PACIFIC MISSILE RANGE • NAVAL MISSILE CENTER
NAVAL CONSTRUCTION BATTALION CENTER

PACIFIC MISSILE RANGE

Stories about missiles and space are usually told with words like trajectory, blastoff, lox, impact, thrust, Mach, orbit, countdown — words that evoke pictures of suspense and power, and of men with imagination and the guts to follow where it leads. It's an exciting story, familiar in one form or another to every American old enough and young enough to focus eyes on a television screen.

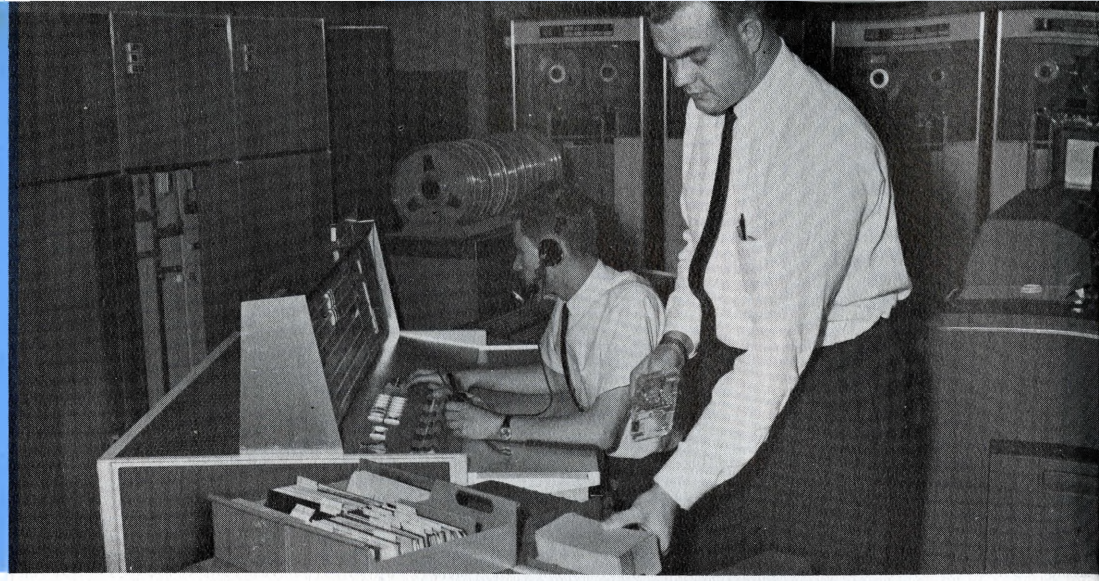
Not so familiar is the day-to-day work of the nation's three missile ranges that is only climaxed in the Atlas seething on its launch pad and the tiny satellite chirping a signal earthward. The work of the largest of the three — the Pacific Missile Range — is our story.

"A wasteland of sand and water" is a phrase that has been used to describe PMR. Physically it may well be evaluated as such, but as the only range in the land which is geographically situated to safely launch the Gargantuan missiles of tomorrow — the polar orbiting satellites and space craft, the Pacific Missile Range must certainly be considered pure gold. Its boundaries enclose more than fifty million square miles and stretch nearly halfway around the earth. And because our world consists not only of flat land and water surfaces but also of their height and depth, the Pacific Missile Range is multi-layered, probing deep into the sea and into the air above.

Within this vast empire, PMR telemetry and radar dishes tower like strange

Data Reduction

Data is the primary product of the Pacific Missile Range. Throughout test operations, information concerning the actions of the vehicle is recorded by radar, telemetry, and photography. To interpret this information, PMR's highly flexible facilities process magnetic tapes and convert raw data to digital values.



vegetation above the fern-forests and lagoons of islands named Kapingamarangi, Canton, Wake, Gugeegue, Eniwetok, Ennelabegan, Kwajalein, Hawaii, and loom over snow-locked outposts in Alaska; while in the Indian Ocean, tracking ships join PMR's coverage with that of the Atlantic Missile Range stretching eastward from its headquarters at Cape Canaveral.

Headquarters of the PMR domain is at Point Mugu, California, a 4300-acre coastal site where not so long ago naked Chumash Indians gathered clams as great flocks of migrating ducks flew unmolested overhead. Sixty miles offshore Point Mugu is San Nicolas Island, less than thirty square miles of rolling brush-covered mesa and sand dunes, falling sharply down to the sea 500 feet below. This island, second in the triad of major PMR installations, is heavily instrumented with radar, telemetry, and communications which are linked with Point Mugu and NMF, Point Arguello, one hundred miles up the coast.

The Naval Missile Facility, Point Arguello, is an investment of one hundred million dollars spread over twenty thousand mountainous acres — the largest piece of real estate in the PMR complex and the range's primary launching site. Host to NASA, the Air Force, the Marine Corps, the Army, the Navy, the Atomic Energy Commission, and the Naval Research Laboratory, Arguello's site seems custom-made to support a variety of programs.

Towering on Arguello's launch pads, the missiles and space boosters are isolated from the nearest towns by a range of mountains, while the wrinkled and crevassed terrain provides natural revetments for each operation. And Arguello's hills have trembled against the thunder of Atlas, Atlas-Agena, Blue Scout, and NASA Scout launches. With the arrival of the still-mightier nuclear rockets and the chemical boosters of the foreseeable future — some with an estimated six million pounds of thrust — isolation will be a still more valuable factor.

This triad of facilities — Point Mugu, San Nicolas, and Point Arguello — is one of the most heavily instrumented areas known to exist anywhere in the world, and much of PMR's field work is conducted within this tightly-controlled sea test range. Here small tactical missiles undergo almost daily work-outs, perhaps bolting groundward to blast targets on San Nicolas Island, or ripping through the sky to score a simulated kill on a supersonic target aircraft. A job exclusively PMR's is providing missile training to air and ground troops — British, Canadian, and Australian as well as U.S. forces — training they cannot get anywhere else. Air squadrons regularly fire their missiles over the sea test range, and Marine Corps anti-aircraft battalions fire away with their missile batteries at PMR-launched drones.

Point Arguello is separated by only a line from Vandenberg Air Force Base, where Atlas, Titan, Thor, and Minuteman roar into space. Intermediate range missiles shoot westward over PMR's watery 1500-mile IRBM range to impact off Hawaii, tracked all the way by PMR airborne, land- and ship-based instrumentation. Giant Atlas ICBM's, too, trace their contrails down a Pacific Missile Range corridor from Vandenberg to their targets near Wake and Eniwetok. These shots are not all experimental research and development efforts, interesting only to the scientists responsible for their success, but many are operational firings in which more than 1500 U.S. and British missilemen

Communication and Instrumentation

PMR's test data is collected by radar and by optical, timing, telemetry, and range surveillance instrumentation. The information is then transmitted to data processing centers by PMR technical communications—also used for routine functions such as area clearance, facilities coordination, frequency control.

have been trained. And if necessary, operational Atlas missiles could be fired in anger to blast into enemy territory half-way around the world.

In addition to affording deep canyons to confine missile blast, PMR's Point Arguello has a characteristic unique to the PMR: its polar orbit range, a freeway to the Antarctic. A missile lofted into such a trajectory from NMF or VAFB passes over nothing but empty water and a few palm-fringed islands until it reaches the snowy Antarctic wastes. Thus the big problem of safety during booster fall-out and during the hazardous early phases of flight is eliminated. And a satellite in such a path has several credits. As it moves north-south above the earth turning from east to west beneath it, the vehicle eventually passes over every point on the earth's surface. A few tracking stations in the polar regions can control it, for it soars over them on each orbiting pass. These reasons make the direct north-south route particularly useful for polar weather studies, advance technology satellites, or for navigation purposes.

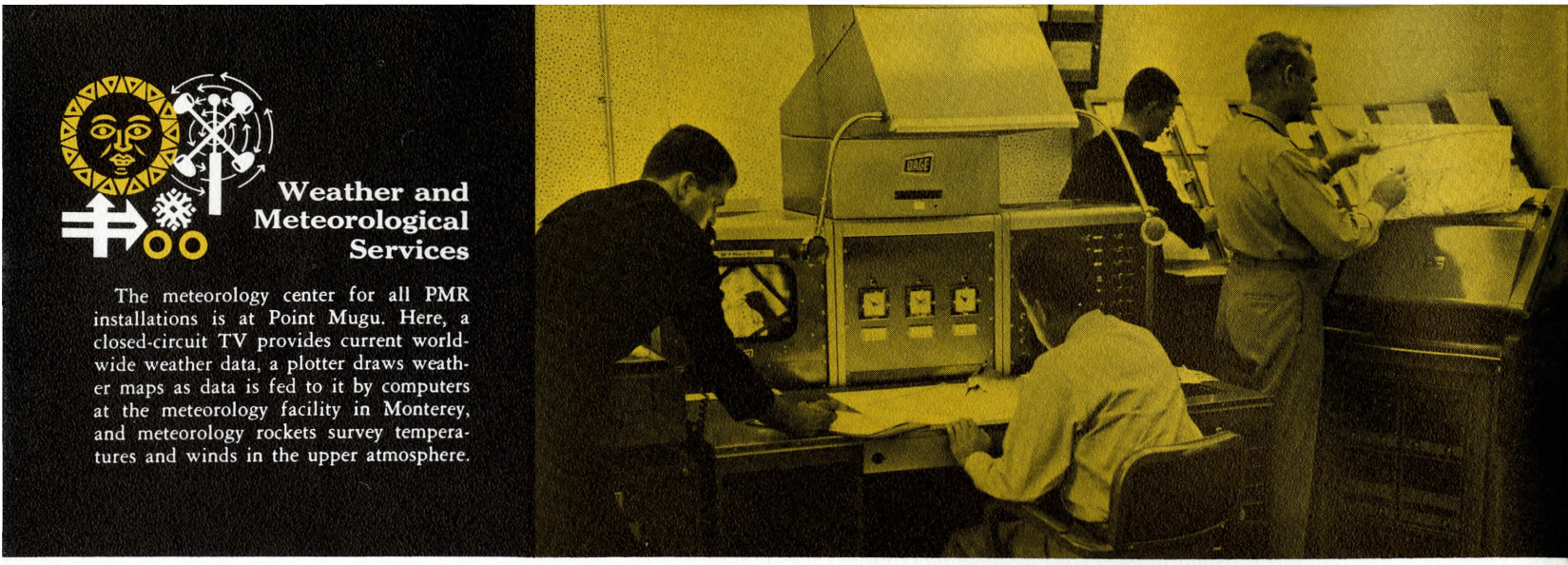
Although the range is Navy-managed, it's a Department of Defense facility available to all authorized military and civilian agencies with missile and space projects to check out. PMR has nothing to do with making the missiles or satellites — it only provides the facilities, space, and experienced personnel for testing and evaluating them.

At any given time there may be more than one hundred programs in progress at PMR which have been assigned by the Office of the Secretary of Defense, and approved for support by the Bureau of Naval Weapons. And establishing priorities and scheduling the operations — several thousand a year — can be an extremely complicated problem. Its success depends, as do all PMR activities, upon efficient communication among the components of the giant empire. When a major launch is scheduled, the sites and personnel who will be involved are alerted by radio teletypewriter channels, CW radio channels, single-side band, micro-wave relay, and leased lines. As casually as a physician calling a drug store, PMR personnel communicate directly with sites in the Philippines, the Pacific islands, Alaska, and with the other national ranges at White Sands and Cape Canaveral.

For each of these operations, special instrumentation must be chosen, with one piece of equipment to fill in where the capability of another leaves off. If the operation requires coverage beyond the range of PMR shore stations, some of the instrumentation will have to be supplied by range ships, and PMR has six of them. These are Military Sea Transportation Service vessels and crews, but Pacific Missile Range and contractor personnel are aboard to direct the operation. From land sites, shipboard, and aircraft, cameras grind to record every second of the missile's launching and flight.

Continuous range timing signals provide the backdrop against which the optical and electronic information is measured, making it possible to pinpoint the missile or space vehicle in time and space throughout the flight, and to answer the question: When and where did it happen?

The ogre of every range operation is frequency interference. A casual electronic signal from a TV tube transmitting "Captain Kangaroo," from a passing ship, or from a poorly calibrated radar could activate rockets, trigger destruct gear, or impel a radar



Weather and Meteorological Services

The meteorology center for all PMR installations is at Point Mugu. Here, a closed-circuit TV provides current world-wide weather data, a plotter draws weather maps as data is fed to it by computers at the meteorology facility in Monterey, and meteorology rockets survey temperatures and winds in the upper atmosphere.

dish on a crazy, futile search. To minimize these threats, PMR's ground and airborne monitoring stations survey the frequency spectrum, detecting, analyzing, and locating sources of radio and radar frequencies that may interfere disastrously with those being used for missile guidance or data collection. It is also vital to keep the destruct frequency from being activated accidentally, and still more important to assure that this frequency can be activated without hindrance if the missile should shoot off course and have to be destroyed.

