U. S. DEPARTMENT OF COMMERCE

LUTHER H. HODGES, SECRETARY

COAST AND GEODETIC SURVEY

H. ARNOLD KARO, *Director*

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ANNUAL REPORT

OF THE

DIRECTOR OF THE COAST AND GEODETIC SURVEY

FOR THE

FISCAL YEAR ENDED JUNE 30, 1961

FOR OFFICIAL DISTRIBUTION

National Oceanic and Atmospheric Administration

Annual Report of the Director of the Coast and Geodetic Survey

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CONTENTS

	Page
Office of the Director	1
Program Planning Coordination Staff	2
New Ship Staff	3
International Technical Cooperation Staff	4
Technical Research and Information Staff	5
District Offices	6
Office of Oceanography	8
Operations Division	9
Facilities Division	19
Marine Data Division	20
National and International Cooperation	25
Office of Physical Sciences	28
Geodesy Division	28
Geophysics Division	39
Photogrammetry Division	48
National and International Cooperation	57
Office of Cartography	61
Nautical Chart Division	61
Aeronautical Chart Division	63
Reproduction Division	65
Distribution Division	67
Cooperation with National Agencies	71
Office of Research and Development	72
Office of Administration	78
Administrative Services Division	78
Budget and Fiscal Division	79
Personnel and Safety Division	81
Organization and Management Division	85
Technical Services Division	87
Instrument Division	89
National and International Cooperation	95
Appendix	97

OFFICE OF THE DIRECTOR

During the past fiscal year, the Bureau underwent a major reorganization both in its emphasis in the areas of scientific research and oceanography and in the realignment of functions to provide for greater unity in the field of administration. These changes streamline and strengthen the organizational structure of the Survey and are designed to meet the needs of the new, revolutionary age of science and technology, and thereby provide new knowledge and new services for use by the Government and the public in promoting sound economic growth.

The revised organization arranges functions into logical and reasonable groups with clear-cut lines of responsibility and authority for achieving an objective. The reorganization was developed with the concept of: relieving the Office of the Director of many details of operations so that more emphasis can be placed on planning and policy matters; establishing a minimum number of office-level Assistant Directors who would be responsible for their respective programs, thereby replacing the large number of Division Chiefs and other officials who formerly reported to the Office of the Director; placing more emphasis on research and development, and on oceanography, through the creation of the Office of Research and Development, and the Office of Oceanography; and placing the primary responsibility for budgetary formulation, execution and control, progress reporting, and related program coordination at the office level.

The five offices established are as follows: Oceanography, Physical Sciences, Cartography, Research and Development, and Administration. The effective date of the reorganization was October 1, 1960.

A number of inspection tours of the field operations of the Bureau were made by the Director and the Deputy Director.

As President of the Congress on Surveying and Mapping for a part of the fiscal year, Admiral Karo took an active part in various meetings and conferences of ACSM. Of particular interest was his participation in the Fifth Annual Surveying and Mapping Conference at the University of Utah during November 1960. He also met with the Georgia Association of Registered Land Surveyors in Atlanta during September, and sent a personal representative to the Southwestern Regional Conference of ACSM held in Austin, Tex.

Among the various scientific and engineering meetings in this country and abroad attended by the Director were

the following: The UNESCO Intergovernmental Conference on Oceanographic Research held in Copenhagen, Denmark. He participated in a ceremony of the East Liverpool (Ohio) Historical Society on the 175th anniversary of the point of beginning for the survey of western public lands of the United States. The National Science Foundation invited Admiral Karo to join a small group of men having interests in polar research to make an inspection of Antarctica. On the return trip from Antarctica, Admiral Karo spent two weeks in Australia and New Zealand inspecting the hydrographic offices of those countries and conferring with various officials on surveying and charting matters. He also participated in the commissioning of a new Australian hydrographic surveying ship.

The Deputy Director attended the 12th General Assembly of the International Union of Geodesy and Geophysics in Helsinki, Finland. Admiral Pierce represented the Bureau at the annual meeting of the U.S. Power Squadron in Miami, Fla.

PROGRAM PLANNING COORDINATION STAFF

The Program Planning Coordination Staff was engaged primarily on program planning, representation on Interagency and international committees, and special studies for the Director. Field survey and nautical chart programs were reviewed with regard to operational and fiscal planning coordination. The staff cooperated with member agencies of the Interagency Committee on Oceanography in preparing reports on, and coordinating oceanographic programs. A staff member served on panels of the committee.

Programing for Emergency Planning was maintained approximately the same as last year, primarily concentrated on security storage, key personnel functions, and emergency facilities. Although budget limitations did not permit the Bureau to institute a realistic readiness plan, further planning for protection of property and personnel was accomplished pending availability of implementing funds.

The Bureau anticipates developing an extensive readiness plan in the coming year. This program will be in keeping with the National Plan and will assure the Bureau of a realistic minimum plan for continuing essential functions in the event of an emergency.

Two Bureau-sponsored bills were introduced in the first session of the 87th Congress, S. 685 and H. R. 4229, companion bills, would amend the Coast and Geodetic Survey Commissioned Officers Act of 1948 and H.R. 7719 would authorize ROTC graduates to accept a commission in the Coast and Geodetic Survey in lieu of a

commission in a reserve component of the Armed Forces.

The first Officer Training Section began operation this year. The first, second, third and fourth sections graduated during the year. The fifth section reported in June to begin training.

Multiple recruiting efforts were initiated during the year. These included, but were not limited to: placement of posters in selected post offices; transmittal of recruiting material to selected seniors in engineering colleges accredited by the Engineers Council for Professional Development; paid advertising in "Career for the College Man"; and procurement of new recruiting material for use both by the District Officers and Headquarters Officers in seeking applicants for appointment to the commissioned corps and scientific civil service jobs in the Survey.

Intensified the procurement of students to participate in the Cooperative Student Training Program of the Bureau. Visited five colleges accredited by the Engineers Council for Professional Development and corresponded with the sixth, which resulted in building up the program from three to ten pairs of students. Cooperated with the Personnel and Safety Division in preparing a training agreement, which was approved by the Civil Service Commission, and in setting up procedures for employment, placement, and training of students. Present plans are to increase the program by five pairs a year until twenty pairs are obtained, then continue at that level. This will give the Bureau a direct source yearly of ten engineering and scientific students for appointment in the Commissioned Corps and Civil Service.

Procurement of recruiting material initiated this year includes a new brochure. "A Career with the Coast and Geodetic Survey," which was written and printed commercially.

Thirty-five ensigns and five deck officers were appointed during the year, and six officers retired.

Processed fitness reports, service reports, annual physicals, and took other routine actions. Prepared and maintained the minutes of the Officers Personnel Board.

NEW SHIP STAFF

A New Ship Staff, consisting of a small group of naval architects and technicians, was created on May 3 to oversee and monitor all aspects of new hydrographic replacement and new oceanographic research ship construction and to cooperate and maintain liaison with

the Maritime Administration in ship construction projects.

An agreement was negotiated between the Coast and Geodetic Survey and the Maritime Administration whereby the Maritime Administration would evaluate bids, examine qualifications of low bidder, award contract, supervise construction and conduct acceptance trials and guarantee surveys and related matters pertaining to construction of two Class III hydrographic ships.

Bids for the construction of two Class III hydrographic replacement ships were opened by the Maritime Administration as contracting agent on May 25 and a low bid of $3,733,040., for two ships, submitted by Marietta Manufacturing Co. of Point Pleasant, W. Va., was accepted and the award made on June 29.

Design studies and preliminary design sketches were made in preparation for the construction of one Class I oceanographic ship and one Class II hydrographic replacement ship. Design studies were also conducted and specifications prepared for the construction of hydrographic survey launches and oceanographic deck winches for use on all classes of ships. The purchase of government furnished equipment for two Class III ships was in progress.

INTERNATIONAL TECHNICAL COOPERATION STAFF

The Bureau continued the technical training of foreign nationals under the provisions authorized by Public Law 665, 83d Congress, Mutual Security Act of 1954, and subsequent amendments.

During the year, 5 International Cooperation Administration (ICA) primary participants reported to the Bureau and were given instruction in the following subjects: In geodetic computations--Rhodesia and Nyasaland (1); in map and chart construction--Colombia (1); in reproduction and map and chart construction--Rhodesia and Nyasaland (1); in gravity--Brazil (1); in hydrographic surveying--Indonesia (1); and in seismology--Chile (1).

From the previous fiscal year, 6 ICA primary participants continued or completed their training programs, as follows: In geodetic surveying--India (1) and Peru (1); in bureau functions and operations--Ecuador (1); in maintenance of instruments--Indonesia (1); and in photogrammetry--Thailand (1). In addition to the foreign participants receiving training under the preceding programs, 4 ICA and 1 Military Assistance Program (MAP) secondary participants reported to the Bureau and were given instruction in the following subjects: In gravity and astronomy--Argentina (1), Indonesia (1);

and in aeronautical chart information--Japan (1), Pakistan (1), and Spain (1). At the request of the National Science Foundation, the Bureau accepted two scientists as guest workers in geophysics for approximately one year--England (1), and Japan (1).

The Bureau received 111 foreign visitors concerned with the observation of facilities and consultation on technical procedures. These visits extended from 1 to 25 days and included representatives from the following countries: Argentina (3), Bolivia (1), Brazil (2), Cambodia (2), Canada (24), China (19), Cuba (1), Ecuador (1), England (1), Germany (2), Iran (1), Japan (10), Korea (3), Nigeria (1), Norway (2), Panama (2), Peru (2), Philippines (8), Portugal (1), Sweden (3), Thailand (6), Tunisia (4), Turkey (8), Uruguay (1), Venezuela (2), and Viet-Nam (1).

Briefing on Bureau activities was provided for 8 ICA Training Officers before accepting assignments with the United States Overseas Missions in the following countries: Africa, Argentina, Ethiopia, France, Korea, Tunisia, and Viet-Nam.

The Chief, as Chairman of the Committee on Surveys of Urban Areas, Commission on Cartography, Pan American Institute of Geography and History (PAIGH), prepared the United States position on the agenda items of the Committee for the IX Consultation of the Commission on Cartography. As Chairman of Commission Four for the American Congress on Surveying and Mapping's participation in the International Federation of Surveyors, the Chief and another representative of the Bureau attended a one-day conference in Philadelphia with the American Institute of Real Estate Appraisers, June 1961. Based on this conference an outline of a work program was prepared.

TECHNICAL RESEARCH AND INFORMATION STAFF

The Technical Research and Information Staff prepared the Annual Report of the Director.

Five technical bulletins were processed and prepared for publication.

The preparation of a Bureau publication on "Shore and Sea Boundaries--With Special Reference to Interpretation and Use of Coast and Geodetic Survey Data" was continued throughout the year.

In response to an urgent request from the Solicitor General of the United States for assistance in formulating the Government's position as to what constitutes the "coast line" of Louisiana, as defined in the Submerged

Lands Act of 1953, for submission to the Supreme Court, a comprehensive memorandum was prepared setting forth answers and recommendations as to principles to be applied and as to specific treatment of certain sections of the coast. Following this, a conference was convened by the Justice Department with representatives from State, Interior, and the Coast Survey, at which a Government position was agreed on.

Consultation was held with personnel of the divisions concerned in the low-water line survey of Louisiana and a comprehensive legal-technical memorandum prepared setting forth the background, the problems involved, and the data required for a determination of the Federal-State boundary in the area of Atchafalaya Bay, particularly with reference to the status of the reef in the entrance in relation to mean high water and mean low water.

Verbal and written information was furnished Bureau personnel and others dealing with the definition of coastal and bottom features, establishment of mean high water line for riparian boundary purposes, the legal principles involved in the restoration of markers on the boundary between two states, the significance of the demarcation line of 1867 in the Bering Sea between Russia and the United States, laws pertaining to salvage of water craft in the inland and navigable waters of the United States, the oceanographic concept of the continental shelf, the principles involved in defining specific limits of a body of water tributary to a larger body, and public rights in the use of private beaches.

DISTRICT OFFICES

District Offices were maintained at thirteen locations throughout the nation, namely, Boston, New York, Baltimore, Norfolk, Tampa, New Orleans, Fort Worth, Kansas City, Missouri; Los Angeles, San Francisco, Portland, Oreg., Seattle, and Honolulu. The primary function of these offices is to supervise and direct all fixed Bureau activities, except observatories, within the respective districts. In pursuit of their duties these offices maintained liaison with government and private organizations and the general public; furnished interested parties with survey data and technical information relative to Bureau activities; contacted educational institutions for recruitment of officer candidates and technical personnel; inspected authorized chart-sales agents to insure faithful performance of contracts; investigated and made recommendations regarding appointment of chart agency applicants; gathered data pertinent to correction of nautical and aeronautical charts, assisted field parties and vessels operating in the respective districts; directed programs for the orderly recovery and maintenance of geodetic control marks;

inspected and serviced primary tide stations; made studies and recommendations on conditions and needs for surveys; maintained stocks of Bureau publications and charts for sale to the public and for official use issue. In addition, supervision and direction were provided photogrammetric units at Baltimore, Tampa, and Portland; nautical charts distribution units at New York and San Francisco; aeronautical chart distribution unit at Kansas City; ship base units and hydrographic survey processing units at Norfolk and Seattle; geodetic computations unit at New York; seismological field survey unit at San Francisco; ship personnel processing unit at Seattle; and geodetic mark recovery and maintenance units at Norfolk, Tampa, New Orleans, Fort Worth, Kansas City, Los Angeles, San Francisco, and Portland.

The Fort Worth District Office was relocated at Room 221, University Plaza, 100 North University Drive, Fort Worth 7, Tex.

OFFICE OF OCEANOGRAPHY

It is the function of the Office of Oceanography to plan, coordinate, and direct all of the Bureau's work at sea. Through its Facilities Division the Office provides and plans for the ships and ships' bases, to carry out its work. Through its Operations Division, the Office plans and supervises all oceanographic projects, including hydrographic surveys and tide stations, and operates the ship bases and related operations. Through its Marine Data Division, the Office of Oceanography administers and supervises the processing and analyses of the data obtained during these operations. In addition to the coordination of these various Bureau activities, the Office of Oceanography acts to coordinate the oceanographic activities of the Bureau with those of the other Government agencies and oceanographic institutions.

The Office of Oceanography is made up primarily of the former Divisions of Coastal Surveys and Tides and Currents with the addition of the Verification Unit of the Division of Charts.

The Operations Division is composed of the Office of the Chief and the Hydrography Branch of the Division of Coastal Surveys and the field parties of the Division of Tides and Currents. The Facilities Division is composed of the Vessels and Equipment Branch of the Division of Coastal Surveys. The Marine Data Division is composed of the Washington Office activities of the Division of Tides and Currents, the Coast Pilot Branch of the Division of Coastal Surveys, the Processing Offices, and the Verification Unit of the Division of Charts.

The National Oceanographic Data Center (NODC) was established in January 1961 through the cooperative efforts and financial support of the Navy, Coast and Geodetic Survey, Bureau of Commercial Fisheries, Weather Bureau, Atomic Energy Commission, and National Science Foundation. This is a milestone on the road of national cooperation in oceanography.

In connection with the coordination and promotion activities, members of the Assistant Director's staff participated in the many meetings of the Interagency Committee on Oceanography and were active in the work of the various panels of this committee. Meetings of the National Academy of Sciences Committee on Oceanography were attended as well as the regular monthly meetings of the informal Coordinating Committee on Oceanography. A close liaison was maintained with private oceanographic institutions through informal meetings at Woods Hole,

Mass., and at the Eastern Pacific Oceanic Conference in California. Lectures and scientific papers were presented at universities and at meetings of scientific societies, and less formal presentations were made before school groups and at meetings of local professional groups.

OPERATIONAL ACTIVITIES

Operations Division

The Operations Division plans, writes the instructions, and supervises the execution of hydrographic, oceanographic, and related surveys involving the operation of ships and shore-based parties. These surveys include the observation, study, and recording of the depths and the physical and chemical properties of ocean water; the determination of the topography and geology of the ocean bottom; the observation and recording of tidal and tidal current phenomena; the measurement of water temperatures and densities; the recording of gravimetric and magnetic phenomena at sea; the collection of meteorological data; the study of marine sedimentation; the collection of marine life specimens; and the collection of other data for charting, navigation, scientific, and defense purposes. The division maintains a system of control tide stations and collaborates with the Geophysics Division in the operation of the Seismic Sea Wave Warning System.

Atlantic and Gulf Coasts

During the year hydrographic and wire-drag surveys were continued along the Atlantic and Gulf coasts as follows:

The ship CONIE continued hydrography in the Potomac River south of Ragged Point and began work in Breton Bay. A 100-hour current station was observed off Piney Point, Md., and two oceanographic stations were occupied. Five magnetic observations were made, four of which were completed in an area where an anomaly appeared to exist. Work was concluded on September 30, and a Coast Pilot inspection of the Potomac River was completed between October 4 and 13 prior to closing the season and returning to Norfolk. All officers attended a 2-day course on operation of a salinity bridge aboard the ship EXPLORER. The radio department set up a training course on the 808 Fathometer for technicians at the Norfolk Base. On April 6, the ship arrived at the working grounds on the Potomac River continuing combined operations. A 100-hour current station was observed and the ship and launch hydrography had progressed to vicinity of Nomini Bay at the close of the year.

Visual-controlled hydrography by the ship GILBERT continued in shoal areas around Tuckernuck and Muskeget Islands and shoran-controlled hydrography continued in Nantucket Sound, Mass. Portable tide gages were installed at Muskeget Island, Nantucket Sound, Edgartown, and Wasque Point, and Martha's Vineyard. An examination of atomic waste sample containers (jettisoned at Browns Ledge, Buzzards Bay in June 1959) was completed July 25 and 26 by five skin divers, three from the Coast and Geodetic Survey, one from Woods Hole Institute, and one from the U. S. Fish and Wildlife Service. A 100-hour current station was observed southwest of Bass Ledge, and magnetic observations were made on Chappaquidick Island. Hydrography was suspended and the season closed September 10. Two current observations were completed September 18 in Fire Island Inlet, N. Y. One meter was lost during Hurricane "Donna." The ship arrived in Beaufort, N. C., September 30 and commenced hydrographic and current surveys in Beaufort Inlet. The smooth plotting of the hydrography was completed by a cartographer from the Norfolk Office. Four 100-hour and two 25-hour current stations were observed and the project was completed December 6. A tagline survey of the dredged area at the Ships Base, Norfolk, was completed. On April 4 the ship sailed for Crisfield, Md., where shoran-controlled revision hydrography was completed south of Tangier Island from Onancock Creek to Sandy Point. On May 13, hydrography was commenced on Nantucket Shoals in conjunction with the ship EXPLORER.

All offshore hydrography and magnetic observations along the Maine coast in the vicinity of Machias Bay were completed August 25 by the ships HILGARD and WAINWRIGHT. On August 17, a shoal in Grand Manan Channel was wire-dragged. The ships arrived in Boston August 28 for installation of new Radar units and completed wire dragging of two wrecks in Boston Harbor. Hurricane "Donna" caused considerable damage to the vessels and launches while tied up in Point Judith Harbor of Refuge, R.I. Two launches were cast on the beach and about 12 feet of the HILGARD's port bulwark torn away. Chief Boatswains Mate Robert M. Beal received the Department's exceptional service award on February 14 at Washington, D. C., for his part in saving the ship HILGARD from almost certain destruction. A 100-hour current station was observed at Point Judith Harbor of Refuge. Wire-drag investigations were made at Vineyard Sound, Mass., Mt. Hope,Bay, R. I., New Haven Harbor, Conn., and Branford Reef, N. Y. The ships sailed for Norfolk October 8. On April 11, the ships departed Norfolk and completed wire-drag investigations at Manasquan Inlet and Beach Haven Inlet, N. J., Oyster Bay and Great South Bay, Long Island, N. Y., and Buzzards Bay near Cuttyhunk Island, Mass. SCUBA divers were used for the first time

which greatly facilitated obtaining least depths over wrecks and obstructions. Hydrography was in progress, one current station had been observed at West Entrance to Harbor of Refuge, R. I., and tide gages were operating at Point Judith and Watch Hill in Block Island Sound at the end of the year.

The East Coast Field Party continued hydrography in Mobile Bay, Ala., operating two launch parties. Several magnetic stations were observed and two sets of salinity and temperatures were observed. Hurricane "Ethel" damaged signals when winds reached 65 m.p.h. Flood waters of approximately 8 feet from Mobile northward delayed hydrography due to excessive currents and debris. A measured mile was established in Mobile Bay for the local Power Squadron. A tide station was reinstalled at Fort Gaines in preparation for commencing hydrography in Mississippi Sound. A 100-hour current station was observed at Dauphin Island Bridge.

