RANGE OVERVIEW
PACIFIC MISSILE TEST CENTER

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ABSTRACT:

This paper provides an overview of the capabilities of the ranges operated by the Pacific Missile Test Center under the management of the United States Navy. Locations, types of instrumentation, operation, and current developments are briefly discussed.

INTRODUCTION

In October 1946, the Point Mugu complex was established as the Naval Air Missile Test Center (NAMTC). The Point Mugu site was selected after much study by a special blue ribbon site selection board. To quote from the report of the Board -- “This (Point Mugu) site is the best in the United States for locating a Naval Air Special Missiles Development Center because of the following assets which exist nowhere else at one location: uninhabited islands strategically located at various distances offshore, and long over-water ranges; proximity to industrial and scientific centers in southern California; . . . good year-round weather; proximity to harbor facilities at Port Hueneme, . . .”. When NAMTC was established, the guided missile was new, and the tools and techniques used for missile testing were primitive in comparison to the well equipped laboratories and facilities which exist at Point Mugu today. The first missile to be launched at Point Mugu, called the LOON, was a converted German V-1 “buzz bomb”. The Point Mugu complex became a National Range in 1958 and was renamed the Pacific Missile Range. At the same time, the Naval Missile Center was formed from other elements of the old Naval Air Missile Test Center and was given the mission of test and evaluation of Naval airborne weapons systems. Reorganization in April 1975 resulted in formation of the present Pacific Missile Test Center. During the more than 30 years since the firing of that first LOON missile, extensive capabilities for the testing of a great variety of weapons and systems have been developed, refined, established, and operated by the Center. Capabilities exist for the testing of air, surface, and undersea weapons; control systems; aircraft; targets; totally

integrated weapon systems (weapon, vehicle, man, target); and weapon and combat ranges.

MISSION

The mission of the Pacific Missile Test Center is to perform development test and evaluation, development support, and follow-on engineering; to provide logistics and training support for naval weapons, weapon systems, and related devices; and to provide major range, technical and base support for Fleet users and other Department of Defense and Government agencies.

LOCATION AND GENERAL DESCRIPTION

The Center maintains and operates two major ranges, the Sea Test Range off the coast of Southern California and an undersea, surface and air testing range at the Pacific Missile Range Facility, Barking Sands, Kauai, Hawaii. See Figure 1. The capabilities and testing facilities of the ranges have been developed and refined over a period of many years. The Center provides a great variety of range support services. In the pre-operations phase, support services cover planning, area surveillance, range clearance, frequency management and interference control, ground safety, and meteorology. During the operations phase, the chief concerns are safety, tracking, and telemetry. These functions are in turn supported by impact determination, recovery, and data transmission, processing, and analysis. Surface, undersea, and airborne targets are provided for threat simulation. Photographic documentation is available through both still and motion picture coverage. Meteorological and oceanographic observations are provided as required. As a national range, support and services are provided at reduced cost to approved programs.

The location of Point Mugu offers unique advantages for the test and evaluation of naval weapons. It is located on the beach, approximately 60 miles west of Los Angeles. A deep ocean area extending approximately 200 miles to the southwest is available for use as a sea test range. The area is conveniently accessible to the Pacific Fleet. Offshore islands are available from which to observe and evaluate by radar, photography, and telemetry, the performance of weapon systems in action. The sea test area between Point Mugu and San Nicolas Island, 60 miles offshore, is one of the most heavily instrumented ranges anywhere in the world. A deep-water harbor (35-foot draft) is nearby at Port Hueneme. Both mainland and island sites with elevations from sea level to near 1,500 feet are available. San Nicolas Island provides a firm platform ideally suited for testing in the marine environment of the Fleet. It approximates a real shipboard platform, but with most of the advantages of a mainland test site. The Sea Test Range has the capability for all types of surface and air weapons testing including large sea-area operations. It encompasses an area of 30,000 square nautical miles and extends approximately 170 nautical miles

seaward from the California Coast, but test operations frequently extend beyond that distance. The range is equipped with sophisticated instrumentation which is permanently installed on shore-based test sites and on conveniently located offshore islands. Figure 2 shows the islands and the general area in which the Sea Test Range is located.

The Pacific Missile Range Facility (PMRF), Hawaiian Area, can support virtually any type of exercise or development test involving air, surface, or subsurface units. The Barking Sands Range is shown in Figure 3. An instrumented undersea test range, the largest in the free world, is located at Barking Sands and augmented by a remote instrumentation site at Makaha Ridge. The Ridge is located approximately 8 miles to the northeast of Barking Sands. The services available at the PMRF include: precision radar, telemetry, underwater tracking, complete data display, command and control, communications, target and ordnance services, weapon and target recovery, and meteorological services. Because of its unique capability, full scale operations can be conducted simultaneously in the air, on the surface, and under the sea. PMRF supports air and surface anti-submarine warfare exercises, submarine versus surface target exercises, surface-to-air missile exercises, air-to-air and air combat maneuvering exercises, etc. In addition, the capability is ideal for supporting operations involving multiple phase weapons systems such as SUBROC. PMRF also provides mid-range support to Intercontinental Ballistic Missile (ICBM) launches from Vandenberg AFB and terminal area support for Navy ICBM launches.

