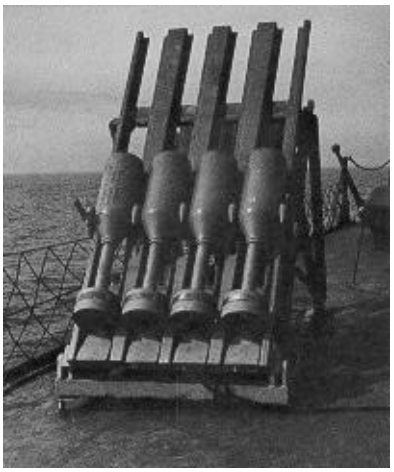


The World WAR II ERA

Introduction

During the World War II era, the Navy presence on the Point Loma peninsula of San Diego grew from a small radio station to an established research facility. Founded in 1940, the Navy Radio and Sound Laboratory (NRSL) worked to improve radar, radio transmission and reception, and sonar. NRSL's success with the design and arrangement of ship antennas eventually led NRSL to an ongoing mission for antenna development.

While technical advances in the electronics and radio field had opened the way for the use of sonar, this new technology required operational testing before it could be reliably used by the Navy. In 1941, the University of California Division of War Research (UCDWR) contracted to perform sonar research at the NRSL facility in San Diego. UCDWR also performed basic research in oceanography and provided field engineering support to U.S. submarines. UCDWR developed the QLA, an FM high-definition sonar system that enabled U.S. submarines to penetrate the heavily mined Japanese Inland Sea and effectively sever communications between the five main Japanese islands. UCDWR also developed the NAC and NAD Sound Beacons (sound decoy devices for submarines) and "racons" (small radar beacons used to assist in navigation).

Prior to the establishment of the Naval Ordnance Test Station (NOTS) at Inyokern in the northwestern part of California's Mojave Desert, the California Institute of Technology (Caltech) in Pasadena managed wartime research that included modifying and testing air-dropped torpedoes. Caltech's ring-tailed torpedo was accepted by the Fleet in 1944 and paid off in tremendous victories by Navy aviators at the Battle of Leyte Gulf.

The success of efforts in San Diego and Pasadena helped establish the value of military research and development (R&D). As the nation moved into the postwar era, it was agreed that continued military R&D was vital to national defense.

Scientists and National Defense

National Academy of Sciences

After the collapse of France in June 1940, scientists affiliated with the National Academy of Sciences in Washington recognized that the nation's scientific talent would have to be mobilized for national defense. As a privately funded advisory organization, the Academy could not itself direct the scientific effort, but because of its close contacts with the government and higher education, the Academy could galvanize political opinion in Washington and scientific opinion within universities.

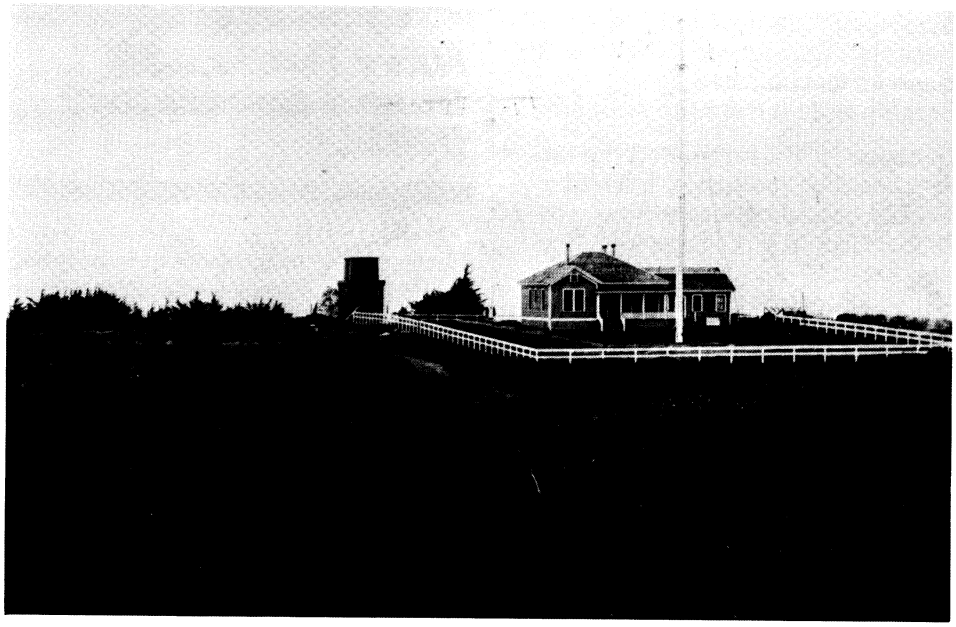
National Defense Research Committee (NDRC)

During World War I, the Academy had organized the National Research Council to coordinate science on behalf of the war effort. In 1940, leaders of the Academy, including physicist Dr. Vannevar Bush, then president of the Carnegie Foundation, thought that a similar organization could play a key role in the present national emergency and approached President Franklin D. Roosevelt. Roosevelt agreed, and in June, established the National Defense Research Committee (NDRC) with Bush as its chairman and its membership drawn from the Academy.

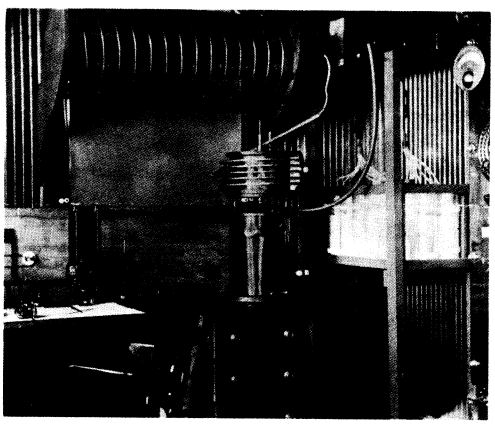
Because NDRC originated the laboratories that eventually formed NOSC, it is worth examining what NDRC sought to accomplish. Bush and his colleagues agreed that NDRC's function would be to direct basic research, not to manufacture military hardware. The Army and Navy would remain responsible for purely military R&D. Bush and his colleagues recognized that the international situation required that NDRC draw upon existing laboratories, private and public. NDRC questioned the Army and Navy on their current research and needs. NDRC also wrote to 725 colleges and universities nationwide to obtain information about their staffs and facilities that might be used for military research. The University of California responded in January 1941 by forming a Defense Council under the chairmanship of the university's president, Robert Sproul, to coordinate all war-related research on the university's two campuses (Los Angeles and Berkeley).