The ship SCOTT continued field inspection and chart revision for a new edition of U. S. Coast Pilot 3. Chapter 4, New York Bay to Delaware Bay, Chapter 5, New Jersey Intracoastal Waterway, Chapter 7, Chesapeake and Delaware Canal, Chapter 8, Delaware Bay to Chesapeake Bay, Chapter 13, Patuxent and Severn Rivers, Chesapeake Bay, Chapter 14, Cape Charles to Chester River, Chesapeake Bay, Chapter 15, Baltimore Harbor to Head of Bay, were completed. The ship arrived at Norfolk November 9 and coast pilot inspection was continued through November and December by truck. Processing records and general repair continued until March 21 when the ship SCOTT departed Norfolk and arrived Key West, Fla., April 3 for revision of Coast Pilot 5. At the end of April, field inspection was completed to Fort Meyers. Chapter 4, Key West to Tampa Bay was completed May 12, Chapter 5, Tampa Bay to Apalachee Bay, was completed June 5, and Chapter 6, Apalachee Bay to Mobile Bay, was completed June 28.

Raydist-controlled hydrographic surveys continued in the Straits of Florida by the ship HYDROGRAPHER, off the coast of Cuba. Enroute to and from these working grounds, sounding lines were run in the Gulf of Mexico. Portable tide gages were operating at Loggerhead Key, Dry Tortugas and at Naples, Fla. Hurricane "Donna" caused no damage to ship or Raydist shore installations. Raydist stations were dismantled and the ship arrived at St. Petersburg, Fla., October 14, ending the field season. Processing field records and ship repairs continued until February 24, when the ship was at the shipyard. On March 9, the ship departed from Miami, Fla., on a survey of a cable route to La Guaria, Venezuela, which was completed April

11. Work was resumed in the Florida Keys on April 26 with Raydist stations installed at Boca Chica and Loggerhead Key. Two 100-hour current stations were observed at Dry Tortugas. Ten oceanographic stations were occupied in Florida Bay. The results of these observations, water, core, and bottom samples will be sent to the Marine Laboratory at the University of Miami. A tellurometer traverse from Sand Key to Loggerhead Key was completed June 17.

The ship SOSBEE basing at Fort Myers, Fla., continued hydrographic surveys in Pine Island Sound and along the Gulf of Mexico shoreline southward from Captiva Pass to San Carlos Pass. A 100-hour current station was occupied in Captiva Pass, one magnetic station and one temperature and salinity observed. Hurricane "Donna" arrived with a barometer reading of 28.19 in. and caused some damage to the launch, and minor changes to the shoreline of Pine Island Sound. While en route to the shipyard, the so-called Mud Hole south of Sanibel Island was located and found to be a light green circular area with a definite slick, which has created considerable interest to fishermen and to scientists connected with the University of Miami. Bottom characteristics (smelling strongly of sulphur) and temperature and salinities were obtained. A charted wreck was located off Captiva Island and a least depth of 11.8 feet in surrounding depths of 22 feet obtained.

The ship EXPLORER continued Raydist-controlled hydrography on Nantucket Shoals. Texas Tower No. 3 was located by Raydist control on an uninterrupted run from calibration areas off Chatham and Nantucket Island, Mass., a distance of 95 miles. Bathythermograph casts were taken and observations made at three oceanographic repeat stations. An electric tape-gage was installed at the Bureau's bubbler type tide gage on Texas Tower No. 3. One hundred hours of simultaneous current observations were made with Roberts current buoys and meters at three levels at each of three stations on a cross section of a channel through the shoals, about 17 miles southeast of Nantucket Island. Bathythermograph and drift bottle casts were made during these observations. Heavy damage was caused to Raydist and communication equipment when lightning struck the Gay Head station on Martha's Vineyard. The field season was closed on Nantucket Shoals, September 30, and the ship EXPLORER proceeded to New York to commence work on the location of Texas Tower No. 4 off New Jersey coast and completed oceanographic work on Hudson Canyon. The season was closed and the ship arrived in Norfolk October 14. Processing of records progressed and the salinity of 172 water samples were determined for the ship HYDROGRAPHER.

On April 4, the ship departed Norfolk to take up surveys of radio active waste disposal areas off the New England coast for the Atomic Energy Commission. The Director of the Marine Research Laboratory, University of Connecticut, and his assistant were on board to make marine biological observations. Raydist stations were placed with a large portion of the baseline over water and control was much improved. Equipment was installed aboard to receive telemetered tidal heights from pressure tide gages located on both the seaward and sound sides of Nantucket Island. Two magnetometer track lines spaced 5 miles apart with oceanographic stations were run between Nantucket Shoals and Cape Charles, Va.. While the ship's Raydist set was inoperative, Hiran control was substituted for one Raydist station. Tests were run on new pieces of equipment, including the DE-723 Fathometer and the sound velocity meter.

Pacific Coast, Alaska, and the Pacific Ocean

The ship PATHFINDER arrived at Dutch Harbor July 3 after completing a deep-sea sounding line from Kodiak, Alaska. Shoran stations were established at Cape Kutuzof and 13 miles northeast of Cape Seniavin to control hydrographic surveys along the north coast of Alaska Peninsula. Ten oceanographic stations were observed north of Port Moller. A tide gage was established in Nelson Lagoon and the standard tide station at Port Moller was reactivated. The tide station and seismic sea-wave warning station at Unalaska were inspected and the field season closed September 12. En route to Seattle, additional tide station sites were inspected for the purpose of strengthening the seismic sea-wave warning net. The ship arrived in Seattle on September 23, and commenced processing seasons records. Ship personnel conducted a wire-drag survey in Lake Union and Union Bay of reported submerged piling and obstructions. From April 13 to 24 an investigation of an uncharted shoal on McArthur Bank, Strait of Juan de Fuca, was accomplished, but no obstruction was found. A deep-sea sounding line was run across the Gulf of Alaska and seven oceanographic stations were observed en route. At Seward, the Coast Survey chart agency was inspected and shoaling in the vicinity of the railroad wharf was investigated. On May 10 work was started on hydrography, current, and wire-drag surveys at the oil tanker pier and approaches at Nikiski, Cook Inlet. The chart agency at Anchorage was inspected.

On July 16 the ship LESTER JONES completed hydrographic surveys in the San Juan Archipelago. The ship proceeded to Saratoga Passage and Deception Pass, Wash., completing a drift-float current survey at Deception Pass and commenced ship and launch hydrography in Saratoga

Passage. A portable tide gage was installed at Greenbank, Wash., two magnetic stations, one current station, and temperature and salinity observations were observed in Saratoga Passage. The field season was closed on October 20. Processing of records continued until April 4 when the ship departed for the working grounds at Wrangell, Alaska. En route, the tide gages at Ketchikan and Juneau, Alaska, were serviced and inspected; also five chart agencies were inspected, one each at Ketchikan and Petersburg, and three at Juneau. A portable tide gage was installed and two current stations were observed. The ship's officers and crew participated in dedication ceremonies at Wrangell for the hand-carved totem pole that was carved for the Seattle Ships Base. Launch hydrography and planetable topography continued. Two current stations and six temperature and salinity observations were completed. One nautical chart agency was inspected at Wrangell.

Field work on the tidal survey in Southeast Alaska was continued by the ship PATTON. The 60-day series were completed at all tide gage sites, closing levels were run, and all structures removed. Observations were made at six magnetic stations completing the magnetic anomaly study in the Peril Strait-Chatham Strait area. New aids to navigation were located in Gastineau Channel and four hydrographic investigations were made. The tidal survey of southeast Alaska and inspection and servicing of tide stations was completed by September 16. A 100-hour current station in Sitka Harbor was accomplished September 19-23. Photo identification of control in the vicinity of Bucarelli Bay was completed October 3, and the ship departed Alaska, arriving Seattle October 7. Processing of records and general maintenance continued until April 4 when the ship sailed for the working grounds, in the vicinity of Whidbey Island, Wash. One magnetic observation was made on Whidbey Island. Launch hydrography was in progress in Holmes Harbor until April 18 when the ship proceeded to McArthur Bank, Strait of Juan de Fuca, to assist the ship PATHFINDER on a wire-drag investigation. Salinity and temperature observations were taken in Saratoga Passage and hydrography continued using visual control.

Visual-controlled hydrography in the vicinity of Fire Island, Cook Inlet, Alaska, was completed by the ship BOWIE. Shoran-controlled hydrography began in the vicinity of East Foreland on July 8. Float type tide gages were operating at Anchorage and at Jumbo Rock near Boulder Point. A bubbler type pressure tide gage was operated at Fire Island. The shoran stations received weekly support from the helicopter group at Elmendorf Air Force Base. Two 100-hour current stations were observed off Anchorage and one current station completed

at East Foreland. Six chart agencies were inspected and the standard tide gages at Yakutat and Juneau were inspected. A special project was completed September 29 in Taku Inlet, and the ship departed the working grounds October 1 for Seattle. Processing records continued until April 11 when the ship departed Seattle. En route to Cordova, a special investigation was completed in Lynn Canal, two tide gages were inspected at Skagway and Yakutat, and three chart agencies were inspected. Field work was in progress in Port Wells, Harriman Fiord in Prince William Sound.

The ship HODGSON continued shoran and visual-controlled ship and launch hydrography in Sumner Strait, Alaska. Chart agencies were inspected at Wrangell and Port Protection. A 100-hour current station was observed off Warren Island. The field season was closed October 6, and the ship arrived in Seattle October 10. Processing of field records continued until February 23 when the ship sailed from Seattle to take up work in Hood Canal, Puget Sound. A hydrographic survey was completed in the vicinity of Lofall for a submerged pipeline across Hood Canal on a reimbursable project for the Natural Gas Transmission Company, Seattle. A tide gage was installed at Lofall and three 100-hour current stations were completed along the pipeline crossing. The ship returned to Seattle on March 8 and sailed April 11 to take up work in Sumner Strait, southeast Alaska. The tide gage and chart agency inspections were made and the transit magnetometer calibrated at Sitka. One current station was observed north of Cora Point. Shoran-controlled ship hydrography continued northeastward and inshore hydrography in the vicinity of Spanish Island and Decision Passage was completed.

Shoran-controlled surveys in the Western Pacific were completed by the ship PIONEER July 1. A bathymetric profile was run from Roi-Namur Island at the working grounds to Point Buchon, Calif., arriving July 25. Ship maintenance and repairs were completed August 23. Joint EPI and Shoran stations were established at Bodega Head and Pescadero Point, Calif., in preparation for oceanographic work offshore. Surface temperatures were taken at each bathythermograph lowering for the Bureau of Commercial Fisheries, using a device furnished by them. A magnetometer was towed on all sounding lines. Six pairs of parachute drogues, surface and subsurface, were released southwest of Point Reyes and six pairs released west of Point Arena. Oceanographic observations were taken at each drogue pair location and drift bottles were released at each pair of drogue plants. The fluxgate magnetometer was returned to Scripps Institution of Oceanography, and a proton type magnetometer was installed. Launch work on an examination in the vicinity of

Raccoon Shoal, San Francisco Harbor, disclosed no shoaling in the reported area. The ship departed Alameda, Calif., for Kodiak, Alaska, April 11. En route, four seamounts were developed, one oceanographic station observed, weather balloons released daily, meteorological data transmitted at 6-hour intervals and magnetic and gravity data were obtained. The Seismic Sea Wave Warning Station and standard tide gage were inspected at Womens Bay, Kodiak, Alaska. The ship departed Kodiak to begin ocean surveys between the Aleutian Islands and Hawaiian Islands to the limit of Loran C control. The proton magnetometer was in operation during bathymetry and the gravity meter was operated, weather balloons were released daily, meteorological data were transmitted at 6-hour intervals. Bottom core samples were taken near Shelikof Strait. A layer of warm water was found at depths ranging from 320 feet to 440 feet between Latitudes 50° and 53° across all sounding lines. Eleven seamounts rising 500 fathoms or more from general ocean floor were discovered. The nautical chart agency at Kodiak was inspected.

The ship SURVEYOR completed a deep-sea sounding line across the Gulf of Alaska on July 2. Raydist-controlled hydrography was started in the Bering Sea. Five current stations were observed, six oceanographic stations occupied, tide gages remained in operation at Nigrakpak Lagoon, St. Lawrence Island, and the magnetometer was towed. Field work in the Bering Sea was completed September 12, and the ship arrived Adak September 16. Arrival at Attu Island was on the 18th when the tide gage and Seismic Sea Wave Warning Station were moved from Murder Point to Pyramid Cove. A deep-sea sounding line was run en route to Seattle, arriving on September 30. Processing of records continued until March 29 when the ship sailed to run a cable route sounding line from Point Buchon, Calif., to Makaha, Oahu Island, Hawaii. Inshore hydrography started in the vicinity of Maui Island and three current buoys planted in Auau Channel operated 120 hours. Tide gages were installed at Lahaina and Makena, Maui. Reported uncharted 12 and 90 fathom depths off Diamond Head were investigated and no shoaling was found. The Hawaiian season was closed June 19 and the ship departed Pearl Harbor on June 28 running an assigned sounding line north to Dutch Harbor. Five launch sheets and one ship sheet were completed, two oceanographic stations were observed northwest of Maui Island, two portable tide gages were in operation, three Roberts current buoys (three meters each) were observed in Kalolu Channel, seven magnetic stations observed on Maui Island and a complete ship swing with the Varian towed magnetometer was made.

Summary of Operations

Locality	Hydrography				Topography		
	Sounding lines	Area	Wire drag	Area	Shoreline	Inspection shoreline	Control stations identified
	Miles	Square miles	Miles	Square miles	Miles	Miles	Number
Maine to Cape Henry	8,286	1,007	27	18	-	-	-
Chesapeake Bay	2,761	93	-	-	-	-	-
Cape Henry to Fla.	213	7	-	-	5	-	-
Gulf of Mexico and Strait of Florida	21,395*	6,328	-	-	-	-	-
West Coast	4,439	5,494	45	7	52	-	-
Western Pacific	23,276**	95,249	-	-	-	-	-
Alaska	17,613	4,358	60	13	18	88	72
Gulf of Alaska	4,040	-	-	-	-	-	-
Total	82,023	112,536	132	38	75	88	72

* Includes 6,135 miles sounding line, Miami to Venezuela.
** Includes 10,235 miles sounding line, California to Hawaiian Islands.

Summary of Operations (Cont.)

Locality	Triangulation		Oceanography					
	Triangulation scheme	Geodetic positions	Bathythermograph lowerings	Oceanographic stations observations	Drift bottles released	Biological samples	Water samples analyzed	
							Salinity	Dissolved oxygen
	Miles	No.	No.	No.	No.	No.	No.	No.
Maine to Cape Henry	-	-	812	52	1,728	21	203	-
Chesapeake Bay	-	-	8	-	-	-	-	-
Gulf of Mexico and Strait of Florida	68***	19	19	15	-	29	24	-
West Coast	-	1	110	8	-	-	44	132
Western Pacific	-	-	360	12	-	-	50	23
Alaska	-	-	323	19	-	-	123	-
Gulf of Alaska	-	-	207	10	630	-	186	162
Total	68	20	1,839	116	2,358	50	630	317

*** Tellurometer traverse.

Facilities Division

The Facilities Division plans and provides the facilities required for the execution of hydrographic and oceanographic data; plans, supervises, and inspects the major repair of the operating facilities; and establishes and provides standards, supervision, and inspection for their safe and efficient maintenance and operation. It maintains the construction, maintenance, and historical records of these facilities.

During the first three months of the fiscal year, the work of the Facilities Division was performed by the Vessels and Equipment Branch of the Division of Coastal Surveys. Its functions were essentially the same, except that added responsibility for the design studies for new ship construction was also a function of that branch. These duties continued until the New Ship Staff was established on May 3, 1961.

In addition to routine repairs of all vessels, the following special repairs were made to the ships:

EXPLORER	Ventilation, magnetometer, new electronics lab, photo lab.
HILGARD-WAINWRIGHT	New radar
PATHFINDER	New oceanographic lab, oceanographic winch
PATTON	Gravity meter, magnetometer
PIONEER	Major repairs to hull plating, oceanographic winch
SURVEYOR	Harbormaster installation, corrected deficiencies

As a necessary part of the maintenance of the Bureau's ships, negotiated contracts were let for the ventilation system on the EXPLORER and for the installation of deep-sea anchoring winches on the EXPLORER, PIONEER, and SURVEYOR. As part of the new ship construction program, a negotiated contract was let for the design of two Class III replacement ships.

The Division also procured oceanographic instruments, equipment, and supplies in the amount of $650,000. This included among other things, magnetometers, a gravity meter, salinity bridges, and a deep-sea camera.

Marine Data Division

The Marine Data Division administers and supervises the analyses and compilation of the collected oceanographic data, and prepares oceanographic and marine navigation publications. Its activities include the investigation of oceanographic phenomena through the study of data obtained by the Bureau's ships and tide stations, processing of survey data for nautical charts and other purposes, compilation and publication of tide and tidal current tables, tidal current charts, Coast Pilots, sea water temperature and density summaries, atlases of oceanographic observations, and other reports as required. The Division also participates in the planning of oceanographic surveys and control tide stations, it determines, compiles, and evaluates tidal harmonic constants, and processes and compiles marine geological and geophysical observations for subsequent joint analyses with other organizations within the Bureau. It cooperated closely with and supplied data to the National Oceanographic Data Center (NODC), established within this fiscal year.

Oceanographic Analysis Branch

The Oceanographic Analysis Branch is responsible for the processing, analysis, and publication of Coast Survey oceanographic observations (with the exception of tidal currents and tides, temperature and density observations obtained at tide stations), hydrographic verification, and participation in the Seismic Sea Wave Warning System (research for improving the system, preparation of tsunami travel time charts, and some participation in expanding the number of reporting tide stations).

Before the Branch was established in October 1960, oceanographic work in the Currents and Oceanography Branch during the first quarter of the fiscal year was mainly in the analysis of 25 oceanographic stations (BOWIE, 1959) in the Port Nellie Juan and Kings Bay areas of Prince William Sound. The temperature and oxygen observations were processed for a study to determine whether stagnant conditions below the sill depths existed comparable with Norwegian fiords. Other work included preliminary processing of the EXPLORER transfer data and drift bottle returns.

The reorganization in October 1960 placed increased emphasis on oceanographic activity with a resulting program of processing and analysis not only of an increased volume of information obtained at sea but also types of geophysical and geological observations obtained by the Bureau for the first time.

The first phase for implementing this program lay in setting up office procedures for the complete analysis and publication of the data. Observations of serial temperatures and salinities of oceanographic stations in earlier years had been used only for refining hydrographic observations obtained by acoustical methods. The format proposed is an annual publication of oceanographic data and related interpretation for each field season beginning with 1959. Earlier work will also be published as time permits. Priority was given to a special oceanographic publication on the results of the EXPLORER transfer in 1960, which was completed and sent to the printer in June 1961.

Considerable processing and analysis was achieved for 1959 data as well as some earlier material. The program of using the facilities of the National Oceanographic Data Center (NODC) for the computation of values of temperature, salinity, oxygen, etc., at standard depths increases the productivity of our available manpower.

By-products of the determination of accepted values of salinity, temperature, and oxygen at standard depths by the National Oceanographic Data Center (NODC) are computed values of sigma-t, dynamic depth anomaly, and sound velocity. The first two will facilitate circulation studies and the computation of dynamic currents in areas with adequate coverage of oceanographic stations; the sound velocity data can be used to improve hydrographic reductions.

The drift bottle program was augmented appreciably during the year, both from our own ships and the initiation of launchings from radar picket ships.

The second phase is the building up of a staff of oceanographers and geophysicists who will go to sea and then, on their return to the Washington Office or an oceanographic laboratory, process and analyze their observations. Beginning with the 1962 fiscal year, we plan to recruit and train physical and geological oceanographers and exploration geophysicists for the program. It is anticipated that the data will receive a more meaningful interpretation if it is done by the scientists making the observations and, furthermore, the quality of observations will be appreciably improved.

The following is a summary of the work accomplished:

Oceanographic stations processed and sent to NODC	138
Oceanographic stations received from NODC	49
Bathythermographic slides sent to NODC	286

Bathythermographic slides received from NODC	689
Drift bottle cards returned	414
Reports received on Bureau surveys	
Current Drogues	1
Geological	2
Biological	1
Serial temperature and salinity (ICTI) stations in New York Harbor (1959)	51

As a result of the widespread damage caused by the tsunami that originated off Chile in May 1960, there was a strong demand for expansion of the seismic sea wave warning system to protect other areas. During the year arrangements were completed for sending warnings to Alaska, Canada, and Tahiti; and arrangements are pending with China, Japan, Mexico, Peru, and the Philippines to be included in the system. Nawiliwili (Kauai), Hawaii, Papeete, Tahiti, and Tofino (Vancouver I.), Canada, were added as wave-reporting tide stations in the warning system. Sixteen seismic sea wave travel time charts were computed to implement these additions and to augment the coverage for places already in the warning system. Tsuanmi research activities are reported by the Office of Research and Development.