TYPES OF INSTRUMENTATION SERVICES

The Range has a general purpose multi-operational characteristic. This is achieved by applying a variety of combination of services. Some of the major Point Mugu technical capabilities are illustrated in Figure 4 and summarized below:

- Tracking

AN/FPS-16 instrumentation radars at Point Mugu are capable of tracking to 4,000 miles. They have been locally modified for more reliable and improved capabilities. These radars operate in the C-band range (5.4 to 5.9 GHz). They can either track a skin echo or a coded transponder signal and provide spherical coordinate position data (range, azimuth, and elevation) in real-time. Digitized data is recorded for post-operation data reduction purposes. One of the radars is configured for pulse doppler tracking which provides very precise range rate data. Radar acquisition aids consist of optical, electrical, and computer systems. AN/FPQ-10 instrumentation radars at Point Mugu provide nearly the same capabilities as the basic AN/FPS-16 radars with the exception that their angular accuracies are 0.5 mil versus 0.1 mil. There are also AN/FPS-16 instrumentation radars and one AN/FPQ-10 radar on San Nicolas Island. A typical radar system is illustrated in Figure 5. Optical theodolites provide information on weapon trajectories, acceleration, velocities,

space position, and attitudes such as pitch, yaw, and roll data, using high precision instrumentation mounts and the medium of photography. Accuracies of the systems range from 20 to 30 arc-seconds of processed data. Range limitation for optimum accuracy of the optical tracking instruments will vary depending on target size and weather conditions, but, generally, is 5 to 10 miles.

- Surveillance

Surveillance and intruder monitoring is accomplished by land-based surface and air search radars and EP-3 aircraft. Data from these radars are collected, correlated, and displayed by a Naval Tactical Data System (NTDS) located in the Point Mugu Surveillance Center. Additional real-time surveillance data are frequently provided by NTDS Link 11 ships and aircraft operating on or near the Sea Test Range.

- Telemetry

The telemetry receive, record, and display complex consists of three ground sites (Point Mugu, San Nicolas Island, and Laguna Peak). Special equipment is employed for quality assurance of telemetry data, and post-operation data processing is routinely provided. The primary telemetry receiving sensors are 30-33 foot and 7-8 foot diameter parabolic antennas. Signals received in the UHF telemetry bands are down-converted to the 215 to 320 MHz operating band of the receiving systems. The receive systems provide both pre- and post-detected signals to wide band record systems and separation/display systems. Selected demultiplexed data signals can be viewed on local display devices, or recorded on oscillographs and ink pen recorders. Selected data signals can be reformatted and transmitted for display on remote meters (analog) or digital readout equipment. Mobile or transportable instrumentation is available for special coverage sites. General purpose trailers contain receive/record and separation/display capability. Analog telemetry tapes (usually provided by the receive/ record stations) are processed, providing oscillographs and pen recordings as a final product. Telemetry tape reformatting and computer-compatible digitizing of analog telemetry data is also accomplished. Figure 6 shows telemetry antennas at Point Mugu.

- Target Control

Control of targets is accomplished by use of radio command link or by the recently developed Integrated Target Control System (ITCS). The latter system combines target tracking, up and down data/control links, and information display in a compact, independently operating system. In addition, it provides the simultaneous control of multiple targets. By reducing the extensive support facilities previously required and

improving control and tracking, ITCS makes it possible to more accurately simulate enemy threats.

- Communications

Communication services are provided for the Southern California complex including Point Mugu and the offshore sites San Nicolas, Santa Cruz, and San Clemente Islands. These major sites contain extensive cable and RF intra-station transmission capabilities, which, when combined with the elaborate inter-station microwave trunking facilities, form the various arteries through which range data and operational information flows. Support can be provided to, and obtained from, the Western Space and Missile Center at Vandenberg Air Force Base through interconnecting microwave trunking. Communications and data interchange with other national and support ranges are transmitted via leased circuits. The communication systems can accept and transmit various types of information including audio, telemetry, digital, or video information with a minimum degradation of signal. For communications with areas outside those mentioned above, mobile communication facilities of various sizes and configurations are available. Mobile units include van-mounted voice and video communication systems that can be used in areas not provided with communication facilities or to supplement existing facilities.

- Radio-Frequency Management

The Commander, Pacific Missile Test Center, has been designated, by Department of Defense, the Western Area Frequency Coordinator as a collateral duty. National Department of Defense, and Navy Department policies in the management of the radio spectrum, are supported. Policy and procedures are established for frequency allocation, assignment, and scheduling; frerequency interference monitoring; electronic countermeasures; engineering; amateur and citizens band radio; and voice call signs.

