CONTENTS

CONTENTS

SPECIFICATIONS

The requirements for horizontal control at Bikini Atoll are essentially the same as the network previously established at Eniwetok Atoll. The requirements include a primary network established to second order specifications of the U. S. Coast and Geodetic Survey supplemented by third order stations in locations of lesser importance.

For second order triangulation surveys, the allowable discrepancy in the length of any line of the scheme shall not exceed 1:10,000 and for third order 1:5,000. The base lines from which a second order survey expands shall have a probable error of not to exceed 1:500,000.

PREVIOUS SURVEYS

The available records of earlier surveys of Bikini Atoll consist of Chart No. 6032 published in 1944 by the U. S. Hydrographic Office and the adjusted data of third order surveys completed in 1946 by the USS Sumner and USS Bowditch. A geodetic report on the preparation of the chart and adjustment of the 1946 surveys was obtained from the U. S. Hydrographic Office.

H.O. Chart No. 6032 as prepared in 1944, and with only minor changes in the later editions, is stated to be a photo transfer of Japanese Chart No. 458. Although records of hydrographic and geodetic surveys, made by the Japanese in 1919, were obtained by the U. S. Hydrographic Office none of the stations of these surveys were recovered. The datum of all charting in the area is based on a scaled value from the Japanese Chart and this value has been adopted for the origin of surveys in the area.

The 1946 survey by the USS Sumner and USS Bowditch consisted of two surveys expanding from independent base lines and covering the eastern portion of the atoll. Three triangulation stations are common to both surveys permitting consolidation of the surveys by a least square adjustment. The apparent purpose of the surveys was to establish the inter-relation of scientific stations which were used in Operation "Crossroads".

As the scheme is stated to be of third order accuracy and the geometry of the scheme is not consistent with requirements of this project, it was not considered practical to expand from these surveys. Most of the stations of these surveys have been recovered and their relation to the new second order network determined. They were also used for preliminary location and orientation of island traverses furnishing basic information for design of project features.

The height of the observing towers was determined so as to provide a minimum of ten feet vertical clearance over any obstruction or the surface of the lagoon. Bilby steel towers were erected at locations requiring a tower height of over twenty feet. Lower towers were constructed of wood. The towers were adequately braced and guyed but some difficulty from vibration was experienced due to high wind velocity during much of the survey. Station COCA in the lagoon, consisted of four steel piling driven in the top of a coral pinnacle, cross braced and decked with a wooden platform and instrument stand. As the pinnacle was approximately twenty-four feet below the surface of the lagoon, it was necessary to observe at low tide to reduce vibration.

All observing was accomplished at night using lights for targets. A Wild T-2 theodolite was used for observing and proved very satisfactory. Station lights were constructed using the reflectors and lenses from U.S. Navy battle lamps. The lights were equipped with rheostats which permitted dimming the lights to the correct intensity for a satisfactory target. Continuous inter-station communication was considered necessary due to the remote locations of the stations. Portable radios were used for this purpose and increased the efficiency in observing as the intensity of the target lights could be adjusted instantly and changes in plans could be transmitted to the survey personnel. This was often necessary due to weather conditions and permitted communication when light signals would have failed.

The observing program started in May 1953. The observing party consisted of an observer, recorder and a varying number of light tenders. The personnel operated from camps at Site Tare and Site Charlie and were quartered on an LSU for observing in the Eastern portion of the lagoon. Considerable time was lost due to rain and high wind velocity and the program was delayed by the priority of other surveys. Transportation was adequate but water transportation by LCM, DUKW and LCU was necessarily slow. Helicopters were not available until late in the observing program. It was generally necessary to distribute the personnel late in the afternnon and return them to their base of operations the following morning. The value of the helicopter was demonstrated during the later part of the survey. The cost of a triangulation survey, as well as all preliminary surveys, could be greatly reduced and the design program advanced if helicopters were available at the early stages of a project of this type.

The observing was started as early in the evening as practical. The intensity of the target lights was adjusted to the minimum which could be observed, thereby, obtaining a small target considering the distance. One or more sets of eight positions each were observed. When the results obtained were within specifications of the U.S. Coast and Geodetic Survey no attempt was made to obtain further refinement.

SUMMARY OF GENERAL FEATURES

Outline of Scheme. A triangulation network encompassing the atoll was established by expanding through a series of check figures from a base line on the south perimeter of the atoll. The base line extended from Airukiiji Island (OBOE) to Reere Island (SUGAR). The survey was for the purpose of coordinating local surveys on the project islands and to determine the interrelation of the various project areas.