Although destroying a malfunctioning missile is the primary job of range safety at PMR, it's not the only one. Range safety includes plans and equipment for the safety of all launches involving the range, and the establishment of procedures like creating safety limit lines to protect personnel, facilities, real estate, aircraft, and ships.

Range clearance before the count-down—"getting the children off the streets" — is also a prime factor in making PMR launch operations safe. All shipping and aircraft in the firing area are pin-pointed and cleared by radio, ground surveillance radars, airborne surveillance radar, and loudspeakers; and the area is inspected visually by men on ships and aircraft. Studies of shipping and aircraft densities in the mid-Pacific show that the odds of accidentally hitting a vessel or plane with a missile are millions to one. If at the time of firing, however, the odds fall to 100,000 to one, the shot will be postponed.

Weather, particularly in the upper air, can mean the difference between success and failure of missile and space probe operations, and PMR is equipped with facilities that make the range perhaps the most competent meteorological site in the Navy. Its routine weather studies blanket North America, the northern Pacific Ocean, and eastern Asia, from the surface to 100,000 feet altitude, and can be expanded to take in the entire northern hemisphere and upper air to 210,000 feet. PMR experts can forecast weather from the wheat fields of the mid-United States to the rice fields of China. The Tiros satellite regularly beams television pictures of the entire Pacific cloud cover to Point Mugu, one of the two stations selected by the U. S. Weather Bureau to receive such data.

Once the missile blasts from its launcher, information concerning its behavior and that of its inner parts is telemetered to receiving stations on the ground, on ships, or aircraft up to 1,000 miles away. Precision tracking radar and optical instruments scrutinize the missile's path.

Flight data are sent from the receiving stations to Point Mugu, where chattering computers unravel and sort it for use by the missile program engineers, who study and analyze the information like anxious parents a report card: What was the missile's velocity at a certain point? Its acceleration, altitude? How well did this or that component function? What was the miss-distance? Could we have knocked out an enemy site? The answers to these questions determine whether the missile has passed its test. Although the newspapers may report a launch as something less than successful, new knowledge can nearly always be gleaned from every operation. To missilemen, a total failure is almost unknown.

Major-domo of the Pacific Missile Range is the Naval Air Station, in charge of maintaining and op-

Bioscience

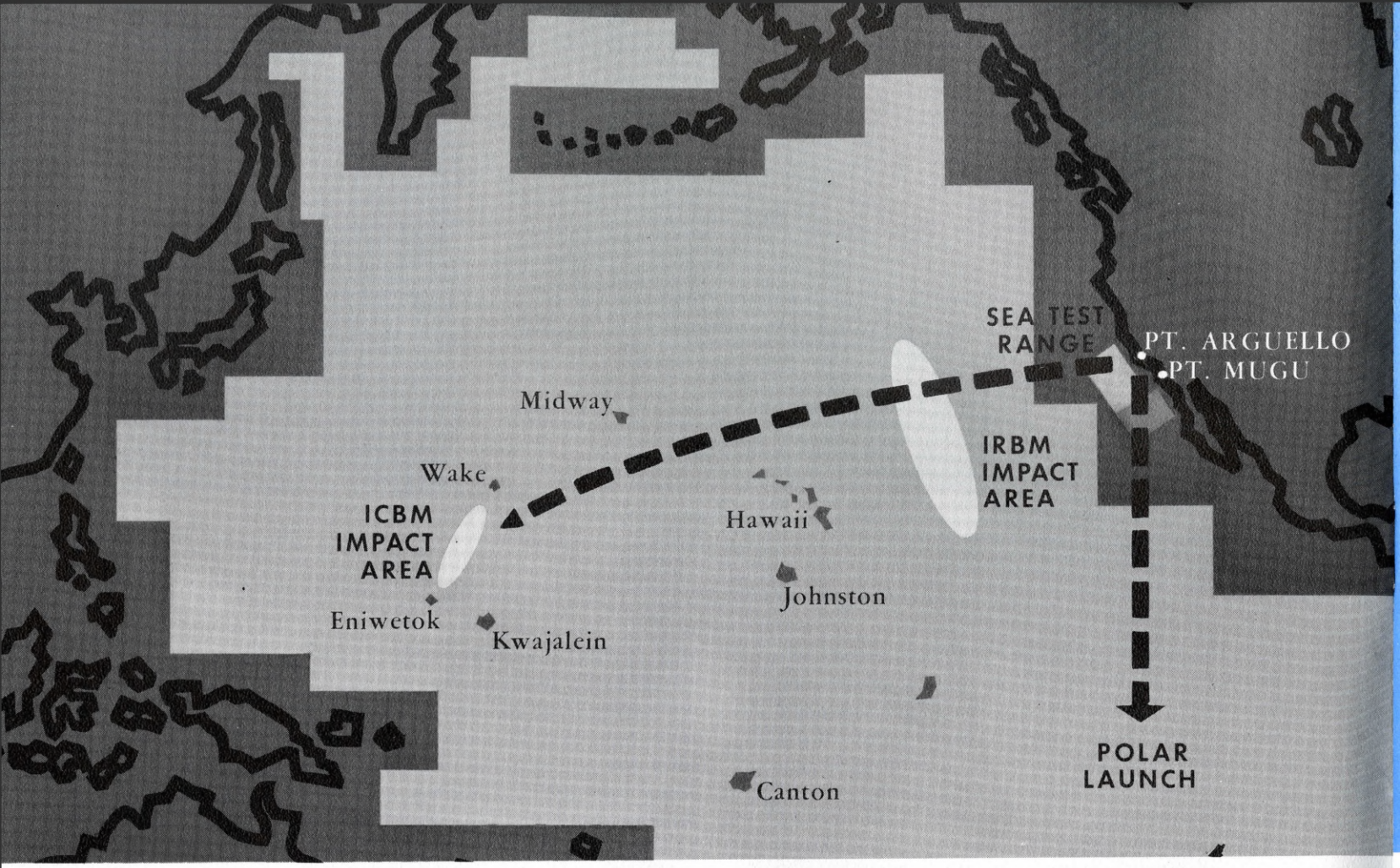
Bioscience functions at PMR are becoming increasingly numerous as more is required of the human component of every system. The problem of providing this support across the vast PMR area has been a difficult one. The range's answer — mobile laboratories, for clinical medicine, physiology, toxicology.

erating the support facilities at Point Mugu and the offshore islands — the airport, aircraft and surface craft, public works, and utilities. The station provides flight crews for the huge, expectant-guppy-shaped WV-2 planes that collect telemetry information, monitor frequency interference during launch operations, and assist in recovering satellite capsules; the station's technical and non-technical personnel service laboratories and other facilities used in launching, testing, and checkout. NAS also performs supply functions including warehousing, distributing, and controlling material required by the Pacific Missile Range. As one of its more athletic functions, the Naval Air Station operates surface craft to recover target drones, nose cones, and capsules from the waters of the sea test range — and also to find and recover an occasional human being.

Consideration for future needs has been an important factor in range development, and PMR has taken new programs in its stride. Range facilities tracked and instrumented the first polar-orbiting satellite lofted from Vandenberg Air Force Base; and to recover nose cones and manned Mercury capsules on re-entry from orbit, PMR equipped ships with telemetry, communications equipment, search radar, frogmen, helicopters, and meteorological instruments. In stressing mobility of its equipment, PMR has benefitted greatly, for it pays off both in quick adaptability and in financial savings.

In April 1962, the Navy Astronautics Group was formed at Point Mugu to carry on the development of the Transit tracking system. A navigational satellite, Transit is a Department of Defense program of particular use to the Navy, for its omnipresent signals will provide reassuring guidance to navigators anywhere on or under the earth's oceans. In planning the establishment and operation of the satellite's worldwide tracking network, PMR has erected towering radar scanners to search the skies over warm blue waters and ice-bound reaches . . . off South Point, Hawaii, the Philippine Islands, Alaska, Australia, Puerto Rico, Japan, the Union of South Africa. The principal command injection transmitter — a mammoth sixty-foot dish — will be raised above Point Mugu's Laguna Peak, and from the brush-covered canyons of Point Arguello, the new Transit satellites will be boosted into space.

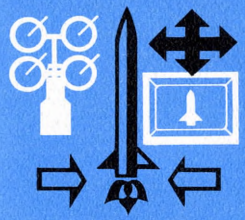
Because the nation's dependence upon the Pacific Missile Range is destined to grow, the instrumentation of PMR's oceanic shooting gallery is being continually developed and intensified to provide that still more complex support required by future operations. For the mighty boosters and the tiny, talented satellites that will blaze meteor-like trails through next week's sky are the spectacular results of steady effort . . . and but a small part of the missile story.


SEA TEST RANGE
PT. ARGUELLO
PT. MUGU
Midway
Wake
ICBM IMPACT AREA
Hawaii
IRBM IMPACT AREA
Johnston
Eniwetok
Kwajalein
POLAR LAUNCH
Canton


SSB-1 MARK II A

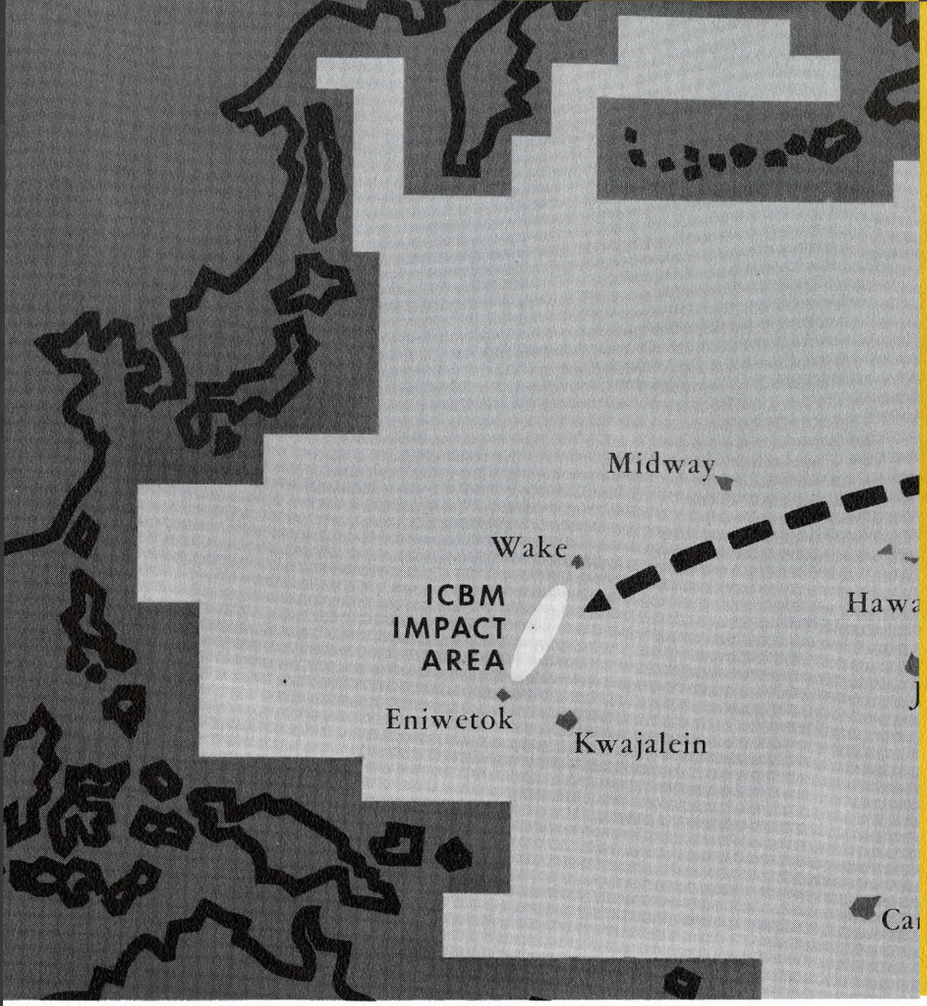
Scheduling and Range Clearance

Since the Pacific Missile Range is available for use by anyone with a recognized program which can use its facilities to advantage, hosting the operations is similar to conducting a gigantic, continuous open house, and "organization" might well be the watchword for men in charge of scheduling PMR's operations. Although the Pacific Missile Range has an enormous area of land and sea available, scheduling remains an extremely complex function, for the operations it supports number in the thousands. Many of these stretch from the North American mainland to beyond the equator, and the far side of the globe. While branch offices are located at NMF, Point Arguello, and at Kaneohe, Hawaii, the master schedule for all PMR sites is maintained at Point Mugu. In this way, PMR assures that operations do not conflict in use of areas or facilities, although tests are held, as nearly as possible, at the time requested by the customer and at a time consistent with maximum range usage. Once a firing is scheduled, clearance is coordinated through the area commander to assure that the space is free for use.