Navy Radio and Sound Laboratory (NRSL)

Recognizing the importance of new technologies and the need for technical expertise, the Navy in 1939 established a sound school in San Diego to train sonar operators. The approach of war in Europe and Asia, however, strengthened the case for the Navy to do more research and development. In May 1939, the Chief of the Navy's Bureau of Engineering (BuEng) recommended to the Chief of Naval Operations (CNO), Admiral Harold Stark, that a radio laboratory be established on Point Loma to coordinate the Navy's research and development in communications and radio propagation. On 1 June 1940, the newly appointed Secretary of the Navy, Frank Knox, formally established the U.S. Navy Radio and Sound Laboratory (NRSL)—the Navy's first laboratory on the West Coast. The location atop Point Loma was optimal for experimental work in radio propagation and reception. Also, NRSL's closeness to the Pacific Fleet meant the laboratory could readily support fleet needs. Initial personnel at NRSL consisted of nine enlisted men, three civilians, and one officer-in-charge.



Navy Radio Station, Point Loma, at time of commissioning. View to northeast. The road at the left of the fence became Catalina Boulevard.



A Massie Wireless Telegraph Company, 5-kilowatt transmitter was installed at the Radio Station in 1906.

Navy Radio Station, Point Loma

Navy activity on Point Loma actually began with the commissioning in 1906 of the Navy Radio Station, Point Loma. The Radio Station, part of the Navy's very low frequency (VLF) communications network, operated for more than 40 years. On several occasions, NPL (also the station's call letters) participated in experiments, but the station was a transmitting facility, not a laboratory. On the eve of World War II, the Radio Station comprised a handful of small wooden buildings staffed by two radio engineers, two enlisted men, a secretary, and an officer-in-charge. The Radio Station continued to operate until 24 June 1949, when it was decommissioned, and its activities were shifted to a new station at Chollas Heights, an area of San Diego approximately 15 miles southeast of Point Loma.

University of California Division of War Research (UCDWR)

When German U-boats began sinking merchant and passenger ships without warning in 1939 the Navy sought an independent review of its capabilities to meet this threat and turned to the National Academy of Sciences. In the autumn of 1940, the Academy appointed a Subcommittee on Submarine Detection to study the problem. The Subcommittee reported in January 1941 that the Navy's methods had hardly progressed since 1918, largely because of the "altogether inadequate research effort on fundamentals...." The Navy had made progress in echo-ranging (the forerunner of active sonars), but a broader research thrust including audible and subsonic frequencies was necessary. To remedy this, the Subcommittee recommended that the Navy research program be broadened to include the development of instruments to measure and record underwater phenomena. In addition, the Navy would have to train more ship sound operators, since submarine detection technology had outpaced the Navy's training facilities.

Expanding research and training programs would require added facilities, and the Subcommittee suggested a new laboratory. NDRC recommended two new laboratories, one on each coast, near existing naval bases to facilitate interaction with the Navy. San Diego offered unique advantages as a site for underwater warfare research: (1) deep ocean was close; (2) the oceanography of the California coast had already been studied extensively by the nearby Scripps Institution of Oceanography; (3) the Navy had an existing sound school in San Diego for training sonar operators; and (4) the Federal Government already owned most of Point Loma.

With the Navy's support, NDRC accordingly decided to establish two laboratories, one on the East Coast at New London, Connecticut, and the other at San Diego. After negotiations with NDRC, the University of California, on 26 April 1941, formally established a Division of War Research (UCDWR) to administer the new laboratory in San Diego. UCDWR was sited on the grounds of NRSL. The combined establishment was known as "UCDWR at the U.S. Navy Radio and Sound Laboratory." Informally, the Navy knew it as the "San Diego Laboratory." (Further references in this history to the San Diego Laboratory will mean the combined establishment of NRSL/UCDWR.)

Coordinating Scientific Research for War

Vannevar Bush had noted in December 1940, in a secret report to Roosevelt, that the U.S. lagged seriously in applying scientific knowledge to military devices and systems. Bush recommended an organization to administer all scientific research related to national defense. Once again, his suggestion was accepted, and on 28 June 1941, President Roosevelt signed an executive order creating the Office of Scientific Research and Development (OSRD) with Bush as director. OSRD incorporated NDRC as an advisory council and took over management of its contracts. During World War II, OSRD (disbanded in 1946) oversaw innumerable R&D projects at many locations nationwide. Work ranged from tropical medicine to radar and from proximity fuses for antiaircraft shells to the atomic bomb.

In California, OSRD contracted with the University of California at Los Angeles (UCLA) to manage the San Diego Laboratory while the Navy paid for most of the R&D costs. OSRD also contracted with the California Institute of Technology (Caltech) in Pasadena to conduct research in rocket propulsion and underwater ordnance. From these wartime beginnings grew the Navy laboratories that today form NOSC.

The Growth of a Laboratory

Personnel

Although most of the facilities on Point Loma were Navy, most of the workers at the San Diego Laboratory were employed by the University of California, not by the Navy. At its wartime peak, NRSL had a staff of about 150 civilians, while UCDWR's staff numbered approximately 575.

Radar and radio experts were transferred to NRSL from the Naval Research Laboratory (NRL) in Washington, D.C.; Navy officers and petty officers were called back from retirement to serve at NRSL.

Dr. Roger Revelle was a Lieutenant, USNR, at NRSL. He later became a Director of Scripps Institution of Oceanography, a founding father of the University of California at San Diego (UCSD), and the person for whom Revelle College at UCSD was named.

