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Recovery - Air Force Ballistic Weapons Systems

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Introduction

The postflight recovery of a Ballistic Missile Re-entry Vehicle is perhaps one of the best ways of gathering data to verify the adequacy of design. The data obtained is indisputable.

Since the beginning of re-entry vehicle flight testing, many attempts have been made to recover data that identified performance of the re-entry vehicle while being exposed to an operational flight environment. Telemetered instrumentation has been the mainstay of this need for data, although postflight recovery of the hardware, which would offer final proof of performance has been the desire.

Trying to reach this goal, the Air Force in the past has devised various methods such as, ejecting capsules during flight that contain data recorders, and deploying parachutes during flight to decrease the forces of impact on the re-entry vehicle so that meaningful data could be gathered. Systems such as these work, however, each either produce only a recording of happenings or impair the true flight conditions.

The United States, acknowledging the importance of physical recovery, has developed two locations in the Pacific Ocean that are capable of recovering a re-entry vehicle that has been exposed to true flight environments and permitted to re-enter the atmosphere and impact under normal flight conditions.

The capabilities and techniques employed to locate and retrieve a vehicle after impact are in part, operations used in other places to perform other tasks, but when used in combination they can accomplish the task of physical recovery of a Ballistic Missile Re-entry Vehicle.

Recovery Locations

The Air Force National Range Division (AFNRD), has two ranges that are capable of flight testing an intermediate range or an intercontinental range ballistic missile.

Air Force Eastern Test Range

The Air Force Eastern Test Range (AFETR), located on the eastern coast of the North American continent has many telemetry ground stations and radars, and is oriented to support ballistic missile flight tests of an instrument configuration. The AFETR does not have physical re-entry vehicle recovery capability other than methods such as parachutes and flotation devices.

Air Force Western Test Range

The Air Force Western Test Range (AFWTR), located on the western coast of the North American continent provides the only location that a re-entry vehicle can be recovered from the ocean floor after a ballistic missile flight. Two locations on the AFWTR have this capability; they are the Eniwetok Atoll and the Kwajalein Atoll, (Fig 1) both located in the Southern Pacific Ocean.

Eniwetok Atoll, a possession of the United States, is located approximately forty-four hundred miles from the coast of California, and is part of (and under the control of) the Air Force National Range Division.

The atoll, as the term implies, is a circular outcropping of relatively small coral and sand islands with the diameter of the inter-lagoon being approximately thirty miles. (Fig 2)

The terrain of each of the islands is a combination of coral and sand, varying in size and altitude. Some of the islands support sparse vegetation. Fred Island, the largest of the group, accommodates housing for personnel, an aircraft runway, and other facilities required to support the atoll.

The depth of the lagoon averages 120 feet, however, the exact configuration of the bottom of the lagoon is unknown. Descriptions of the bottom closely parallel and conclude that the bottom is made up of minature mountains of coral, outcropping three to six feet in height and that there does exist, individual coral outcroppings up to 40 feet in height. One outcropping, several miles from the normally used impact area, extends up to eight feet of the surface of the lagoon.

The flat or near flat surfaces of the lagoon floor are covered with a fine layer of silt, which if disturbed, clouds the immediate area for extended periods of time. Re-entry vehicle pieces small enough, will bury themselves in this silt on impact. Only the fragment outline is discernible. After one or two days, even large re-entry vehicle pieces are covered by the silt, and again - only fragment outlines tell of their presence. To minimize the disturbance of the silt during recovery operations, SCUBA diving equipment is used and not hard-hat equipment which requires the diver to walk on the bottom.

The personnel on Eniwetok Atoll are male only. They consist of military personnel that administer the atoll and contractor personnel to maintain facilities, perform diving activities and operate instrumentation.

Kwajalein Atoll, a trust territory of the United Nations is located about four thousand miles from the California coast. It is approximately two hundred miles closer to the coast than Eniwetok. The Kwajalein Atoll is not part of the AFNRD, and is under control of the Army. Army MaterielCommand (AMC). (Fig 3)

The atoll above the surface of the water is the same as that of Eniwetok, but is larger and "boot-shaped" rather than circular. Kwajalein Island, one of many that make up the atoll, accommodates housing and other facilities including an air strip.