Frequency Monitoring and Control

Each major missile has built within it the means of its own destruction—an explosive part triggered to react instantly to a particular radio frequency. Should the missile fail to follow the planned trajectory, the press of a button will activate this frequency, exploding the vehicle harmlessly in mid-air. However, to avoid the accidental energizing of the frequency, the air is thoroughly policed before launch, insuring that no equipment is operating within that frequency range. Control personnel at Point Mugu are responsible for this function for the entire range complex, including downrange activities. Several semi-permanent FIC stations are maintained on PMR's Pacific island installations, and in a matter of hours, airborne and wheeled facilities may be brought to any other site within the Pacific Missile Range. The monitoring facilities maintained by PMR, in addition to the permanent stations, consist of more than a dozen trailers and vans, and these—combined with aircraft based at Point Mugu—provide an efficient, flexible base for the administration of the frequency interference control function.

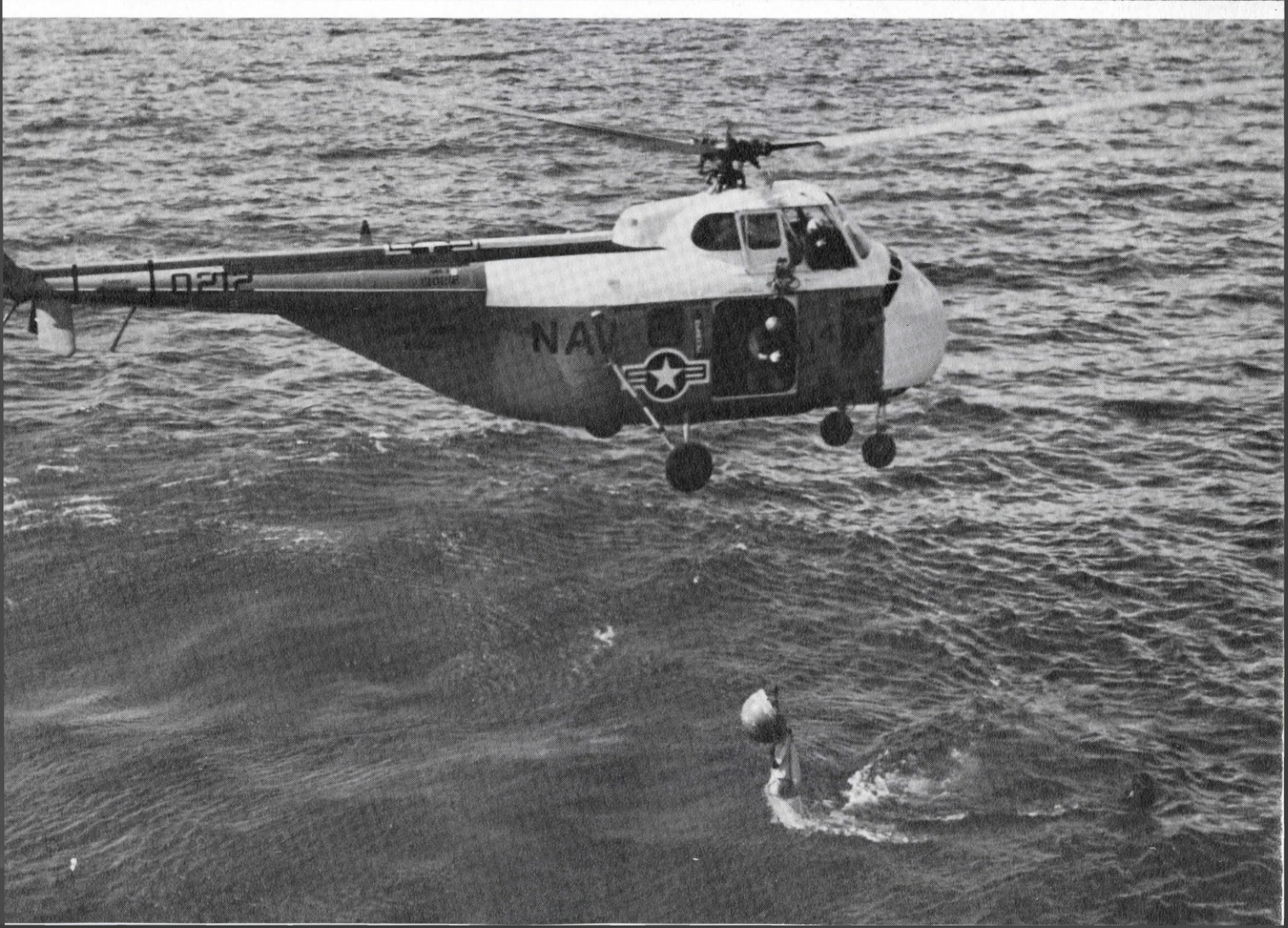


Range Safety

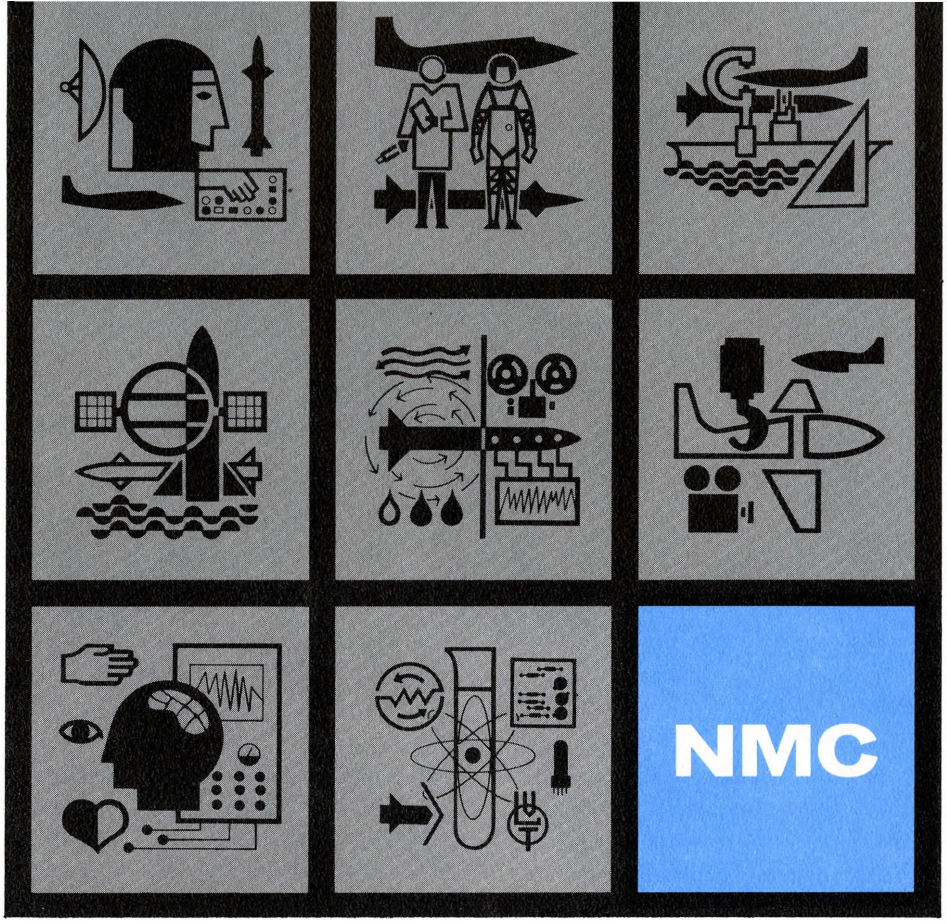
No matter how carefully a missile is evaluated and scrutinized in the laboratory, when the moment arrives for its flight test, it may take off in a crazy, erratic trajectory all its own. Yet, even if this should occur, the danger to life or property is almost nonexistent. In all the thousands of missile firings on our national ranges, there has not been a single fatality. This record is no accident. At PMR it is the result of carefully conceived and strictly enforced safety procedures. For each flight, the safety office mathematically establishes distinct hazard and impact areas. During the flight, instrumentation pinpoints the vehicle's position and computers predict where it will impact, based on that position. This data is fed to the flight safety officer responsible for destroying the missile if it violates the safety criteria. Located atop a hill at Point Arguello, a new tracking facility designed specifically for PMR range safety, takes the two- to four-second decision out of human hands and gives it to a computer for instant, automatic action—thus reducing still further, the possibility of error.

Recovery

The sea is both a friend and an enemy during operations to recover a missile or a nose cone. While it softens the impact, the sea is large and its gray swells obscure the valuable item. That missiles can be recovered at all, is due to the efforts of both engineers and recovery teams. Since missiles are usually designed to be fired to destruction, for test purposes they must be equipped with special recovery devices. Parachutes can slow the missile to minimize impact, while radio or sonic instruments built into the missile can emit guiding beeps to recovery teams. The especially trained forces are stationed near the predicted impact area, the nose cone or missile hits the surface, and from their stations, men and instruments search the sea. Helicopters, ships, and small boats converge as the exact location is pinpointed. When the floating missile is spotted, Navy divers hit the water and make fast the recovery lines. Dangling from a helicopter or aboard a vessel, the bird is on its way to the laboratory, where analysis will help make this missile and its successors, better tools for the nation's Navy.


NAVY


JET INTAKE
736
566

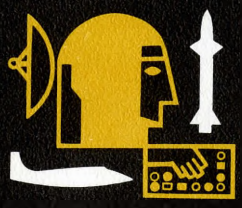


NAVAL MISSILE CENTER

Man has a new power . . . the rocket. It is called the finest of science, the peak of technology, and the best of industry. Although it may seem that the era of missiles and rockets has burst suddenly upon us, the seeds of its growth were planted centuries ago. A search for the first rocket takes us so far back that details are lost in history, but in reality, men have dreamed of air travel almost from the beginning of recorded time. And some actually attempted it.

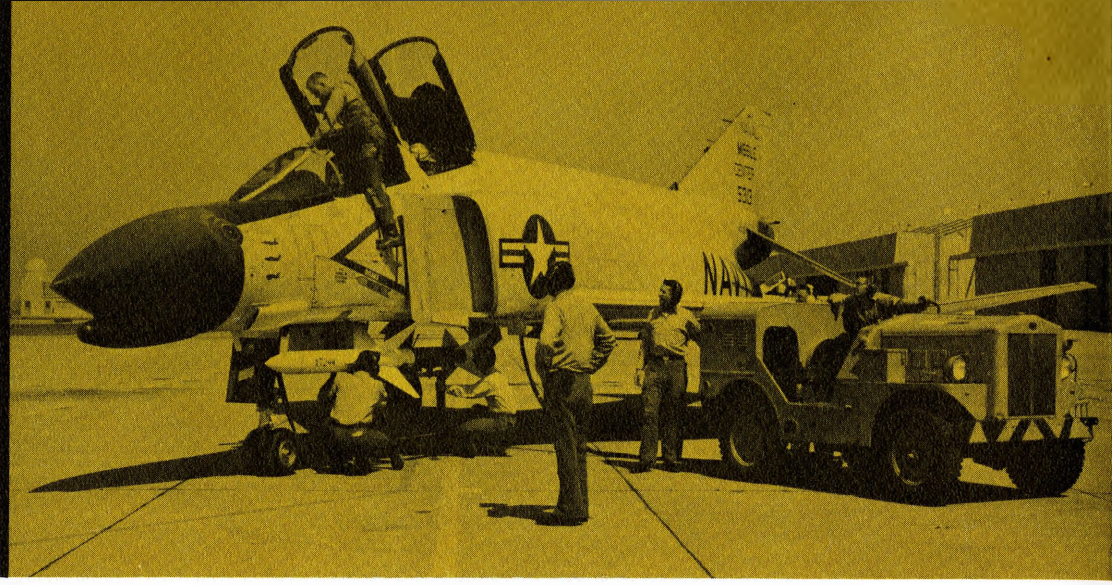
The real pioneer of manned flight was Wan-Hoo, a 16th Century Chinese gentleman and scholar. Wan-Hoo's machine consisted of two large kites arranged side by side and fixed to the framework of a chair. To the frame he attached forty-seven of the largest rockets he could buy. When all was arranged, Wan-Hoo settled himself in the chair and his coolies lit all forty-seven rockets. A roar and a blast of flame ended the experiment . . . and Wan-Hoo's only trip was a short one to the celestial home of his ancestors. For Wan-Hoo had overlooked the primary ingredient in any successful flight operation — thorough test and evaluation.

Until only a generation ago, the accepted way to test something was still by trying it. "The proof of the pudding is in the eating," so a dreamer with a strange mechanical device went out in a field or down in a cellar and tried it. If the device worked, he was jubilant and perhaps set a milestone. If it didn't and if he were still alive, he tried again. In the early days of missilry, this



Systems Integration

When, at NMC the parts of a weapon system are first combined into a unit, interface problems are almost invariably found. The center's special capability is their resolution. Data regarding the problem and its solution is sent to the Bureau of Naval Weapons, who advises the manufacturer of the changes necessary.



method of testing was called "shoot and look."