The scheme was designed to provide horizontal control throughout the atoll with primary stations established where necessary to meet project requirements and consistent with the geometrical specifications for strength of figures. Secondary stations were established at locations of lesser importance by expansion from the primary net and by local triangulation at project areas. The permanency of the station marks was considered in locating the stations, and all stations were referenced with the exception of a station located on a coral pinnacle in the lagoon. References independent of the station structure could not be established for this station.

Standard procedure and specifications of the U.S. Coast and Geodetic Survey for second order triangulation were carefully followed in executing the survey. The geometry of the scheme was strengthened by construction of a station in the lagoon which became the hub of the network and resulted in all figures being well above minimum figure strength.

Distribution of Control Points. The scheme consists of ten primary stations established to second order specifications, nine of these are on the perimeter of the lagoon and the tenth is the lagoon station. Seven additional stations were established to third order specifications. Six stations of the earlier USN Survey were incorporated into the scheme and the relation to the scheme of six additional USN stations was determined. Other stations were established to second and third order specifications at various locations by local triangulation and traverse. The distribution of the stations of the completed network is such that destroyed stations can generally be replaced with a minimum of field work by observing a single triangle using the known line between two existing stations as a base. Where practical, to simplify reference to the station they have been given the code name of the location.

Field Procedure. A tentative layout of the scheme determining the locations where stations would be required was made from a study of the atoll chart. The location of the base line, and including a lagoon station to obtain a strong base expansion figure, resulted from this study. A field reconnaissance of these locations was made and station markers established. The stations were located inland from the high tide line to reduce the possibility of damage or distruction from wave action.

OBOE-SALT Base Line. The base line for the network extended from Station OBOE on Airukiiji Island (OBOE) to Station SALT on Reere Island (SUGAR). Due to the configuration of the islands, it was necessary to establish a broken base consisting of the two sections OBOE-PIPER and PIPER-SALT.

Standard procedure of the U. S. Coast and Geodetic Survey for second order base line measurement was followed. Angles were measured with the Wild T-2 theodolite and the measurement was made with three Lovar tapes using thermometers and stretcher apparatus of an approved type. The calibration certificates of these tapes are included in this report. Stakes were set at fifty meter intervals for chaining bucks, and the tapes were alternated so that in completing the forward and backward measurement all three tapes were used in each direction.

The computed probable error of total measurement is one part in 2,800,000. The allowable maximum probable error is one part in 500,000.

First Order Traverse. The relation between Stations 50 and 2210 at Site TARE and 20 and 1201 at Site CHARLIE were required to a tolerance of not to exceed 1:25000. This requirement was accomplished by first order traverse measurement following standard procedure of the U. S. Coast and Geodetic Survey and with Lovar tapes and chaining bucks similar to the OBOE-SALT base line measurement. A base line for local triangulation was established to first order traverse specifications on Romurikku Island (FOX).

Due to the velocity of wind in the area, it is generally necessary to provide a wind break in order to obtain accurate results. The wind break used consisted of a thirty-six inch strip of canvas approximately fifty-five meters in length which was held parallel to the line on the windward side as each measurement was made.

Geographic Position. The origin of geographic position of the USN Survey, completed in 1946, is based on scaled values from a Japanese chart. As the accuracy of this chart was considered satisfactory for publication of a hydrographic chart of the atoll and for origin of position for the USN Survey, the slight refinement which could be obtained by astronomic observations for geographic position would not justify the additional expense to the survey.

USN Station AIR on Site OBOE is common to both the USS Sumner and USS Bowditch surveys. As this station was recovered and was in a desirable location for this purpose, it was adopted as the origin of geographic position for this survey. The USN adjusted values for the station are Latitude 11-30-24.906 North, Longitude 165-24-55.168 East.

Geodetic Azimuth. Examination of the USN Survey records shows that three stations: AIR, SOUTH, and ENYU are common to both the USS Sumner and USS Bowditch networks. The two surveys were combined in an adjustment which adopted a stellar azimuth observed by the USS Sumner as the origin of geodetic azimuth. It was intended to include a triangle formed by these three stations, in the network of the new survey and accept a mean value obtained from the directions AIR-SOUTH and AIR-ENYU as the origin of azimuth. However, as Station SOUTH was not recovered the USN value for the forward azimuth of the line AIR-ENYU was adopted as the basis of geodetic azimuth. A check triangle including Station KANS, of the USN Survey resulted in a computed difference of directions at Station AIR of 0.4". This was considered to be within project requirements for orientation of the scheme. The USN adjusted value for the forward azimuth of the line AIR-ENYU is 268-00-01.4 or N88-00-01.4E.