The depth of the lagoon averages 200 feet - slightly deeper than Eniwetok. The bottom of the lagoon is completely unknown. Since recovery operations have not been performed in the lagoon and it has not been dragged, only soundings are available to determine anything about the lagoon floor. It is suspected though, that since the Kwajalein and Eniwetok Atolls are so similar, that the floors of each are alike.

Being of sufficient size, the atoll can - and does - house both male and female personnel. Military personnel administer the atoll and as at Eniwetok, contractor personnel maintain facilities, instrumentation and perform diving operations. Military personnel that are assigned to Kwajalein are permitted to have dependents on the atoll.

Geodetic Accuracies in the mid - and southern-Pacific areas are difficult to establish as information is both sparse and conflicting. The Air Photographic and Charting Service estimates the geodetic accuracy of AFWTR impact areas with respect to Vandenberg AFB to be 600 feet. The Passive Geodite Earth Orbiting Satilite (PAGEOS) project is expected to improve this to a figure of 35 feet when the project is completed in 1970.

Recovery Techniques

Eniwetok Atoll

Location Methods at Eniwetok used to determine the re-entry vehicle impact point are optical, radar and soundings.

Optical coverage has become the standard for impact scoring on the AFWTR. Although all of the Optical Systems require daylight and clear weather for satisfactory results, the tropical conditions common in these areas favor the use of photography. The lighting is usually brilliant which gives a strong shadow contrast and good visibility. Cloud cover is generally present, but is mostly limited to high drifting cumulus clouds.

The Optical Scoring Systems at Eniwetok are of two types; tower mounted cameras both still and motion picture that are fixed and manually controlled, and ground based cinetheodolites and optical tracking mounts that record space positioning data. In addition, tower mounted surveyor transits provide reasonably accurate quick-look information.

The Optical Scoring Systems both ground and tower-mounted are located on three islands of the Eniwetok Atoll - Fred, Elmer and Yvonne.

The fixed still and motion picture cameras are aimed to photograph a predetermined segment of the incoming trajectory. The line-of-sight azimuths are measured during the get-ready operations. Range timing, used to record impact time, is recorded on each frame or on shutter-correlated strip charts. The impact location from these cameras is derived by triangulation after film processing.

The tower based surveyor transits with spotting scopes mounted on horizontal azimuth circles, give quick-look impact information that is reasonably accurate. The instruments are manually operated and use the plume of the impact as a sighting target. The impact location is determined by triangulation from the three islands. Recovery operations will proceed on this information.

Precision tracking cinetheodolites photographically record the test objects image and angular coordinates versus time on each frame. The instruments are time synchronized and correlation between two or more of the cinetheodolites can produce trajectory and rate data. The cinetheodolites seldom record actual impact.

Although Optical has become the standard on the AFWTR for impact scoring, the restriction that it is only operable during daylight hours and fair weather has created the need for additional impact scoring methods, that can score under all conditions. To satisfy this requirement, two other scoring systems have been developed at Eniwetok; a radar system and a hydrophone system.

The radar AN/SPN-8A is an ex-carrier GCA X-Band radar and is intended only for impact scoring and is not a tracking instrument. The unit has a 100° scan and a twelve nautical mile range. The radar is located on Elmer Island of the atoll and satisfies the requirement for all weather and night impact scoring.

Another system that has been developed at the atoll to satisfy the all weather and night scoring requirement is an assembly of hydrophones termed All Weather Impact Location System (AWILS). The system consists of seven hydrophones that rest on the lagoon floor in a circular pattern. The hydrophones detect sounds of the surface impacts within this pattern. Each hydrophone is connected to a surface float with a transmitter which is moored above its hydrophone. At impact, signals are sent via radio link to a receiver station that interprets the data for identification of the impact point. The system concept has been proven very successful and plans for improvements are in process.

Search and Diving Methods in the Eniwetok Lagoon are conducted with the use of modified Navy seacraft and SCUBA divers.