When the missiles were little more than modified skyrockets, there was little reason for change. Inevitably, however, they increased in complexity and cost, and it was highly impractical to launch a million-dollar behemoth merely to check one cigar-sized component. Additionally, after World War II, it was discovered that more U.S. equipment had been lost because of exposure to extremes of temperature, humidity, and other environmental conditions than through enemy action. Testing under simulated conditions, then, seemed to be the answer to both situations. Laboratory methods were established not only to prove individual parts before they were incorporated into the missile, but to test the complete weapon system, preventing its loss by premature flight or through environmental conditions. And so, test and evaluation became recognized as paramount factors in the success of every new concept, from a missile to a filter-tip cigarette; and along with this recognition, the Naval Missile Center, Point Mugu, developed into a major naval activity.

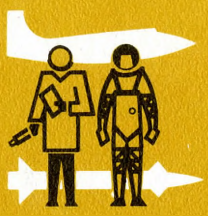
Visualize a few nondescript buildings scattered over a desolate beach, a few cars parked nearby, and sea gulls squalling as they pass the time dipping into the surf or waddling along its fringe. This was the Naval Air Missile Test Center in 1946, first Navy facility established to test guided missiles over land and water. Its history is one of pioneer growth, ingenuity, and enterprise, of failures, frustrations, make-do, and try-again.

The first operation was a test of a launcher, a 155-foot powder tube. The breech was blown off. One observer reported drily, "We secured for the day." The first missile to be launched was the Loon, a modified version of the German V-1, and it unceremoniously plummeted into the breakers on the beach. Seven sailors were stationed at strategic vantage points to report what they had seen. They gave seven different reports. A few days later, a missile launched with its full 180-gallon ration of 72-octane gasoline crashed and burned.

Today's missilemen may well look back, however, and wonder how these pioneers accomplished as much as they did. The tools they had were alarmingly inadequate. Their first electronics gear was from Army surplus stores, and early in 1947, a Los Angeles newspaper reported that the men of Point Mugu "scrounge materials wherever they are to be found." Still, from the breech failure came an improved launcher; and after the seven muddled visual reports of the Loon's flight, the first range instrumentation was planned. Thus the Naval Missile Center, as it is known today, began to grow.

The importance of test and evaluation is spelled out in NMC's mission: to test and evaluate Navy guided missiles, their components, and related weapon systems for the Bureau of Naval Weapons, and to provide equipment and skills for the solution of problems in astronautics.

Located at Point Mugu, California, the site of the Pacific Missile Range Headquarters since 1958, NMC is under the military control of PMR and is the primary user of PMR facilities. Because the missions of the two commands require many of the same tools and functions, NMC and PMR, like friendly next-door neighbors trading lawn tools, assist each other with various support and services. For example, the missile center uses PMR's range support, air station, and



Flight Evaluation

After all the laboratory evaluations are completed, the final proof required of a guided missile is in its flight evaluation. For this test, the air-launched missile is cradled beneath its aircraft, carried aloft, and fired. Only when this data is collected and analyzed can NMC answer the question, "How well does it work?"

technical facilities, in addition to various staff services such as administration, comptroller, bioscience, and communications. In return, NMC provides PMR with operational support, technical information, patent counsel, and other services in astronautics and life sciences.

Much of NMC's support also goes to other naval organizations such as the Naval Ordnance Test Station, China Lake; the Naval Ordnance Laboratory, Corona; the Naval Air Development Center, Johnsville; and the Naval Air Test Center, Patuxent. In addition to supporting other government agencies, the Naval Missile Center assists civilian contractors during research and development flight tests of naval programs. At a given time, NMC may be furnishing test pilots, missile assembly space, office space, and bench test area for as many as six hundred contractor personnel representing some thirty different companies. While the Pacific Missile Range is used for national range programs, NMC's business is exclusively naval programs, most of which are eventually flight tested on the PMR for final evaluation by NMC.

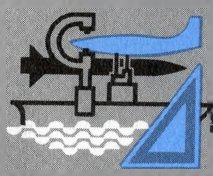
The Naval Missile Center is the last staging area for guided missile weapon systems before their delivery to the fleet, and here the parts of a system are brought together for the first time as they come from the various manufacturers. Early in the test and evaluation program, the missile components, such as guidance or nose-cone units, are tormented by extremes of altitude, temperature, speed, pressure, vibration, and shock: temperatures from a raw one hundred degrees below zero to a seething 350 degrees above, altitudes from sea level to 150,000 feet, and pressures as scant as those found at 500,000 feet. A disk centrifuge 32 feet in diameter subjects the parts to violent gravity forces up to 100g's while at the same time it carries equipment creating other major environmental conditions.

The high-intensity sounds that occur within missiles are also considered, for sound can destroy as efficiently as death rays concocted by a Rod Serling or a Ray Bradbury. In the missile center's acoustic chamber, the test items tremble under 155-decibel sound intensities — agonizing enough to permanently damage the human ear. They are shaken in a brute force vibrator or a complex wave simulator at 5,000 cycles per second; and, in a 90-foot atmospheric chamber, they are encrusted with snow and sleet, while outside, the Southern California sun shines brightly.

Once the components pass the tests, they are assembled to form the complete missile and re-tested under the same unsparing conditions, thus showing the interaction of one part with another.

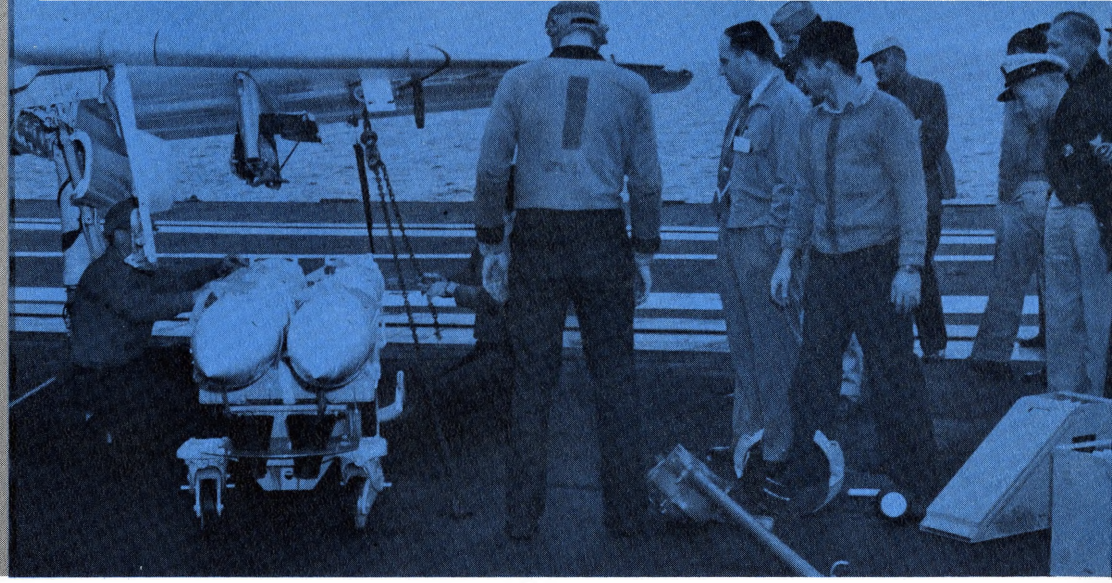
In the last of the non-firing tests, the missile and the aircraft or vessel it will arm, are combined for what is called "serviceability evaluation." Aboard the launching craft, the missile is handled entirely by fleet personnel — the men who will use it, not the engineers who have fostered its development. Can it be moved from storage to the firing or loading site efficiently? Could it be done more easily if . . . ? Does vibration, acceleration, or normal handling affect the missile adversely?

Finally the system is scheduled for the operational test. This is it. Hundreds of eyes, both human and mechanical, are poised to follow the flight path, from launcher to impact. On a control panel lights are blinking amid row after row of knobs and



Serviceability Evaluation

Perhaps the greatest hazards to a missile in service use result from shipboard vibration and shock. Thus, the complete evaluation of an air-launched missile involves the launching aircraft, the aircraft carrier, and the ocean. Through such realistic tests, NMC assures the dependability of the Navy's weapon systems.



toggle switches. Electric motors whine urgently, while strange steel radar antennas peer expectantly upward. This is an air-launched bird, and in the distance is the whine of the jet's engines. The wind sweeps harshly over the beach. Suddenly the F4H is overhead, pulling its scream-roar behind it. It's passed, over the ocean, and the sound pours down. With a shrill scream of its own, the missile blasts from beneath the jet's wing, an infuriated, savage creature —it seems alive as it knifes through the sky toward an unseen target. Every action, both internal and external, is being recorded on rolls of film and tape, picking the bird's brain, showing where something is not quite right, how something can be improved. This is information to be pored over in weeks to come, by NMC scientists and engineers.

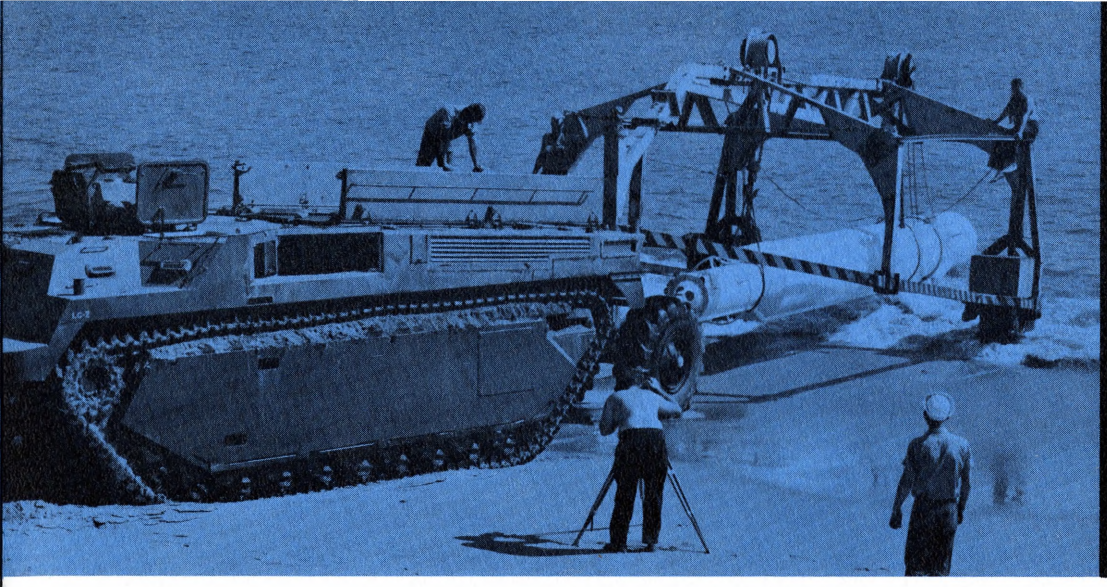
Not all NMC's operational tests are successful, and this is to be expected. For the center is where missiles are developed. Once they are reliable, NMC is less concerned, and works to replace them with better weapons, which in turn will have their pre-operational failures.

Destined perhaps to become one of the most revolutionary research and development studies conducted at the Naval Missile Center, is Hydra—the concept of substituting bodies of water for the usual complex launching facilities. The concept is simplicity itself, and is based on Archimedes' principle that any object partially submerged in water is supported by the liquid it displaces. The larger the body and the greater its proportion beneath the surface, the more firmly it is held.

A ninety-foot intercontinental ballistic missile floats free, upright in the cold choppy waters of the Mississippi, the Pacific, the Gulf of Bothnia, the Atlantic, or the Bay of Bengal. Only the missile's nose emerges from the undulating waters. In the distance a ship waits, motionless. Then with a rumble-roar-blast, the ICBM rises skyward, slowly at first, then faster, its churning wake healed by the insistent waves even before the creature thunders silently into the clouds.

This will be Hydra: a missile — the size does not matter — launched from water — the location is of no consequence — fired by remote control radio command. Economical, strategically desirable, logistically advantageous, and feasible. Definitely feasible. NMC's scientists and engineers have proved that a rocket designed for ignition in the air can be successfully ignited under water with only minor modifications; no instability results from the rocket exhaust; and there is no choking of the supersonic exhaust by the water inertia. As missiles continue to increase in size, NMC's Hydra concept will inevitably increase in importance. Its validity is proved in every floating object—a beach ball, a coke bottle, or a missile.

Nearly as important as the missiles themselves, are the targets, also developed by NMC, which test the weapon's accuracy. In the case of air-to-air missiles, the target is a drone — an unmanned aircraft flown by remote control from ground stations or from other aircraft. The stand-in must represent as nearly as possible, the actual aircraft the missile is designed to attack. Two important characteristics which must be accurately imitated are speed — perhaps twice as fast as sound — and the reflective surface of the target, which is important to the acquisition of the target by the missile's radar.



Astronautics

Seventy percent of the earth's surface is water, and NMC's Hydra research and development study in astronautics has proved that any body of water is a potential firing pad. Replacing a million-dollar concrete slab and sky-scraping steel structures, a lake, a sea, or a river can be an indestructible, practical launch facility.

The work of NMC, however, does not end with the release of the approved system to the fleet. As the missiles are produced by the manufacturer, the center conducts exhaustive tests of random samples from the production line to assure that the missiles received by the fleet are up to standard in quality.