- Range Computer System

Real time processing requires a computer system interfaced and integrated with instrumentation systems including radar, telemetry, target control, destruct systems, and communication systems. Two Cyber 175 computers and peripheral equipment are currently being integrated into the range system to effectively provide this capability. The computer system will receive, process, correlate, and output data required in performance of the following functions: safety, test monitoring, and control. Safety functions include processing in support of surveillance, clearance, and vehicle flight safety. Test monitoring functions include processing of data in real-time for graphics and alpha-numeric displays for the effective conduct of operations. Control functions include processing of data in real-time for the control of tests in progress. This control function involves, for example,

flight control of vehicles involved as well as control of various instrumentation systems within the range complex. The computer system will provide real-time data processing to simulate target flight and weapon performance (including missile flight trajectories and weather effects) for the effective conduct of tests and exercises. Post-run playback will provide for the immediate review of test data collected and processed during the test. This will enable assessment of performance and determination of whether to terminate test operation, or rerun the test while test vehicles and range resources are still available. Post-operation data reduction includes processing to produce data packages and reports required by range users. Post-operations processing will use data common to real-time processing supplemented by additional data collected during the test, but not previously processed. The combination of a common data base, along with increased computer capability, will result in more effective post-operational test data reduction with prompt data delivery.

- Tracking Control and Display

Multiple air and surface vehicles (ships, aircraft, missiles, and targets) can be monitored and controlled in real time utilizing a complex of four tracking and control centers. These centers include digital, analog, and television display techniques to provide performance, position, and status information on firing platforms, missiles, and targets used in each exercise. Entire operations can be reconstructed and replayed after completion. The tracking centers also provide a means of displaying data from which real-time safety decisions can be made.

- Geophysics

One of the Nation’s most complete operational meteorological activities is available at Point Mugu, offering a wide range of conventional and specialized instrumentation, measurement, forecasting, interpretative and climatological services. Surface meteorological observations are taken hourly at Point Mugu and San Nicolas Island and are supplemented by automatic weather stations operating at San Nicolas, Santa Cruz, and San Miguel Islands, and atop Laguna Peak. Refractometer-equipped aircraft are available for obtaining detailed profiles of the refractive structure over the test area. Radiosondes, carried by balloon to around 100,000 feet, measure pressure, temperature, speed of sound, relative humidity, and winds. The balloons are released several times a day at San Nicolas and Point Mugu. Rocketsonde soundings extend measurements of temperature and wind up to about 300,000 feet.

- Targets

Today's weapons are designed to counter the sophisticated threats of enemy air, surface, and undersea craft and weapons. Each weapon must be tested against targets which simulate the characteristics of the specific threats against which that weapon will be deployed. The targets must display the necessary electromagnetic, electro-optic, dynamic performance, and tactical characteristics and the testing environments must include appropriate electronic countermeasures. The Center operates in excess of 20 different aerial, seaborne, and special target systems. Targets are especially configured and operated to user specifications. Typical targets are destroyers hulks; high speed remote controlled boats; full-scale aerial targets including supersonic QF4B and the all-attitude QF-86F aircraft; and subscale aerial targets including BQM-34A/S FIREBEE, supersonic BQM-34E FIREBEE II, MQM-74C CHUKKAR, and the MQM-8G VANDAL (TALOS). Figure 7 shows a CHUKKAR launch. Figure 8 shows a VANDAL launch.

UNIQUE PMRF INSTRUMENTATION

The PMRF technical capabilities are generally similar to the Point Mugu capabilities, differing primarily in numbers of instruments. The PMRF instrumentation system is illustrated in Figure 9. Unique capabilities are summarized as follows:

- Underwater Tracking

The PMRF Underwater Range consists of an instrumented underwater tracking area covering more than 600 square miles. The total range is sub-divided into two regions, each with particular technical characteristics. The original portion of the range, installed in 1966, is a 5X10 square mile sea area west of Barking Sands, instrumented with 37 bottom-mounted hydrophones, each individually cabled to shore. This portion of the range is ideally suited for support of small scale exercises requiring high precision tracking accuracy. The newer portion of the range, installed in 1977, provides a very large tracking area to support large scale exercises requiring less tracking accuracy. Hydrophones in this range expansion area are serially installed on two instrumented cable runs. Frequency division multiplex techniques are used for data transmission to shore. Objects to be tracked in the underwater range area are required to contain an acoustic tracking pinger.

- Underwater Communications

Two-way underwater communications capability is available to surface and submerged vehicles in the underwater range area. Communications from shore to in-water vehicles is accomplished through projectors which are bottom-mounted within the range area. Communication from in-water vehicle to shore is accomplished by receipt of acoustic data

through the tracking hydrophone arrays. Capability is provided for either voice or CW communications.