The craft consists of: a Yard Facility Utility (YFU) barge, equipped with a decompressure chamber for diver use, a crane to remove the debris from the water, and other support equipment; a Landing Craft Infantry (LCI) used as a utility boat; and another LCI referred to as an "M" boat that is used for miscellaneous tasks.

The diving crew at Eniwetok consists of eight divers of which the lead diver performs dual functions during the recovery operations. The lead diver acts as captain of the YFU. In addition, there is a crane operator and a "pusher" boat operator; and should the re-entry vehicle be of some special interest to a contractor, his representative may also be present during the entire recovery operations.

The techniques involved to locate a re-entry vehicle on the floor of the lagoon, have been proof tested many times and are conducted in a conscientious manner.

The search begins after the re-entry vehicle has impacted in the lagoon and an impact bearing has been obtained by one or more of the three location methods. An azimuth is given to the crew and the Yard Facility Utility (YFU) barge is dispatched to the impact area. Radio communications with the scoring system is maintained for directing the YFU to the impact point. As the barge passes over the impact point as determined by exact correlation from the three tower operators, the instruction "drop" is issued. At this time, a marker buoy with 220 feet of line and anchor attached thereto is thrown over the stern of the YFU. The YFU cannot stop in zero time and therefore proceeds past this mark. Upon turning around, the YFU drops one stern anchor prior to reaching the marker buoy. At the buoy, two additional anchors are loaded aboard a Landing Craft Infantry (LCI) called the "pusher", taken a distance from the YFU and dropped; thus, the YFU is centered between three anchors laid out at the apexes of a triangle. Final positioning of the YFU takes place by taking in or letting out the anchor lines as necessary to position the YFU close to the marker buoy. The water depth is determined by a calibrated line lowered over the side. At the close of the diving day, the YFU is up-anchored and returns to port. Since the decompression chamber on board the YFU must be available for diver use at all times, the repositioning and anchoring operation is repeated each day. The marker buoy is left until all diving operations are terminated.

The diving operations begin after the recovery barge is positioned. Should the re-entry vehicle impact in deep water, safety precautions dictate that the divers work in pairs. The first pair of divers attempts to locate the re-entry vehicle. The time that can safely be spent on the bottom at this depth of the normally used impact point is only ten minutes. Standard SCUBA gear using air is the equipment worn by the divers.

The divers descend to the bottom via the line on the marker buoy. At this time if the re-entry vehicle is not visible, the divers play out a 100 foot line with one end attached to the buoy anchor. Depending on the visibility, which can be less than 5 feet and as great as 50 feet, the men hold this radius line and swim in a circle around the buoy anchor. Each man positions himself within his visibility distance from the other and from the buoy anchor. The divers have underwater compasses and can determine the radius vector in which he starts. Depending on the topography of the bottom, the divers may or may not be able to swim one full circle in their 10 minutes down time. Should they not complete the 360°, the radius line will be left on the bottom for the next pair of divers to continue the search.

During their return to the surface, the divers decompress for 10 minutes at 70 feet, 20 minutes at 40 feet, and 30 minutes at 20 feet. At the 20 foot depth, it is sometimes practiced that air hoses from the barge will be furnished to the divers for breathing, their SCUBA air tanks being almost exhausted by this time. Since the divers are breathing air while diving, this technique allows them additional decompression time to operate via a very safe procedure.

While the two divers are on the bottom, two additional divers are on the barge completely suited ready to dive at an instant's notice, thus, an additional safety item. Also, a diver will snorkel on the surface near the barge and observe the air bubbles as they ascend from the bottom divers. Any trouble can be determined in short notice by watching these bubbles.

When the first pair of divers reaches the surface, they will brief the remaining divers as to the bottom topography and on any pertinent details which were discernible on the first dive.

The second pair of divers will descend and continue the search if the re-entry vehicle has not been found, or commence salvage operations if it has been found.