Verification of 32 hydrographic surveys was completed during the year. A study is being made to develop techniques for decreasing the time lag between hydrographic surveys and the completion of verification.

In service courses in "Physical properties of sea water" and a review of "Calculus and vector analysis" were taught by B. D. Zetler and M. D. Schuldt, respectively. D. H. Benson was an instructor in the cartographic training program. Outservice courses in "Dynamic oceanography" and "Ocean surface waves" were taken by 12 and 3 members of the Office of Oceanography, respectively.

Tides and Currents Branch

Control tide stations were in operation at 105 locations on the Atlantic and Gulf coasts, the Pacific coast and islands at the close of the year. The station on Timbalier Island, La. was dismantled in May 1961. Stations at Rye Beach, N. Y., and Virginia Beach, Va., were destroyed by hurricane "Donna" September 12, 1960; the latter was re-established in April 1961. Original tide records from 31 stations in Central and South America

were received through the Inter-American Geodetic Survey and processed by this office. The second phase of the mapping project of the Louisiana coast, Atchafalaya Bay, was completed in June 1961. Tidal studies to determine vertical land movement in southeast Alaska were completed. Greatest change in the land emergence has been in the Glacier Bay-Icy Strait-Lynn Canal area as indicated by the survey. Regions to the south have been subject to the same land emergence but to a lesser degree.

Inspection and servicing of tide stations were continued with one party operating on the Atlantic and Gulf coasts and the other in the Pacific Islands area. Stations on the Pacific coast were serviced through the District Offices and those in Alaska by personnel of the Survey ships operating in that area.

Pressure (bubbler type) tide gages have been used successfully by hydrographic survey parties for control in Cook Inlet, Alaska, and in the vicinity of Nantucket Island, Mass.

A current survey of Beaufort Inlet, N. C., was made for the Corps of Engineers to determine the cause of the rapid rate of shoaling in these waters. In connection with cooperative projects with other agencies, current observations were made in the Hood Canal, Wash., Fire Island Inlet, Long Island, N. Y., and off Cape Cod, Mass. In addition, field parties engaged in hydrographic surveys made current observations at 33 stations to obtain data for navigational purposes.

At the end of the year, monthly records of daily sea water temperatures and densities were being received from 127 stations, 88 in the U. S. and possessions, and 39 in foreign countries. During the summer, daily observations of sea water temperatures at local resort areas were furnished the press and radio stations in Washington, D.C.

Four volumes of tide tables, and two volumes of tidal current tables were published, and tables for 5 small craft charts were prepared for publication. Also special tide tables for Arctic ports were prepared for the Navy Hydrographic Office. These tables furnish advance tide and current information for the mariner, engineer, and the fishing industry.

Coast Pilot Branch

The Coast Pilots are a series of nautical books containing a wide variety of information important to navigators of United States coastal and intracoastal waters. Subjects include navigation regulations,

prominent features, channels, anchorages, dangers, tides, currents, weather, ice, freshets, routes, and port facilities. Most of this information cannot be shown conveniently on the standard nautical charts and is not readily available elsewhere.

There are eight Coast Pilots: Four for the Atlantic coast; one for the Gulf coast, Puerto Rico, and the Virgin Islands; one for the Pacific coast (California, Oregon, Washington, and Hawaii); and two for Alaska. New editions every five years are planned for the six Atlantic, Gulf, and Pacific coast volumes; the two Alaska volumes may vary up to 10 years. Cumulative Supplements, containing revisions reported since the dates of the editions, usually are issued early each year.

Most new editions of Coast Pilots are written only after a thorough field inspection by special Coast Pilot ship or shore parties. On November 15, 1960, the ship SCOTT completed the remaining 77 percent of the inspection begun in the preceding fiscal year for the revision of Coast Pilot 3, Atlantic Coast, Sandy Hook to Cape Henry. On April 15, 1961, the SCOTT began field inspection for revision of Coast Pilot 5, Gulf Coast, Puerto Rico, and Virgin Islands; by June 30, 1961, the ship had progressed northward and westward from Key West, Fla., to Mobile, Ala., and the inspection of the Gulf coast was about 35 percent complete.

United States Coast Pilot 1, Atlantic Coast, Eastport to Cape Cod, Sixth (March 26, 1960) Edition, was delivered by Government Printing Office and approved for issue on September 6, 1960. Coast Pilot 2, Atlantic Coast, Cape Cod to Sandy Hook, Sixth (September 10, 1960) Edition, was delivered and approved on March 6, 1961. Coast Pilot 3, Atlantic Coast, Sandy Hook to Cape Henry, Seventh (June 17, 1961) Edition, went to press on June 13; the seventh edition will have 204 pages as compared with the 402 pages in the sixth edition.

Cumulative Supplements, all dated January 7, 1961, for Coast Pilots 4, 5, 7, 8, and 9, went to press on January 5 and the printed copies were approved for issue on March 3 to 9. Coastline of the United States, Fourth (April 1, 1961) Edition, was approved for issue on June 15; this one-page table is in wide demand and is distributed free.

The compactness and low printing costs of the 1958-1962 series of "Blue Coast Pilots" brought the following comment from the International Hydrographic Bureau, "There literally are hundreds of Pilots and Sailing Directions published, and if Coast Pilot 2 can serve as a model, the space saved aboard ship, on book shelves, and in bulk storage would reach a staggering figure - to say nothing of decreased

costs of compilation and printing." The answer to IHB is contained in a short article written for their January, 1962, issue of the International Hydrographic Review; meat of the article is the paragraph which compares for 14,000 copies with the preceding edition's 503 pages and estimated costs of $25,150 for the same number of copies.

National and International Cooperation

Oceanography as a field cuts broadly across agency lines within the Federal Government, consequently there must be an extensive amount of free interchange of data, cooperation at the program planning level, and also actual cooperation at the operational level. Within the field of Oceanography there is probably closer coordination and cooperation between agencies than in any other discipline. This is being carried out primarily through the recently formed Interagency Committee on Oceanography through which the Bureau's plans for oceanographic activities are coordinated with those of other agencies such as the Navy Hydrographic Office, Office of Naval Research, Weather Bureau, Bureau of Commercial Fisheries, Coast Guard, Atomic Energy Commission, National Science Foundation, and other agencies whose involvement in oceanography is less extensive.

By the same token, the oceans are international, and there is perforce a considerable amount of international cooperation in the activities of the Office of Oceanography. As an example, this office took part in the planning of the United States part of the International Indian Ocean Expedition.

Throughout the year, cooperation continued with the various agencies and private institutions whose work aboard the ship EXPLORER during her 1960 oceanographic expedition is being included in the report of that expedition. These include the U. S. National Museum of the Smithsonian Institution, Geological Survey, Bureau of Commercial Fisheries, Navy Electronics Laboratory, Oregon State University, Scripps Institution of Oceanography, and the University of Miami.

For the Hydrographic Office various data and techniques were exchanged.

For the Atomic Energy Commission, simulated radioactive waste disposal areas were studied along the coasts of Massachusetts, south of Martha's Vineyard, northeast of Cape Cod, and off the entrance to Boston Harbor. Sample radioactive waste containers at Browns Ledge, Buzzards Bay, Mass., were reexamined by Coast Survey divers.

For the Corps of Engineers, U. S. Army, hydrographic and current surveys were accomplished in the vicinity of Beaufort Inlet, N. C.; current stations were observed in a newly dredged channel at Fire Island Inlet, Long Island, N. Y., for use as a basis for current predictions; and wire-drag survey of an obstruction was made in Mill Neck Creek, Oyster Bay, N. Y. The Corps was also furnished with some tsunami data.

Personnel from the Geological Survey and the Weather Bureau were aboard the PIONEER taking part in the ocean-wide survey operations in the north Pacific during the spring of 1961. A balloon shack and console were installed aboard for the Weather Bureau. Water surface temperatures were taken for the Bureau of Commercial Fisheries at the time of bathythermograph casts off the California coast.

For the U. S. Coast Guard, an investigation was made of the shoaling of Katzehin River Flats, Lynn Canal, Alaska.

For the U. S. Air Force, the EXPLORER determined the accurate location of Texas Tower No. 4 off the New Jersey coast using Raydist control equipment.

Information on tide station operation and other tsunami information for the Warning System was furnished the Weather Bureau, Coast Guard, Navy Department, Federal Aviation Agency, Civil Defense Administration, Institute of Geophysics of the University of Hawaii, Scripps Institution of Oceanography, and Matson Navigation Company.

For the Marine Laboratories, University of Miami, ten oceanographic stations were observed in Florida Bay; Chesapeake Bay Institute, Johns Hopkins University, salinity and temperature data, New York Harbor; Scripps Institution of Oceanography, various, including physical, geological, and biological studies; University of Washington, salinity analyses; and Woods Hole Oceanographic Institution, drift bottle data.

For the American Telephone and Telegraph Company, a hydrographic sounding line was run along a proposed cable route between Miami, Fla., and La Guaria, Venezuela. Sounding lines were also run along a proposed cable route between Point Buchon, Calif., and Makaha, Oahu Island, Hawaii, and another between Roi-Namur Island to Oahu Island, Hawaii, via Eniwetok, Wake, and Midway Islands, thence from Hawaii to Point Buchon, Calif.

For the Natural Gas Transmission Company, Washington, a survey of a pipeline route was made across Hood Canal,

south of Lofall, Wash.; for the Puget Sound Pilots Association, a wire-drag investigation was made of an uncharted danger on McArthur Bank, Wash.; for the Power Squadron at Mobile, Ala., a measured mile was established in Mobile Bay.

On the international level, tidal data are exchanged on a routine basis with various maritime nations of the world.

The Office of Oceanography was represented in the Bureau delegation at the Helsinki meeting of the International Union of Geodesy and Geophysics in July and August 1960. The Brussels meeting of the Earth Tides Commission, International Association of Geodesy, in June 1961 was attended.

The IGY World Data Center A, Oceanography, at A & M College of Texas, was furnished information on Coast Survey observations.

OFFICE OF PHYSICAL SCIENCES

The Office of Physical Sciences directs and coordinates the activities of the Divisions of Geodesy, Geophysics, and Photogrammetry. Through its divisions, the office provides geodetic, geophysical, photogrammetric, and cartographic data for charting and scientific purposes. The office serves as the focal point in matters of policy and procedure below the Bureau level, encourages the liberal combined use of resources within the divisions to further scientific and technical matters pertinent to the physical sciences, the accomplishment of research and development programs, and the provision of scientific and technical information and data to other Government agencies, foreign countries, and civil interests.

OPERATIONAL ACTIVITIES

Geodesy Division

This Division plans, writes the instructions, and supervises the execution of geodetic control surveys, including triangulation, traverse, leveling, base measurement, and astronomic and gravity determination; operates geodetic field parties, latitude observatories, and computing offices; performs the office computation and adjustment of field survey data; compiles, publishes, and distributes geodetic control data for use by the Government and the public for surveying, engineering, cartographic, scientific, and defense purposes; compiles and publishes other matter relating to geodesy; performs studies and collects data relating to astronautics and astrophysics; cooperates with state and local governments concerning control surveys and state coordinate systems; performs precise geodetic surveys for missile systems, satellite tracking and trajectory studies, highway surveys related to the interstate highway program, and other special computations.

A small area of only a few thousand square miles could be mapped without reference to a geodetic control network. But the uninterrupted mapping and charting of continental areas, such as the United States, requires an accurate geodetic framework consisting of thousands of marked points systematically spaced throughout the country. The positions of these points are defined in a horizontal sense by latitude and longitude, and in a vertical sense by elevation above the mean level of the sea. The long distances and great areas involved require the employment of instruments, methods, and computations of much greater refinement than those of ordinary plane surveying. Triangulation, traverse, and astronomic observations are the geodetic operations which determine latitude and longitude, and precise spirit leveling determines elevations.

The primary purpose of geodetic control is to furnish accurate locations, elevations, and distances for all engineering and scientific purposes including mapping and charting on a national, state, and local level. It is a basic requirement in geophysical exploration, in planning and development for natural resources, and in boundary demarcation.

Observations for the intensity of gravity and for astronomic latitude and longitude provide data not only for the determination of the size and shape of the best fitting earth ellipsoid, but also for the details of the ellipsoid-geoid relationship. And, finally, all types of geodetic surveys are needed to secure information required in the testing of military rockets and to determine launch-target relationships.

Several members of the Geodesy Division attended and participated in the Twelfth General Assembly of the International Union of Geodesy and Geophysics held at Helsinki, Finland, July-August 1960. Mr. C. A. Whitten, Chief of the Triangulation Branch, was elected President of the International Association of Geodesy. Mr. D. A. Rice, Chief of the Gravity and Astronomy Branch, was elected President of the Section of Gravimetry, IAG.

Field

Triangulation

Horizontal control was established for mapping and regular surveying operations and, in addition, for interstate highways, defense, and other engineering projects. Three parties averaging 26 men each were on the regular observing projects and three parties of 2 men each were on reconnaissance.

Leveling

Three main multiple-unit parties averaging 15 men each completed 86 unit-months of leveling in the Western, Central, and Eastern States in extending the basic control net and releveling.

Releveling of old first-order lines was undertaken in Arkansas, California, Georgia, Idaho, Illinois, Louisiana, Mississippi, Montana, New Mexico, Ohio, South Carollina, Texas, West Virginia, and Wyoming. Leveling was undertaken in California, Idaho, Illinois, Pennsylvania, Tennessee, and Virginia as part of the interstate highway program.

Whenever feasible, our main level parties set bench marks consisting of copper-coated steel rods driven to refusal at 5-mile intervals along the level lines. Supplementary marks consisting of copper-coated nails and brass washers are placed in roots of large trees.

Astronomic Observations

Astronomic positions and azimuths were observed at approximately 50 rocket launch sites established by the U.S. Air Force in the western United States. Additional observations were made in connection with triangulation control, geodetic development of the Atlantic and Pacific Missile Ranges, and the testing of inertial navigation devices and gyroscopic compasses. Beginning early in 1961, as astronomic observing unit conducted the initial reconnaissance and performed first-order astronomic observations for a Hiran trilateration survey extending from the main islands of Hawaii westward along the archipelago to Midway and Kure Islands.

A new procedure was instituted for time recording on second-order longitude observations, adapting the portable electric-drive drum chronographs originally developed for first-order work. Higher accuracy and better stability of personal equation were achieved, with a reduction in the time required for training new observers.

Gravity Observations

Gravity traverses were observed in both directions over the line between the national bases in Washington, D. C., and Ottawa, Ontario, with connections to the trans-Atlantic base in New York City. These measurements were followed by similar operations on the Mid-Continent Gravity Calibration Line to improve the basis for comparing the U.S. and Canadian calibration standards.

Operations were continued over primary bench mark lines with gravity determinations at an average spacing of 5 miles, to provide data for refinement of spirit level adjustments. The line between San Francisco, Calif., and Kansas City, Mo., was completed, then extended eastward to New Bern, N. C., and southward to Jacksonville, Fla. In June 1961 similar operations were begun in a mountainous region of central Colorado.

A considerable number of special gravity determinations were made at various physical laboratories throughout the United States for the calibration of inertial devices and dead-weight balance systems.

A LaCoste-Romberg sea gravity meter was installed on the Ship PIONEER and operational procedures established. A regular program of gravity measurements was begun when the ship departed from San Francisco for Kodiak, Alaska, early in April 1961; the measurements were continued on oceanographic survey tracks south of the Alaska Peninsula.

Variation of Latitude

The variation-of-latitude observatories at Ukiah, Calif., and Gaithersburg, Md., continued in operation throughout the year. At Ukiah, 3,909 star pairs were observed on 239 nights with complete observations on 178 nights. At Gaithersburg, 3,282 star pairs were observed on 267 nights with complete observations on 95 nights.

Special Projects

Three parties averaging 18 men each were on interstate highway control surveys.

Two 14-man parties provided leveling and one 3-man party made astronomic observations for defense projects. Three triangulation parties of approximately 14 men each, one 25-man party for three months and four reconnaissance 1-man parties were on defense surveys. In addition, one party averaging 14 men provided surveys for Vandenburg AFB and Point Mugu Pacific Missile Range and one party of 22 men surveyed for Patrick AFB Atlantic Missile Range.

The program for determining VOR, VORTAC, and TACAN aeronautical facilities was continued in cooperation with the Division of Photogrammetry for the Federal Aviation Agency.

The interstate highway control surveys by private contractors were inspected and monitored for projects in District of Columbia, Kentucky, Minnesota, Mississippi, and Tennessee.

Horizontal and vertical control was established for the Chesapeake Bay Bridge-Tunnel crossing in the vicinity of Norfolk. This included special leveling by reciprocal observations between Chesapeake Beach and Cape Charles, Va. There were 11 reciprocal observations made to carry levels the 17 miles across the Chesapeake Bay. Some of the observations were over 2 miles in length.

Releveling was undertaken in the San Joaquin-Delta Area and San Jose Area, Calif., where an extensive study is being made in cooperation with the California Department of Water Resources of changes in elevation. Releveling was done in southern Montana and northwestern Wyoming to study earthquake movement.

Reobservations for horizontal earth movement were made in the Point Reyes-Petaluma Area and vicinity of the Taylor Winery in Calif.

Recovery and Maintenance Program

An average of ~~11~~ 13 men were on geodetic recovery and maintenance in Arkansas, California, Florida, Georgia, Alabama

1961 Mass. Wash.

Indiana, Kansas, Louisiana, Mississippi, Missouri, North Dakota, Oregon, Texas, and Virginia. Assistance has also been obtained from state and local organizations and the public in protection and reports on geodetic marks.

Witness signs mounted on metal posts are placed near survey marks by the geodetic parties and the recovery and maintenance men in areas where they will afford protection and aid in recovery of markers.

Tabulation of Field Activities

Interstate Highway Control Surveys

State	Stations	Miles of highway
District of Columbia.....	235	86
Idaho.....	104	140
Illinois.....	216	245
Minnesota.....	92	285
Mississippi.....	24	50
Pennsylvania.....	249	295
Tennessee.....	168	235
Total	1,088	1,336

Leveling

State	First-order	Second-order	State	First-order	Second-order
	Miles	Miles		Miles	Miles
Alabama.....	3	0	New Jersey.....	16	83
Arkansas.....	92	30	Ohio.....	0	77
California..	1338	385	Oklahoma.....	0	161
Colorado.....	5	114	Pennsylvania.....	41	727
Florida.....	86	45	South Carolina...	494	64
Georgia.....	16	0	South Dakota.....	0	85
Idaho.....	184	329	Tennessee.....	13	368
Illinois.....	483	398	Texas.....	27	395
Kansas.....	3	104	Utah.....	0	11
Louisiana....	21	98	Virginia.....	6	43
Maryland.....	0	2	Washington.....	2	55
Minnesota....	0	1	West Virginia....	0	90
Mississippi..	73	4	Wisconsin.....	9	25
Montana.....	533	474	Wyoming.....	57	25
Nebraska.....	34	92			
Nevada.....	11	9	Total.....	3547	4294

Triangulation, First- and Second-Order

State	Number of stations	Area
	Marked and intersection	Square miles
Alabama	13	1
Arizona	2	
Arkansas	52	1,120
California	107	4,053
Colorado	63	1,845
District of Columbia	235	**
Florida	124	2,515
Georgia	10	60
Idaho	135	2,630*
Illinois	221	755*
Indiana	2	
Iowa	33	800
Kansas	73	1,470
Louisiana	50	97
Maine	61	2,430*
Maryland	19	1*
Massachusetts	29	600*
Michigan	30	465*
Minnesota	334	6,080*
Mississippi	31	12*
Missouri	95	2,420
Montana	133	5,030
Nebraska	55	870
Nevada	1	
New Mexico	251	12,461
North Dakota	16	40
Ohio	1	
Oklahoma	69	1,121*
Oregon	1	
Pennsylvania	252	776*
South Carolina	5	
South Dakota	11	120*
Tennessee	168	853*
Texas	288	6,521
Utah	9	35
Virginia	54	121**
Washington	51	86
West Virginia	22	750
Wisconsin	2	
Wyoming	17	485
Total	3,125	56,623

*Tellurometer Traverse not included.
**Geodimeter Traverse not included.