Dr. Vern Knudsen came from UCLA to be the first head of UCDWR. Dr. H. U. Sverdrup, then Director of Scripps, left Scripps to work at UCDWR. Other scientists were recruited from universities and private industry. Dr. C. F. Eyring came from Brigham Young University in Utah where he was one of the few experts on underwater sound. He brought with him one of his new Ph.D.s, Dr. Ralph Christensen, who later became Technical Director of the San Diego Laboratory from 1960-1968 when it was known as the Navy Electronics Laboratory (NEL) and then the Naval Electronics Laboratory Center (NELC). Many others came to Point Loma in the early years and continued their association in important roles later in the Laboratory's history.

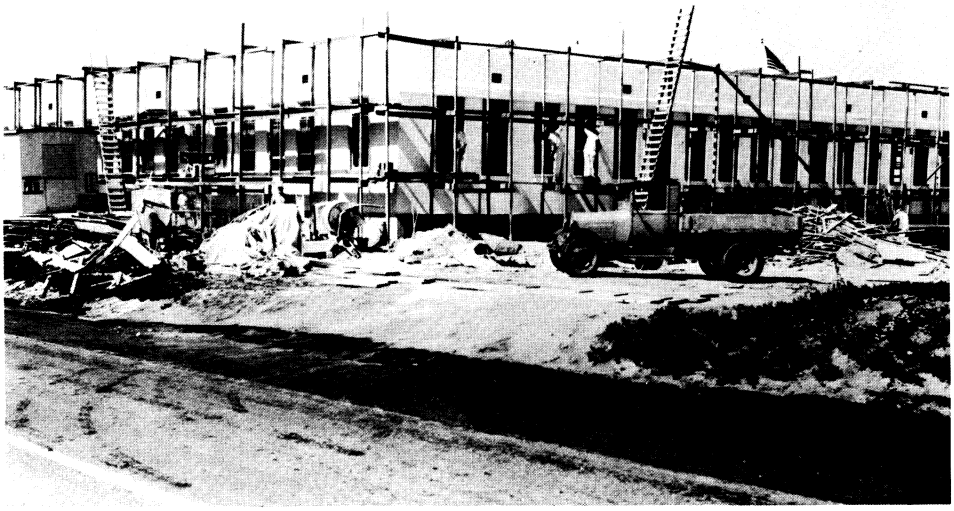
Also during the early 1940s, almost the only people who knew about electrical recording and projecting of sound were in the movie industry. Several people were recruited from Hollywood. Arthur Roshon, who was a key figure in the development of both the QLA mine-avoidance sonar and the first ice-piloting sonars (discussed later in this history), came from the Walt Disney studio.

Facilities

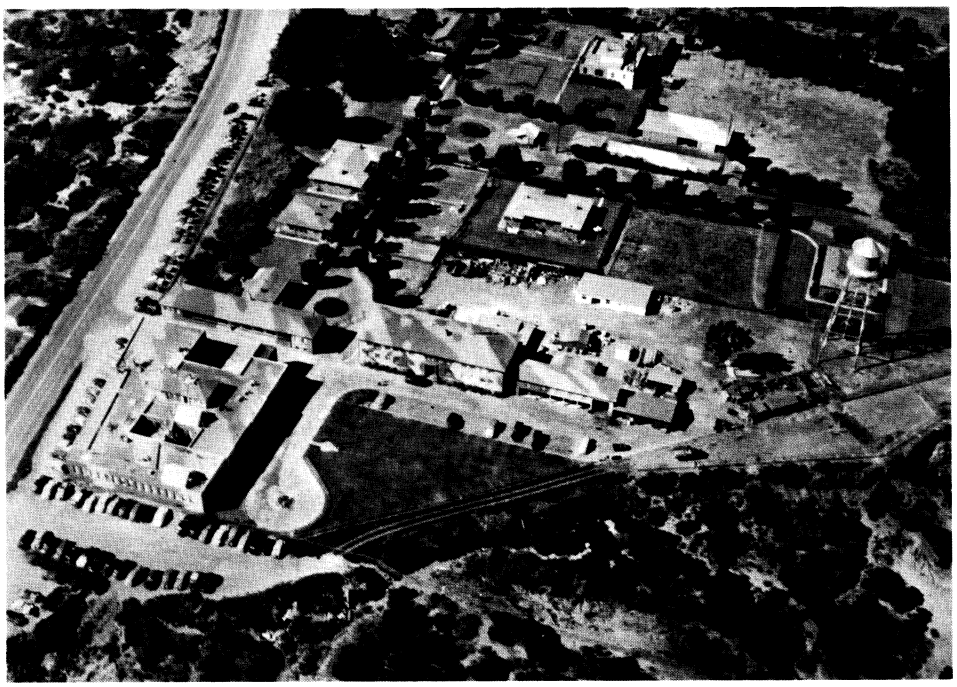
Under the terms of the OSRD contract, the Navy built all new buildings at the San Diego Laboratory. The first headquarters building (today, Building 4) began construction in 1940. Construction of the next two buildings (known as Buildings 1 and 2, Topside) began in late 1941 and finished in early 1942. Building 1 housed the cafeteria and the stockroom. Building 2 contained the machine shop in its basement and offices in the upper two floors. During wartime, the machine shop expanded into several Quonsets north of Building 2.

Neither Building 1 nor 2, however, was well suited as a laboratory, and the topside location was inconvenient to the waterfront. As a result, in 1942, the Navy began another structure on grounds provided by the Naval Training Station. The site adjoined the Fleet Sonar School, the user of much UCDWR work. This building, first occupied in August 1943, was designed as a temporary structure but, like most such buildings, proved to be enduring. Today, Building 3 is the Admiral Kidd Officers Club at the Naval Training Center. Another building, a combined galley and housing for enlisted personnel, was completed and later modified to accommodate WAVES. Today, this is the NOSC Topside Library.