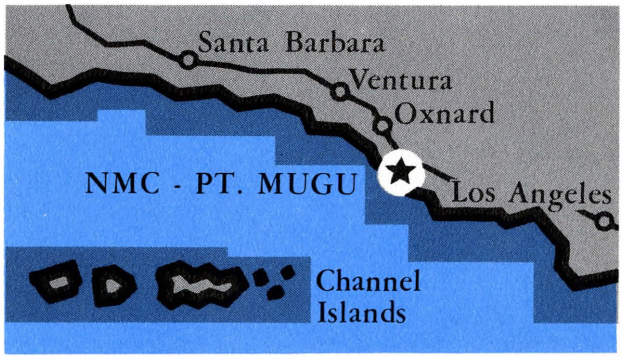
The development of missile systems results, too, in valuable knowledge which NMC gives to fleet personnel: on-the-job instruction in the limitations, capabilities, and use of the particular missile system. In addition, as a specific missile program is developed at NMC, better research methods are discovered and these are transmitted to the Bureau of Naval Weapons for possible inclusion in advanced projects.

During the sixteen years it has been evaluating weapon systems, the Naval Missile Center has acquired a vast array of equipment and a large staff of men well-trained and experienced in missilry. Because the laws of physics and mechanics are constant, many of the problems anticipated in space travel are not new, and the center's ability can be readily adapted to the requirements of space vehicles.

To assure the safety and well-being of the astronaut and the success of his space mission, he and his craft must be proved under the conditions to be encountered, and these too, must be simulated in the laboratory. Although NMC's equipment was designed to test aircraft and missiles, it may be used as well for work with animal and human subjects. Especially useful are the disk centrifuge that holds equipment to create a nearly complete environment in addition to extreme acceleration, the atmospheric chamber, the 500,000-foot-altitude simulation chamber, and various acoustic chambers and vibration machines which will all have definite places in serving the Navy's and the nation's space objectives.

Man himself is the limiting factor in space flight, and a capsule alone cannot adapt him to the new environment. Hence, NMC has been testing a full pressure-suit, one which protects the man from conditions such as extreme gravity and low pressure, and from conditions he will encounter if he must escape from the craft. The need for pressure suits is a standing one to the Naval Missile Center; certain models are routine equipment for crews of high-performance aircraft used in daily operations.

There are fewer sea gulls along the beach at Point Mugu now than there were in 1946. Their place has been taken by the 2500 missiles which each year rip through the skies in flight evaluation. The 612 men of the old Naval Air Missile Test Center who worked with scrounged equipment in nondescript buildings now number more than two thousand, and no laboratory facilities in the nation are more complete than Point Mugu's. Indeed, the Naval Missile Center has come a long way, and the end is . . . nowhere in sight.




COMPUTER

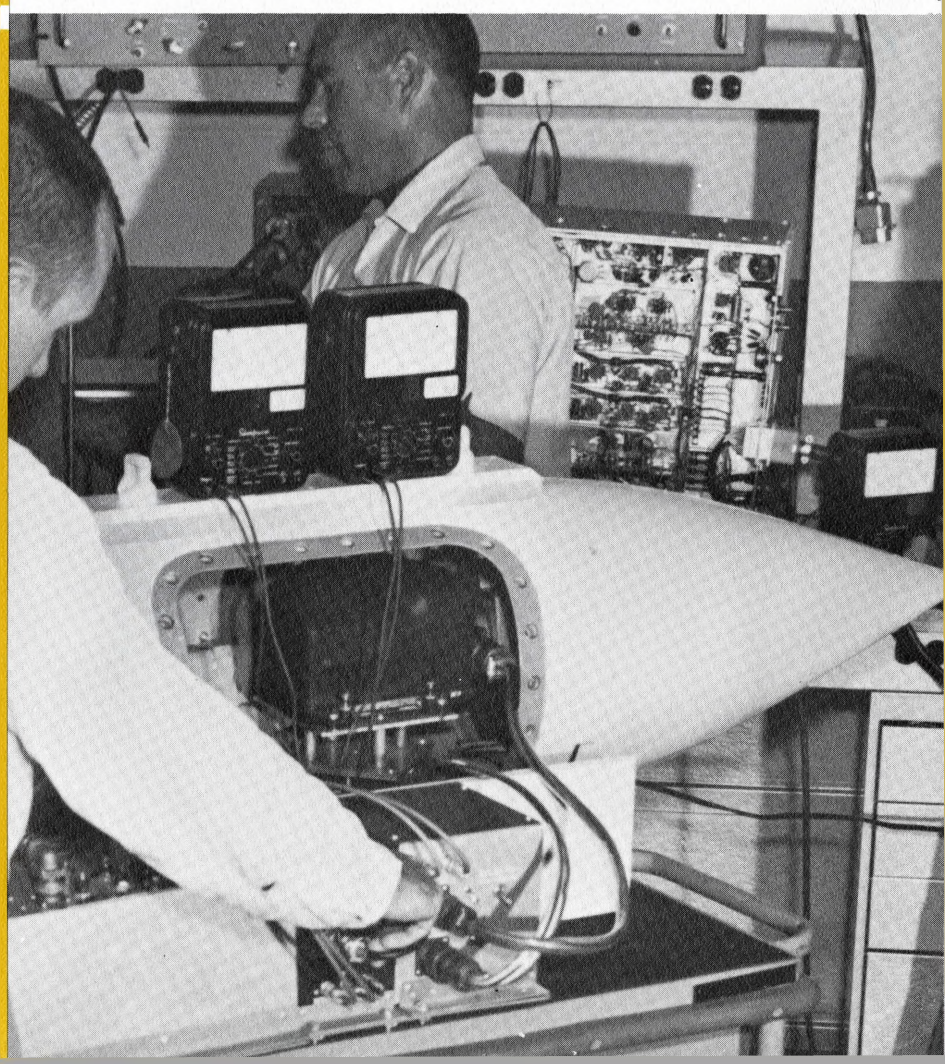

U.S. NAVY

Environmental and Functional Simulation

A missile failure predicted . . . a faulty component pinpointed . . . a test pilot checked out . . . a warhead's performance projected. Without a pilot climbing into an orange suit, without a missile ever leaving the ground, these results are obtained at NMC from computer and environment simulation. For example, a plotting table with computers is used to simulate systems that are too expensive, or even impossible for actual field tests. An instrumented cockpit mockup to test the complete weapon system also provides pilots with experience in the use of a weapon system early in its development, perhaps even preceding it. New weapon systems are evaluated before their details are firmed up, and if the outlook is unfavorable, the computer can show where the fault lies. In the environment laboratory, on the other hand, testing involves fewer variables, for the item itself is subjected to extremes of temperature, altitude, gravity . . . and technologists see the results. Here specific items, rather than general, are tested. Thus NMC's facilities provide a combination for the ultimate in pre-launch evaluation.

Operational Support

As there is no measurement of success without a goal, so is there no evaluation of a missile's accuracy without a target. As part of its operational support, NMC provides aerial and surface targets for the missile operations conducted at Point Mugu and for ships engaged in training exercises. Flight evaluation also requires aircraft, many different kinds, for their functions are varied. They assist in tracking and recovery operations, photography, and may control a supersonic target as it shoots across the range. The maintenance of the aircraft is another NMC function, performed by crews with special training in servicing, repair, and check-out and in maintaining the aircraft's electronic gear, survival equipment, and armament. Recording missile tests is one of the tasks performed by photographic experts at NMC. From component test to impact, each step is photographed to be minutely analyzed and evaluated. Training films are made concerning missiles newly-released to the fleet, and documentary motion pictures—with scripts by NMC writers—may publicize the progress of an entire missile program.