Gravity Determinations

(Including old stations)

Locality	Base net stations	Level line stations
California	7	
Colorado	2	137
Florida	3	13
Georgia		38
Illinois	6	42
Indiana	5	
Iowa	4	
Kansas	23	127
Kentucky		83
Maryland	5	
Missouri	3	65
Nebraska	10	
Nevada	3	1
New Jersey	7	
New Mexico	1	
New York	21	
North Carolina		158
North Dakota	18	
Ohio	4	
Oklahoma	22	
Pennsylvania	27	
South Carolina	4	55
South Dakota	7	
Tennessee		52
Texas	76	
Utah		117
Virginia	47	
West Virginia	1	
Canada	6	
Total	312	888

Earthquake Surveys

	Number of stations		Area
	Old	New	Square miles
Vicinity of Taylor Winery, California	8	0	
Point Reyes-Petaluma, California	46	8	1,800
Total	54	8	1,800

Triangulation Reconnaissance

State	Area Square Miles
California	825
Florida	4,180
Idaho	6,350*
Illinois	2,360*
Iowa	3,010
Kansas	10,155
Kentucky	5
Massachusetts	1,260
Mississippi	14*
Missouri	1,500
Montana	15,665
Nebraska	827
New Mexico	2,808
New York	1,080
North Dakota	135
Oklahoma	4,733
Pennsylvania	706*
South Dakota	540
Tennessee	1,130
Texas	3,950
Utah	6
Washington	812
Total	62,051

*Tellurometer traverse not included.

Astronomic Determinations

(Including old stations)

Locality	Latitude	Longitude	Azimuth
Alabama	1		1
Alaska	3	2	4
Arizona	1	1	1
California	5	5	8
Colorado	13	12	19
Florida	12	12	7
Hawaii	13	13	13
Idaho	2	2	2
Kansas	5	5	10
Massachusetts			1
Minnesota			1
Montana	16	16	8
Nebraska	15	15	1
Nevada	2	2	1
Texas			1
Utah	1	1	1
Washington	10	10	8
Wyoming	5	5	2

Astronomic Determinations (Cont.)

Locality	Latitude	Longitude	Azimuth
British West Indies.....	1	1	
Canada.....			2
Total	105	102	91

Geodimeter Baseline Measurements

Locality	Length in Miles
Vero Rm 8 - Adams, Fla	8.36
Vero Rm 8 - Egg 2, Fla	8.28
Vero Rm 8 - Emerson, Fla	9.28
Kents - Mt. Lona, N. Y.	11.80
Connery - Mount Tom, Mass	8.63
Rockport (USLS) - Albion (USLS), N. Y.	11.63
Breckenridge - Piute, Calif	11.38
Banks - Hawkeye, Iowa	7.06
Maida (GSC) - Cavers (GSC), N. Dak	9.52
Andy - Mission, N. Dak	9.00
Hurd - Crystal, N. Dak	6.59
Westhope (GSC) - Moxbass, N. Dak	6.82
Morlang - Irwin, N. Dak	12.79
Buford - Snake, N. Dak	17.13
Eagle - Werner, N. Dak	11.32
Davenport - Naughton, N. Dak	14.33
Griggs - Turbyfill, Okla	6.61
Dewey - Dawson, Okla	10.69
Walsh - Haystack, Okla	14.17
McDowell - Boy, Tex	13.09
Thomas - Hillen, Tex	11.01
Hansford - Childress, Tex	9.05
Scott - McKensie, Tex	11.83
Andrews - Davis, Tex	10.01
Bangs - Santa Anna, Tex	10.08
Lampasas SWB - Flat Top, Tex	9.85
Loyal - Bauer, Tex	9.58
Humble - Dry Creek, Tex	11.27
King - Fritz, Tex	7.70
Shannon - Powell, Tex	13.86
Southside - Fort Peck, Mont	10.08
Rasmussen - Neilson, Nebr	6.01
Bristow - Meek, Nebr	10.10
Lettman - Avondale, Mont	5.95
Wietus - Freeman, S. Dak	14.31
Bald Butte - Blacktail, Mont	7.24
TOTAL	366.41

3 lines checked from 1962 total and corrected as G. Trans. 1963 [illegible]

1961

Summary of Geodetic Work

	July 1, 1960 to June 30, 1961	Total to June 30, 1961
Triangulation, first-, second-, and third-order stations.....	3,125	166,255
Leveling, first- and second-order, miles.....	7,841	457,417
First-order baselines.....	0	453
Geodimeter baselines.....	36	199
Second-order baselines....	0	59
Latitude stations.....	97	1,640
Longitude stations.....	94	1,448
Azimuth stations.....	87	1,566
Gravity stations.....	865	14,872

Office

Adjustment of Triangulation and Data Processing

In recent years there has been an increasing interest in special purpose, high precision geodetic surveys. Although the adjustment of the basic and fundamental network of triangulation continues to be a primary task, an equal amount of time was required to adjust interstate highway, missile site and missile range surveys. During the year, adjustments for 4,595 points were completed and the records transmitted to the archives. Many points for which the coordinates are classified are not included in this total.

A few projects required the readjustment of older surveys. In all cases, the older network was strengthened by the new surveys, thus providing more accurate coordinates. Some of the areas involved were northern Michigan, western Tennessee, northern New Hampshire and Vermont, central Illinois and southern California. In many instances tellurometer or geodimeter lines were included. In fact, the weakness of the central Illinois control had been detected by Tellurometer measurements made in connection with an interstate highway survey. The major program of revision in southern California is nearly complete. This project has involved connecting many older surveys to each other by direct measurement so as to remove positional closures which had existed in the published control data.

An extensive area network near the junction of the San Andreas and Garlock faults was adjusted independently as well as on the N. A. 1927 Datum. These surveys, made at the request of the Water Resources Board of California, will be repeated in about 5 years in an effort to detect horizontal movement in that region. Other earth movement studies included the adjustment of a small survey near Taft, Calif., where the horizontal movement is probably

due to withdrawal of oil rather than major tectonic forces and the remeasurement of the small nets near the Taylor Winery at Hollister where the crust is slipping almost continuously at a rate of 1.5 mm per month.

A Geodimeter party operated in the central part of the United States most of the year. This group measured lines in the primary nets in Texas, Oklahoma, Kansas, Nebraska, North and South Dakota and Montana. Most of the checks against the existing adjusted values were excellent but several indicated weaknesses of the order of 1 to 40,000 or 1 to 50,000. This program will be continued and the results used whenever a regional or national readjustment seems required.

The adjustment of the triangulation in the Blue Nile River Area of Ethiopia has been completed although the listing of the final data has not been finished. This project included 252 primary points, 118 supplemental points, 9 invar base lines, 7 Tellurometer base nets (each with 3 or more lines) and 11 Laplace Azimuths.

The work in the Automatic Data Processing Section was extremely heavy. The magnetic drum calculator, IBM 650, is no longer adequate to carry the work load of the Bureau. Additional computer facilities will be needed in the near future. Geodetic computing requires only about one-fourth of the available time. The activity now requiring the greatest amount of computer time is the epicenter determination program for Seismology. This work has been on a productive basis for the full year. Data processing in connection with the fiscal operations is the second heaviest use. The recent development of programs for the analytical adjustment of aerotriangulation will increase the machine time needed for photogrammetric work.

These are only a few of the applications within the Bureau to data processing and high speed engineering and scientific computing. Each year broader applications are made with the result that the existing installation must be enlarged to provide satisfactory service to the various offices and divisions.

Adjustment of Leveling

As of June 30, 1961, the total amount in the level net was 457,711 miles of first- and second-order leveling along which 399,762 bench marks have been leveled over.

The following computations and adjustments were completed during the year: preliminary computations for 3,222 miles of first-order and 4,776 miles of second-order leveling; 48 least-squares adjustments comprising 6,001 miles of first-order and 16,000 miles of second-order leveling; and the distribution of closing errors on 8,742

miles of first-order and 19,748 miles of second-order leveling.

The adjustments totaled 1,133 equations. The largest adjustment required the solution of 128 equations and consisted of 2,254 miles of first-order and 5,195 miles of second-order leveling in Colorado and Wyoming.

Astronomic Computations

Astronomic data processing was maintained essentially current with field work during the year. A total of 92 positions and 100 azimuths were computed. Processing was continued, as time permitted, on the Danjon astrolabe data observed at the IGY stations in Honolulu.

Gravity Reductions

Positions, elevations, and gravity anomaly data were compiled for primary bench marks observed along the traverses recently completed between Dallas, Tex., and Los Angeles, Calif., and between San Francisco, Calif., and Kansas City, Mo. Processing of gravity calibration data was kept nearly current with field operations.

Geoidal heights and deflections of the vertical were determined in several areas in connection with special survey requirements of the Department of Defense. Orthogonal components of the gravity anomalies were computed for points along various rocket trajectories on the Atlantic Missile Range.

Gravity data were compiled for the Weather Bureau for use at several hundred meteorological stations in the United States and abroad. Similar data were furnished for a large number of physical laboratories and universities as requested throughout the year.

Sea gravity results were analyzed and processed on completion of the first phase of measurements aboard the Ship PIONEER.

New York Computing Office

The New York Computing Office continued operation during the fiscal year with an average personnel of about 20. The work accomplished at the New York Office supplements that of the various branches of the Washington Office. Included are the computation of adjustment of triangulation and leveling, and the editing and typing of geodetic data for reproduction and distribution.

Geophysics Division

The Division of Geophysics plans, writes the instruc-

tions, and supervises the execution of magnetic and seismological investigations; conducts magnetic and seismological field surveys; operates magnetic and seismological observatories and laboratories, and seismological stations; determines the location of earthquakes and analyzes earthquake wave motion; investigates the relationship between seismological or magnetic phenomena and other geophysical phenomena; analyzes, compiles and publishes the results of its activities for use by the Government and the public for charting, engineering, scientific, and defense purposes; calibrates magnetic instruments and maintains the international magnetic standards; calibrates and standardizes seismological instruments; collaborates with other countries in the study and exchange of geomagnetic and seismological data and serves as the international depository for geomagnetic and seismological data; collaborates with the Operations Division, Office of Oceanography, in maintaining the Seismic Sea Wave Warning System; and cooperates with Department of Defense and other Government agencies in making magnetic and seismological field surveys, monitoring nuclear and chemical detonations, and in the analysis of geophysical field records.

Geophysics is the application of general physical principles to a study of the earth. Two of the major subdivisions of geophysics are geomagnetism, the study and application of the effects of the earth's magnetic field; and seismology, the study of earthquakes and related phenomena by means of teleseismic and strong motion instruments.

The Bureau is the official Government repository for geomagnetic data; and we also maintain World Data Center A, for the collection of geomagnetic, seismic, and gravity data. The data from geomagnetic surveys are utilized in determining secular change in magnetic declination for navigational and surveying purposes, changes or disturbances in the magnetic field and their effect on radio propagation, and the relationship of magnetic disturbances to cosmic ray or other solar activity.

Seismological investigations are concerned primarily with locating earthquakes, and the study of seismic waves. The Bureau contributes about 25 percent of this country's total effort toward this program. The Department of Defense has underwritten extensive studies and surveys in this field. The location and magnitude of earthquakes are determined by the application of the knowledge of the forces which affect the time required for seismic waves to radiate from the point of origin (hypocenter) to the seismographs.

To assist in our epicenter program, thousands of reports are received annually from a volunteer observer corps located at observatories and institutions in all parts of the world. Minor shocks are often reported which have not been detected by instruments in our own net.

The data compiled from this program are utilized by scientists in determining the structure of the earth, from the upper crust to the deep interior with its various physical parameters of density, bulk modulus, etc.; by insurance companies to determine earthquake risk; by engineering firms in designing buildings, dams, and roads to withstand expected shocks; by exploration geophysicists to detect oil-bearing formations; and by others. Seismic methods are used to measure earth motions caused by nuclear or chemical explosions and by the thrust of missiles being launched.

One of the most promising seismological studies is that concerned with the repeat surveys performed by geodetic methods to detect slow ground movements resulting from increasing crustal strains in seismic areas. It is hoped that sufficient knowledge will eventually be obtained through these and related studies so that crustal deformation can be related to the probability of earthquake occurrence.

The Seismic Sea Wave Warning System utilizes seismic data to locate earthquakes occurring under the sea, tidal data to determine whether a tsunami has been generated, and a vast network of radio and telegraphic communication systems to obtain this information and alert areas which may be affected. While it is impossible to change the amplitude or course of these destructive waves, many lives have been saved by the timely warning and evacuation of populations in lowlying areas.

The Chief Seismologist and the Chief of the Seismological Field Survey attended the 2nd World Conference on Earthquake Engineering in Tokyo, Japan. While in Tokyo, Dr. Carder visited the Matsushiro Seismological Observatory and consulted with Japanese seismologists relative to the Seismic Sea Wave Warning System.

The Twelfth General Assembly of the International Union of Geodesy and Geophysics held at Helsinki, Finland, in July-August 1960 was attended by the Chief of the Seismology Branch, who was principal delegate to the IUGG for the Association of Seismology, and was responsible for the conduct of seismology sessions in which the United States participated.

The Chief of the Seismological Field Survey spent 5 weeks in Chile conferring with engineers, seismologists, and government officials on programs of seismic instrumentation for investigations of ground motion caused by earthquakes in that country. Enroute to the United States, Mr. Cloud visited the Institute of Huancayo in Lima, Peru, and the University of Mexico, Mexico, to discuss seismological problems in those countries.

The Chief of the Seismology Branch attended a meeting of area scientists at the Carnegie Institution of Washington to discuss and develop plans for United States participation in the Upper Mantle and Crustal program which will take place between January 1962 and 1964. During this period emphasis will be placed on encouraging and expanding national projects to obtain greater cooperative effort by government agencies, universities, and private organizations, rather than on large international cooperative projects.

The Chief of the Seismology Branch attended a meeting of the International Geophysics Committee (CIG) in Paris, France, January 25-29, 1961, to present the proposed American research program for studies of the Upper Mantle and Crust and to review with other members of the CIG the programs offered by other countries. Concentrated and extensive research on this portion of the earth is being encouraged by CIG through National Committees during the period January 1961 and 1964. While in Paris he attended a UNESCO meeting at which a program to survey the needs of about twenty countries in the field of seismology was reviewed. UNESCO plans to send teams of three seismologists and one economist to South America, southeast Asia, and the western Mediterranean countries for a period of 9 months. These teams will investigate seismicity problems, the seismograph stations and observatories, and the type and amount of research being conducted in engineering and earthquake seismology. They will then submit a comprehensive report which will be used to determine UNESCO's future programs in seismology in these countries.

As a member of the ad hoc Committee on Earth Sciences for the President's Science Advisory Committee, the Chief of the Seismology Branch attended two meetings in June 1961, one in Washington and the other in Boston. Representatives in the fields of geology, meteorology, oceanography, and seismology attended. In seismology, plans were presented for upgrading the teaching of seismology in the universities, the modernizing of seismic stations, the training of earthquake and engineering seismologists in this country and abroad, and organizing and administering this scientific work by foreign governments, so that within a few years they would assume the full responsibility of the program. In geology, seismology, and hydrology, the estimated cost was $2.8 million for the next 10 years.

Geomagnetism Branch

Monitoring the earth's magnetic field is an important and continuing Bureau responsibility, calling for a substantial effort commensurate with the complexities of the phenomena and the expanse of the nation's territory. Eight magnetic observatories are the foundation of this work. They are situated at Fredericksburg, Va.; Tucson,

Ariz.; San Juan, P. R.; Honolulu, Hawaii; Guam, Mariana Islands; and College, Sitka, and Barrow, Alaska. For further data on the secular change in the strength and direction of the geomagnetic field, field parties made observations at 18 magnetic repeat stations, with the support of a nearby portable magnetograph, following a plan that has proved to be efficacious in recent years.

The acquisition of new worldwide data by correspondence and exchange is currently beginning a buildup looking toward the planned work on the 1965 magnetic charts. A new tabulation form has received international approval for the dissemination of these results, with a good prospect for stimulating their collection and exchange through an international committee on World Magnetic Survey. Data already received include a large volume of results from the operation of vector airborne magnetometers in the Navy Hydrographic Office Project Magnet. Preliminary studies are well advanced on analytical techniques for improving the charts.

Towed total-intensity magnetometers of two different kinds were operated extensively at sea during the year. Observations of this type, readily conducted in conjunction with other hydrographic and oceanographic operations, yield information of great value for studies of the ocean-floor geology, at a relatively minor cost in time and equipment. They will also be of material benefit in the regular chart program.

Under a continuing arrangement with the U. S. Antarctic Program, the magnetic observatories at Byrd Station and at the South Pole Station, first set up during the International Geophysical Year of 1957-58, were continued in operation with improved instrumentation. Bureau participation in two traverses yielded very substantial and badly needed increments of ground magnetic data for the Antarctic. One of these extended from McMurdo to the Pole Station, and the other from Byrd Station nearly to the Bellingshausen Sea.

The routine use of the proton vector magnetometer at Fredericksburg has led to a substantial improvement in the calibration standards for much of the Bureau's geomagnetic work. Similar instruments are being obtained for two other observatories.

Seismology Branch

As a result of actions by several seismological panels since 1959 which expressed the need for improved data for seismological research, the Coast and Geodetic Survey was selected to conduct a study and recommend a network of approximately 125 seismograph stations around the world to be equipped with new standard, calibrated seismometers and

auxiliary equipment. The output from this equipment would be quantitative data that would be used for studies of world seismicity, earthquake mechanisms, seismic wave propagation, and energy determinations.

The Seismology Branch has been actively engaged during the period of this report in all phases of the project, including the preparation of performance specifications for the construction of the instruments, the procurement and training of geophysicists for installing the equipment, the selection of the stations to participate, and scheduling the installation.

The standard instruments, both short and long period, will be installed in 125 stations, chosen from 420 applicants, located on all continents. All negotiations with foreign countries have been conducted through the State Department and with the advice of the Advanced Research Projects Agency of the Department of Defense, the operator of the (VELA) program of which this station standardization effort is an integral part.

The data from the standard network of seismograph stations will be collected at a center in Washington, D.C., where it is estimated one thousand copies a day will be processed to fill requests from research seismologists around the world. A staff of theoretical seismologists is being assembled to analyze the incoming data in order to make studies for the improvement of depth and magnitude determination and travel time curves. This information will be used in turn to study path anomalies, crustal parameters and focal mechanisms. Much of this work will be possible only because of the improvement in the quality of the data resulting from the standard seismograph network.

A catalog of special events and earthquakes at comparable distances was prepared for the Advanced Research Projects Agency. Seismograms from 10 explosions, including the 2 chemical explosions of Promontory and Ripple Rock, and two Novaya Zemlya events recorded at six United States stations were chosen. One or more earthquakes at comparable distances and of like magnitudes were also included for comparison. Data on distance to the event or earthquake, instrumental constants, and arrival times of the identified phases were given. Six photographic copies of this material with location maps were prepared as a catalog of about 110 pages.

The Seismological Investigation Section, working in close collaboration with the Computer Section of the Geodesy Division continues to make progress in the program to locate earthquake epicenters by electronic computer methods. A one-pass iterative method of adjusting preliminary hypocenters has been developed and programed for the IBM 650 computer. The method used previously was

noniterative and required two passes through the machine. The new method also incorporates improved travel-time approximations and will provide more accurate results.

On June 19, 1961, the construction of the new Seismological Laboratory at Albuquerque was approved and accepted by the Bureau of Indian Affairs and turned over to the Coast and Geodetic Survey. The installation will consist of seven buildings and two vaults on a 673-acre tract of land. Research and development of advanced instrumentation in all phases of seismology will be a prime objective. It is planned that 8 scientists and instrument makers will be the initial staff at the Laboratory.

In the study of earthquakes, the Survey maintains and operates 28 stations, extending from the South Pole to Fairbanks, Alaska. These stations, with modern sensitive seismographs, annually detect about 45,000 earthquakes, and daily report their observations by telegraph to the Washington Office. In addition, about 190 other stations, located in all parts of the world, cooperate by furnishing earthquake data through communication facilities made available by the military and other agencies.

Through the medium of this program, locations of 1,829 earthquakes were furnished on a biweekly schedule to seismologists and other scientists around the world. These statistical data and pertinent descriptive information about the stronger earthquakes are compiled in an annual report for those scientists, engineers, and professional people who have need for such information. Requests for information about earthquake geography were filled for 116 domestic and 70 foreign areas. Special earthquake readings and seismograms, primarily for use in research projects, were supplied to seismologists in the United States, Australia, Canada, Chile, Denmark, Equador, Fiji, France, India, Iran, Mexico, New Guinea, New Zealand, Norway, Peru, and U.S.S.R.