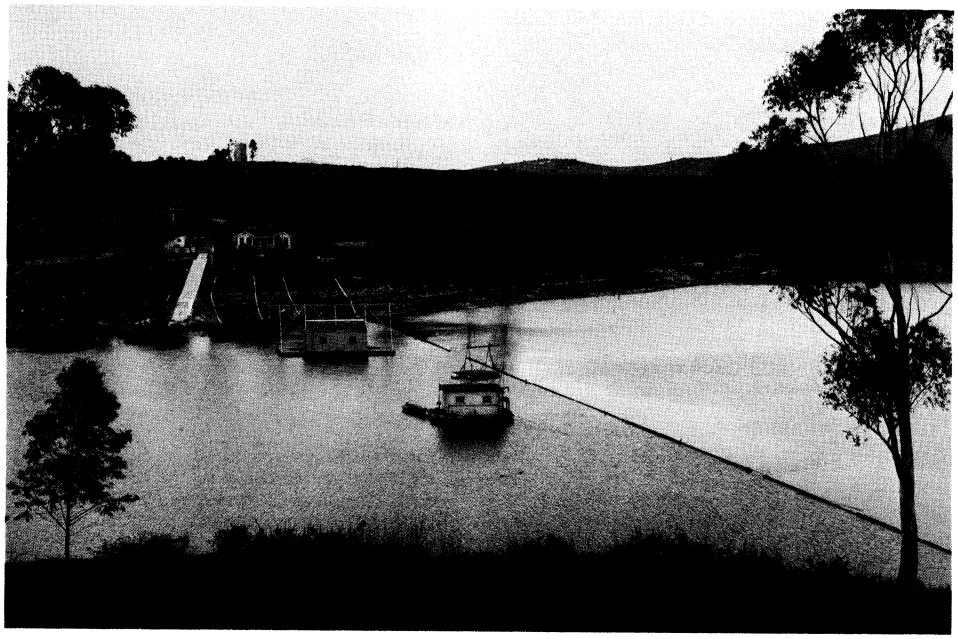
As a result of increased staff, UCDWR temporarily moved its headquarters to the Bridges Mansion off Chatsworth Boulevard near Point Loma High School. The Bridges family leased the mansion to the Navy. Known as "Building X," the mansion was first occupied in June 1944 and also housed the UCDWR support group: business, publications, and drafting, as well as parts of the oceanographic and training devices sections.



Navy Radio and Sound Laboratory, Building 4, under construction. View to northeast from Catalina Boulevard.



Navy Radio and Sound Laboratory, 1943. View to northwest with Catalina Boulevard at left. Navy Radio Station, Point Loma, in background.

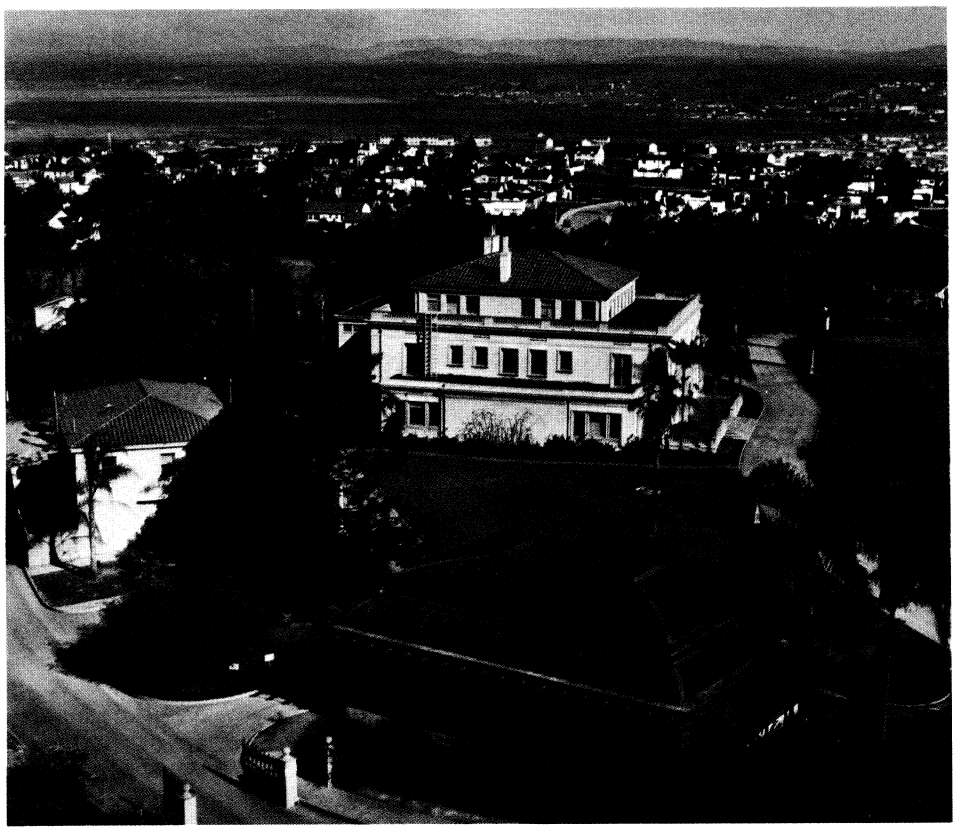


Sweetwater Lake, 17 miles from Point Loma, was used as a field station for the transducer program.

Wartime Field Stations

As the work of the San Diego Laboratory grew, so did its need for more specialized facilities. In addition to its other work, UCDWR designed transducers and acoustic homing torpedoes. Originally, the Laboratory calibrated transducers from a barge anchored in San Diego Bay, but the heavily used bay was a poor environment for taking sensitive measurements. In 1943, the Navy began using Sweetwater Lake, 17 miles southeast of Point Loma. The reservoir was deeper (60 feet in places) than San Diego Bay and free of the background noise present in the bay or in the open ocean.

From 1943 to the end of the war, one of the highest priority tasks at the Laboratory was the NAC and NAD Sound Beacons, self-propelled sonar decoy devices that would enable U.S. submarines to evade Japanese sonar. The heavy demands of the transducer program ruled out using Sweetwater Lake, so the Navy negotiated with the City of San Diego for the use of another reservoir, El Capitan Lake, 32 miles from Point Loma.



"Building X." In June 1944, UCDWR moved its headquarters to the Bridges Mansion off Chatsworth Boulevard.