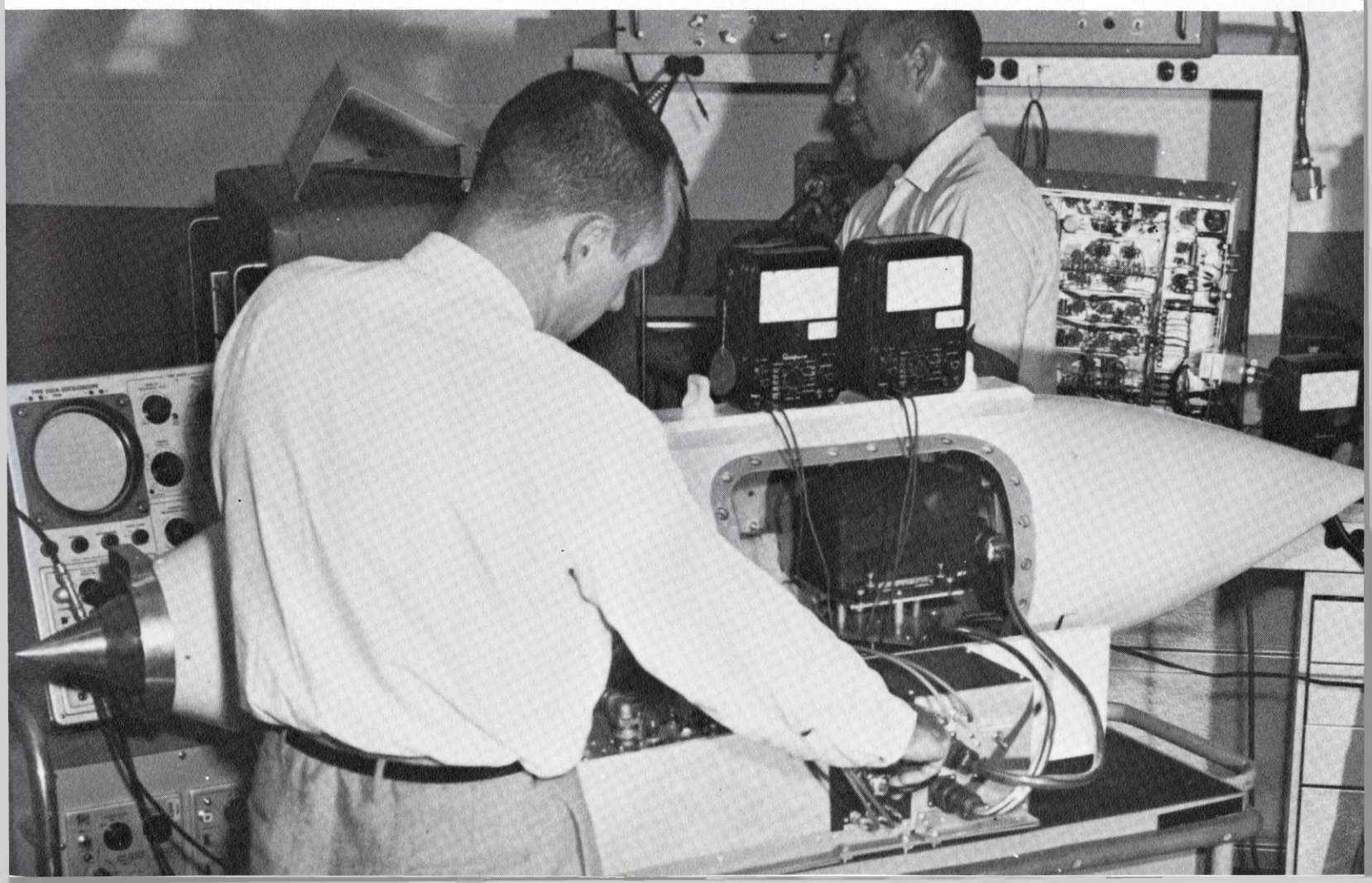


Life Sciences

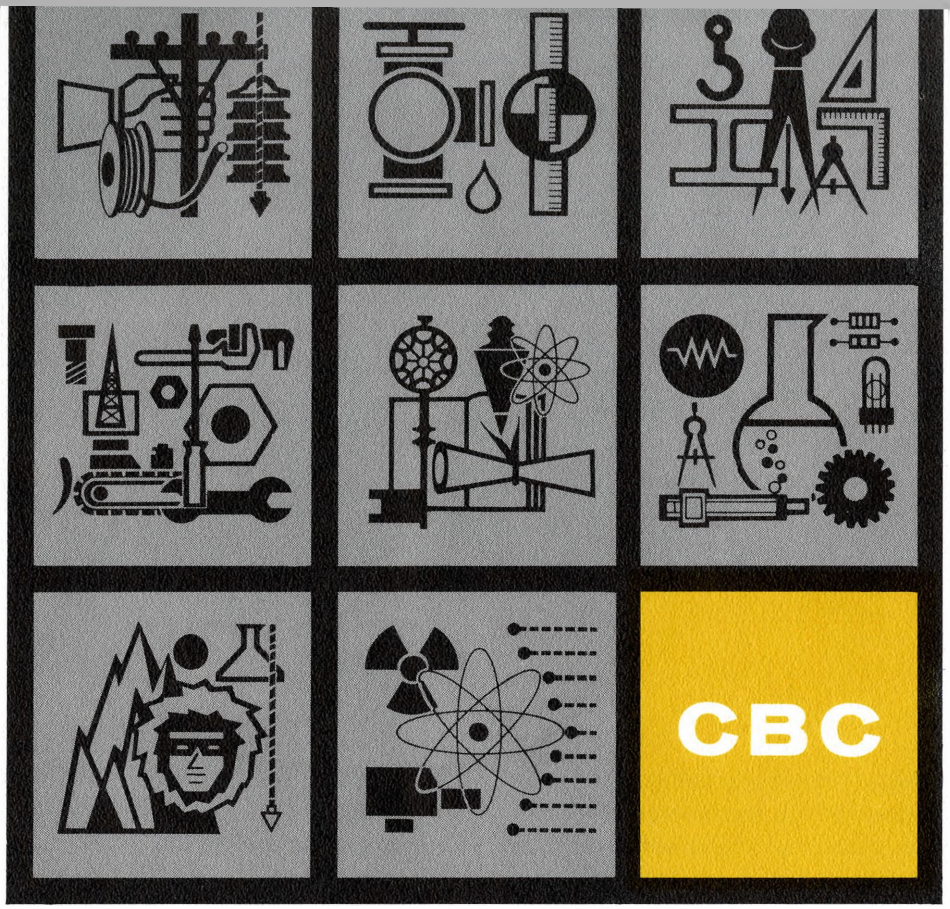
His knowledge of the ways in which people communicate, make judgments, feel, and react is the primary tool of a life scientist. And at the Naval Missile Center, life sciences personnel are using this knowledge to improve the compatibility of human operators with high-performance aircraft, missiles, and space vehicles. Their investigations determine which tasks can better be done by machine and which by human operators, and, where a task is to be performed by a man, what information and controls he will need. For the aircraft, missile, or space vehicle must not require more than human ability. Environmental simulation gives the answers to questions of capability—and not only of the man-machine combination under environmental stress, but of a man and of a machine individually affected by environment. And the result? A system efficient under both normal and emergency conditions, and less-stringent operator requirements. Only through laboratory research of the complete system—man and machine— in complex, extreme environments, is the development of a reliable system possible.

Laboratory Investigation

An inanimate object will, at a human command, soar into the air, perform prescribed motions, and descend when and where man directs—a process that requires of every part, the ultimate in precision. All the hundreds of components that make up a guided missile must be tested individually and in combination. The Navy's heaviest field concentration of missile test equipment is at the Naval Missile Center, and a large part of this equipment is in the laboratory facility where the missile's sub-systems, components, and finally the complete systems themselves are studied. The launching system is tested and evaluated; the performance of propellants and pyrotechnics is analyzed in the chemistry laboratory; and solid fuels for use in ramjet engines are evaluated. Laboratory personnel test, evaluate, and modify the command, seeker, infrared, and inertial guidance systems, and the control, electrical power systems, and missile checkout equipment. Both static and dynamic tests are conducted in conjunction with studies of the dynamics of structures, their elasticity, and elastic-plastic stability.




YD-148
USN83-00037

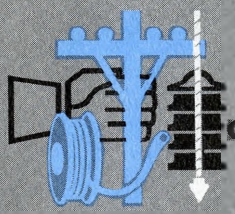


NAVAL CONSTRUCTION BATTALION CENTER

A hard working, hard fighting, rugged crew with small regard for military niceties when there's work to be done; admitting to no obstacles, thriving on impossible tasks; and blasting, drilling, and bulldozing their way to accomplishments: these are the men of the Construction Battalion Forces, the Seabees.

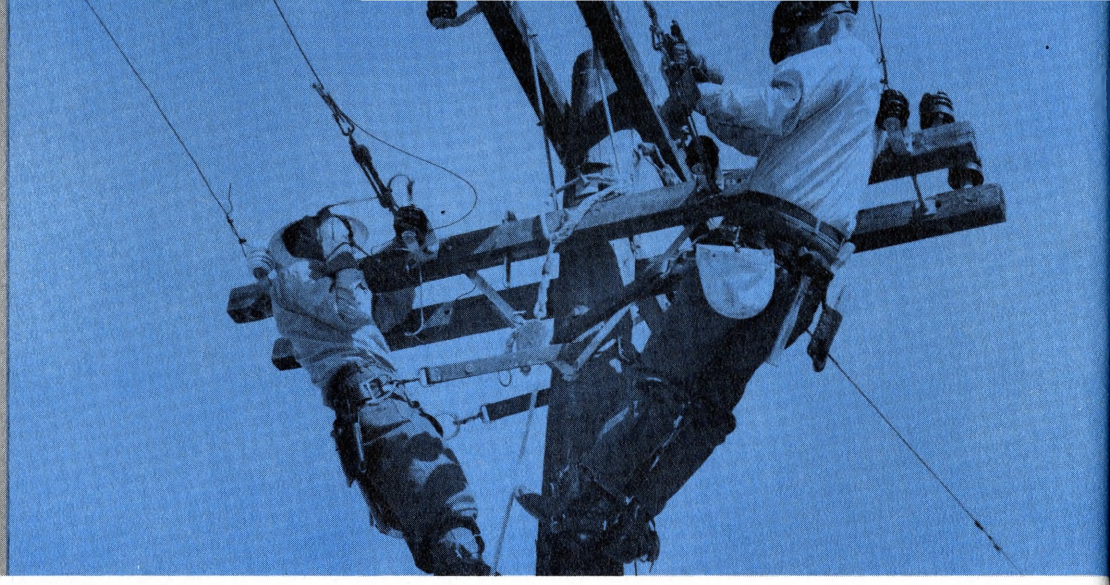
Born of an urgent need in the early days of World War II, their first big job was to construct island bases in preparation for U.S. military advancement in the Pacific. They shipped out of ports from the east and west coasts before most of them could tell a belaying pin from a capstan, and they won a Paul Bunyan-like reputation for being men who could get things done against great odds. Pick-and-shovel sailors, the swashbuckling Seabees became a colorful legend in the jungles and atolls of the Pacific.

*"Rear Admiral O. O. Kessing said of the Seabees under his command: 'They're a rough, tough, loyal, efficient bunch of men who don't give a damn for anything but doing the job and getting the war over.' The late Admiral William F. Halsey commented after an inspection trip ashore: 'I had to move lively to keep from being bulldozed off the beach.' And after the fierce battle for Henderson Field on Guadalcanal in which the Seabees did plenty of fighting while rebuilding the base, an officer of the 1st Marine Division reported: 'Those Seabees build roads so fast the Japs are using them as avenues of escape.'



Construction Electrician School

The U.S. Naval Schools, Construction, train selected enlisted personnel for early ability in their rates. Classes are supplemented by training, which, for Construction Electrician's Mates, includes splicing multiple wires, installing conduits, wiring a switchboard, and high-line experience —ball games atop power poles.



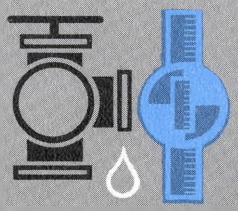
"A proud heritage of today's Seabees is the ingenuity and valor displayed by the Seabees of World War II. For instance, there was Machinist's Mate First Class Aurelio Tassone who introduced bulldozer warfare. When a Japanese pillbox pinned down the Marines during a landing in the Treasury Islands, Tassone drove his bülldozer up to the pillbox, heedless of the fire, and dumped a ton of dirt on it, smothering the occupants. This action, for which Tassone won the Silver Star, led to the armored bulldozer, a telling weapon in later campaigns."

In 1942, the Navy realized that an advanced base depot on the West Coast was imperative, and Port Hueneme, with its excellent harbor, open fields, and level terrain, appeared to be the ideal location. Hence, the Navy bought the Hueneme harbor from the local ranchers who had built it to transport their products to Los Angeles, and who made up the Harbor District. For two million dollars, the Navy obtained the harbor itself and 1700 acres of land surrounding it, and on March 12, 1942, began construction. Upon completion, the center consisted of barracks and messing facilities, 32 miles of railroad track able to handle 1997 freight cars, 39 miles of surfaced roads, and berthing frontage for nine deep-water ships and two LST's. During the war, Port Hueneme trained, outfitted, and shipped 176,476 men, and shipped out more Navy war tonnage, supplies, and equipment to the Pacific area than any other port in the United States.

While the Seabees must build shore facilities overseas for use by operating forces of the Navy, they must also be able to defend their construction against enemy harassment and attacks. The importance of this military side of today's Seabee has increased tremendously in recent years. No longer is it enough for a builder or construction electrician to know just the specialties of his trade. He must also be a machine gunner, fire team leader, radio operator. The old get-the-job-done attitude has gradually undergone a change until today it is more nearly get-it-done-and-defend-it. To accomplish this new task, the Seabee undergoes extensive training, for in contrast to the skills of the building trade, which can be learned right on the job, specialized military training is required to acquaint the Seabee with the rudiments of modern warfare, and defensive combat tactics in particular.

A new dimension in technology has been added to the mission of the Naval Construction Battalions—to take measures of passive defense against nuclear attack and to recover bases and facilities damaged by such a disaster. A direct result of this requirement was the establishment of the Disaster Recovery Training Division at Port Hueneme. Its purpose is to train personnel in the recovery of an area after atomic, biological, or chemical warfare attacks. The premise upon which it is based is this: men once exposed to a given situation are less likely to panic should the situation be repeated. Thus, realism is a major requirement of the program, and the training area itself is designed to resemble the facilities normally found on a naval station. A simulated bomb crater fifty-five feet in diameter is the center of the "destroyed" area, and damage to the basic construction is graduated from "ground zero" as if from a 1/10 kiloton atomic blast. The blast itself is simulated by a detonation of cordite, gasoline, and diesel fuel, and the training exercise includes personnel rescue, field communication, field monitoring and other techniques vital to recovery from a nuclear disaster.

Engineering Aid and Utilities Man Training



An Engineering Aid, whose basic task is surveying, may often have to perform his own drafting and office work. This he is trained to do at the Seabee schools. Similar is the Utilities Man, who learns the drawing of plumbing and ventilating layouts. This basic and advanced training is given all men with Seabee rates.

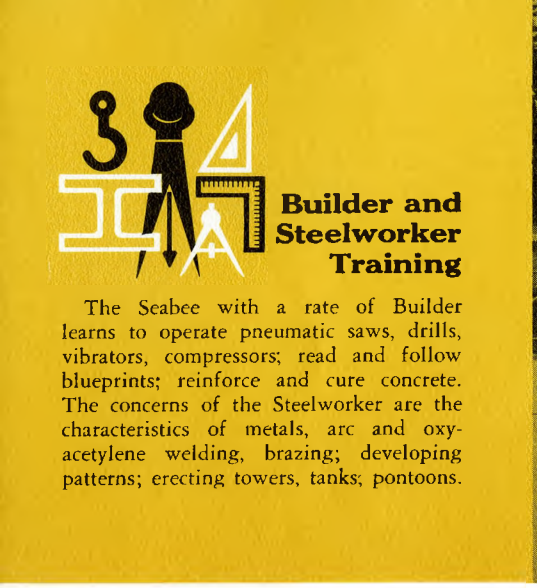
In addition to an expanded wartime mission to build and fight, the Seabee today has an important role in preserving national security and world peace. Active Mobile Construction Battalions now operate in peacetime to preserve priceless Seabee construction skills and to train new men to maintain this vital element of national readiness. Seabee training is accomplished through actual construction operations in areas where work could not be done easily by civilian contractors, especially overseas. Seabees must also stand ready to effect quick recovery from natural catastrophes such as hurricanes and earthquakes, when other construction forces cannot be mobilized readily. Similarly, an accidental nuclear explosion in the United States would require the special decontamination skills of the Seabees for disaster relief, and the peacetime battalions have this responsibility.

*"Today the Naval Construction Forces consist of five Mobile Construction Battalions and an Amphibious Construction Battalion assigned to the Pacific Fleet. There are five mobile and one amphibious battalions assigned to the Atlantic Fleet. From their respective bases at Port Hueneme and Davisville, Rhode Island, the Navy's 11,000 Seabees are deployed to all parts of the world to construct and maintain facilities. Their projects include guided missile and advanced undersea warfare facilities, power stations, complete airfields, pipelines, ordnance shops, and other essential defense construction, as well as huge housing units needed for Navy personnel.

"Although headlines are fewer in peacetime, today's Seabees are seeing their share of the world's hot and cold spots. A detachment of Seabees hit the beach with the Marines in the Lebanon crisis of July 1958." And at Byrd Station, eight hundred miles from the South Pole, the Seabees are currently building an under-snow camp which will be the base for extensive scientific research in astronomy, glaciology, meteorology, and communication. In March 1961, the Seabees completed the first nuclear power plant in the Antarctic, to supply electric power to the Navy base at McMurdo Sound. And, to the Seabees go the jobs of repairing roads, bridges, piers, and other facilities vital to efficient functioning of naval bases abroad.