In the engineering field, 70 strong-motion seismograph stations are operating in the area west of the Rocky Mountains, and 7 in Latin America. The instruments in these stations differ from those previously mentioned in that they operate only during the earthquakes, and they have very low magnification, 100 or less. The data obtained are scaled in acceleration and displacement of the earth movements and are employed by engineers in the design of structures to withstand earthquake forces and in the establishment of building codes and safety regulations.

As of January 1961, 61 seismoscope stations have been implemented in southern California and 31 stations in northern California. During the January 19, 1960, and April 8, 1961, Hollister, Calif., earthquakes, both seismoscopes at the W. A. Taylor Winery on the San Andreas

Fault exceeded the recording limit of the smoked watch glass. The instruments were located side by side on the winery concrete floor at the edge of the fracture line through the building. The large recorded velocities during the earthquakes may have been due to the instrument location. Seismological Field Survey personnel, to provide a basis for judgment, increased the number of seismoscopes from 2 to 4 and located the instruments to cover a fairly large area on both sides of the fracture line.

Observations were made of the periods of induced vibrations on the following buildings: California Bank, Federal Savings & Loan, Travelers Insurance Co., Airport Control Tower, Tishman Building, Los Angeles; Encino Dam Intake Tower, southern California; Crown Zellerback Building, San Francisco; and buildings and water tanks at Valdivia, Huachipato, and Concepcion, Chile.

Six additional cameras were purchased for the Sprengnether vibration seismograph. The additional cameras will speed up field work by making it unnecessary to reload cameras during a day's operation.

Two strong-motion seismographs were installed in the new Bethlehem Steel Building located at 100 California Street, San Francisco; one instrument in the basement and one on the 12th floor.

A new strong-motion station was installed at the Contra Costa County Diablo Valley College near Pleasant Hills, Calif. The instrumentation for this station was purchased by the Contra Costa County. The station will be maintained by the Survey as a unit of its net of strong-motion stations.

In March, the Santa Ana strong-motion station was moved to the recently completed Engineering Building and the instrumentation improved. The station now has a standard strong-motion seismograph and a seismoscope.

The Wilmot Engraving and Instrument Co. of Pasadena, Calif., was contacted by the Seismological Field Survey about rebuilding the Mark III Spectrum Analyzer plotting table, and construction of strong-motion seismographs. The inquiry on construction of strong-motion seismographs was in line with developing a source of supply should the need arise. Rebuilding of the plotter is required to permit preparation of film disks directly from field records. Variable speed between film drum and record drum is needed for direct time scale expansion; variable leverage between curve follower stylus and film shutter is needed for direct amplitude expansion.

The continuation of the Antarctic International Geophysical Cooperation (IGC) seismological stations at Byrd

and South Pole has provided essential control for the location of earthquake epicenters in the southern hemisphere. They were particularly helpful in locating 27 earthquakes south of 50° South latitude from July 1960 through June 1961. Most of these eipcenters were located near the active island arc zone of the Sandwich Islands. The Balleny Islands, Macquarie Islands, Easter Island Caordillera, Indian-Antarctica Rise, and Bouvet Island also showed activity. No earthquakes local to the Antarctic were reported from Byrd or South Pole stations. The stations at Guam in the Mariana Islands and Thule in Greenland have continued to provide data for world seismic studies.

At Boulder City, Nev., the film recorder was replaced by a single drum paper recorder and galvanometer hooked to the vertical Benioff. The film recorder was shipped to the Washington laboratory for overhaul.

A chronometer received from the Times Facsimile Corp., was tested for suitability by the Washington laboratory as a precision time and frequency standard for seismograph station operation. Tests indicated time accuracy of one-hundredth of a second is readily obtained. Further tests are being made on rate stability and the possibility of obtaining a frequency controlled output for synchronous operation of a seismograph recorder.

The Seismological Field Survey personnel installed a teleseismic station at Western Washington College in Bellingham, Wash. The station will have 3-components of Wilson-Lamison seismometers recording three galvanometers on Sprengnether drum recorders. The vertical Wilson-Lamison will also record on a visual recorder.

An automatic recentering device for the split beam visual systems was developed by the Washington laboratory.

Seismic Sea Wave Warning System

In accordance with a request from the International Union of Geodesy and Geophysics, a bibliography on tsunamis will be compiled by the Seismological Branch. It was agreed that the compilation would be comprehensive and the assistance of scientists in other countries would be solicited. It is anticipated that 1½ years will be required to complete the bibliography.

One visible recording seismograph system for use in the SSWWS was constructed in the Washington laboratory and shipped to Guam Observatory. Additional systems are being constructed, tested, and calibrated to modernize the systems at the College, Sitka, and Honolulu observatories. Seismic sea wave warning alarm boxes of new design were built to accompany the visible systems.

Photogrammetry Division

The Photogrammetry Division makes the detailed surveys and does the mapping of land areas required for Bureau programs and also accomplishes special surveys and mapping for other Federal and State agencies. The work of the Photogrammetry Division follows the establishment of basic control (1st and 2nd order triangulation and leveling) by the Geodesy Division and goes on to provide the terrain data needed for charting and for other Bureau purposes. The principal activities of the Photogrammetry Division include surveys and maps of the coastline to obtain control for hydrographic operations, to locate aids to navigation, and to obtain terrain data for the construction and maintenance of nautical charts; surveys and mapping of airports and the areas adjacent thereto for the production of special airport obstruction charts and for the location of aids to air navigation; participation with the Office of Oceanography in measuring tidal currents and in developing and operating deep sea cameras for photographing the ocean floor; and participation with the Geodesy Division in the Satellite Tracking Program relative to the development and operation of special ballistic cameras. The Photogrammetry Division also does a very considerable amount of surveying for other agencies on a reimbursable basis and this work is increasing year by year (As technology in Government becomes more and more complex there is an increase in requirements by other agencies for expert surveying services).

The Chief of Division, Mr. B. G. Jones, and Mr. G. C. Tewinkel attended the Ninth International Conference on Photogrammetry at London, England, in September 1960. Following this Conference the Chief of Division visited mapping and charting agencies in France, Germany, Switzerland, and Italy.

The Chief of Division attended a Scientific Conference of Federal Executives at Williamsburg, Va., that was arranged by the Brookings Institute.

Personnel from the Photogrammetry Division also attended a Symposium on "Geodesy in the Space Age" at Ohio State University.

Photogrammetric surveys include the principal phases of aerial photography, field surveys, photogrammetric aerotriangulation, map compilation and finishing. Consequently, the following description of activities in Fiscal Year 1961 is separated according to these principal phases and also in accordance with the principal functions of the Division.

Aerial and Laboratory Photography

Two aircraft were operated during the photographic season to obtain a variety of photography (nine-lens, and single-lens panchromatic, infrared, and color) for charting and for special surveys. Photographs were taken in each of the 50 States. The volume and types of photography are shown in the attached statistical summary. The percentage of color photography is indicative of the now general use of this medium for charting purposes.

The Aero Commander Aircraft (leased), Mission 702 manned by an all Coast and Geodetic Survey Crew operated throughout conterminous United States from April 1 to about August 1 and from November 1 to December 31, 1960.

Conversion of the DC-4 aircraft to replace the former B-17 was completed and then the Mission departed for Alaska in August 1960. Photography was continued in Alaska, Hawaii, and in conterminous United States until November 30, 1960.

Air Photographic Mission 701 (DC-4 Aircraft) is a cooperative Coast Guard-Coast and Geodetic Survey undertaking that was first started in 1941. The Coast Guard provides the aircraft and flight crew; the Coast and Geodetic Survey the navigator, photographers, and all photographic equipment. This aircraft provides for simultaneous operation of the nine-lens camera and two single-lens cameras. It has the long range capabilities required for our work in Alaska and other areas outside conterminous United States. In fact, this joint Coast Guard-Coast and Geodetic Survey Mission has provided since the war the essential photography for the completion of modern mapping of most of the coastline of northern and western Alaska and the Aleutian Islands.

Aircraft modifications were completed for use of the new RC-9 Camera (superwide-angle single-lens camera) in both of the above aircraft and the camera has been in operational use this year. A new color film with faster emulsion for aerial photography was tested and adopted for regular use during the year.

The Division's Air Photographic Laboratory was redesigned and modernized during the year for the processing of color photography and for more efficient operations throughout. This modernization included the installation of complex color printing equipment which was ready for testing at the end of the fiscal year.

In recent years the Division has had considerable difficulty in the hiring from Civil Service registers and the retention of aerial photographers. For this reason a training program for aerial photographers was initiated during the year and put into effective operation.

A statistical summary of our Air Photographic and Laboratory work follows:

Statistical Summary-
Aerial Photography and Laboratory Processing

	Nine-lens	Panchromatic	Infrared	Color	Total
Number of rolls of film exposed:	15	140	35	60	250

	Nautical Charting Program	Aeronautical Charting Program	Reimbursable Projects	Total
Linear Miles of Photography:				
Mission 701:	1,475	2,880		4,355
Mission 702:	4,305	8,500	1,730	14,535
Total	5,780	11,380	1,730	18,890

	Aerial Negatives Developed	Nine-lens Prints	Single-lens Paper Prints	Single-lens Glass Plates
Processing and Printing	40,000	600	60,000	2,400

Total Prints
103,000

Field Surveys

Photogrammetric field survey parties worked in every state except Alaska during fiscal year 1961. These were, for the most part, small mobile units (2 to 6 men) engaged in establishing supplemental horizontal control for aero-triangulation and in gathering a variety of terrain data that cannot be obtained solely from office interpretation of aerial photographs. The work of this nature in Alaska was done by ships of the Office of Oceanography.

Electronic distance measuring instruments, specifically Tellurometer and Model 4 Geodimeter, have proven to be extremely effective for the establishment of supplemental horizontal and vertical control by these small photo-

grammetric field parties. During this year, additional field personnel were trained in use of these instruments and the application of such instruments is now general throughout the field operations of the Photogrammetry Division.

Fiscal year 1961 saw our first full-scale application of tide controlled aerial photography for mapping for nautical charting. The method seems most promising and is discussed in detail in a subsequent section.

Field surveys were completed during the year for an extensive photogrammetric test area in the Shenandoah Valley, Va. This work included the premarking of a considerable number of targets with a special plastic material and surveys to determine the horizontal and vertical position of these targets.

Office Photogrammetry

The system of analytic aerotriangulation discussed in more detail under "Research and Development" was put into production late in the fiscal year. Excellent results were obtained on the first project completed by this method. Analytic aerotriangulation now provides for bridging with our new superwide-angle single-lens camera without the necessity of procuring a special analog bridging instrument for this new type of photography.

A Clary Computer (desk size electronic computer) was installed toward the end of the year for survey and office photogrammetry computations. This computer was selected to handle the smaller survey computations that could not be held out of production and accumulated in sufficient volume to warrant making them on the larger computer of the Geodesy Division (IBM-650).

Arrangements were made toward the end of the year for the installation of a Wild B-8 wide-angle plotter on a trial basis. This plotter is designed specifically for map delineation from the superwide-angle RC-9 photographs that will be bridged by analytic aerotriangulation.

The availability of electronic instruments for supplemental control surveys coupled with improvements in single-lens methods have reduced our use of the more expensive nine-lens photography but have by no means eliminated the use of the nine-lens camera. For this reason, our first nine-lens stereoscopic plotter, the "A" plotter will be removed and turned over to the Smithsonian Institution. Eventually, the nine-lens aerial camera will also be turned over to the Smithsonian so that this unique photogrammetric system that has served so well in the Coast and Geodetic Survey for almost a quarter of a century will be preserved.

Surveys for Nautical Charts

Photogrammetric surveys of the coast provide shoreline and control for inshore hydrography; the location of aids to navigation and landmarks; and the detailed terrain information (shoreline, foreshore and offshore, and inland features of interest to the mariner) for nautical charts.

During the fiscal year 1961, field or office work was in progress on 41 mapping projects (a total of 550 maps) in various places along our coastline including Alaska, Hawaii and Puerto Rico.

A total of 114 specially prepared map sheets with aerial photographs for the location of hydrographic control was provided ten ships and one shore based hydrographic party. Six photogrammetric field unit worked directly with hydrographic parties building and locating signals.

Cape Cod Project: In April 1961, for the first time, the Photogrammetry and Nautical Chart Divisions initiated a new approach to the photogrammetric compilation of land information for nautical charts. All of the topography (terrain information) for 11 charts of the Cape Cod area is being photogrammetrically compiled directly to the chart drawings at chart scale, thus eliminating the usual expensive and time-consuming intermediate step of compiling large-scale planimetric or topographic maps first and then reducing these to chart scale.

Modern photogrammetric methods permit this direct method without loss of accuracy and the method is applicable in instances where the intermediate large-scale mapping is not required in connection with hydrography.

The Cape Cod Project also included our first full scale application of tide controlled photography to mapping for nautical charts. Tide staffs were installed at 8 existing tide stations and the photography controlled by radio. Infrared photography was taken at mean high water for mapping the shoreline for charting. Color photography was taken at mean low water for mapping the low-water line and alongshore rocks. The arrangements for tide controlled photography are rather complex and the method is expensive, but is doubtless paying off on this project because of the very considerable savings in field inspection time that would otherwise have been required. No detailed alongshore inspection is being done prior to compilation. The topography is compiled to the chart drawings and these chart drawings are then field edited to dispose of any difficulties encountered by the compiler. However, this field edit is proving to be quite limited. This project is being done in close coordination with the Nautical Chart Division as to their requirements,

and at this time both Divisions feel that this approach will reduce costs and reduce the timelag between the taking of aerial photography and the completing of the chart drawing.

Revision of Chart Drawings from Aerial Photographs: Up-to-date maintenance of nautical charts is a major and most important part of the nautical chart program of the Bureau. For some years, the Photogrammetry Division, in cooperation with Nautical Chart Division, has maintained a small photogrammetric section for revising and keeping up to date the terrain information on nautical charts by applying new aerial photographs directly to the chart drawings. Stereoscopic instrument compilation, radial plot, and graphic methods are used, as required, to apply corrections and to locate the aids to navigation and landmarks. Color photography is used extensively.

In fiscal year 1961, this five-man photogrammetric section corrected 72 chart drawings from some 3,500 aerial photographs. This included: the correction of 15 basic drawings, 14 larger scale inserts for one series of small-craft charts, the location of 65 landmarks (mostly recommended in Coast Pilot Reports), and the location of 73 aids to navigation (from color photography).

Photogrammetric Surveys for Airport Obstruction Charts and for the Location of Air Facilities

This program applies throughout the United States and territories and includes the preparation of special airport obstruction charts, the location of air facilities (that is, omni directional ranges, tacans, etc.), and the preparation of mosaics for noise abatement studies at airports. Airport obstruction charts are special purpose charts used by the Federal Aviation Agency (FAA) and the airlines to administer and comply with safety regulations governing the gross takeoff and landing weights of aircraft in accordance with the length and gradient of runways, obstacles along the takeoff and landing flight path, and other factors. These charts are also used to plan flight operations at airports and in the planning and improvement of airports. The Airport Obstruction chart program has been in progress on a small scale since 1945. It includes the preparation of new charts of airports not previously covered and the periodic revision of existing charts. The location of all of the air facilities along the federal airways was initially undertaken in 1956 and has been completed except for a maintenance program that provides for the location of newly established facilities and for the relocation of those that are moved from time to time.

Aerial photography for this program is done by Mission 702 previously described and photography is taken at

Summary of Coastal Photogrammetric Surveys

Locality	Field Surveys (Inc. Hydrographic Support) Shoreline (Linear Miles)	Field Surveys (Inc. Hydrographic Support) Area (Square St. Miles)	Aerotriangulation and Map Compilation Shoreline (Linear Miles)	Aerotriangulation and Map Compilation Area (Square St. Miles)
Atlantic Coast				
Maine to Cape Henry	125	75	90	
Cape Henry to Key West	35	80	45	105
Puerto Rico and Virgin Islands				
Gulf Coast	310	630	300	610
Pacific Coast				
San Francisco Bay and south		45	20	75
North of San Francisco Bay		135	45	200
Alaska				
Gulf of Alaska			315	305
Western and Northern	115	70	85	170
Hawaii				
Total	585	1035	900	1465

altitudes of from 10,000 to 20,000 feet. Field parties provide supplemental control for aerotriangulation and do the important work of searching out and determining elevations of obstacles in the vicinity of airports and along the flight paths off the ends of runways. Horizontal positioning of obstacles and other features (and to an increasing extent the vertical positioning of features) is accomplished by aerotriangulation. Chart drawings are compiled stereoscopically and graphically from the aerial photography and field data.

The rapid increase in the volume of air traffic in recent years and the advent of turbine powered aircraft (with different safety regulations) have brought many changes in this program. Beginning in fiscal year 1960, two types of charts are produced: Airport Obstruction Charts (Piston) are the original series; Airport Obstruction Charts (Turbine) are the new series designed especially to provide data required by the new takeoff regulations for turbine powered aircraft. These latter charts show the takeoff flight paths with obstacles for a distance of 20 miles from the end of each runway used by turbine powered aircraft which extends the areas that have to be surveyed and yet at the same time the charts are urgently needed. Production methods have been restudied and redesigned to produce these new charts as rapidly as possible.

Late in fiscal year 1961, after a joint study by the FAA and the Coast and Geodetic Survey, the FAA decided that beginning in fiscal year 1962 the Airport Obstruction Charts (Turbine) would be discontinued in favor of a "Turbine Data Sheet" in order to expedite publication of this information.

In the fall of 1960 the Budget Bureau decided to transfer the fiscal responsibility of this entire program from the Coast and Geodetic Survey to the Federal Aviation Agency beginning with fiscal year 1962. Tentative plans are that the Coast and Geodetic Survey will continue to carry the program for the FAA on a reimbursable basis in fiscal year 1962.

Nine 2-man field parties were engaged on this program during the year. Eight of these parties were assigned to airport obstruction chart surveys and the other party to the location of air facilities. Accomplishments during the year were as follows:

Summary of Photogrammetry Surveys for Aeronautical Charts

	Airports surveyed	New charts published	Charts revised and re-issued
Airport obstruction charts (Piston)	64	9	55
Airport obstruction charts (Turbine)	64	24	
Air Facilities located (omni directional ranges, tacans, etc.)	39		
Noise abatement mosaics completed	65		

	Total airports for which charts were on issue June 30, 1961	Total completed to June 30, 1961
Airport obstruction charts (Piston)	469	
Airport obstruction charts (Turbine)	24	
Air facilities located (omni directional ranges, tacans, etc.)		754
Noise abatement mosaics completed		65

National and International Cooperation

The peculiarity of the functions performed by this office are of such a nature that cooperation is required in almost every phase. In order to maintain a cohesive operational report much of the cooperative work has been included under the section "Operations." The following significant contributions have not been previously stated.

The Survey agreed to furnish epicentral and tidal data to Valparaiso, provided a responsible organization was authorized to disseminate the data. Upon completion of a tsunami travel time chart for Valparaiso by the Marine Data Division, it will be possible to furnish estimated arrival times for seismic sea waves originating at great distances from Chile. Arrangements were completed for the Alaskan Civil Defense Agency, the Canadian Department of Transport, and the Hydrographic Mission at Tahiti to be included in the SSWWS and receive warning information from the Honolulu Observatory. Stations at Victoria, Canada; Papeete, Tahiti; and Nawiliwili, Hawaii have agreed to participate in the program by furnishing either seismic or tidal data to HMO.

One of the subcenters of World Data Center A, operated by the Coast and Geodetic Survey for the collection and exchange of data in geomagnetism, seismology and gravity, has continued to function. The office processing of IGY and IGC-59 (International Geophysical Cooperation, 1959) results from magnetic observatories is also continuing. Most of the IGY data from observatories operated by the Bureau have either been distributed or printed and ready for distribution shortly.

As part of our cooperation with the International Association of Geomagnetism and Astronomy, magnetic activity reports from all of the Coast and Geodetic Survey observatories were prepared and forwarded to the international center in the Netherlands. This work included a substantial effort devoted to examination of magnetograms for selected magnetic effects.

In response to a request by the Japan Meteorological Agency, it was agreed that the Honolulu Observatory would furnish Japan with epicentral and tidal data, and that the College Observatory will transmit seismic readings to Tokyo.

International Agencies

Information about seismographs and earthquake motions was supplied to seismologists in the following countries: Argentina, Australia, Canada, Chile, Congo (Leopoldville), Guatemala, India, Ireland, Israel, Italy, Mexico, New Guinea, and U.S.S.R.