Should the entire 100 foot circle whose center is the anchor of the marker buoy not contain the re-entry vehicle, additional sightings from the impact scoring systems towers are requested. The barge is then positioned at the new marker buoy drop point and a search commences around this point. Should re-entry vehicle impact take place in shallow water, the same basic techniques will be used as are practiced in deep water but with several modifications.

The "bottom time" for divers is dependent upon depth. A diver bottom time at a 200 foot depth is only 10 minutes, whereas downtime in 40 to 50 feet of water is hours. Exact decompression times are tabulated in handbooks which the crew possesses. A diver can make only one 200 foot dive each day.

In a case where a re-entry vehicle was imbedded in coral and hard to get to, a fire engine was brought out on the "M" boat and coral debris is removed via hydraulic methods using the fire truck pump. The diver, in this case, uses hard hat diving equipment.

Retrieval Methods used are determined by the condition of the re-entry vehicle on the floor of the lagoon. Assuming the re-entry vehicle has been located in the first dive and found to be broken, the divers will pick up any special piece and bring it to the surface when they ascend. The snorkeling diver may descend to the 20 foot decompression depth and bring the special hardware recovered to the surface.

If the re-entry vehicle is broken up, a blackboard is used for briefing the next pair of divers. The general location and disbursement of material will be outlined on the board to facilitate the search. Before the second pair of divers descends, a large metal basket is lowered over the side. This basket will be used by the divers to put the re-entry vehicle debris in as they are collected. The basket is approximately 4 feet square with 18-24" sides.

Because the bottom has a layer of fine silt, this basket is not placed on the bottom to prevent the clouding of the search area with silt or covering the debris. Each diver has a small perforated bag and will swim just over the bottom, again being careful not to disturb the silt, and pick up the pieces. The handbag is emptied into the large basket as necessary and as down time warrants. Should there be R/V hardware of special interest, the divers will have been informed during the briefings and will search out this hardware first. Such hardware can be data records, special test indicators, etc. There is much friendly competition between the divers as to who will recover the most desired piece. If the piece is small enough, the diver will bring it up when he ascends. The basket is only brought up at the end of the diving day.

Should the re-entry vehicle major structure be intact upon discovery, the divers will determine the type of sling/holding fixture/jig necessary to hoist the entire vehicle to the surface in one operation. Any broken pieces will be returned to the surface as debris. The briefing of the next diving pair will then determine the method of attaching the necessary equipment to the re-entry vehicle for moving it to the surface in one operation.

The YFU will call ashore and have another LCI, called the "M" boat, come out with a truck on board. When the re-entry vehicle is brought to the surface, it is placed directly in the truck ready for immediate transportation and storage on shore.

No equipment is raised or lowered to the bottom while the divers are in the water, another safety precaution.

<u>Kwajalein Atoll</u>

Location methods at Kwajalein used to determine the re-entry vehicle impact point is presently an interim Optical System only. A radar system is programmed for the near future. A hydrophone system to record impact scoring such as the one that exists at Eniwetok is not presently programmed for Kwajalein.

The system is tower and ground, located on Legan, Gillinam, and Eniwetak Islands, and encompasses an area approximately 11 miles in diameter.

The Kwajalein Impact Scoring System is for interim optical scoring of an impacting re-entry vehicle. The data is gathered through optical and photographic means that will allow determination of impact coordinates of the re-entry vehicle to a relatively high degree of accuracy. Triangulation of data from the three stations will provide the impact coordinates from angular data provided by the surveyors transits and 70 mm motion picture cameras. An azimuth spotting scope is also mounted at each station to provide an auxiliary line of sight if necessary and also to aid in positioning recovery craft, if the need arises.

The K& E Surveyor's transits on the islands are used for visual acquisition of the vehicle impact water plumes. The transits are locked in elevation so that the horizon is just below the horizontal reticle line and the azimuth is left free to slew. The operator acquires the plume with a gun sight mounted on the transit telescope and then immediately sights through the telescope barrel and makes fine adjustments to superimpose the plume with the vertical crosshair. The transit circles are calibrated with major divisions representing degrees and minor divisions every 30 minutes. A vernier scale provides readings to the nearest minute of arc.