San Diego: Research and Fleet Support

Radar

Even though it was a small facility, NRSL was entrusted with some of the most important experimental work done anywhere in the Navy: testing the Navy's first operational radar set. NRSL then used the set to train fighter interceptor pilots at the Naval Air Station, North Island. Beginning in October 1941, the Laboratory began to train radar operators as well. At that time, the Fleet had only a few qualified radar operators, and radar was a closely guarded military secret.

NRSL grew as its work extended to improving radar and radio transmission and reception. By 1943, NRSL research had shown that poor radio reception, previously attributed to weather or hostile jamming, was often due to self-interference. NRSL radio researchers established that the design and arrangement of antennas and their proximity to parts of a ship's superstructure, such as funnels and masts, caused self-jamming. Proper layout of antennas could solve this problem. As a result, in 1944, the Bureau of Ships (BuShips) made NRSL responsible for high-frequency (HF) antenna development, a mission that has remained to the present.

Navigation Systems

During the war, Laboratory researchers developed radar beacons, known as "racons," to assist in navigation. By the end of the fighting, radar was in sufficiently widespread use on ships of all descriptions that the Coast Guard was operating a racon station on the top of Point Loma. The racon station fulfilled the same protective function as the lighthouse had in the past. By war's end, a network of navigational beacons at both high and low frequencies extended over all continents and constituted an important aid to navigation of radar-equipped aircraft.

Sonar

Before 1943, the sonar school taught only how to operate and maintain the equipment. No one knew enough about sound in the ocean to teach anything about how to best use the sonar equipment.

The maximum effort and greatest contributions of both NRSL and UCDWR between 1941 and 1943 were in research. The physics of sound in the sea was not well understood. Sound propagation can be greatly affected by currents, marine organisms, water temperature, salinity, depth, and the structure of the ocean bottom. The San Diego Laboratory carried out studies and experiments on sound propagation, sound scattering, target strengths, ambient noise, etc. A brand-new science, entirely related to oceanography, had to be invented on a "crash basis."

This effort led to knowledge that the sonar schools and the Fleet could use to teach personnel how to use sonars to detect and attack submarines. The same knowledge was also used to teach U.S. submarines how to evade enemy sonar. During this time, information was also acquired for harbor defense, and an extensive series of charts of the Pacific was prepared by Laboratory oceanographers.

This broad knowledge base in such new categories then allowed development of equipment in 1944 to 1945 that led to important victories by the Fleet.

Fleet Support

Sound Decoy Devices

UCDWR scientists developed several sound decoy devices for submariners. Known as the NAC and NAD Sound Beacons, these self-propelled decoys emitted noises similar to U.S. submarines and could follow a preset course for 30 to 60 minutes. In 1945, NAD Sound Beacons were used by the Fleet to jam enemy sonars by transmitting echoes at exactly the same frequency as Japanese sonars.

QLA

UCDWR also developed an FM, high-definition sonar system, the QLA. The QLA evolved from Echoscope, an earlier project.

NAD Sound Beacon. Used to jam enemy sonars, this self-propelled decoy could follow a preset course for 30 to 60 minutes.

The Echoscope mixed a continuous signal with a continuously returning echo on the same frequency so that target range could be calculated. The Echoscope was tested successfully in early 1942 but could not be developed further for 2 years, due to a shortage of suitable transducers and the absence of basic research to develop accurate engineering design data.

Early in 1943, as the focus of submarine warfare began to shift from defense to offense and from anti-submarine warfare (ASW) in the Atlantic and Mediterranean to pro-submarine warfare in the Pacific, UCDWR engineers began to adapt the Echoscope to the role of sonar, whereby its outputs could be displayed on a cathode-ray tube (CRT) screen. In February 1943, a scanning sonar was tested in San Diego Bay. UCDWR's shops completed an

engineering prototype in the spring of 1944. The data generated by the sonar were presented visually on the CRT screen and audibly through earphones. Tests in the Mediterranean early in 1944 showed that the sonar could detect mines. This sonar, called the QLA, was the first sonar to provide a plot display of multiple targets and to offer an excellent capability as a moored-mine detector. UCDWR built a few QLA sonars, but once the design was complete most of the sonars were made in Hollywood, California, by Western Electric Company. The QLAs were constructed to serve several purposes: submerged close-contact navigation, submarine detection, under-ice navigation, and mine detection. By the summer of 1945, 48 QLA sonars were with the submarine fleet, enabling U.S. submarines to penetrate the heavily mined Japanese Inland Sea. In the final months of the war, QLA-equipped submarines had effectively severed communications between the five main islands of Japan.

Sea and Swell Forecasting

Another example of the importance of the research done by the San Diego Laboratory was "sea and swell" forecasting: an effort led by Dr. H. U. Sverdrup. During the invasion of Tarawa, 21–24 November 1943, U.S. Marines suffered a disaster when heavy surf swamped landing craft before the men got to the beaches. Although the island was eventually captured, many Marines drowned. Thanks to the sea and swell forecasting manuals produced by the San Diego Laboratory, such a tragedy never happened again throughout the many invasions of Pacific islands during the rest of the war.

Submarine Command, Pacific

During the latter part of the war, the increased activity of our own submarine forces in the Pacific caused the prosubmarine aspects of the San Diego Laboratory program to assume major importance. With over half of the Laboratory's activities directed toward one or another aspect of prosubmarine warfare, the visits to the Laboratory by Admiral C. A. Lockwood, Jr., then Commander Submarine Force Pacific Fleet, and his interest in many of the devices under development, greatly stimulated this part of the program. By the middle of 1944, UCDWR had representatives in the Pacific Area attached to the Submarine Command almost continuously. Field engineering was emphasized: fitting newly developed electronic devices to ships, debugging the devices, and teaching sailors and officers how to use them. UCDWR personnel trained sailors in maintenance and participated in numerous fleet trials.

Civilians in Uniform

As part of their research, a few scientists accompanied submariners on patrol in war zones. The scientists wore uniforms similar to those of officers' except that a small insignia at the top denoted civilian status. Even though few of the scientists at UCDWR had direct experience fighting U-boats, the scientists learned quickly and were able at times to offer tactical advice. For example, submarines had learned to avoid the pinging of active sonars by submerging more deeply as the pings got louder. To defeat this tactic, UCDWR personnel helped the Fleet develop a technique for a two-ship coordinated attack whereby one ship "pinged" while its partner attacked the unsuspecting submarine.