- Tracking, Control, and Display

Numerous air, surface, and underwater vehicles (submarines, targets, and weapons) can be tracked and displayed in real time, using multi-colored symbolism. During the exercise, progress can be followed on 8X8-foot large screen displays. If desired, the entire exercise can be reconstructed and replayed after completion. Range data can be merged and synthesized with information from other sources; replays of selected portions of the exercise can be run at up to 60 times real time, stopped at any time, reversed and blown up in scale, as desired. It is possible to display a large-scale exercise on one 8X8-foot screen while an expanded display of a selected event can be shown on another.

- Ambient Noise and Data System

An Ambient Noise and Data System consisting of removable in-water sensor arrays, an encrypted telemetry link, and shore-based display and analysis facilities at Barking Sands are available for ships' noise measurement and silencing analysis.

OPERATIONS

The ranges can be configured to support a variety of operational scenarios. At Point Mugu some of the more frequent include air-to-air, surface-to-air, surface-to-surface, and air-to-surface exercises; and at PMRF, air, surface, and subsurface Anti-Submarine Warfare operations. Figure 10 shows an actual launch of the PHOENIX missile from an F-14 Tomcat during an air-to-air test. Figure 11 shows a submarine launched TOMAHAWK cruise missile as it crosses the shore line, beginning the over-land portion of its flight to an inland target. The ranges support fleet training exercises of many varieties and sizes by both United States and allied participants. Ballistic missile and space programs (including Space Shuttle) are also regular users of the ranges with numerous launches from the Western Space and Missile Center. Fleet electronic warfare and total weapons systems test exercises such as the Mark-48 torpedo trials at the PMRF are additional operational examples.

CURRENT DEVELOPMENTS

The improvement of the range system is a continuing process. The instrumentation utilized in the range systems represents significant monetary and technological investment. Maintaining these investments and continuing to evolve the capabilities to keep pace with the changes required to support the test and evaluation of new weapon systems requires

continuing development effort. Examples of range improvements in various stages of development at the Pacific Missile Test Center include:

- TRIDENT Missile Tracking Facility

The TRIDENT weapon system will be a major component of the nation's strategic capability in the 1980's and beyond. Major tests of the system will be conducted in the Pacific. Significant facilities, complex precision instrumentation, and missile flight safety systems are being developed to support TRIDENT missile operations in the Pacific. Instrumentation improvements being provided include high precision, multi-lateration tracking, telemetry, command destruct, data processing, high reliability, range safety, and precision ship location systems.

- Range Display and Control Center

The Range Display and Control Center is the nucleus of the future tracking and control function at Point Mugu. The center, which will include the Integrated Target Control Systems consoles and main computer, Range Operational Display System, communications, and new operator interaction displays, will eventually replace several tracking and control rooms equipped with older display devices. The new center will provide an integrated display of a multiplicity of test parameters in real time and will permit the alteration of tests underway in order to greatly increase their effectiveness. This new facility is already in limited use.

- Secure Telemetry

Planned encryption of weapon system telemetry data requires modification of the range real time data system. In addition to display of telemetry data for real time analysis and evaluation of weapon system performance, telemetry data is regularly utilized in the decisions involving the control of operational testing and in the range safety process. The Secure Telemetry development will modify the Range System to enable decryption and display of encrypted telemetry data where required for effective prosecution of the test and evaluation process while preserving the integrity of the classified data transmission.

- Digital Microwave

The Pacific Missile Test Center has been a leader among ranges in the development of digital microwave systems. The range has an extensive complex of conventional microwave links between Point Mugu and other sites, such as Laguna Peak, San Nicolas Island, Santa Cruz Island, and the Western Space and Missile Center. In an environment in which constantly increasing data evaluation requirements create a need for mass data

transfer, digitization of these links is required to enable the efficient transfer of complex digital data and permit encryption of sensitive data.

- Extended Area Test System

Test and evaluation of longer range and more versatile tactical weapon systems greatly increase the spatial requirements for test ranges. To accommodate these requirements, an Extended Area Test System is being developed to augment the existing Sea Test Range instrumentation. This effort involves a complex integrated ground-based and airborne range system to provide metric tracking, telemetry reception and relay, target control, and communications relay over a large area at sea (250 nautical mile diameter circle) and beyond line-of-sight of land instruments.

- Multiple-Target Instrumentation Radar

The Multiple-Target Instrumentation Radar is a NAVAIRSYSCOM-sponsored development to provide a single radar system capable of high accuracy tracking of several participants. The Range is performing the test and evaluation of the radar system and will be a recipient of several of the systems, for both the Pacific Missile Test Center and Pacific Missile Range Facility, once the test and evaluation phase is complete. The radar is intended to reduce future range operational costs by permitting a single system to replace several of the existing single-object-track radars as well as providing higher relative accuracies between test vehicles.