The azimuth spotting telescope is used to provide an auxiliary line of sight if necessary and also aid in positioning recovery craft, if the need arises. The focal length of the objective is $23\frac{1}{2}$ inches with a selected field of view of either two degrees or three degrees, depending upon the eyepiece used. The system includes an erecting prism for natural terrestrial use. A horizontal reticle is calibrated in degrees and has an adjustable pointer that will traverse the length of the reticle. The telescope has a special mount that will allow approximately 10 degrees movement in elevation and 360° movement in azimuth. The mount has an azimuth scale only, and is calibrated in 30-minute intervals.

The Hulcher 70, Model 102, Camera provides negatives $2\frac{1}{4}$" high by $2\frac{1}{8}$ " wide on 70 mm film at varying frame rates of from 5 to 20 frames per second. Shutter speeds from 1/25 of a second to 1/2880 of a second are available. The camera is driven by 110 VAC motor, and had full reflex focusing with a ground glass on the side of the lens mounting. The camera is equipped with a sports-type folding view finder and spade handles for ease of track when required. Lenses, 3" and 6", are available for use with those cameras.

Since this system has never been proven under actual conditions, simulation tests of an impacting re-entry vehicle have been conducted at the Optical Impact Scoring Sites for training purposes. A series of five explosive charges were dropped into the lagoon area from aircraft creating water plumes.

As a result of these tests, it is believed that re-entry vehicles impact point can be determined with an adequate accuracy.

This Optical Scoring System, like that of the Eniwetok Atoll, is only operable during daylight hours and fair weather. A radar system is programmed to be in operation in the near future that will give the Atoll an all weather impact scoring capability.

<u>Search and Diving</u> methods at Kwajalein differ in some respects to those of Eniwetok. The Kwajalein search and diving techniques are conducted with a Landing Craft Utility (LCU) barge, two man submarines and SCUBA divers. (Fig 4)

The LCU barge contains a diverse equipment room, and decompression chamber and cranes. It is used to support the diver's activity and to remove the debris from the water. The barge also carries on deck, the two-man submarine. The submarine is the underwater search vehicle.

The diving crew is made up the same as that of Eniwetok, and after the vehicle is located on the lagoon floor, retrieves it.

Recovery operations have not been demonstrated at Kwajalein, however, based on partial tests, it is believed that they will be successful.

As at Eniwetok, the search begins after the re-entry vehicle has impacted in the lagoon and an impact bearing has been obtained by the Optical

Scoring Systems. An azimuth bearing is given to the crew and the LCU proceeds to the general impact area. At this time, the search is performed differently than that at Eniwetok. After the barge has anchored in the area, a two man submarine - not divers - is dispatched to locate the re-entry vehicle on the floor of the lagoon. When the submarine locates the vehicle, a buoy is sent to the surface, denoting the exact location. The anchor fastened to the other end of the buoy line is dropped, thereby permitting the marker buoy to remain "on station" as long as required.

After the location of the re-entry vehicle is identified, the LCU proceeds to the location and drops anchor.

Retrieval Methods used are governed by diver safety rules and the condition of the re-entry vehicle, as they are at Eniwetok. The actual working methods used to retrieve the vehicle from the floor of the lagoon are the same as that of Eniwetok - the exception being, Kwajalein does not have an "M" boat, therefore, the debris is returned to shore before packaging and shipment.

General

Packaging of recovered items is handled by the personnel on the atolls. Although the personnel on Kwajalein have not performed recovery, the tasks of shipment, etc, will be the same as that of Eniwetok.

After the re-entry vehicle and/or debris are brought aboard the recovery craft, they are washed with fresh water and placed in boxes. After the day's diving activities have been terminated, the barge up-anchors and proceeds to the docking area. Should special items be onboard which require clearances for viewing, the barge radios ahead this information. The security officer then clears the docking area and has available the necessary containers to package and obscure the items.

Upon completion of the recovery activities, all debris are either packaged in boxes constructed on sight, or in special containers supplied by the range user. Toxic materials, if present, are housed in air-tight plastic bags furnished by the range user, prior to their packaging for shipment.