Scientific Azimuth. Geodetic azimuths are computed in a clockwise direction from South. The azimuths used in the description of scientific stations are computed in a clockwise direction from North.

Plane Coordinated-Castle Grid. A plane grid has been established common to the entire atoll from which the inter-relation of structures and areas and their location can be specified. Due to the limited area incorporated within the survey, the slight additional refinement obtained by computing a transverse mercator grid would not be justified.

The origin of plane coordinates N103,872.0, E128,879.0 was taken at Station AIR of the US Navy Survey which has also been adopted as the origin of geographic position.

The basis of bearings for this grid is a true meridian through the USN Station AIR determined by adopting the adjusted value of that survey for the forward azimuth of the line USN-AIR to USN-ENYU 268-00-01.4 or N88-00-01.4E.

The adjusted length of the line USN-AIR to USN-ENYU, as determined by expansion from the now OBOE-SUGAR base line is 51473.8 feet. The USN Survey value is 4.8 feet more or 51478.6 feet. While this difference is within the specifications for second order triangulation, it is believed to be mainly accounted for by the stronger figures of the new survey made possible by inclusion of the lagoon Station COCA.

The adjusted length and direction of the line OBOE-NAN (USN-ENYU) as determined from its relation to the line USN AIR-USN ENYU has been adopted as the initial line for computation of geodetic and plane coordinates for this survey.

Triangulation Adjustment. The computed closing error of the triangulation net, before adjustment and using the observed angles plus or minus one-third of the closing error of a triangle, was less than 1:25000. As the closure was well within second order specifications, and considering the size of the network, the additional refinement obtained by a least square adjustment could not be justified. To satisfy the requirements of a plane coordinate grid, the value of a station should remain the same independent of the direction of computation through the net. This was accomplished by applying a side equation adjustment which, while approximate, satisfied the requirement.

Plane and geodetic coordinates were computed for all primary stations based on this adjustment. The geodetic coordinates of the recovered USN Survey stations were computed as a means of comparison between the surveys.

LOCATION OF PRIMARY HORIZONTAL CONTROL STATIONS

BIKINI ATOLL MARSHALL ISLANDS

ISLAND	CODE	CASTLE STATIONS		U.S.N. STATIONS	REMARKS
		2nd ORDER	3rd ORDER		
BOKOBYAADAA	ABLE				
BOKONEJIEN	BAKER				
NAMU	CHARLIE	CHARLIE			
YUROCHI	DOG			CHI	USN-CHI DESTROYED
UORIKKU	EASY				
ROMURIKKU	FOX	FOX			
AOMOEN	GEORGE			HON *	
AOMOEN	GEORGE			GELL *	
REEF				BIK	USN-BIK DESTROYED
BIKINI	HOW	N. HOW		KANS *	
BIKINI	HOW	S. HOW		BASE *	
BIKINI	HOW			LINE *	
BIKINI	HOW			NORTH	
BOKONFUAAKU	ITEM				
YOMYARAN	JIG		JIG	SOUTH	USN-SOUTH DESTROYED
REEF				FIVE	USN-FIVE DESTROYED
ENIAIRO	KING				
ROCHIKARAI	LOVE		LOVE	ROCK *	LOVE=USN-ROCK
IONCHEBI	MIKE		MIKE	EBI *	
ENYU	NAN	NAN		ENYU *	NAN=USN-ENYU
ENYU				CENT	
AIRUKIILJI	OBOE	OBOE		AIR *	
AIRUKIRABU	PETER				
BIGIREN	ROGER			REN *	
REERE	SUGAR	SALT			
ENINMAN	TARE				
ENIIRIKKU	UNCLE	UNCLE		RIK	USN-RIK DESTROYED
RUKOJI	VICTOR		VICTOR	RUJI *	VICTOR=USN-RUJI
CHIEERETE	WILLIAM			CHI	USN-CHI DESTROYED
ARRIIKAN	YOKE	YOKE		ARAN *	
OURUKAEN	ZEBRA		ZEBRA	ORUK *	ZEBRA=USN-ORUK
BOKOAETOKUTOKU	ALFA		ALFA	BOKU *	ALFA=USN-BOKU
BOKORORYURU	BRAVO		BRAVO	BORO *	BRAVO=USN-BORO
LAGOON	COCA	COCA			

* = USN STATIONS RECOVERED