- Radar Data Management System

In addition to implementing local range instrumentation improvements, the Range also provides system development support capability for other agencies. An example of this activity is the responsibility given to the Pacific Missile Test Center for the development of a Radar Data Management Center for the Atlantic Fleet Weapons Training Facility at Roosevelt Roads, Puerto Rico. This system, designed, developed, and produced at the Pacific Missile Test Center, will completely replace their real time radar data handling capability. The system is patterned after a similar system developed earlier for use at the Pacific Missile Test Center.

CONCLUSION

The Pacific Missile Test Center operates two major Ranges. Both the Sea Test Range Facility and the Pacific Missile Range Facility offer significant modern, general purpose capabilities for conducting the test and evaluation of weapon systems. The Ranges are

national assets maintained primarily for Department of Defense test and evaluation support missions, but are also available to all users having a valid requirement for their capability.

ACKNOWLEDGEMENTS

Some of the information contained herein was derived from the Pacific Missile Test Center Technical Capabilities Guide by Paul G. Perschbacher, 1 July 1978.

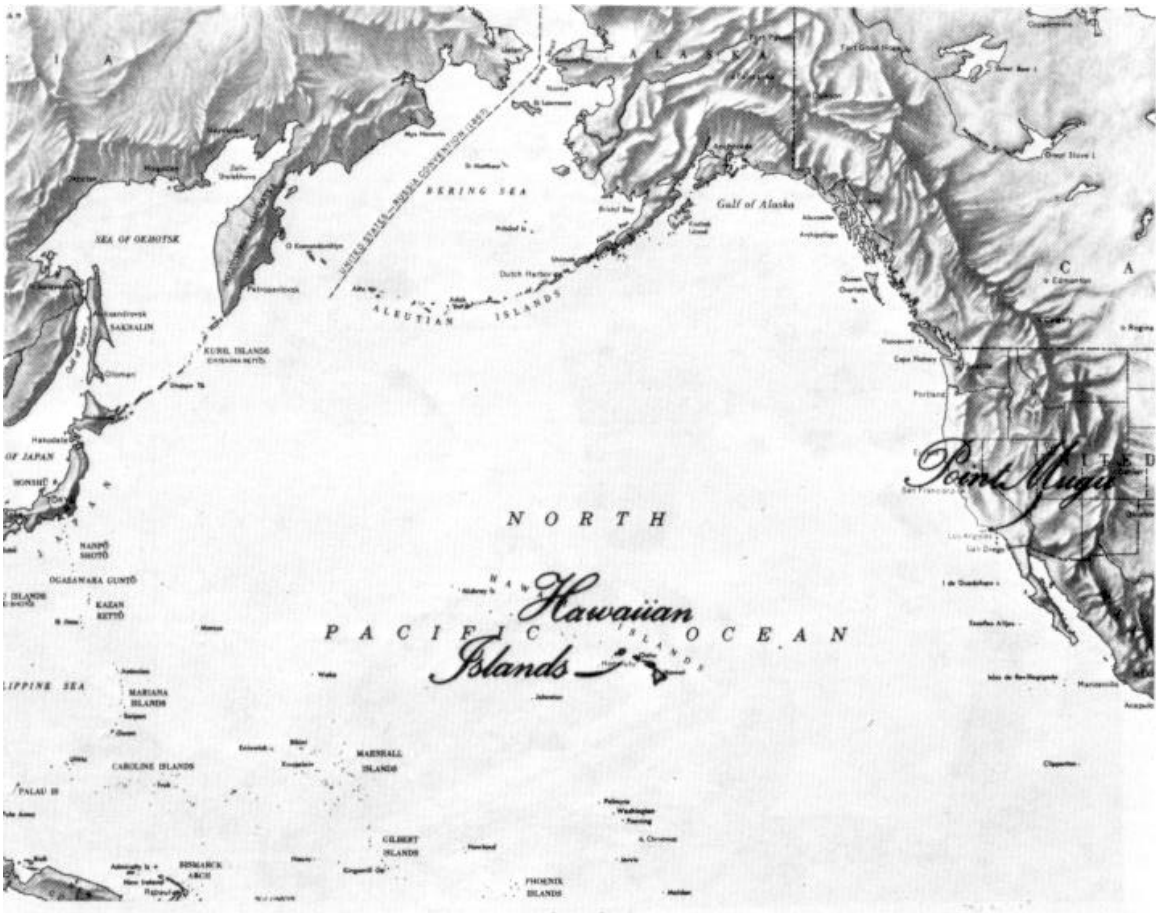


Fig. 1

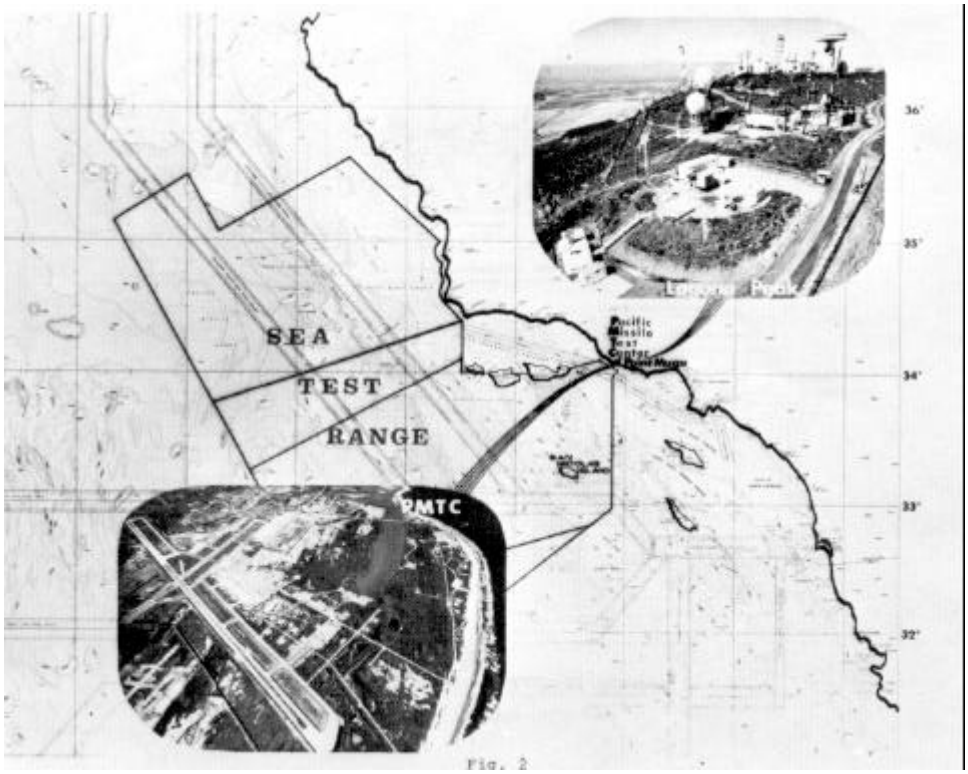
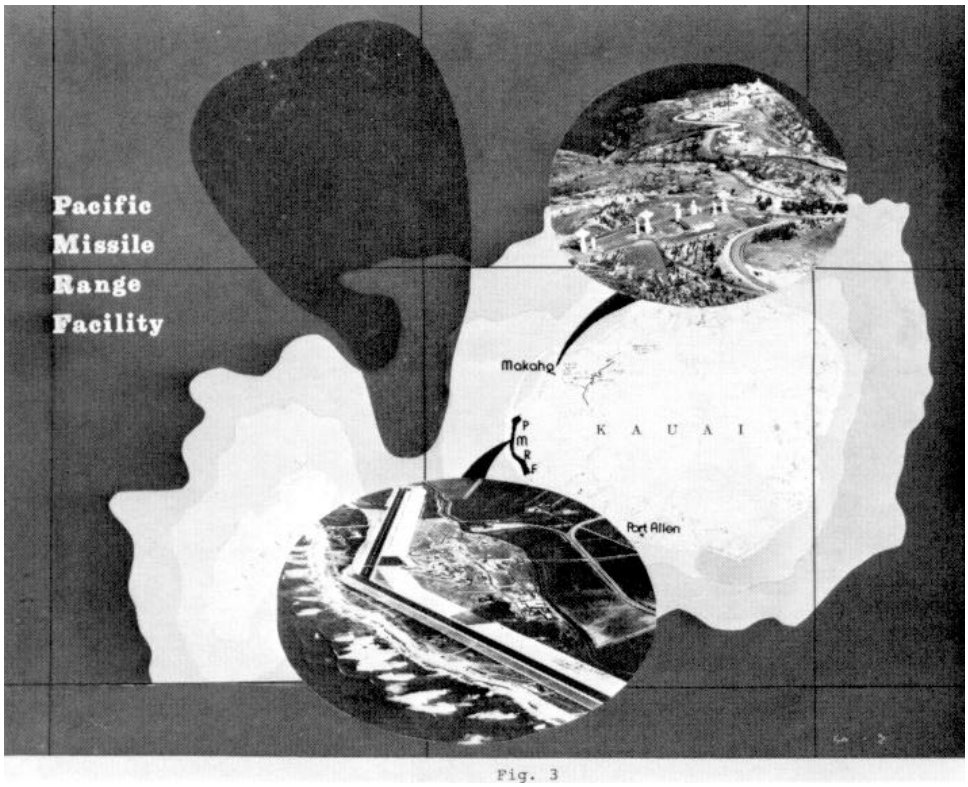