Shipment to the mainland is arranged by the personnel at each atoll. If the recovered material is not of a high priority to be returned, it will be put on the first available plane that is passing through on the way to the mainland or Hawaii. If, however, the recovered material is of a high priority, as soon as the impact point has been identified, on the recovery operations started, the transportation officer on the atoll will request a Military Air Transport (MATS) plane to be dispatched to the atoll immediately. Under high priority conditions, the material is normally on the mainland within two days after the recovery operations are completed.

Security on the atolls is not a problem since all personnel related to the recovery operations possess a Department of Defense (DOD) secret clearance. This level of clearance is adequate for recovering and handling all material other than Atomic Energy Commission (AEC) equipment. The AEC clearance can be obtained by requesting same through the San Francisco AEC Operations Office.

Adequate secured areas are provided on the atolls for classified materials.

Other Scoring Capabilities

Impact Scoring can be assisted by the re-entry vehicle itself. Devices such as a Pingers located in the vehicle, that transmit sound energy pulses and when monitored with adequate equipment can assist search operations.

The AFWTR has other locations that will score impact, however, these systems are located outside the Eniwetok and Kwajalein Atolls where recovery is impossible due to the depth of the water.

The array of other impact scoring systems, such as the Wake Splash Detection System (Wake SDS), the Miniture SOFAR System (MSS), and the Broad Ocean Area System (BOA), consists of a network of hydrophones that require the use of SOFAR bombs to differentiate impacting bodies.

Radar is used extensively on the AFWTR. The Eniwetok and Kwajalein Atolls do or will have radar systems to determine impact, but these radars are just two of the many radars that exist on the AFWTR. Most radars on the AFWTR are used for signature and trajectory measurements and are not designed to accommodate ballistic missile re-entry vehicle impact scoring.

Ballistic cameras, a high-precision fixed position metric camera that exposes the object against a star field, restricted to night time use, are located at Kwajalein, but only provide trajectory data and does not compliment recovery.

Other systems used on the AFWTR such as the Airborne Astrographic Camera System (AACS), the Advanced Range Instrumentation Ships (ARIS), and the Terminal Radiation Airborne Program (TRAP) aircraft gather data, but do not provide data to assist physical recovery of a re-entry vehicle.

Future Improvements

Improvements that will aid re-entry vehicle scoring and recovery at the Eniwetok and Kwajalein Atoll are programmed in the near future.

Eniwetok Atoll will have installed within two years, a more refined all weather impact location system. The new system termed Shallow Water Impact System (SWIS) will be made up of six self-calibrating hydrophones in an eight mile diameter pentegon, and will be hard wired to a receiver station. Installation of this system will be done after an extensive survey of the lagoon floor has been performed. The SWIS will have a greater accuracy than the existing AWIIS.

Kwajalein Atoll improvements within the near future to aid physical recovery are, an improved optical scoring system and a radar that will give impact scoring during darkness and other than fair weather.

The existing Optical Scoring System is to be augmented by an infa-red scaning network in the near future. These sensors will track the re-entry vehicle to impact. Impact location will be derived by triangulation.

A rapid scan K_a band radar is to be installed on Eniwetak, one of the islands of the Kwajalein lagoon. This unit will permit all weather impact scoring.

The above are the improvements programmed for Kwajalein and Eniwetok in the near future, but as new requirements for recovery arise, new methods will be developed to satisfy those requirements. The fact that a re-entry vehicle can and has been recovered after a strenuous flight on a ballistic missile, invites new ideas for better recovery capabilities.

Physical Recovery Benefits

The benefits of physical recovery are far reaching. Analyzing the recovered re-entry vehicle can present the data for conclusive determination of the level of performance. There are many reasons why recovery can offer this determination.

