was always the danger of emotional upsets caused by difficult sleeping arrangements.[32]

Throughout the Signal Corps, Wacs's illnesses appeared to be related more to the hours than to the work itself. However, some preferred to blame the stress on the need for accuracy and security.

> The only major problem in WAC employment encountered by the theater was that of the Signal Corp Wacs. By midsummer of 1944, women in this work began to suffer from fatigue and depression; their sick rate was twice as high as other Wacs', and morale was low. The theater chief signal officer diagnosed the fatigue as 'resulting from working long hours over a period of several months under pressure caused by the necessity for speed and security in handling messages, and the realization of the operational importance of every duty they perform'. WAC and Medical Corps officers felt that the difficulty was due, not to the work itself, but to the lack of leaves or furloughs, the rotating shifts so short that sleeping habits never became adjusted, and the long hours of off-duty training in other Signal Corps work.[33]

WAVE Lieutenant Sylvia Rosenwasser and Commander McDonnell corroborated the opinion that living conditions, and not the work itself, caused the problems. They confirmed that the WAVES on the Bombe deck were feeling stress not from their work but rather from the lack of privacy and the adjustment to a different lifestyle.[34] Also, civilian women performed many of the same duties as some Signal Corps Wacs and yet were not sick as often. The major difference was that civilians ate and slept regularly, took routine vacations, and lived in private housing.

Living conditions for Wacs stationed overseas were frequently less than desirable. They lived in whatever facilities were available–schools, factories, local homes, but mostly in tents.

The Wacs stationed in the Southwest Pacific area suffered the most. The climate in New Guinea and similar regions was extremely hot and humid. Supplies of lightweight uniforms were nearly unavailable, and Wacs were forced to wear heavy winter clothing. The women wore long pants to protect against malaria-carrying mosquitoes. But the perspiration and damp clothing resulted in a higher rate of skin diseases. Rather than

wear all the protective clothing and suffer the heat, some women chose to take their chances with the mosquitoes. As a result, women contracted malaria more often than their male counterparts, who were issued the long, yet lightweight uniforms.[35]

Despite the stress, monotony, heat, noise, lack of privacy, and hours of their work, women in cryptology enjoyed their work and their military duty. Lieutenant Rosenwasser remembers, "They were very devoted and very caring and [had] a wonderful esprit de corps. They were proud of their uniforms and proud of being in the navy."[36]

Epilogue

Few memoirs written by Wacs and WAVES conducting cryptologic work include details of their jobs. This is undoubtedly due in some part to the ingrained need for secrecy. Some made note of the difficulty sleeping during the day, others of the harsh overseas climate. But these are only small passages in their books. Most remembered and wrote about the lifelong friendships they developed and the enjoyable hours they spent exploring the cities and villages near their stations. For these young women, their time in the service was an opportunity to experience people, places, and, in some cases, cultures they could never have seen at home.

While many of the civilian women remained to carry on the work of providing and protecting vital information, most servicewomen chose to leave the cryptologic field at the conclusion of the war. They, like their brothers, husbands, boyfriends, and neighbors, had done their part to serve their country. A WAC commander reported, "When demobilization came, my women swore they would never come back to the War Department or to shift work, but about 25 percent eventually did–as civilians."[37] Even though the servicewomen were happy to leave, they were still quite proud of the work they had done.

> I feel that what I did was worthwhile in helping to win the war, even realizing at that time I was merely a tiny, tiny cog in the

> wheel. The breaking of the Japanese code was our finest hour, and I will always be proud of being part of that, small as my part was.[38]

Thousands of women helped to win World War II through their cryptologic efforts. Few will know the significance of their contributions or of the lives they helped save. Although women have long been a part of cryptologic history, even before the Second World War, the presence of servicewomen in cryptology allowed others to follow. Their dedication and abilities proved, to more than one doubting male commander, that women could more than adequately do this exacting, detailed, and important work. They left behind a strong legacy, allowing thousands of women to follow in their footsteps. These women played vital roles throughout the Cold War era and will continue to bring their talents, skills, and abilities to cryptology, one of the nation's most secret sciences.