Fig. 2



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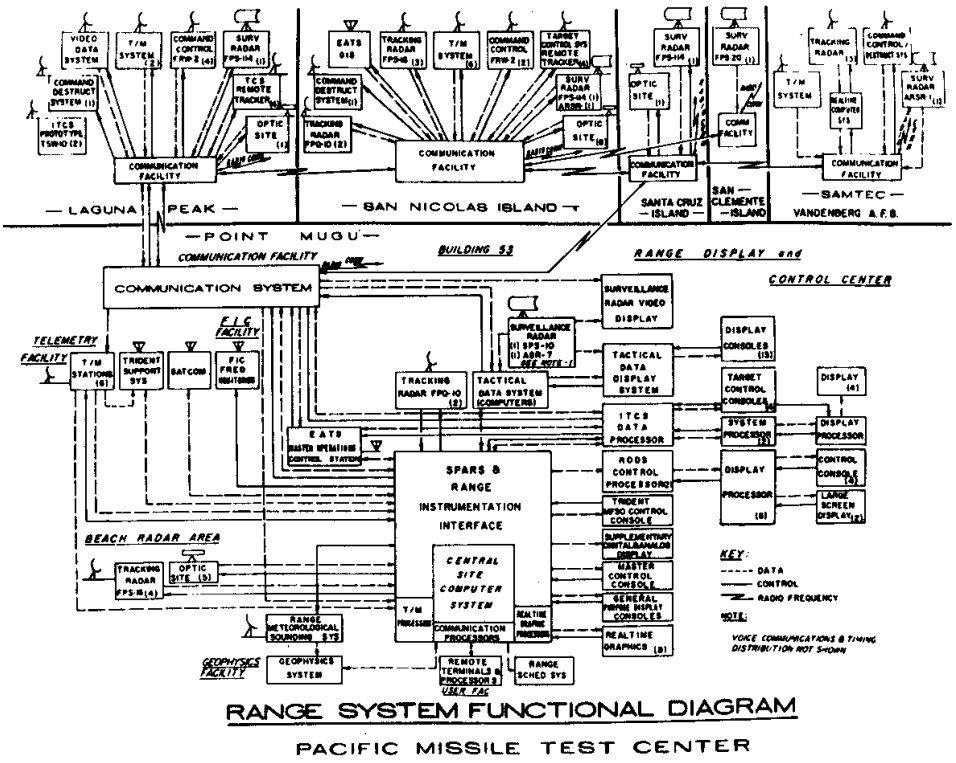