True Flight and re-entry conditions can be preserved when recovery is an objective. Since the vehicle is to be recovered from the floor of the ocean, there is no need to "slow-down" the descent of the system prior to impact on the water. If break-up occurs, and it often does, the data is not lost; each piece can be retrieved and if required, the vehicle can be reconstructed in a jig-saw fashion. (Fig 5)

Passive Instrumentation can be used extensively when recovery is employed. Recorders can be inserted in the vehicle to measure happenings from G levels to signal timing. The recorder, tape, squib, or other type hardened to survive the forces of impact, can be retrieved from the ocean floor, and the data reduced. Passive instrumentation has been used extensively in the past on the AFWTR with extremely good results.

Telemetry Data can be Validated or invalidated by the recovery of a vehicle. Telemetry instrumentation is not exact. All Telemetry systems have tollerances and combined with the other tollerances of receiving stations and data reduction methods, false indications can be given. Happenings during flight of course, can not be determined if only a postflight analysis of a recovered re-entry vehicle is conducted, but the effectiveness of the performance can be determined. Recovery of a rocket motor, for example, if the vehicle configuration includes one, will show positively if the rocket has been expended or not. Re-constructing the trajectry that was flown, and considering analyzed results of other performances, one can be assured if the rocket did or did not do its intended function.

Laboratory Analysis that can be performed on the recovered re-entry vehicle will give a data point that can not be questioned. An analysis of each of the components and structures that make up the vehicle can be made and the level of performance be determined.

Temperature sensitive paint, as an example, can be placed on locations within the re-entry vehicle that are considered heat critical, and when recovered, a study of the results made.

One of the greatest benefits of recovery is that unforeseen failures can be discovered and corrected. Recovery offers the opportunity to analyze the complete re-entry vehicle, and not just those parts that are instrumented.

Summary

In summary, the United States does have the capability to recover a re-entry vehicle from the ocean floor after a ballistic missile flight. This capability exists on the AFWTR at the Eniwetok and Kwajalein Atolls. The requirement for physical recovery has been increasing in magnitude since the first time it was proven that a re-entry vehicle could be recovered after being subjected to a ballistic missile flight environment.

The recovery capabilities at Eniwetok and Kwajalein are constantly being updated to satisfy new requirements. For example, to decrease the time required for recovery. Kwajalein possess a submarine to search for the vehicle on the floor of the lagoon, versus the slower Eniwetok method of using divers to conduct the search. Both locations either presently have or will have, scoring systems that permit recovery, and do not restrict impact to daylight hours or fair weather conditions. Not having to delay flight tests schedules and permitting flight tests to be conducted at night for re-entry observables data gathering, along with recovery, are the benefits of these systems.

The existing techniques employed to locate and retrieve a vehicle after impact do satisfy the present recovery needs. However, as new and more stringent recovery techniques are required, they will be developed.

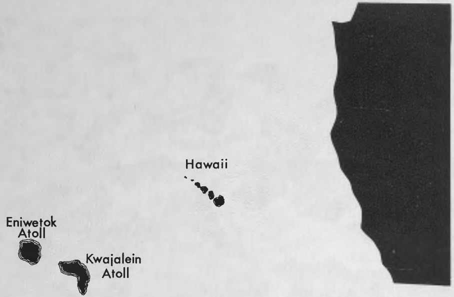


FIGURE 1

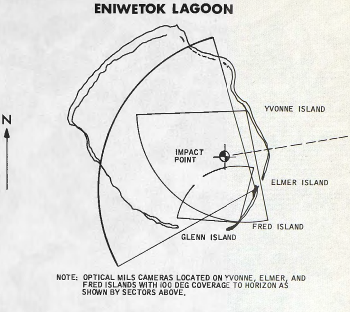
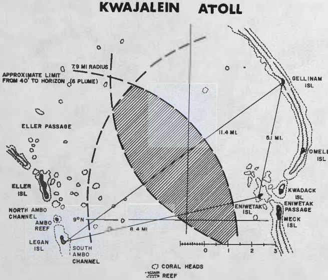


FIGURE 2



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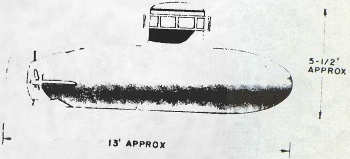

Figure II 4 (U) Search Vehicle

FIGURE 4

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