National Agencies

The use of the facilities at Fredericksburg by other agencies has continued and increased. The National Aeronautics and Space Administration, the National Bureau of Standards, the Air Force Research and Development Command, and the U. S. Navy Hydrographic Office have been particularly active. A number of foreign purchasers of American geomagnetic instruments made arrangements through the manufacturer to have them standardized at Fredericksburg.

Navy Electronics Laboratory, San Diego, Calif., was furnished a list of Chilean earthquake epicenter locations for the destructive shocks of May 1960. Also epicenter maps of the United States for the years of 1952-1959. The Naval Propellant Plant, Indian Head, Md., was furnished the interpretation of the Georgetown University seismogram of August 17, 1960, which was related to a series of explosions at Indian Head. Bureau of Yards and Docks was furnished the seismic history of Scotland, northwest Australia, and South Africa.

The Army Engineers was furnished the seismic history of Murfreesboro-Arkadelphia, Ark., references on various reports for the Chilean earthquakes of May 1960, and 25 seismicity maps for the United States for various regional offices.

Two additional topographic maps at scale of 1:6,000 with the 10-foot contour interval were done for the Corps of Engineers on the Clearwater River, Idaho.

A reimbursable project was undertaken with the Walla Walla (Wash.) District of the Corps of Engineers for mapping and charting of the Ice Harbor Pool on the Lower Snake River, Idaho. Plans for this project called for detailed mapping of the area prior to the filling of the pool so that the information required for nautical charts will be available without the need for hydrographic surveys after filling of the pool. Aerial photography and field work on the project were done early this year and work was then discontinued pending flooding of the pool in October 1961.

Cooperation with the U. S. Air Force included conducting triangulation, astronomic, leveling, and gravity surveys in connection with the Atlantic and Pacific Missile Ranges and the many operational launching sites mostly confined to the western half of the United States.

Magnetic surveys were made to test the suitability of compass swing areas at 40 air fields within the United States. Such areas are used for compensating and calibrating navigation compasses mounted in aircraft, and the areas must be magnetically smooth and the value of

magnetic declination must be accurately known so that the deviations of the aircraft compass may be determined.

National Security Agency was furnished epicenters of two earthquakes off the coast of Kamchatka. Defense Atomic Support Agency was furnished the addresses of domestic and foreign seismograph installations.

Representative Jessica Weis, of New York, was furnished 25 copies of "The Microseismic Program of the U.S. Navy, a Terminal Report" by D. S. Carder and R. A. Eppley. Capt. P. S. Bauer, Consultant, House Committee on Merchant Marine and Fisheries, was furnished information on seismology, seismic sea wave warning system, and seismological instruments.

The National Inventors Council was furnished an evaluation of a hydraulic seismometer; the Bureau of Standards was furnished microseismic data and information relative to seismograph vault construction; the Maritime Administration, Washington, D. C., was furnished the seismic history of Galveston, Tex.; and the Weather Bureau was furnished a history of seismic sea waves for the last 15 years.

The Bureau of Reclamation was furnished references to assist in the preparation of a report on the Hebgen Lake, Mont., earthquakes and monthly reports on the analysis of seismic records from Flaming Gorge and Glen Canyon seismograph stations; the Geological Survey, Idaho, was furnished information on the seismic history of southeastern Idaho and Geological Survey, Washington, D. C., was furnished copies of seismograms for the Colorado earthquake of October 11, 1960.

Part two (Atchafalaya Bay and vicinity, La.) of the cooperative project with the Bureau of Land Management and the State of Louisiana was in progress during most of this year and was nearly completed at the end of the year. This project provides for tidal data and basic maps for charts for use of the Coast and Geodetic Survey and for a special series of maps showing the low-water line for the use of the Bureau of Land Management and State of Louisiana in administering the leasing of offshore areas in accordance with the Submerged Lands Act of 1953 (Public Law 31). Specifications call for mapping the mean low-water line to within 0.1 foot vertically. This project was carried on cooperatively between the Photogrammetry Division and the Operations and Marine Data Divisions of the Office of Oceanography. It involved a 1 year series of tide observations at 8 stations; special infrared aerial photography taken at exact low-water stages by radio control from these tide stations, and extensive supplemental control surveys, including triangulation and Tellurometer measurements.

Additional boundary survey work was done for the FAA at the Dulles International Airport and will be continued through the first quarter of fiscal year 1962.

The cooperative project with the Maryland Department of Tidewater Fisheries was continued throughout the year. This project started in fiscal year 1960 will be completed in mid-fiscal year 1962. Toward the end of the year, the agreement was extended to include an additional area on the Atlantic coast side of the State that will be done in fiscal years 1962 and 1963.

Assistance was given to the National Aeronautical Association and others through the computation of airline distances. Many cooperative projects with national agencies were conducted throughout the fiscal year.

Information about the purchase, construction and operation of seismographs was supplied to: Davidson County Board of Education, Nashville, Tenn., Western Washington College of Education, California State Division of Water Resources, Radio Corporation of America, Washington and Lee University, Stanford Research Institute, University of Utah, and University of Wisconsin.

Earthquake information was given to the following: American International Underwriters Corp., American Institute of Architects, Preload Co., Marine Office of America, M. A. Hanna Co., M. W. Kellogg Co., Hughes Nuclear Electronics Laboratory, Southern Pacific Co., University of Texas, Iowa State University, Sandia Corporation, Factory Mutual Rating Bureau, Raytheon Co., Socony Mobile Co., University of California, Pacific Fire Rating Bureau, Bell Telephone Laboratories, University of North Carolina, National Geographic Society, Portland Cement Association, Montana State College, Western States Land Corp., Rice University, Auburn University, Intermountain Chemical Co., Shell Oil Co., Princeton University, Lockheed Aircraft Corp., and Texas Instruments Co.

OFFICE OF CARTOGRAPHY

The production and distribution of nautical and aeronautical charts and related publications continued to be the major activities of the Office of Cartography through its Divisions: Nautical Chart, Aeronautical Chart, Reproduction, and Distribution. The Office planned, coordinated, and directed the compilation, maintenance, printing, and distribution of nautical and aeronautical charts; maintained liaison with Government agencies and civil interests concerning cartographic matters; and, through its Divisions, conducted research in cartography and graphic arts, in accordance with the Bureau's overall research and development program.

OPERATIONAL ACTIVITIES

Nautical Chart Division

This Division initiates and is responsible for the nautical chart program of the Office of Cartography and provides the necessary liaison and coordination between the supporting Divisions of Reproduction and Distribution. It plans and directs the construction and maintenance of nautical charts from original surveys of the Bureau and other sources. Preparatory to compilation, it registers and makes final reviews of hydrographic, wire drag, and topographic surveys of the Bureau. Another important function is the acquisition, examination, and evaluation of cartographic source material from various sources. The Division furnishes critical information for hand correction of nautical charts to the Distribution Division. It also cooperates with the U. S. Hydrographic Office and the U. S. Coast Guard in the preparation of the weekly Notice to Mariners. As a result of Bureau reorganization, the responsibility for verification and inking of hydrographic surveys was assigned to the Marine Data Division, Office of Oceanography, on October 1, 1960. Responsibility for the review of the surveys was retained in the Nautical Chart Division.

To produce and maintain an adequate supply of the 826 nautical charts issued by the Bureau, 472 drawings were forwarded to Reproduction as follows: 9 new charts, 4 reconstructions, 131 new editions, 300 new prints, 18 reprints, and 10 overprints. A total of 1,119 items, relative to navigational changes and related information, were compiled for inclusion in the weekly Notice to Mariners. Five thousand two hundred and sixty items containing source material were received and evaluated, and all critical information therefrom was applied to the charts.

One new Small-craft chart, Series 184, Bellingham to

Seattle, Wash., and new editions of two others were published during the year. The compilation of a fourth series, San Francisco to Antioch, Calif., was completed. It is expected that this series will be ready for issue in October 1961.

As in previous years, where feasible, advance prints of new compilations were submitted for examination by our District Officers, the Corps of Engineers, and the Coast Guard.

During the year 10 charts with excessive corrections were forwarded to Reproduction for overprinting. This method of applying excessive corrections eliminated the need of either destroying 11,124 copies of the charts or the addition of 823,826 hand corrections by the Distribution Division.

Sixty-eight correction chartlets were compiled and forwarded to the Hydrographic Office for printing and insertion in the Notice to Mariners. A correction chartlet is a small, revised drawing, at chart scale, made for issuance with each affected chart.

Close liaison was maintained with the Operations Division, Office of Oceanography, in providing presurvey reviews, reviewing project instructions, and in consultation on problems common to the two divisions.

The program, begun last year, to make film positives of surveys and chart bases for security storage, was continued. About 1,375 film copies of hydrographic surveys were made and placed in a repository.

In accordance with Bureau policy to provide training in the nautical chart program for professional employees, five cartographers received field hydrographic surveying duty and nine others received organized training in the Washington Office. One Division employee served as an instructor in the Bureau's training course in cartography.

Twenty-five man-days were spent in computing, surveying and marking race courses, and preparing layouts and chartlets for local regattas. Representatives of Geodesy, Photogrammetry, and Operations Divisions assisted in the field work for the President's Cup Regatta.

The following new unclassified charts were published:

New Nautical Charts Published

No.	Title	Scale
184	Bellingham to Seattle, Wash.....	1:80,000
6158	Columbia River--Lake Celilo, Oreg., and Wash.....	1:20,000
6159	Columbia River--John Day Dam to Blalock, Oreg., and Wash.....	1:20,000
6160	Columbia River--Sundale to Heppner Junction, Oreg. and Wash.....	1:20,000

Aeronautical Chart Division

This Division initiates and is responsible for the aeronautical chart program of the Office of Cartography and for providing the necessary liaison and coordination between the supporting Divisions of Reproduction and Distribution. It plans and directs the construction and maintenance of aeronautical charts and related publications to meet requirements of civil and military aviation. The Division acquires, evaluates, and selects basic source material concerning air navigation for use in chart construction. An important function is research leading to development of new or experimental charts and related products to meet changing needs of civil and military aviation and to improve the usefulness and accuracy of existing charts. Flight checking of aeronautical charts is also accomplished periodically.

Civil and joint civil and military demands required the production of 1,723 aeronautical charts in several series. This represents a net increase of 81 charts over the previous year. Added were 1 Aircraft Position chart, 1 Hawaii Radio Facility chart, 28 Low Altitude Radio Facility charts, 8 Intermediate Altitude Radio Facility charts, 22 Area Arrival and Departure charts, 5 Terminal Area L/MF and VOR charts, and 145 Instrument Approach Procedure charts; and discontinued were 2 Hawaii Radio Facility charts, 32 Low Altitude Radio Facility charts, 44 Terminal Area charts, and 51 Instrument Approach Procedure charts.

The following charts were maintained: 189 standard aeronautical charts with 279 issues, 71 Radio Facility charts with 675 issues, 45 Terminal Area charts with 452 issues, 1390 Instrument Approach Procedure charts with 2617 issues, and 28 auxiliary charts with 3 issues.

The recompilation of Sectional charts to meet changing visual flight requirements was continued on a limited basis. Three charts were recompiled under this program, which began in fiscal year 1956, making a total of 39 now being issued on the new format.

The new Hawaiian Islands Enroute chart, RF 191, was produced under the specifications of the United States series using only one side of the sheet for portrayal of the enroute information. The Honolulu Arrival and Departure chart and a chart of the North Pacific Ocean are printed on the reverse side.

The new Aircraft Position chart 3097, Subpolar Route, North America-Europe, was published in December 1960. The chart is prepared on an Oblique Mercator Projection and portrays necessary information for air navigation on great circle routes between the Pacific Coast of the United States and western Europe.

The Low Altitude Radio Facility charts were reconstructed to portray airway systems between ground level and 14,500 feet MSL. There are 28 charts in this series covering the conterminous United States.

Eight Intermediate Altitude Radio Facility charts were produced and issued depicting the Very High Frequency Airway Structure between 14,500 and 24,000 feet. This series covers the conterminous United States.

A new series of Area Arrival and Departure charts was constructed to portray the arrival and departure routes and holding patterns for ingress and egress into these areas. Twenty-three charts cover the conterminous United States.

Thirteen Terminal Area L/MF charts were discontinued due to the revocation of the LF airways in these areas.

Special notices were produced and distributed as follows: 9 new Oil Burner Route charts showing the routes used by the Strategic Air Command for target runs; 14 Notices of Military Climb Corridors established at Air Force Bases; and 8 special notices to bring prompt attention of all airspace users to areas in which hazardous conditions will exist.

The following table is a summary of aeronautical charts published:

Summary of Aeronautical Charts Published

Series	Number in series, July 1, 1960	New charts	New editions	Reprints	Number in series, June 30, 1961
U.S. WAC.....	43	.....	45	1	43
Alaskan WAC.....	19	.....	16	.....	19
Sectional.....	88	.....	148	.....	88
Jet Navigation.....	4	.....	4	4	4
Local.....	23	.....	47	3	23
Route.....	5	.....	4	.....	5
Planning.....	1	.....	1	1	1
Aircraft Position..	5	1	3	1	6
Radio Facility:					
Low Altitude.....	33	28	379	.....	29
Int. Altitude....	.....	8	24	.....	8
High Altitude....	8	.....	104	2	8
Alaskan.....	1	.....	10	.....	1
Hawaii.....	2	1	4	.....	1
Fed. Airways and Mileage.....	2	.....	4	1	2
Terminal Area....	84	5	417	30	45
Area Arrival and Departure.....	.....	22	88	.....	22
Instrument Approach Procedure.....	1,296	145	1,754	718	1,390
Outline Map.....	10	.....	.....	3	10
Geomagnetic.....	9	.....	.....	.....	9
Azimuthal.....	3	.....	.....	.....	3
Miscellaneous.....	6	.....	.....	.....	6
Total.....	1,642	210	3,052	764	1,723

Reproduction Division

The Reproduction Division supported the nautical and aeronautical programs and also provided miscellaneous lithographic support for the entire Bureau. This Division plans and directs integrated printing facilities for the lithographic reproduction of charts and maps. It utilizes all the processes for making lithographic copy from a manuscript which include negative engraving, type composition, photographic processes, platemaking, and multicolor press operation.

The production of over 46,800,000 copies of the Bureau's nautical and aeronautical charts and related miscellaneous data, such as dates of latest prints, special notices, etc., and 607,570 copies of miscellaneous Bureau and reimbursable work was accomplished during the year.

A new five-color lithographic offset press, placed in operation in December, is being used to print the multi-color aeronautical charts published by the Bureau. The press can print on paper as large as 43 x 60 inches, at a speed of 6,000 sheets an hour. Its continuous feed and double delivery feature permits printing without stopping to load or unload skids of paper.

A Monomatic keyboard and caster was installed as a replacement for one of our older machines. Improvements include the ability to mix type styles in composition with a greater number of matrices; and a hydraulic pumping mechanism insuring improved type casting quality and better reproduction proofs.

Other new equipment secured during the year included a 51 x 76 inch precision layout table which facilitates the layout of film negatives for processing to large printing plates, and a modern photostat machine.

The Division Chief attended technical sessions of the Research Committee of the Lithographic Technical Foundation in Chicago in January. The Chief of Graphic Arts Development Section initiated the practice of consulting research personnel of the Aeronautical Chart and Information Center, Department of the Air Force, in St. Louis, and similar personnel of the Army Map Service and the Hydrographic Office in Washington. These contacts and consultations will be continued. Problems and accomplishments of mutual interest are pooled as a result, with great benefit to the four agencies concerned.

One technical assistant to the Division Chief and the Chief of Graphic Arts Development Section attended the technical sessions, clinics, and exhibits in Chicago at the annual convention of the National Association of Photolithographers.

Key personnel received intensive cross-training within the Division during the year. The Chief of the Transfer and Process Branch, one platemaker, and one pressman studied the use of wipe-on printing plates at the Army Map Service. One Fotosetter operator completed a 3-week course in advanced Fotosetter operation and maintenance at the Harris Intertype Company in Brooklyn, N.Y. Five key personnel completed courses at the U.S. Department of Agriculture Graduate School as follows: two in offset photography, two in portrait photography, and one in work standards and work measurement.

Studies are being made for optimum staffing and methods to meet the increasing demand for Radio Facility charts. These charts are printed on a tight 4-week schedule which complicates and handicaps the scheduling of other charts and other work through the reproduction plant and often

delays getting out this work which is also important and sometimes in urgent demand.

Distribution Division

The Distribution Division plans and directs the distribution of new and current issues of nautical and aeronautical charts, maps, tide and current tables, and related publications. These publications are sold and distributed through the Washington Office, designated Bureau District Offices, and authorized agents located at principal seaports and airports throughout the United States, the West Indies, and a few foreign countries. To provide more efficient service, chart distribution centers are maintained in New York, San Francisco, and Kansas City, to supply agents and the public in those areas. The Division performs the finishing functions of trimming, folding, punching, collating, and packaging preparatory to issue; makes hand corrections to nautical charts; directs the establishment and inspection of sales agents; and performs certain bookkeeping, accounting, and other clerical work pertaining to the distribution of Bureau products.

The Bureau was represented by 1,005 chart agents at the close of the year, an increase of 40 over the previous year. It is Bureau policy to inspect agencies every two years to maintain proper distribution standards.

The Division issued 1,243,164 nautical charts and 41,608,012 aeronautical charts during the year. Nautical charts showed an increase over the previous year of approximately 118,000 issues which appears to be equally distributed among the public, the military, and other Government agencies. In the case of aeronautical charts, there was a decrease of over 1,370,000 issues to the military, but issues to the public and other Government agencies exhibited a marked increase which resulted in a net total increase over the previous year of approximately 900,000 issues.

The subscription service to the Bureau's instrument flight charts continued to grow. A total of 39,098 subscriptions were being maintained at the end of the year, 2,074 more than the previous year.

A total of 9,413,861 hand corrections were made on nautical charts during the year--6,381,921 corrections in the Washington office and 3,031,940 corrections at the distribution centers in New York and San Francisco. A thorough study of the practice of hand correcting nautical charts will be made in fiscal year 1962. The policy inaugurated in fiscal year 1960 of issuing small-scale charts uncorrected where the area is completely covered by larger-scale charts has helped, but the Division is

unable to stay abreast of this work with the present complement of chart correctors.

In January 1961 the Bureau assumed responsibility for the sale of Air Force Flight Information Publications to civil users.

In the Finishing Branch over 11,800,000 copies of aeronautical charts were folded, over 47,300,000 charts were trimmed and checked, and approximately 39,400,000 sheets were punched and drilled. A new "00" folding machine was purchased and installed to help meet the compressed schedule for distribution of Enroute Radio Facility charts.

During the year, Court 1-A adjacent to the Finishing Branch was roofed over. The new area provided space for chart pullers and the Chart Correction Branch. As a result, the movement of charts was more efficient.

An attractive sales room was created in part of the space formerly used for chart storage. Increased sales and better general service have resulted from this change.

The remainder of the vacated chart storage space has been utilized to place clerical help for better operation. In addition, the Royal-McBee "Keysort" card system, a semi-automatic data processing technique, is being adopted for more efficient record keeping and statistics. This system should be in full operation early in fiscal year 1962.

The distribution of charts and related publications for the past three years is shown in the following table:

Charts and Related Publications Issued

Type of chart or publication	1959	1960	1961
Nautical and Tidal Current Charts.....	1,033,195	1,125,373	1,243,164
Standard aeronautical charts.....	5,568,662	5,050,717	4,548,438
Instrument Flight charts.....	31,159,279	35,644,537	37,059,574
Miscellaneous maps and charts.....	80,445	73,814	75,540
Coast Pilots.....	10,387	16,168	15,305
Tide and Current Tables.....	66,879	69,590	67,086

The distribution of nautical and aeronautical charts during the year was as follows:

Distribution of Nautical and Aeronautical Charts

NAUTICAL	Number	Percent
Sales	560,254	45.07
Official Distribution:		
Coast and Geodetic Survey	15,302	1.23
Coast Guard	12,237	.99
Other Executive Departments	21,259	1.71
Congressional	4,038	.32
Foreign Governments	6,829	.55
Miscellaneous	2,152	.17
	61,817	4.97
Reimbursable:		
Department of Air Force	2,083	.16
Department of Army	80	.01
Department of Navy	548,356	44.11
	550,519	44.28
Condemned	70,574	5.68
Total	1,243,164	100.00
STANDARD AERONAUTICAL		
Sales	1,417,356	31.17
Official Distribution:		
Coast and Geodetic Survey	17,596	.39
Federal Aviation Agency	191,249	4.20
Other Executive Departments	30,237	.66
Congressional	244	.01
Foreign Governments	2,795	.06
Miscellaneous	1,373	.03
	243,494	5.35
Reimbursable:		
Department of Air Force	1,776,054	39.05
Department of Army	2,942	.06
Department of Navy	429,702	9.45
Special printings	73,400	1.61
	2,282,098	50.17
Condemned	605,490	13.31
Total	4,548,438	100.00

Distribution of Nautical and Aeronautical Charts--Con.