Notes:

1. The Army's cryptographic office changed names several times throughout its history. For clarity, this brochure will refer to it as the Signals Intelligence Service.

2. Frank B. Rowlett, *The Story of Magic: Memoirs of an American Cryptologic Pioneer*, Laguna Hills, CA: Aegean Park Press, 1997.

3. Frank Rowlett in a conversation with the curator of the National Cryptologic Museum, June 14, 1997.

4. The WAAC became the Women's Army Corps (WAC) in September 1943. The capitalized abbreviations WAC refers to the organization, lowercase Wac refers to its members.

5. Lucy Greenbaum, "10,000 Women in U.S. Rush to Join New Army Corps," *New York Times*, 28 May 1942.

6. Judith A. Bellafaire, *The Women's Army Corps: A Commemoration of World War II Service*, CMH Publication 72-15 (Carlisle, PA: Center for Military History), 4.

7. "Wave Applicants Swamp the Navy," *New York Times*, 13 August 1942, 22, col.2.

8. *The Origin and Development of the Army Security Agency 1917-1947* (Laguna Hills, CA: Aegean Park Press, 1978), 31.

9. T*he Origin and Development of the Army Security Agency 1917-1947*, 21, 29-30. The Second Signal Service Battalion also had name changes throughout the war, but this paper will always refer to it as a battalion.

10. Mattie E. Treadwell, *The Women's Army Corps* (Washington, DC: Office of the Chief of Military History, Dept. of the Army, 1954), 314-315. (Hereafter referred to as WAC.)

11. Navy Department, Communication Security Section, *Memorandum for OP-20-WP*, dated 1 January 1942.

12. *The Origins and Development of the Army Security Agency 1917-1947*, 33.

13. "Confidential Work is Waiting for WACs," *New York Times*, 17 July 1944, 12, col. 4.

14. Navy Dept., *Memorandum for Applicants for the Proposed Women's Naval Auxiliary Reserve Corps*, dated 17 July 1942.

15. *OP-20-G WAVE History*, Naval Security Group WAVE folder.

16. George R. Thompson, Dixie R. Harris, Pauline M. Oakes, and Dulaney Terrett, *The Signal Corps: The Test*, (Washington, DC: Office of the Chief of Military History, Dept. of the Army, 1957), 204.

17. Frederick O. Musser, "Ultra vs. Enigma." *The Goucher Quarterly*, 1992, 70:2 4-7.

18. Ibid.

19. RADM Edwin T. Layton, USN (Ret.), *And I Was There* (New York: Wm Morrow & Co., 1985), 58.

20. Mary Bromble, Interview with author, 12 October 1996.

21. Elizabeth Allen Butler, *Navy WAVES* (Charlottesville, VA: Wayside Press, Inc., 1988), 41.

22. Musser, "Ultra vs. Enigma."

23. Georgia Ludington, Interview with author, 9 May 1996. National Security Agency Oral History 36-96.

24. Gilman McDonnell, Interview with author. National Security Agency Oral History 08-96.

25. Treadwell, WAC, 316.

26. Ibid., 318.

27. Wacs were sent to Australia to work for Central Bureau Brisbane. For more information on that activity, see *Quiet Heroes of the Southwest Pacific Theater*, published by the Center for Cryptologic History.

28. Treadwell, WAC, 435. Citing Col. Westray B. Boyce report to Chief of Staff, USA, following her visit to the overseas theaters after the war.

29. Historical Review of OP-20-G, SRH-152 (1944), 2.

30. Treadwell, WAC, 319.

31. Butler, *Navy WAVES*, 58-9.

32. Treadwell, WAC, 319.

33. Ibid., 369-70.

34. Sylvia Rosenwasser and Gilman McDonnell, Interviews with author. National Security Agency Oral History 36-96.

35. Bellafaire, *The Women's Army Corps*, 14-15.

36. Sylvia Rosenwasser, Interview with author. National Security Agency Oral History 36-96.

37. Treadwell, WAC, 321.

38. Butler, *Navy WAVES*, 90.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