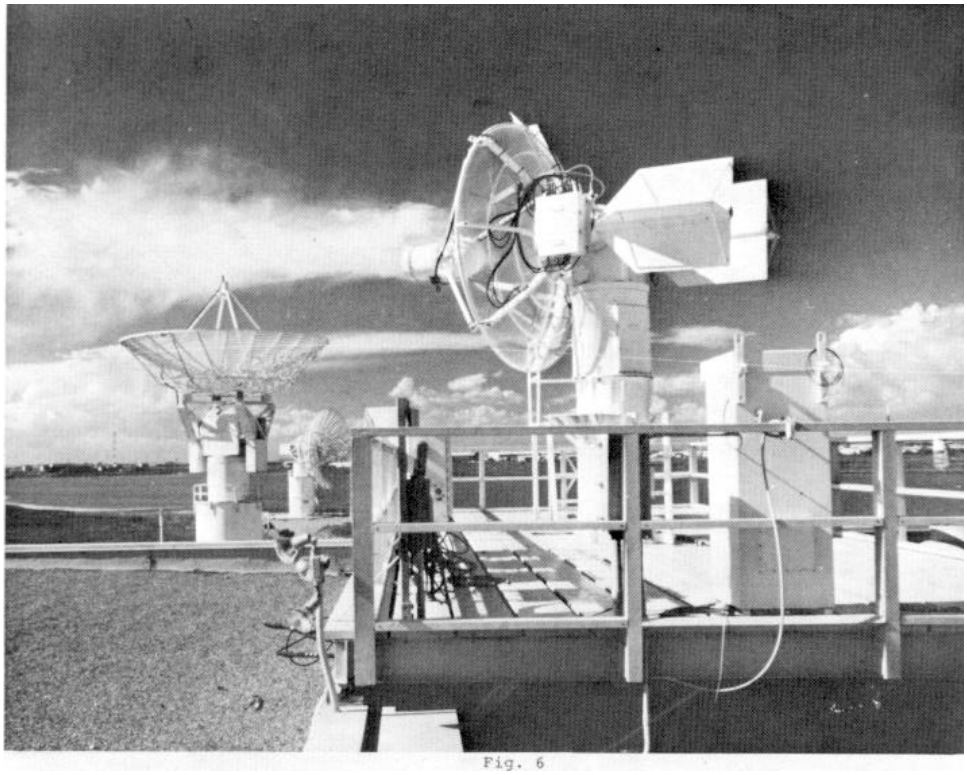
RANGE SYSTEM FUNCTIONAL DIAGRAM

PACIFIC MISSILE TEST CENTER

Fig. 4

Fig. 5

Fig. 5



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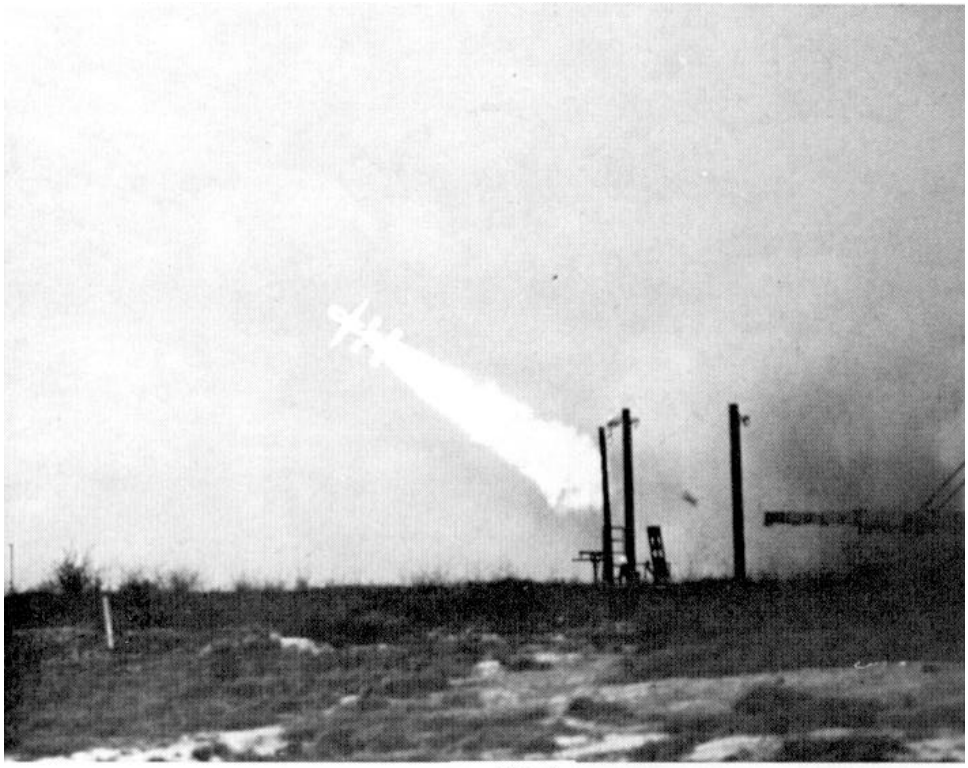
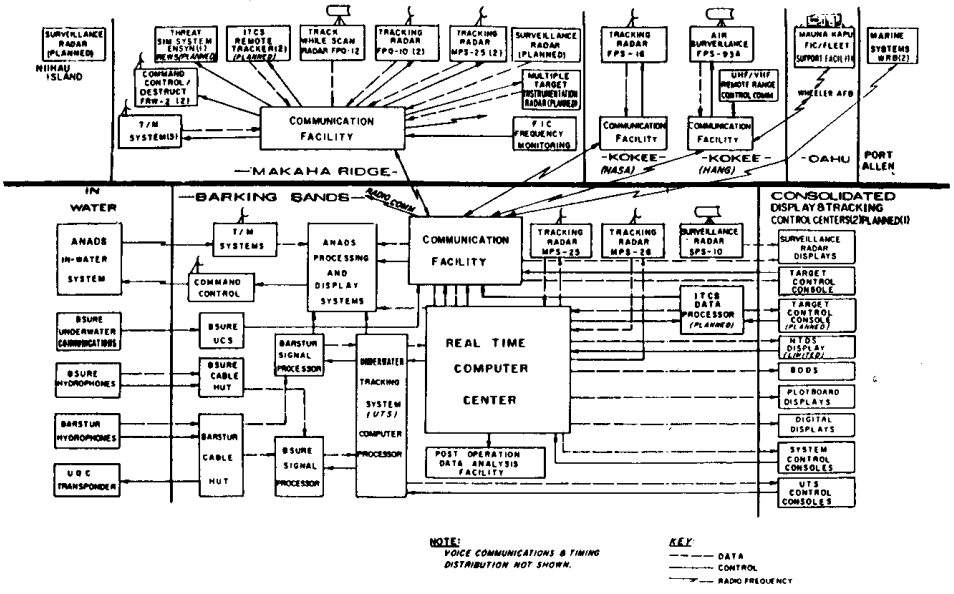


Fig. 8



— RANGE SYSTEM FUNCTIONAL DIAGRAM —
PACIFIC MISSILE RANGE FACILITY, HAWAIIAN AREA

Fig. 9

Fig. 10

Fig. 11