INSTRUMENT FLIGHT		
	Number	Percent
Sales	8,082,399	21.81
Official Distribution:		
Coast and Geodetic Survey	41,590	.11
Federal Aviation Agency	3,278,156	8.85
Other Executive Departments	463,632	1.25
Miscellaneous	3,125	.01
	3,786,503	10.22
Reimbursable:		
Department of Air Force	23,258,800	62.76
Department of Navy	3,000	.01
	23,261,800	62.77
Condemned	1,928,872	5.20
Total	37,059,574	100.00
AIR FORCE AERONAUTICAL		
Total issue	1,055,113	
Grand total	43,906,289	

COOPERATION WITH NATIONAL AGENCIES

Thirty-nine classified nautical charts were maintained for the Hydrographic Office, U.S. Navy, of which 3 were revised and printed during the year; and anchorage data were revised and overprinted on 25 nautical charts.

For the Coast Guard, three radiobeacon charts were revised and printed; and a special map was prepared showing Coast Guard Districts, Marine Inspection Zones, and Captain of the Port Cities.

In response to requests from Federal agencies, engineers, oil companies, universities, law firms, and others, 3,228 copies of original hydrographic and topographic surveys were furnished. Of these, about 100 were certified for use in court. Numerous requests were also filled for information regarding survey coverage, shoreline changes in specific areas, survey methods and accuracy, interpretation of symbols, and datum changes.

Film positives of color separations and other reproduction materials of various aeronautical charts were prepared and furnished the Geological Survey; the Naval Photographic Interpretation Center; the 8th Air Force, Westover Air Force Base; Aeronautical Chart and Information Center, Department of the Air Force; Aero Service Corp., Philadelphia, Pa.; Williams and Heintz Map Corp., Washington, D.C.; and Jeppesen & Co., Denver, Colo.

Corps of Engineers/OCDM United States base maps were completed and furnished the Office of Civil and Defense Mobilization.

Work performed for the Federal Aviation Agency included printing of an FAA map titled "Flight Operations and Airworthiness District Offices;" copies of a VOR Line of Sight graph; photographic prints of the New York Terminal Area chart; geographic positions of 34 oceanic reporting points and bearings to shore stations, computed by the Geodesy Division from information furnished by the Aeronautical Chart Division; and copies of a composite base map with film aeronautical overlays, prepared from portions of two Sectional charts.

OFFICE OF RESEARCH AND DEVELOPMENT

The Office of Research and Development conducts basic researches in the technical areas of Bureau operations, and coordinates Bureau-wide research and development activities. Through its own activity and the stimulation of research work throughout the Bureau, and through the promotion of vigorous development work in equipment and procedures, the Office is intended to advance Bureau efficiency and services, and to contribute scientific knowledge to the community.

The staff members have no production workload and are free to work unrestrictedly on research and development undertakings. The Office is intended ultimately to have leading scientists in each of several fields, including physical oceanography, submarine physiography, perhaps hydrodynamics, geodesy and space, photogrammetry, geomagnetism, seismology, and cartography. This principal staff will be supported by junior scientists, an administrative officer, secretaries, clerks, etc. Staffing is now partially completed.

Some of the present objectives of the Office are as follows:

Basic research.-- Inquiry into unsolved problems and unexplored phenomena of geodesy, geophysics, oceanography, cartography, surveying, and mapping, etc.

Tsunami research.-- Understanding of the generating mechanism; mathematical description of the earthquake/tsunami coupling effects; and gravity-wave formation. Detection and quantitative evaluation of tsunamis through seismogram analysis, tide-gage or wave-recorder indications, or deep-sea detectors. Analysis of the hydrodynamic problems of tsunamis in bodies of water, or whole oceans. Study of run-up or terminal effects of tsunamis for various coastal configurations. Possible use of hydraulic model experiments in this field. Improvement of the tsunami warning system.

Cartography.-- Development of improved types and formats of nautical and aeronautical charts to suit the requirements of modern navigation.

Hydrography.-- Automation of shipboard operations of data recording and readout to replace manual methods. Development of a modern hydrographic data processing system for the elimination of expensive and delaying hand methods.

Oceanography.-- The stimulation of effective oceanographic research by the development of a suitable organization therefor.

Photogrammetry.-- Development of an improved photogrammetric technology.

Geodesy and space development.-- Studies of the geoid, its gravitational field, and the application of geodetic data to improve positioning of terrestrial objects. Studies of satellite orbital motions, tracking methods, and applications to geodetic and navigational applications. Applications of geodetic skills to space operations.

Geomagnetism.-- Improvements in the technology of geomagnetic investigations, including automation of observatories. Theoretical studies of geomagnetic phenomena. Analytical studies of magnetic phenomena. Analytical studies of magnetic chart making, using computer techniques.

Seismology.-- Basic study of earthquake and explosion wave phenomena. Applications of seismic information to building technology.

Relations with scientists and institutions.-- Establishment of functional relationships with universities and geophysical institutions, particularly with respect to College and Honolulu Observatories. Use of research contracts or grants-in-aid for the accomplishment of fundamental researches in fields of Bureau interest. Support of invited research associates, particularly foreign workers, for mutual stimulation and accomplishment.

Dissemination of research data.-- The Office of Research and Development is responsible for the assignment and preparation of reports, monographs, and other media to disseminate effectively the results of our basic and applied research. This function is one of the most important aspects of our research programs since the evaluation and acceptance of our research and development will be predicated on the effectiveness of the dissemination of our results. The matter is being studied with a view to supplementing the present media of dissemination. The fullest possible emphasis is placed on the preparation of articles on research and development subjects, participation in technical meetings, and dissemination of results through speaking engagements.

OPERATIONAL ACTIVITIES

The principal activities of the Office of Research and Development are summarized:

Design and construction (by contract) of a metastable helium automatic observatory magnetometer. A study of the characteristics of magnetic profile lines over 2,000 miles in length led to a published conclusion that magnetic anomalies arise from the shallow crust and in the earth's core, but not from the mantle. In cooperation with the U. S. Geological Survey, a study was begun of magnetic records taken from aircraft in the Arctic by the Coast Survey and the Air Force in 1950-52. In cooperation with the Hydrographic Office, an analysis was started of around the world magnetic profiles. A major study was started to determine whether regenerative electric currents in the earth's core can account for the main part of the earth's magnetic field.

A study of new navigational systems, including the use of artificial satellites. Participation in the planning of the geodetic satellite project "Anna."

An extensive study of automation trends in photogrammetry. Collaboration with David W. Mann Instruments Co. in the development of an automatic, precision comparator for photogrammetric use.

Experimental sea test of special photographic equipment for distance penetration of ultraviolet radiation. Collaboration with General Electric Co. in development of pulse-light, high-gain TV recording of objects at great distances in sea water.

Extended analytic study of earthquake and tide gage spectrums for possible cross correlation. Investigation of the theoretical possibility of deducing earthquake epicentral ground disturbances related to tsunami generation through the analysis of distant seismograms. Advising the Advanced Research Projects Agency on proposed methods of discriminating between natural and artificial ground disturbances. Placing of a theoretical research contract for the hydrodynamic study of tsunami generation effects. Completion of a feasibility study on possible hydrographic model tests of tsunami effects.

The conduct of numerous physiography studies based on the Bureau's hydrographic surveys. Important information about erosion and sedimentation in coastal areas resulted. Support by research grant of a submarine sand wave study in an area of rapid physical change.

Accomplishment of a cooperative research agreement with the University of Hawaii. Housekeeping support for two foreign guest workers--one engaged in the study of IGY data on earthquake aftershocks; the other on theoretical researches based on IGY data in geomagnetism.

COORDINATION ACTIVITIES

Various research and development activities carried on in the other Offices of the Bureau and coordinated by this Office are grouped by Divisions as follows:

Geodesy Division.-- Graduate studies of one geodesist at Ohio State University. Investigation of gravity observations in moving vehicles was undertaken. Assignment to the ship PIONEER provided for application of the results. A report, "Preliminary Report on Coast and Geodetic Survey Marine Gravity Observations," was presented to the Pacific Science Conference. Improved numerical methods were incorporated in a new iterative program for final earthquake hypocenter determination.

Photogrammetry Division.-- A system of Analytic Aerotriangulation was put into productive use for routine photogrammetric mapping. A Wild RC-9 superwide-angle single-lens aerial camera, which increases the coverage per photograph, was installed in both the Coast Guard R5D and the leased Aero Commander Aircraft. Initiated a study of the magnitude and character of aerial film distortion. A new aerial color emulsion having a speed twice that of previous emulsions was tested. Stereoscopic deep sea camera system was purchased for oceanographic studies. A Wild BC-4 Ballistic Camera was purchased to initiate instrumentation for the Bureau's program of using earth satellites for geodetic purposes.

Geophysics Division.-- A seismic background survey was made for the Navy at the Norfolk Naval Air Station, Va., for a proposed test site for inertial guidance systems. Ground vibration tests were conducted near Valkaria, Fla., for the Army Engineers in connection with the design of a missile tracking system. Recorded ground effects of a one million-pound high explosive detonation at the Nevada Test Site which will help determine feasibility of using nuclear explosions for excavation purposes. A seismic survey was made in connection with tunnel excavations at Conowingo Dam, Md. Spectrum analysis techniques were applied to selected seismograms in an effort to differentiate between the frequency spectrums of natural and artificial events. A feasibility study was made at Cape Canaveral, to conduct a seismic survey of the ground effects produced by the large thrust of missile launchings. Participated in special projects vital to the national security with six mobile recording seismic stations capable of monitoring earthquake aftershocks. A report entitled "Seismic Ground Effects from Coupled and Decoupled Shots in Salt" by D. S. Carder and W. V. Mickey, was distributed to the Atomic Energy Commission, Lawrence Radiation Laboratory of the University of California, and various government agencies and geophysical companies.

Continued research on analytic techniques for improving the treatment of chart data. Research on magnetic storms in high latitudes continued. Continued a study of elliptic pole patterns. Studies continued on the development of daily variation patterns registered at the Koror IGY Observatory. Continued studies leading to refinement of the geometry of the large Braunbek coils at the Fredericksburg Observatory. Initiated a special study of field patterns on the island of Oahu. Started a statistical examination of activity at Sitka.

Operations Division.-- An electric tape gage was installed at the Bureau's bubbler type tide gage on Texas Tower No. 3. Equipment installed aboard the ship EXPLORER for receiving telemetered tidal heights from pressure tide gages established on Nantucket Island, Mass. Scuba divers were successfully used in conjunction with wire-drag surveys. Improved Raydist shore stations. Transmitted and received signals from a single Raydist antenna with the installation of filters at each shore station to prevent interaction between transmitters and receivers. Magnetometers, transducers, and a gravity meter were used on Coast Survey ships with excellent results. A shipboard noise level survey in the radio emission spectrum was made by the Boston Naval Shipyard. A transistorized Raydist navigator was used successfully aboard ship under adverse noise conditions.

Marine Data Division.-- Research in tsunamis primarily directed toward improving the seismic sea wave warning system was continued. The three areas of research considered in seismic wave phenomenon were: (1) the source, (2) the open ocean, and (3) the coastal areas.

Instruments Division.-- A long range telemetering system for the pressure tide gage was developed and installed on Nantucket Island, Mass., to test the feasibility of correcting soundings. Developed a sea water sound velocity meter to aid in a study program of sounding correction of hydrography. A prototype digital recording system is being constructed by the Datex Corporation of Monrovia, Calif. A prototype echo sounder delivered by the Raytheon Company was tested and evaluated. A Seismic Sea Wave Warning System station utilizing a pressure tide gage, was developed and tested. This is an adaptation of the bubbler tide gage modified so that it will respond only to the tsunami disturbances and not to wind and tidal waves. This device has the advantage over the conventional system that the sensor may be placed a considerable distance offshore in areas where it is impossible to locate the conventional detecting system, Two types of digital tide gage recorders are undergoing tests and evaluation. Engineers from the Electronics Laboratory studied the operation of the duplexed Raydist system.

Nautical Chart Division.-- An analytical study is being made of the work problems involved in producing a small-craft chart in the form adopted by the Bureau. A new method in chart making was started which involved by-passing the making of large-scale planimetric maps in advance of a charting project and using photographs. A study of the best methods to improve the legibility of nautical charts under red light illumination was made. Extensive studies to speed the training of new employees in chart construction and maintenance were completed. Completed improvement of chart coverage in Hawaii and the Mississippi River Delta. Studies have been started for the general improvement of nautical chart coverage. An automatic data processing system (ADP) for the collecting of data for cost accounting, production management, and payroll input has been devised and will be implemented shortly.

Aeronautical Chart Division.-- Prototypes were developed for portrayal of variable ceilings and floors on VFR charts and submitted to the Federal Aviation Agency, (FAA). Preliminary and final sheet line layouts were prepared of Enroute Intermediate Altitude charts. A prototype of a portion of an Enroute High Altitude chart was developed and submitted to the FAA.

Six experimental Area Transition charts depicting the transitional data required for transit into intermediate and high altitude operation airways were produced for the FAA and distributed to civil users. A jacket was designed for holding new area charts in the ring binders. Two prototypes of ARTC (Air Traffic Controller) Controller charts were submitted for test and evaluation. Preliminary studies of Standard Instrument Departure charts resulted in a prototype chart for the Kansas City area. A second prototype for the New York area is nearing completion.

Reproduction Division.-- A rub-on diazo sensitizer was adopted for producing guide images on coated plastic sheets. A "pin-register" system for layout and assembly of radio facility chart negatives was introduced. Improved quality negative opaque paint, critically important to efficient negative engraving, was successfully developed. A procedure was developed for producing standardized vignettes for radio facility charts.

Technical Services Division.-- Developmental work was done in the area of mounting and lighting display materials. Long term research was accomplished on map and geographic names source material for specific purposes and in connection with congressional requests.

OFFICE OF ADMINISTRATION

The Office of Administration provides the Bureau with administrative and technical services for all its activities; plans, coordinates, and directs budget and fiscal activities; personnel activities; organization, management, and internal review activities; procurement and supply activities; construction and maintenance of instruments and equipment; and library and map reference services. The Office of Administration is composed of the following divisions: Administrative Services, Budget and Fiscal; Personnel and Safety, Organization and Management, Instruments, and Technical Services.

OPERATIONAL ACTIVITIES

Administrative Services Division

In the past fiscal year reorganization caused many changes in all areas of the Bureau. The Administrative Services Division had the responsibility for furnishing and equipping the new physical environment for these changes. New program and personnel expansion was accommodated by the acquisition of about 45,000 square feet of air conditioned space in the Inter-Ocean and Longfellow Buildings.

Internal changes in the Division brought about by the reorganization consisted of the addition of the forms, records and space management programs together with the travel section.

Procurement actions processed by the Division accounted for a total dollar value of approximately $4,300,000. Excluding one contract, reimbursable in the amount of $1,960,000, this represents an increase of 23 percent or $465,000 over the previous fiscal period. Two cost plus fixed fee contracts and one grant are new types of procurement actions for the Bureau. The grant is the first made by the Department of Commerce for any of its bureaus under authority of 42 USC 1891.

Proposed legislation and regulations concerning procurement, property management, specifications, supply, and various other items were reviewed and reports furnished.

Total inbound and outbound shipments amounted to 913 tons and consisted of charts, instruments, equipment, materials, and supplies of which 90 percent went by motor freight and the remaining 10 percent were carried by rail, air, express, and mail. This is an increase of 27 tons over the last year.

Approximately 661,000 pieces of incoming and outgoing mail cleared the mail room and included 25,000 items of cash and negotiable paper, together with about 6,200 items of incoming registered mail. This represented an increase of about 17 percent over last year which showed a decrease of 6 percent over 1959.

The Addressograph and Duplicating Section made some 28,700 address changes and approximately 431,000 envelopes and cards were addressed; about 602,000 copies were made from 12,000 masters on the hectograph duplicator. While there was an increase of 50 percent in changes made on Addressograph plates during the past fiscal year there was approximately a 14 percent decrease in the number of envelopes and cards addressed in the same period. Although there was a 10 percent decrease in the number of copies made on the duplicator, they were made from about 3,500 more masters.

The Bureau operated 341 motor vehicles 3,974,656 miles during fiscal year 1961 as compared to 338 vehicles driven 3,834,050 miles for the previous year. In addition, 70 vehicles were rented from General Services Administration (GSA) motor pools. Utilization of vehicles increased 449 miles per vehicle year while the average cost per mile remained at $0.07 per mile. Forty-four new vehicles, three office trailers, and one storage trailer were purchased to replace worn-out equipment. Safety seat belts were installed in all vehicles during the year.

Property in the amount of $1,006,972.09 was obtained from various agencies without cost to the Bureau and excess property in the amount of $131,837 was transferred to GSA and other agencies.

Sixteen claims for damages totaling $390,162.30 were recommended for settlement in the total amount of $54,312.84.

Depreciation accounting procedures were set up in the last three months of the fiscal year to take effect at the beginning of the 1962 fiscal year.

Budget and Fiscal Division

A system of depreciation accounting was formulated to be implemented as of July 1, 1961. This system is Bureau-wide in scope and will apply to direct and reimbursable projects. The installation of the system will distribute costs of fixed assets to the periods and activities benefitting from their use and will result in more realistic charges being made for reimbursable work performed for others.

Consumable supplies at bases, aboard vessels, and at field installations were placed under accounting inventory control. The information now being compiled should reflect more correctly the Bureau's financial position in future reports.

The Finance Manual is in the process of being reissued. The procedures are thus being updated and presented in a simplified, nontechnical, and functional manner more readily understandable by personnel of the operating divisions.

Procedures were instituted to improve the accounting control over travel advances through a vigorous followup of pending settlements. The tightened control has released funds for further utilization by operating divisions.

Revisions were made in the Bureau's system of distributing the cost of employees' leave to its operations, to improve the accuracy of charges made to operations for the cost of leave taken, and to simplify the accounting for various types of leave.

During the summer months a training program was conducted for college students majoring in accounting. This was a pilot plan conducted prior to the consummation of a formal training agreement with the Civil Service Commission for a student training program involving college students majoring in accounting and business administration.

The following funds, from the sources indicated, were made available to the Bureau during the fiscal year 1961:

Appropriations:	
Salaries and Expenses.....	$18,121,000
Construction and Equipment,	
Geomagnetic Station.....	11,023 1/
Construction of Surveying Ships.....	4,736,163 2/
Construction and Equipment.....	340,000
Total Appropriations.....	23,208,186
Reimbursement from other Agencies.....	6,691,828
Transfer from:	
International Cooperation Administration.....	95,299
Total Funds Received.....	$29,995,313

1/ Carry-over from 1960.
2/ Includes carry-over from 1960 of $36,163.

Miscellaneous receipts from the sales of nautical and aeronautical charts and related publications totaled $834,465 as compared with $800,989 during the preceding year.

Personnel and Safety Division

The Personnel and Safety Division develops and directs the civil service personnel programs and the safety program of the Bureau, guiding and assisting all other offices and divisions on matters of personnel and safety administration.

Safety Program

The Bureau was the recipient of the Secretary of Commerce Award of Honor for Safety. The award was presented to the Bureau for its excellent reduction in the rate of accidents and for maintaining an outstanding safety program. The real effort meriting the award was made by supervisors and employees through their participation in the Bureau Accident Prevention Program.

Placement and Employee Relations Branch

The Branch has expanded the Student Trainee Program, both vacation work-study and cooperative, during the past year. At the present time 4 vacation work-study and 12 cooperative student trainees are on the rolls. These students are employed in the fields of oceanography, geophysics, geodesy, and civil engineering. Participation in this program began 3 years ago on an experimental basis and has now been expanded to a full program, with a training agreement approved by the Civil Service Commission, with an anticipated total of 40 cooperative students over a 4-year period. The objective of the program is to encourage college students to choose a career in the Bureau upon graduation.

District Offices in six major cities were visited by the Placement Officer who gave training in qualification requirements, Civil Service examining procedures, interviewing techniques and staffing needs prior to fall and spring visits to local colleges where the seniors were interviewed. Through this means, approximately 35 candidates were encouraged to file for examinations that would qualify them for positions in the Bureau. The majority of applications were received from the Gulf States area. However, the difficulty with this approach is the length of time consumed between the time the student is first interviewed and the time a firm job offer can be made, due to rating procedure, vouchering of applications, and certification procedure. To speed up this process, the Civil Service Commission Board of Examiners has, upon our recommendation, revised its rating schedule to eliminate vouchering of applications which should reduce the rating time approximately 30 days.