Pasadena: Caltech at War

Naval research at the California Institute of Technology (Caltech), Pasadena, was another product of wartime collaboration between higher education and OSRD. In May 1940, as Germany overran France, concerned faculty at Caltech established a "Council on Defense Cooperation" that contacted NDRC to offer its services. The Council stated in its report that there were 221 members of Caltech, including 95 professors and instructors, willing to devote part or all of their time to national defense. Of these volunteers, 34 had served in military service in World War I. In 1941, NDRC signed a contract with Caltech to develop rockets, and Dr. Charles C. Lauritsen became the head of the wartime rocket development program.

Antisubmarine Rocket (ASR)/Mousetrap Launcher

The military potential of Caltech rockets could be seen with the development of an antisubmarine rocket (ASR), the launcher for which became popularly known as the "Mousetrap."

The U.S. Navy needed to learn what happened to projectiles as they hit the water and how the fuzes of fast-sinking depth charges functioned. Because the launcher for the British-developed "Hedgehog" depth charge had a powerful recoil, it was limited to large ships such as destroyers. The Navy needed a lighter version of this "ahead-thrown," standoff weapon for smaller ASW vessels.

Initially, progress was slow due to problems finding a suitable propellant. The parallel development of dry-extruded powder for the Hedgehog enabled Caltech researchers to complete the Mousetrap, a reduced version of the Hedgehog that gave smaller craft a powerful antisubmarine weapon.

By the fall of 1942, Mousetrap ASRs were in extensive use along the Atlantic Coast and in the Caribbean. Six months later they saw extended service in the Pacific and were promoted for use on ships as large as destroyer escorts. Rather than being used in place of depth charges, the ASRs were used in conjunction with them whenever the presence of a submarine was suspected. If ASR firings from Mousetraps resulted in further evidence of a submarine (such as an oil slick), then the depth charges were used. In some cases, the rockets reportedly ruptured the pressure hulls and forced the submarine to surface and become susceptible to attacks. The ASR was credited with many assists in submarine attacks and is historically the first Caltech rocket to be fired against the enemy. Since the Caltech program began the Navy's modern rocket program, the ASRs from Mousetrap launchers became the first Navy rockets of the new era to see tactical use.

"Mousetrap" Launcher. Mousetrap-launched antisubmarine rockets were credited with many assists in submarine attacks during World War II.

Air-Dropped Torpedoes

By 1943, Caltech's work had grown to encompass underwater ordnance, specifically air-dropped torpedoes. The Navy needed scientific and engineering expertise to make torpedoes that could be dropped at the end of a brief, high-angle descent (which reduced the likelihood of the airplane being shot down) and that would still run true. Thus, the Navy needed a test facility to experiment with different angles of launch (corresponding to aircraft altitude and speed when releasing a torpedo) and to study the effects of these different angles and speeds of water entry on torpedo performance. The Torpedo Mk 13 was the only aircraft-launched torpedo available for fleet service at that time. Naval aviators laid down the basic parameters for the research: aircraft speed would be 350 knots, and the altitude of release would be 800 feet (compared with the 100 feet at the Battle of Midway that had led to such catastrophic losses of aircraft and crew). Exactly what design features required modification they did not know.

Early in 1943, Caltech scientists began to build a fixed-angle launcher to test water entry of air-dropped torpedoes. Because of the need for secrecy, a remote site in the San Gabriel Mountains was chosen: the Morris Dam reservoir, 20 miles east of Pasadena. The launcher was a 300-foot tube that could propel torpedoes into the water at a 19-degree water-entry angle. The launcher could also vary the speed of torpedoes (and thus their impact). In addition, a bridge, a crane, and various buildings and camera positions were built. By August 1943, the basic equipment was in place.

The Navy provided torpedoes, and Caltech engineers built additional dummies that matched real ordnance in weight, propulsion, and hydrodynamics. The Morris Dam tests showed that when the Mk 13 torpedo hit the water at 350 knots, its fins and rudder would be bent or the control mechanisms damaged. As one engineer recalled, "The solution to these problems consisted of several things, but the major change was the shroud-ring welded onto the tail fins, which stiffened them, strengthened them, and at the same time provided a control surface that stabilized the torpedo during the critical water-entry period. That, together with

Facilities at Morris Dam reservoir. Caltech built unique facilities at Morris Dam to test water entry of air-dropped torpedoes.

some internal improvements in the gyroscope and other control components, really made the torpedo an effective weapon again." The ring-tail had been developed by Caltech researchers for the "Mousetrap" ASW weapon. They then adapted it for an air-launched torpedo. Improved heat treating of the blades reduced damage to torpedo propellers at water entry, and the gyroscope was ruggedized.

The Morris Dam tests suggested that the Mk 13 torpedo could be safely dropped from 800 feet and at speeds of 300 knots. By the summer of 1944, the ring-tailed torpedo had been tested, and the Fleet had accepted delivery of the first 1000 torpedoes thus modified. The ring-tailed torpedo first saw operational use on 4 August 1944, and it paid off for the Fleet in the tremendous victories won by Navy aviators at the Battle of Leyte Gulf in October 1944. Sixty Japanese ships were sunk at a cost of seven U. S. vessels.

Naval Ordnance Test Station (NOTS)

The Navy's rocket program was, for all purposes, the Caltech program, and if it were to succeed it needed Navy support, particularly in providing the ranges and aircraft. The separate requirements for a rocket proving ground and an aviation ordnance station were eventually combined into one proposal. The two key architects of that proposal were Caltech's Dr. Lauritsen and Navy Commander Sherman E. Burroughs, Jr., a Bureau of Ordnance (BuOrd) officer fresh from combat where the limitations of naval aviation weapons were apparent.

Acceptance of the proposal by the Navy led to the establishment, in 1943, of the Naval Ordnance Test Station (NOTS) at Inyokern, approximately 155 miles northeast of Los Angeles. Burroughs was promoted to Captain and took command of the fledgling Station in December 1943. Personnel at the Station included only four officers and a small crew of enlisted men. Civilians consisted of a few scientists and technicians who commuted from Pasadena to Inyokern.