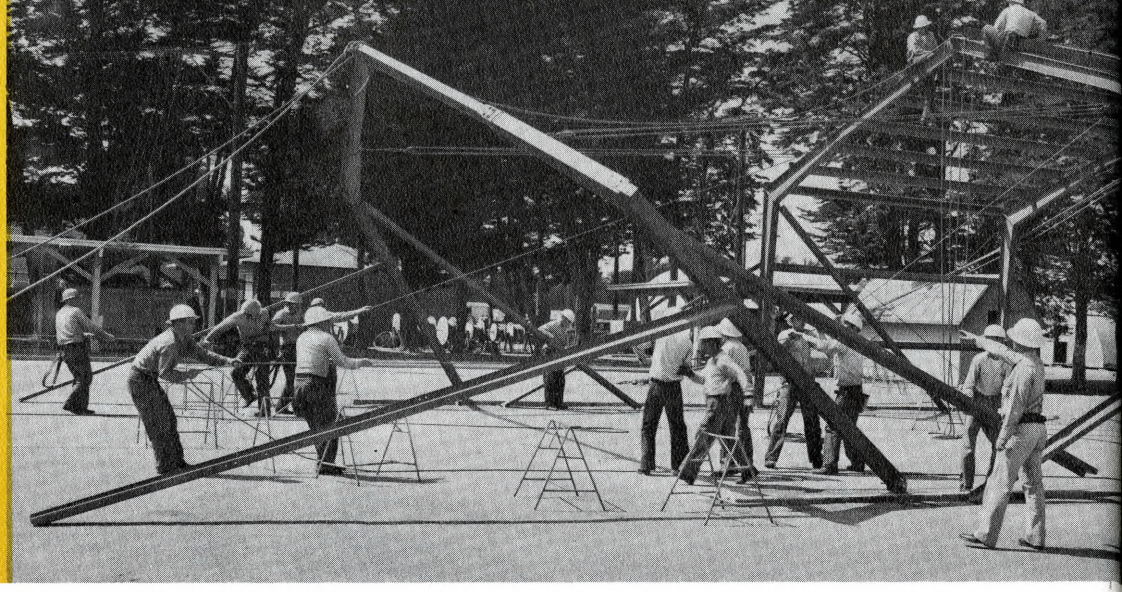
Through the years that the Antarctic Operation Deep Freeze has been functioning, one of the greatest handicaps to efficient operation has been the inability to maintain suitable snow surfaces for aircraft runways, taxiways, marshaling areas, and roadways for motor vehicles for any extended period of time. Until last year, wheeled aircraft operations virtually ceased after the first of January. Now, however, because of the efforts of the Seabees, wheeled aircraft are never kept from flying onto the Antarctic Continent because of poor runway conditions. For the first time, support personnel and supplies can be transported by air the year around—a mandatory factor if the Navy or any other agency is going to stay in Antarctica for any length of time.

The center at Port Hueneme is the home port of Mobile Construction Battalions Three, Five, Nine, Ten, and Eleven, and exercises military command and coordinative control over four components — the U.S. Naval Civil Engineering Laboratory, U.S. Naval School for Civil Engineer Corps Officers, the U.S. Naval Schools for Construction, and the Commissary Store. Logistic support is provided to the U.S. Naval Construction Battalion Base Unit, Yards and Docks Supply Office,



Builder and Steelworker Training

The Seabee with a rate of Builder learns to operate pneumatic saws, drills, vibrators, compressors; read and follow blueprints; reinforce and cure concrete. The concerns of the Steelworker are the characteristics of metals, arc and oxy-acetylene welding, brazing; developing patterns; erecting towers, tanks; pontoons.



service craft, the Point Mugu Naval Air Station Boat Division, and four Pacific Missile Range support ships, which use this port as home base.

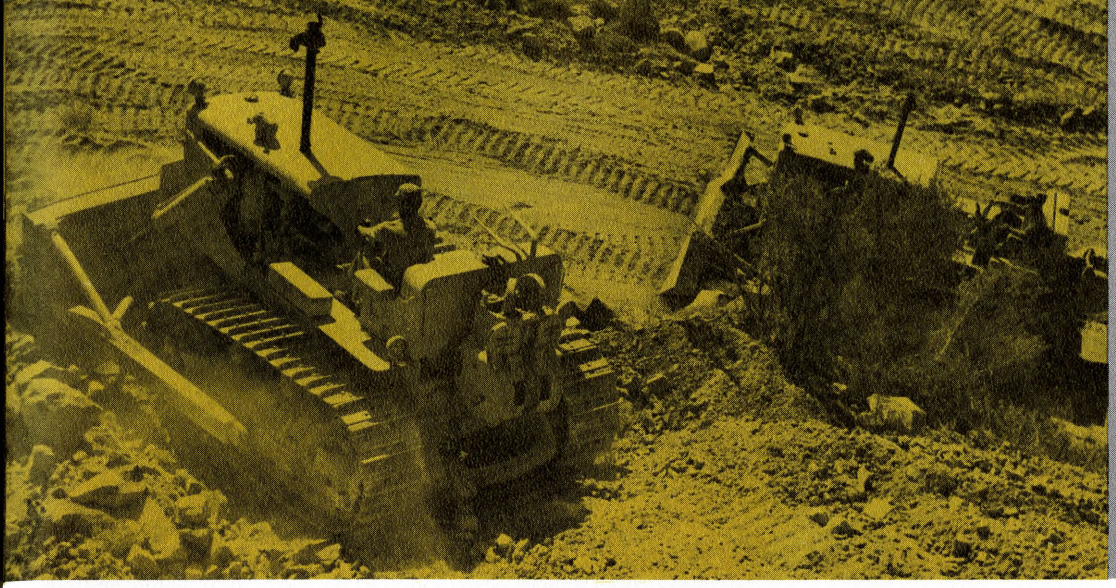
The only activity of its kind in the Navy, the Civil Engineering Laboratory is a major research and testing arm of the Bureau of Yards and Docks. Its mission is to conduct research, development, and proof tests of various types of equipment for use at advanced bases and shore activities and in amphibious operations; and to develop techniques, equipment, material, and structures best suited for the construction, maintenance, and operation of Navy shore activities.

A joint military-civilian organization, the laboratory's staff of three hundred scientists, engineers, and supporting personnel is active in many technical fields. Included on the staff are civil, electrical, sanitary, mechanical, and structural engineers, as well as marine architects, chemists, biologists, electronics scientists, and physicists. They hold memberships in some forty-five different technical and professional societies and serve on some of the foremost technical committees in the country. Because the laboratory has a relatively small staff with such a diversity of disciplines, each engineer and scientist is afforded an early opportunity for rapid personal development, broad responsibilities and experience, and professional recognition.

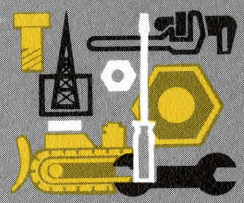
One of the more unique projects at the Civil Engineering Laboratory involves the use of the laboratory-conceived and designed atomic blast simulator. The first of its kind, the simulator duplicates atomic pressures without using atomic devices, and makes it possible for scientists and engineers to analyze the effects of nuclear and thermo-nuclear blasts on structural elements. The laboratory's simulator has a distinct advantage over actual atomic blasts such as those conducted at the Nevada test site, in that the blast pressures can be measured and controlled, while the actual pressures cannot be regulated or predicted accurately at the site in Nevada. The purpose of the atomic blast simulator is to test the effects of extreme, sudden pressures on structural connections, walls, soil, and structural sections and beams.

The destruction caused by marine boring organisms is another concern of the Civil Engineering Laboratory. Every year the creatures cause some $50,000,000 worth of damage to waterfront structures along the coasts of the United States. These animals are present in all harbors and may honeycomb untreated wood so rapidly as to cause structural failure within a few months. Hundreds of varieties are under study. Bankia and Teredo begin as minute free-swimming larvae that attach themselves to untreated piling and bore into the interior. In six months they are fully grown and some species attain a length of six feet and a diameter of more than an inch. Another species is the size of a grain of rice, and gnaws on the surface, eating away the creosoted exterior. This leaves sizeable openings for other types of borers to enter. The laboratory's chemists are developing various types of protective inhibitors such as mercurated dyes, and studying the chemistry of woods which are naturally resistant to the attacks of the borers.

During the Olympic Games at Squaw Valley, California, laboratory personnel served as consultants to the Seabees who were given the task of compacting approximately eighty acres of snow for a parking area. It was found that a thin sawdust cover over the compacted snow served as an insulator on warm days,



Equipment Operator and Mechanic Courses



Equipment Operators maneuver bulldozers up trackless hills, use delicately balanced cranes, handle a variety of earth-moving vehicles. Repair of the equipment is the job of the Construction Mechanic, whose tasks vary from one requiring a micrometer to one calling for a sledge hammer. NAVSCON trains them all.

and also aided traction. The sawdust caused the formation of a two- to three-inch layer of ice at the snow surface, which prevented deterioration of the snow by traffic. During the two weeks of the games, the parking areas and snow road were operational at all times.

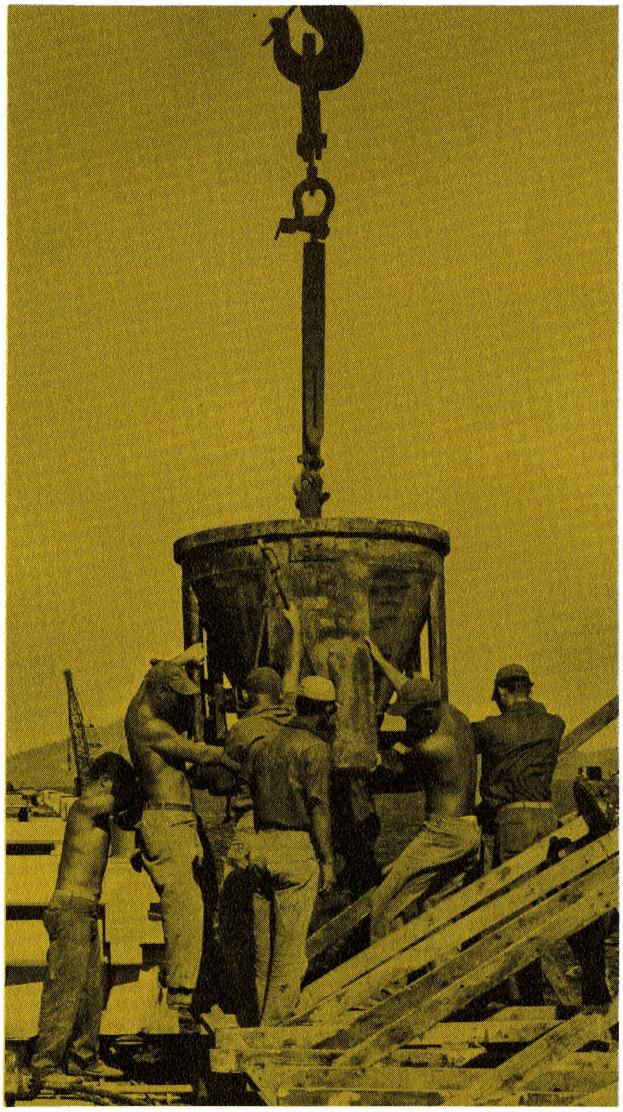
The Civil Engineer Corps Officer's School provides courses of instruction for officers of the CEC, regular and reserve, through which they may become acquainted with the specialized administrative and technical engineering information necessary to equip them for the demands of military duty.