The Burroughs–Lauritsen contacts in these early years were particularly important for they set the pattern that would become traditional at NOTS in respect to the military-civilian team. From the Burroughs-Lauritsen association came answers to the technical problems as they related to facilities and Station operations. Lauritsen's headquarters were at the Kellogg Laboratory on the Caltech campus at Pasadena, but the contacts with NOTS were frequent.

Facilities

By early 1944, there was a general trend toward building permanent rather than temporary facilities at Inyokern. This shift was influenced by the turning tide of war.

As the United States shifted to the offensive, more people became concerned with the future peacetime Navy. Officers who had witnessed the nation's traditional peacetime disinterest in experimental ordnance facilities and who had personally observed the World War I demobilization looked for ways to make a stronger Navy and one that was abreast of technology.

On 1 February 1944, the Secretary of the Navy released $9,500,000 for construction at the Station. On 16 February 1944, another $1,553,833 was released to begin construction of a propellant manufacturing plant at China Lake, a new site 4 miles from the center of the community.

Naval Ordnance Test Station, Inyokern, CA. First base of operations at NOTS in California's Mojave Desert.

Wartime Transitions

Wartime activity at NOTS peaked during the closing months of 1944. A turning point had been reached for Station construction—ranges, administrative and test facilities, Navy housing—and also for rocket development programs.

The history of NOTS achievements during World War II includes not only the development of rocket weapons but also fleet training in the combat use of such weapons. Nevertheless, it is the hardware that is most often associated with the NOTS wartime effort: spinners,

fuzes, warheads, launchers, rocket sights, and rockets such as the Holy Moses and Tiny Tim.*

NOTS was to evolve from a wartime station serving the rocket programs of Caltech and the rocket training needs of the Fleet to a permanent center for weapon research and development. The transition plan that evolved set the pattern of the postwar years. Rocket development and test work would be transferred from Caltech to NOTS. Rocket production would be picked up under a broad contract with the General Tire and Rubber Company. The torpedo launching facilities at Morris Dam, along with the associated torpedo programs and underwater studies, would become a substation of NOTS Inyokern. Propellant work and activities would be absorbed by the new China Lake Pilot Plant. China Lake would later become one of the largest Navy research and development laboratories in the country.

Professors at War

By 1945, whatever doubts the Navy and Congress may have felt in 1939 about funding research and development had been answered. Equipment developed at Pasadena and San Diego had saved American and Allied lives and had enabled American sailors to sink German U-boats in the Atlantic and Japanese ships of all descriptions in the Pacific. San Diego's sonar research had helped to train sailors in fighting a world war on two oceans—an assignment more demanding than those offered by any university. For the Navy's scientists in San Diego and Pasadena, many of whom had come from farther afield than UCLA or Caltech, working for the Navy had enabled them to research problems full-time, to get to sea to test their hypotheses, to publish their results promptly, and to hear the heartfelt thanks of those whose lives depended on the results of their work.

*For further information on specific NOTS wartime projects, see Christman, A.B. 1971, *History of the Naval Weapons Center, China Lake, California, Vol. 1, Sailors, Scientists, and Rockets.* Naval History Division. Government Printing Office, Washington, D.C. and also Gerrard-Gough, J.D. and A.B. Christman, 1978. *History of the Naval Weapons Center, China Lake, California, Vol. 2, The Grand Experiment at Inyokern.* Naval History Division. Department of the Navy, Washington, D.C.

Fort Rosecrans Batteries

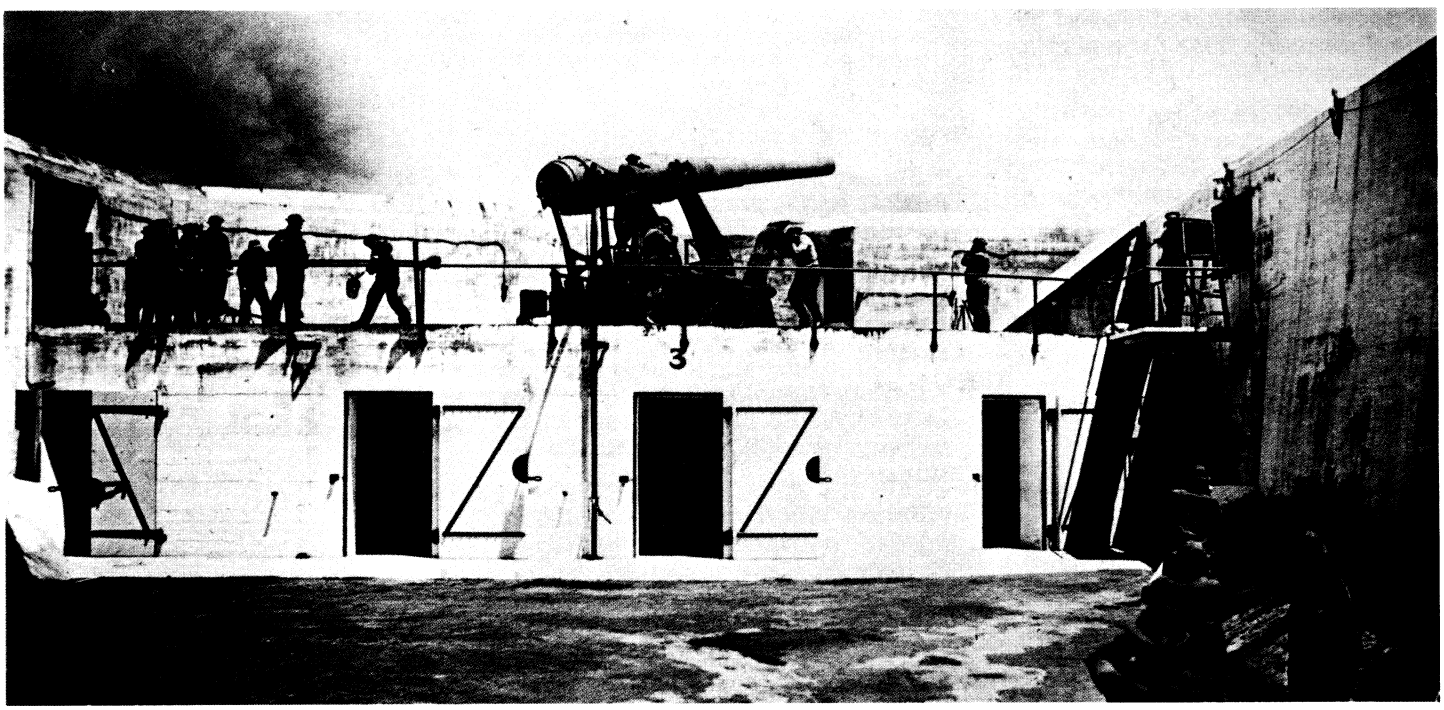
Throughout the 1920s, Fort Rosecrans was reduced to the caretaker status of keeping guns and equipment in good condition. The garrison remained small, although activity increased somewhat during the later years of the decade.

Despite the de-emphasis of armament during the 1920s, additional batteries of antiaircraft guns had been installed on Point Loma by 1930. The increased artillery consisted of two batteries installed to cover the southwest, west, and northwest approaches to San Diego Harbor. The installations were known as Battery Point Loma (located on the west side of the peninsula below the Cabrillo National Monument lighthouse) and Battery Gillespie (located on the northwest corner of the military reservation).

From 1930 to 1940, Point Loma's defenses were revitalized. On 22 July 1936, Battery White was practice-fired for the first time in 11 years. The following year construction of the new building and an additional battery started. The new battery was called Battery Strong and represented the latest in seacoast fortifications designed to defend against attack by battleships and long-range and carrier-borne aircraft.

In 1939, with the outbreak of war in Europe, and France falling in

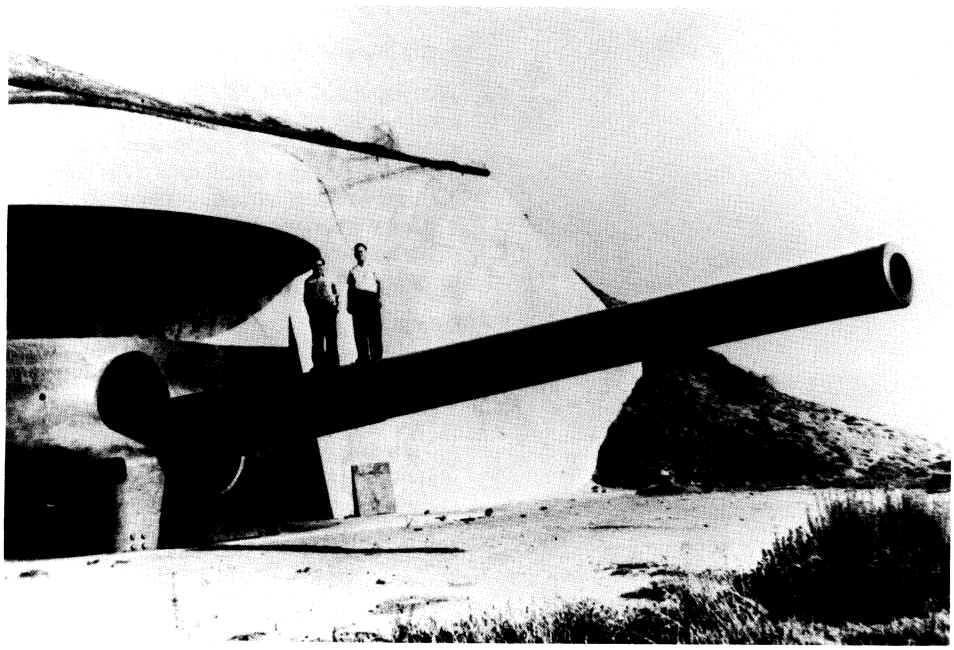
Battery Wilkeson, Fort Rosecrans, 1910. View of emplacement during target practice. The 10-inch disappearing gun shown was one of four Buffington-Crozier 1895 models installed in 1897-98.



1940, the U.S. concern for defense increased. By 1940, this concern accelerated the schedule for construction of coastal defenses. San Diego's plan called for a network of artillery batteries and fire-control facilities along approximately 30 miles of coastline.

The plan called for batteries in three locations: Point Loma, Silver Strand, and Fort Emory. Battery Strong, begun in 1937, was completed. Construction of the other batteries began in early 1941, before the attack on Pearl Harbor, and continued through 1945. Following is a list of Point Loma's batteries and their present status.

- *Battery Wilkeson was completed in 1897. (In 1915, the battery was split in half and the northeast half of the battery was renamed Battery Calef.) Today the battery is in good condition and is used by the Submarine Base for workshops and storage.*
- *Battery White, completed in 1916, was declared obsolete and scrapped in 1942. Today, NOSC uses Battery White for storage.*
- *Battery Whistler, completed in 1920, was declared obsolete and scrapped in 1942. However, Battery Whistler is being used today as part of the Arctic Submarine Laboratory.*
- *Battery Gillespie was completed in 1930. This battery provided cover for the west and northwest approaches to San Diego Harbor until completion of Battery Woodward. Today, Battery Gillespie is intact although in a state of disrepair.*



Battery Ashburn, Fort Rosecrans. One of two 16-inch guns installed and proof-fired in 1944.

- *Battery Strong was completed in 1941 and is presently used by NOSC for surveillance technology.*
- *Battery Zeilin, completed in 1942, was only a temporary emplacement of Navy guns; it no longer exists.*
- *Battery Humphrey was completed in 1942. NOSC currently uses this battery for satellite communications.*
- *Battery Woodward was completed in 1943. With the completion of Battery Woodward, Batteries Zeilen and Gillespie were discontinued. Battery Woodward is currently in use as a radio facility.*
- *Battery Ashburn was completed in 1944. This structure has been extensively altered by NOSC and has no resemblance to the original building. NOSC currently uses northern Battery Ashburn for microelectronics and southern Battery Ashburn for theater communications.*