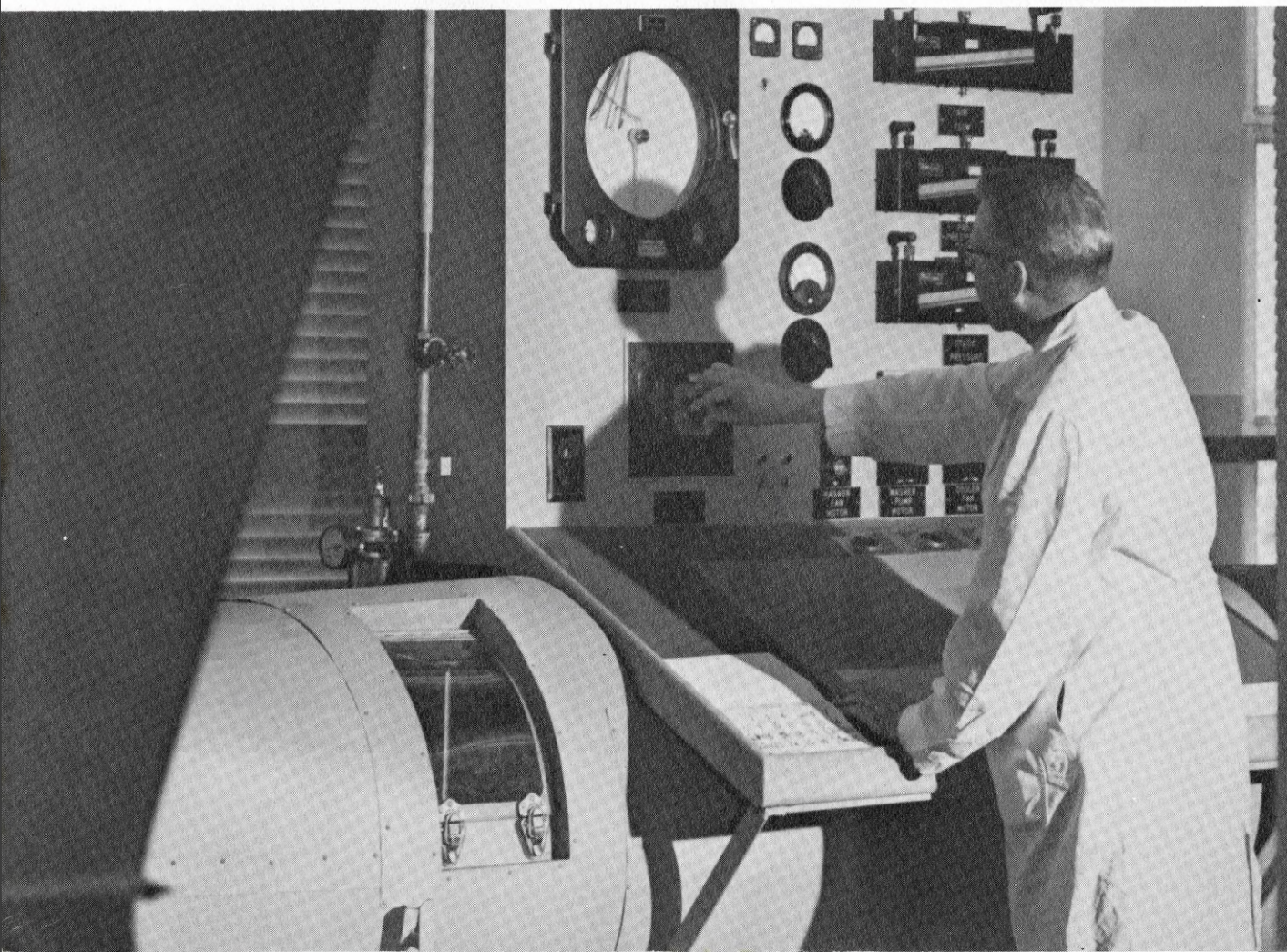
Thousands of Naval Civil Engineer Corps officers and key civilians of the military establishment now serving throughout the world are graduates of the U.S. Naval School, Civil Engineer Corps Officers at Port Hueneme, the only school of its kind.

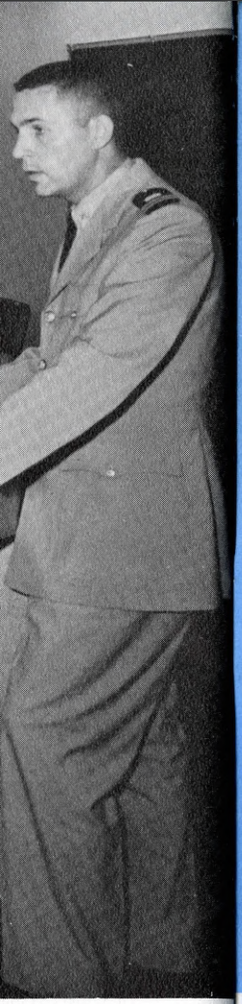
The Naval Schools of Construction train builders, equipment operators, surveyors, construction electrician's mates, draftsmen, mechanics, steel workers, and utilities men. Each year about four thousand enlisted personnel are trained, including men of the Marine Corps. From time to time, military personnel from foreign nations such as Thailand, Korea, and Nationalist China receive training in these schools, also the only ones of their type.

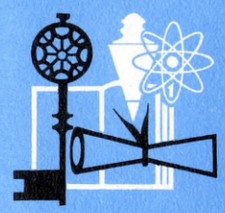
Although a mere youngster of twenty years, the Seabee organization is already battle-starred with tradition and prestige. Today's Seabees are a special breed of Navy men, proud of their versatility and ability to do almost anything, anywhere, anytime. They constitute a mobile, compact, and capable operating force, working and building for peace, but prepared to fight.

*Excerpts from an article by India McIntosh, printed in "The Navy Blue Book" published by the Military Publishing Institute, Inc., 55 W. 42nd Street, New York 36, N.Y.



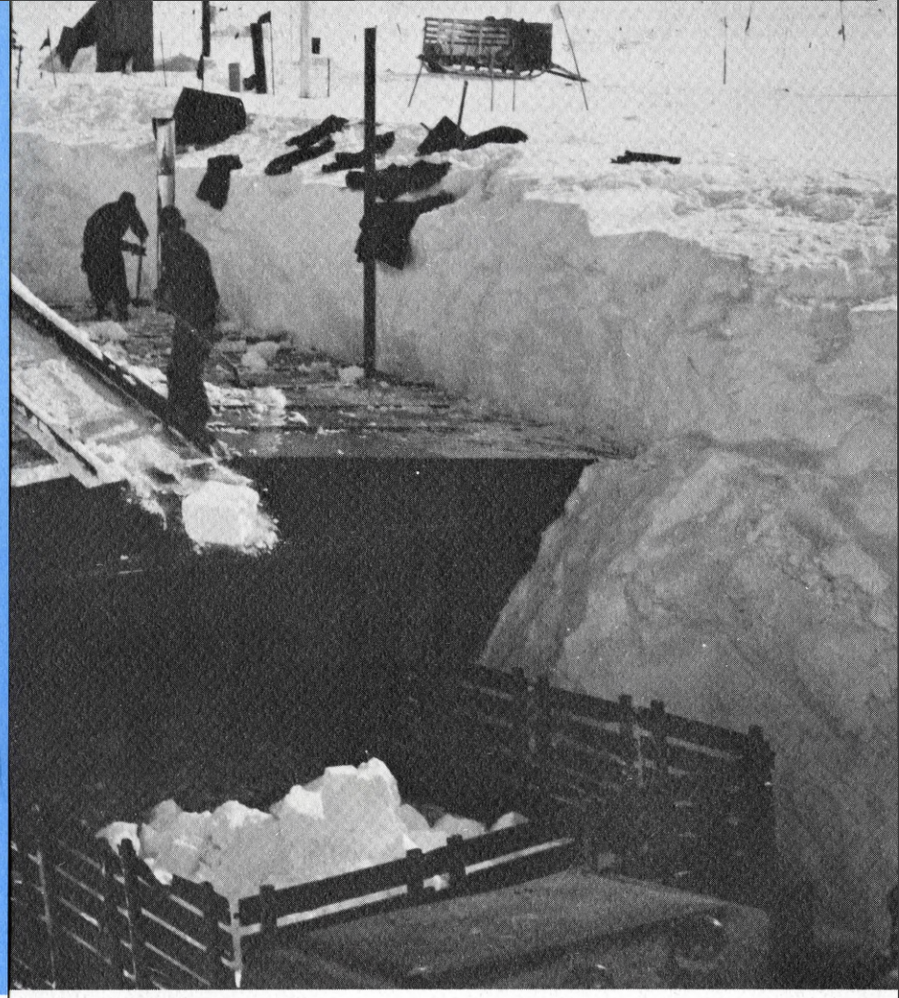


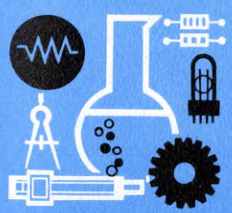




Civil Engineering Officer's School

Men who attend the Civil Engineer Officer's School at Port Hueneme are already graduate professional engineers, but because special capabilities will be required of them as military engineers, this course was established in 1946. In 1961 alone, 850 students enrolled. They were Navy officers up to the rank of captain—to the rank of colonel in the other services, civilians, foreign officers from such countries as China, Korea, Japan, Thailand, Indonesia, Canada, Turkey, Great Britain, and Chile. Thirteen different courses are taught at the school. Among these are projects for training in atomic defense engineering, Seabee operations, public works, and shore facilities planning. School instructors are both military and civilian, but all are chosen because of their exceptional qualifications in their special fields. Most are civil engineers, but many hold degrees in mechanical engineering, structural engineering, architecture, or nuclear physics. Guest speakers, both civilian and military and from points as distant as Washington, D.C., often lecture on subjects of specialized knowledge and experience.



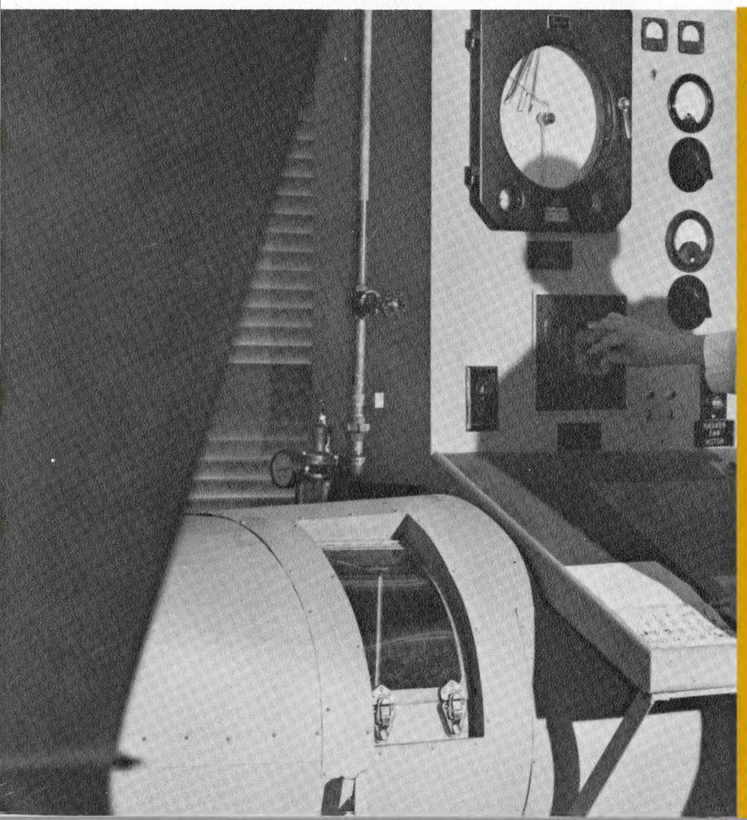


Naval Civil Engineering Laboratory

One of the laboratory's newest and most important areas of research is a group of projects to study the environment of the deep ocean. The least-explored region of the earth, the deep ocean offers a tremendous challenge for the scientists and engineers of the laboratory. Present efforts are centered about developing a method for studying those regions so that the biological, physical, and chemical effects can be defined, providing engineering design criteria for deep ocean construction. Already, many samples of biological life and sea bottom soils from the 6,000-foot depth have been recovered and analyzed, and a submersible test unit containing hundreds of material samples has been placed at a depth of 5300 feet. When recovered, the samples will be taken to the laboratory for detailed analysis. Another aspect of the same program has been the development of high-pressure test chambers to create pressures simulating, in the laboratory, the deep ocean environment. When fully developed, the deep ocean program will provide a major quantity of the Navy's knowledge of its most important ally, the sea.

Operation Deep Freeze

For scientific purposes, the Antarctic is an important Navy base of operations. Construction at the site, however, has been difficult to maintain, and early camps built on the deep-snow surface were demolished in only a few years, crushed by tons of the snow that falls and never melts. But new techniques are being developed. The Navy is going beneath the surface. Seabees with precision snow cutters slash out trenches twenty to thirty feet wide, laid in a geometric pattern and roofed with steel arches that protect the buildings within from the snow layer. Temperatures in the camp are mild and uniform, reducing fuel costs; and access from building to building is never restricted by high winds. Facilities to support the scientific operations such as study of ionospheric phenomena and meteorology are incorporated into the camp. A full array of modern utilities—electric generators, water and waste systems—provide the essential services for the scientists and Seabees who man the camps. Slowly and surely the threats of the frozen wastes are being overcome as man conquers the fury of the polar climate.



Disaster Recovery Training

The simulated flash of an atomic bomb begins the Disaster Recovery Training operation at the Construction Battalion Center, but preparations were made long before the flash came. In the DRT area is a complete atomic, biological, and chemical warfare shelter with room for more than a hundred people. Its equipment includes an electric generator, decontamination facilities, and air-filtering devices. After the blast, the recovery teams begin operations. Surveying the damage are the monitoring personnel with radiation counters and gas detectors, who relay their reports to the command center by radio and messenger. Firefighting and rescue of injured from damaged buildings is another job; while decontamination teams clear harmful concentrations of radioactive materials and gases. CBC, Port Hueneme has been called "the Pacific capital of disaster recovery training." Its purpose is to produce men competent to help in every kind of disaster, for the same skills that are needed in nuclear attacks will serve to rescue the wounded and reclaim vital areas after natural disasters or conventional warfare.

DESIGNER Don Fay

WRITER Dorothy Nehlsen

Published by Armed Services Publishers, a private firm, in no way connected with the Department of the Navy. Not published with Department of the Navy funds, either appropriated or non-appropriated.