Other recruitment aids that were developed are the advertising in the Career Resume Service and the College

Placement Annual. Although the Career Resume advertisement is primarily intended to attract young men to the Commissioned Corps, correspondence was directed to those applicants who do not meet the rigid physical requirements for the Commissioned Corps, urging them to apply for Bureau civil service positions. Through subscription to the Career Resume Service approximately 20 career resumes a month were received. Although most of these applicants specified a higher entrance salary than could be offered approximately eight a month are contacted, suggesting that they apply for Civil Service examinations.

The Placement and Employee Relations Branch has been working in conjunction with the Officer Personnel Staff in preparing a brochure, representing both the Commissioned Corps and professional civil service positions, which will be used as a recruiting aid at universities and as an enclosure to correspondence with applicants meeting the requirements of our professional civil service positions.

Training Branch

The total training effort of the Bureau has been enlarged to meet the challenge of expanding activities in oceanography, geophysics, geodesy, photogrammetry, cartography, and research and development.

In order to systematically plan for the development, training, and utilization of the capabilities of employees, the Bureau established new training programs, and increased its participation in interagency, and outservice training programs. New training programs have been initiated for student trainees, newly commissioned officers, supervisory personnel, and professional employees in the cartographic field. This training is designed to obtain greater flexibility in assigning personnel, and to develop new employees to replace experienced personnel who retire or otherwise leave the service.

Training programs initiated in the Bureau during this year:

1. Formal 16-week training--8 weeks in the Washington office and 8 weeks aboard ship--for newly commissioned officers.

2. Training of student trainees under a training agreement approved by the U.S. Civil Service Commission. The training is in engineering, physical sciences, mathematics, and cartography under a cooperative plan with universities.

3. Personnel management course for supervisors.

4. Health benefits program orientation.

5. Augmented training of geophysicists in earthquake recording, operational procedures, and the testing and calibration of seismographs.

6. Rotational training of recently appointed cartographers and civil engineers which included a 1-season assignment in the field and a 1-week training tour of the Bureau.

7. Accelerated training of personnel in the field of geomagnetism because of continually changing and expanding activities in the geophysical and related scientific fields.

8. Training for newly recruited negative engravers.

9. Cross-training program for cartographic employees in the Chart Distribution Division.

Bureau employees received interagency training in the categories of general management, personnel administration, administrative operations, automatic data processing, communications, shipboard skills, protection and safety, and civil defense.

Training was provided and opportunities made available to employees in outservice facilities for their self-development in the following categories: oceanography, geophysics, geodesy, general management, personnel administration, automatic data processing, engineering, mathematics, physical sciences, specialized training in job-related courses, protection and safety, and clerical.

Employment

At the close of the year, the Coast and Geodetic Survey employed 2,393 persons. This figure represents an increase of 151 above the 2,242 persons on the rolls on June 30, 1960.

Civil Service personnel actions included 979 appointments and 754 separations, of which 9 were deaths and 36 retirements.

Awards

Under the Honor Awards Program of the Department, the Exceptional Service Award of the Department of Commerce (gold medal and citation) "for outstanding contributions to the public service, the Nation, or humanity" was received by

Robert M. Beal

The following personnel received the Meritorious Service Award of the Department of Commerce (silver medal and citation) "for service of unusual value to the Department":

L. Gilbert Burdine
Wesley M. Butler
Bessie N. Cameron
Charles N. Claire
Paul M. Fisher
Rear Adm. Frank G. Johnson
Ivan H. Olsen
Lt. Comdr. Allen H. Powell
Lt. Comdr. Eugene W. Richards
Capt. Max G. Ricketts
Philip C. Ryan
Josef J. Streifler
Albert M. Weber

Geodetic Field Party--1960 under the command of Comdr. Glen W. Moore received a Meritorious Group Award.

The following were also granted during the year: 3 supervisory leadership awards, 49 cash awards for superior performance on the job, 171 suggestion awards, and 165 length-of-service awards.

Retirements

The following commissioned officers were retired from active duty after the indicated number of years of service in the Bureau:

Capt. William F. Malnate (36)
Capt. Ernest B. Lewey (33)
Capt. A. Newton Stewart (33)
Capt. Karl B. Jeffers (32)
Capt. Fred A. Riddell (32)
Capt. Clarence R. Reed (31)

The following Civil Service Personnel retired from active duty after the indicated number of years of service in the Government:

Albert, Frank M. (42)
Cordero, Manrique (42)
MacEwen, Harold E. (42)
Saint Clair, Wilbur W. (42)
Oberheim, Carl G. (40)
Taylor, Joseph C. (37)
Cox, Lafayette (36)
Packer, Eli B. (36)
Walker, Jesse T. (36)
Knotts, Mary E. (33)
Alpaugh, Walter A. (31)
Aquino, David A. (31)
Kester, Clarence A. (30)
Brehm, Sarah E. (29)
Reeb, John A. (28)
Otto, Sadie Rae (27)
Stinchcomb, George B. (26)
Monk, Arthur J. (25)
Volkman, William C. (23)
French, Thomas J. (20)
Kemp, George C. (20)
Noack, August W. (20)
Sun, Eileen (20)
Johnson, Taylor (19)
Galle, Lothar M. (18)
Paredes, Delfin P. (18)
Bonderenko, Paul L. (17)
Kemp, Rose M. (17)
Kenney, Myrtle M. (17)
Klein, Claire A. (17)
Steele, Laura W. (17)
Loya, Emilio L. (16)
Tenseth, Louise H. (16)
Remers, Lilyan (15)
Chapman, Marguerite E. (13)
Infante, Bestoy D. (12)

Organization and Management Division

Activities of the Organization and Management Division during fiscal year 1961 dealt with the Bureau reorganization, internal reviews, followup on the General Accounting Office comprehensive audit and replies and action thereto, realignment of operating space and facilities, analyses of administrative functions and procedures development, organizational studies, and coordination and maintenance of administrative issuances.

The full reorganization of the Bureau became effective October 1, 1960. The creation of the Office level and grouping of divisions has decreased the number of organizational units reporting directly to the Office of the Director. The reorganization places more emphasis on research and development and on oceanography. Functional statements were completed and distributed for each organizational unit down to the Section level.

In May 1961, the Comptroller General submitted his report to the Congress on the first comprehensive audit of the Bureau. The audit was conducted by a team of General Accounting Office auditors who spent over a year completing it. Most of the recommendations in the report have already been acted on by the Bureau, with corrective action completed. Final action on the other recommendations should be completed during fiscal year 1962.

During 1961, it was decided to give greater emphasis to the internal review function. This function is concerned with independent studies, reviews, analyses, and appraisals of the effectiveness of internal controls, the efficiency with which specific functions or activities are being carried out so as to assure compliance with related legal, financial, and administrative requirements. The internal review staff has been increased, thus permitting expansion of the review program to the field as well as the headquarters activities.

Considerable time was spent on planning for the occupancy of 39,000 square feet of space in the Longfellow Building allotted to the Bureau and realignment of space in the Commerce Building.

The Bureau's cost accounting system was further refined through the development and installation of depreciation accounting into the central system. Depreciation accounting provides for charging the cost of wear and tear of capital equipment to the periods and projects for which it was used. As a result, the Bureau will recover depreciation as well as other costs incurred on reimbursable projects. It will also provide more accurate project costs.

A comprehensive review of the chart distribution activity was made. A system was developed for maintaining a perpetual inventory of sales items and for recording transactions and subscriber information, the recording media being Keysort tabulating cards. The processing of these cards will provide the necessary statistical information for chart production, sales accounting, and reporting. Assistance was provided in developing the procedures, ordering equipment, and training personnel.

Sixty-three items of management improvement for the fiscal year were included in the Bureau's annual management progress report submitted to the Department.

Procedures were developed for the control, accountability, and reporting of consumption of consumable supplies at District Offices and vessels.

The U.S. Government Correspondence Manual was distributed throughout Bureau headquarters and the field. Supplementary instructions to the Manual were developed and given the same distribution.

Considerable work was done on developing the pricing and procedures for the sale of geodetic control data.

Organizational studies were made in the Geophysics Division and the Technical Services Division.

Division personnel attended the following courses or classes during the year:

Dwight L. Greene - "Economics of National Security," 10-months residence course at the Industrial College of the Armed Forces.

James J. Finley - "Internal Auditing," two semesters at the Department of Agriculture Graduate School during the 1960-61 academic year.

Aaron E. Bonner - "Internal Auditing," one semester at the Department of Agriculture Graduate School, spring semester.

J. Donald French - "IBM 1620 Programming," given by IBM in Commerce Building, May 24-26.

Thirty-five special reports and evaluations were prepared for submittal outside the Bureau. Division personnel attended 52 meetings, discussions, seminars, demonstrations, and special training classes outside the Bureau.

Sixteen General Circulars or amendments, 4 Office Circulars or amendments, and 8 Informational Bulletins

were issued; and 20 Circulars or amendments were rescinded. Thirty-nine additional or revised pages to the Regulations were issued.

Technical Services Division

The activities of the Technical Services Division, which are diverse in scope, were carried out in a coordinated program throughout the fiscal year, with considerable improvement in most phases of the operations.

The Division received and processed approximately 80,000 new maps in the maintenance of the Bureau's collection of map source material. More than 65,000 maps were distributed from the files, of which approximately half were used in support of the cartographic program of the Bureau, and the remainder were issued in the practice of disseminating map information to the public and to other agencies of the Government. Over 25,000 maps were eliminated from the files as obsolete or superseded. Approximately 400 copies of early Coast and Geodetic Survey charts, many for use in litigation, were issued, and hundreds of letters containing map information were sent out in response to specific inquiries.

Among those receiving maps and map information outside the Bureau were various state highway departments, National Geographic Society, Texas Company, Pan American Airways, and Florida Development Commission. Among those within the Government were Navy Research Laboratory, Bureau of Labor Management, Beach Erosion Board, National Oceanographic Data Center, Federal Power Commission, Bureau of Public Roads, Soil Conservation Service, Geological Survey, Federal Aviation Agency, Army Map Service, and various agencies of the State Department.

Geographic names for approximately 200 nautical charts and 100 aeronautical charts, together with various other Bureau publications, were checked or provided as part of the name-checking procedure for Bureau publications. In addition, name lists were supplied for 60 new hydrographic survey sheets and 80 planimetric maps. As a result of names research in the division and field reports, more than 150 cases of name conflict were submitted to and decided upon by the Board on Geographic Names. In addition, about 150 cases of name disputes were settled with the Geological Survey without recourse to the Board.

A new set of geographic names standards for nautical charts was started during the year, and name corrections applied as new prints of these charts are scheduled for issue. Approximately 450 new names standards have already been made in this program. As a result of names research in the division and other sources, over 300 name changes were made on nautical charts during the year, and more than

200 such changes were effected on aeronautical charts. In answer to requests for names information from the public and other sources, most of which required considerable research, some 100 letters were written during the year.

Special sheets for the field investigation of geographic names were prepared for 25 project areas. In response to this, 22 geographic names field reports were received and processed in the division. Geographic names standards were made for all the Bureau's new small-craft and other special charts, and standard name-correction copies were set up for Coast Pilots and Tide Tables.

A card file of Board on Geographic Names decisions, alphabetical by states, was established with nearly 1,000 cards. Another file of considerable value, also started during the year, is an alphabetical card file of Atlantic Coast place-name locations. In this file, about 3,000 location cards have been prepared.

Public relations were improved by the initiation of a system of soliciting geographic names information from valuable local sources by mail. Some 50 such solicitations were made, resulting in good public relations, as those consulted felt that they were a part of an interesting and important undertaking.

The file on source material and indexes for the compilation of aeronautical charts was maintained. Approximately 1,600 aerial photographs were received and processed. Source material was provided for the revision of 322 aeronautical charts, in keeping with the aeronautical chart revision program.

More than 600 photographs and slides were accessioned and placed in the files during the year as part of the division's visual aids activities. Approximately 1,800 photographic prints and slides were issued, and 85 motion-picture films representing Bureau subjects were loaned. The Bureau's District Offices, together with various colleges and other schools throughout the country, were important users of the visual aids. Other recipients included International Press, various magazine and book publishers, Navy Hydrographic Office, Federal Aviation Agency, U.S. Air Force, Army Map Service, Civil Service Commission, and National Academy of Sciences.

Panel exhibits about the Bureau's work, prepared and put on display throughout the country during the year, numbered more than thirty. Among these were exhibits at the Department field offices and special displays at Bureau District Offices; also included were exhibits at the Commerce Department Building, various regional boat shows, the Philadelphia International Airport and numerous conferences such as the annual meetings of the American

Congress on Surveying and Mapping--American Society of Photogrammetry and the U.S. Power Squadron.

The special cartographic work performed in the division amounted to approximately 220 special maps, graphs, signs, and drawings prepared for a variety of Bureau and Departmental needs. These included graphs for the presentation of the budget and maps illustrating Bureau work. More than 300 certificates were prepared, including Bureau commendations and Departmental awards.

The Bureau library received and processed in excess of 3,500 books and pamphlets during the year, and eliminated slightly more than 100 volumes. Circulation of books and pamphlets amounted to more than 6,000 which is an increase for the fourth consecutive year. Field and office reports and records circulated by the Archives Section increased, and Federal Records Center borrowings decreased to nearly 1,000 items. About 8,000 reports and records were received and processed by this section during the year, and only those which were deemed obsolete or nonessential were transferred to the National Archives.

In the capacity of the publications officer of the Bureau's and Department's publications committee, the chief of the division expedited final production of all Bureau book and pamphlet publication during the year. Included in this, in addition to regular annual publications was the production and issuance of 5 new Bureau technical bulletins. By arranging the Bureau's publication program in line with that of the Department, the timely issuance of these publications on a definite schedule was effected.

Instrument Division

The prototype of the portable echo sounder developed during the last fiscal year has been thoroughly tested in the laboratory and field. This instrument is known as the Raytheon DE 723 and production models are now being purchased to replace the worn-out models of the 808 echo sounder.

Field experiments to improve the Raydist ground station operation were continued. As a result of these tests, the stations now radiate almost twice the power and are far less critical in adjustment. A further improvement was made later in the field season by adding harmonic filters to the ground stations. This made it possible to use complete and successful duplexing on a single Raydist tower.

Two types of Helmholtz coils were constructed in the Mechanical Branch. These coils consist of two pairs of mutually perpendicular coils. One type is used as part of the automatic magnetometer observatory and the other

as part of the proton vector absolute magnetometer. The design for the coil was made by the Design Branch. Attempts to make these coils outside the Bureau proved unsuccessful, due in part to excessive cost but mainly because of extreme difficulty in casting a nonmagnetic coil. The Mechanical Branch was required to make separate jigs in order to fabricate such large and accurately machined coil forms.

Experiments have been conducted in the design of a cast plastic intake for use on the floatwell of the portable tide gage. This type will be more advantageous, as it will be rust proof, less fouling by marine life, and more economic to build.

The Division assisted in rigging a towed transducer on the ship PIONEER. This equipment is known as a polliwag transducer towed by a thermistor chain.

Experiments were made with a V-fin type carriage for the UQN transducer. This equipment will be much lighter and require a smaller and less expensive towing support.

Standard test sites have been set up at the Electronic Laboratory in order to test the geodimeter and tellurometer over accurately known distances. This has aided in the calibration and testing of these instruments. A shoran test range was also established, and it is now possible to more nearly simulate the field conditions during laboratory tests.

Studies of the methods for making and testing precise level vials have been continued. Two-second vials have operated successfully, and it is expected that within a short time techniques will be perfected enough to enable this Bureau to fulfill its own requirements, if the need arises.

Routine services were provided on the following electromechanical systems: tellurometer, geodimeter, Kelsh plotter, tide predicting machine, marigram meter, and echo sounder.

Considerable assistance was given in the design and construction of special equipment for the new color photographic laboratory in the Photogrammetry Division.

The Instrument Division assisted in the preparation of the instrument program for the Interagency Committee on Oceanography. Specifications were written for required systems to complete the world-wide oceanographic survey program.

The procurement of frequencies for communication, electronic navigation, and telemetering activities of the

Bureau, is coordinated in the Instrument Division. A brochure was prepared indicating the frequencies assigned to the Bureau and showing how, when, and where they are to be used.

Technical assistance was rendered in writing specifications for the towed magnetometer, Loran C, and Raydist and also in field testing these systems.

Because of considerable trouble with contacts on sounding clocks a transistor was added between the contacts and relay to reduce the contact current. This has proved successful in the field and all future sounding clocks will be transistorized.

The Division made an examination of the technicians on Bureau vessels for the purpose of determining their technical qualifications and other personal characteristics. At the same time, the electronic equipment on all the vessels was inspected and a procurement program instituted to replace worn-out and obsolete equipment.

Evaluation studies were made on electronic survey systems; among these are the Decca Hi-Fix navigation system, the Alden Depth Recorder, and a Canadian navigation system known as Raydan.

A scale correlation was constructed in the Electronics Laboratory to determine the face error in the 808 echo sounder. This enables the operator to determine the error before the ship is sounding and should result in a considerable saving of time over the earlier method which required the ship to stop in specific depths with the scale overlap system.

A radio telemetered pressure tide gage was installed near Franklin, La. A regular handic-talkie was used to carry the tidal information over a 7-mile link with the receiver and recorder being conveniently located. A second telemetered bubbler type pressure tide gage was installed about 8 miles offshore in the Atchafalaya Bay, La. The tidal heights at this gage, as read by a transducer are fed to a radio transmitter. For a period of one minute, every fifteen minutes, this tidal data is transmitted to a shore station, 8 miles distant. A radio receiver at the shore station receives this signal and feeds it to a strip recorder, which records the tidal heights. To insure continuous operation while aerial photographs were being taken, the original equipment was duplicated and installed at the tide gage. In case one failed this second installation of equipment continued to telemeter the tidal heights. At the shore station, duplicate radio receivers and strip recorders were installed. These receivers and recorders were capable of individual or simultaneous operation. Assistance was also given in setting up a radio communication

system to be used in conjunction with the tide recorders while making flight photographs at low tide for the Photogrammetry Division.

The Division assisted in special geodimeter surveys on the Chesapeake Bay Bridge-Tunnel Crossing Project.

Assistance was given the ship EXPLORER in setting up Raydist stations to obtain the geographic position of a Texas tower off the Atlantic Coast. One of the stations, damaged by lightning, required equipment replacement and necessary adjustments for proper operation of the damaged ground station.

The portable echo sounders NK7 have been converted to 808 echo sounders to meet the Bureau's requirements. This is an interim measure until the new type of echo sounder can be converted for use on field parties.

Experiments in replacing the bearings of the portable tide gage with Teflon bearings have been conducted. There has been considerable difficulty in the past with these bearings due to corrosion. This tide gage is now undergoing field evaluation.

The deep-sea echo-sounder recorder has been designed to resolve the ambiguous soundings that are present on the PGR recorder. This recorder automatically switches to the 2,000-fathom scale to resolve the 400-fathom ambiguity and then return to the normal 400 scale sounding range. This instrument has been tested on the ship HYDROGRAPHER. It has also proven useful in sounding on the small-scale range in areas where it is impossible to identify soundings on the large scale.

A change in the design of the nine-lens camera drift sight was required for the installation of the camera in the new R5D aircraft. A study of the feasibility of converting a Wild RC8 drift sight and intervalometer was made, and it was found that, if required, this could be done in such a manner that the intervalometer could be restored to its original function quite simply. The necessary changes in the intervalometer gear train were made and a mount was designed to adapt the Wild drift sight to the nine-lens camera.

Since the automatic operation of the Wild cameras differs from that of the nine-lens in that the shutter operation of the former occurs at the end of the film transport cycle while in the nine-lens it precedes, it was necessary to design and build a delay relay system to synchronize the camera and intervalometer. It was also necessary to provide a windproof window and cover to fit the new sight installation to the aircraft. The successful conversion of the Wild sight and intervalmeter to the

nine-lens camera indicated the possibility of a somewhat similar conversion to adapt an intervalometer for use with both 90° and 120° lenses. It could also be used with the new wider angle RC9 camera, as well as with the older cameras with 60° and 90° lenses.

An improvement in the leveling control of the RC8 mount was made by extending and rerouting the leveling screw controls. A universal leveling mount for the RC8 drift sight was designed to allow the use of this sight with an RC9 camera which is originally equipped with a simple viewing sight without provision for drift correction or automatic interval tripping.

The following table is given for the purpose of illustrating type of instruments and equipment serviced or repaired for the operating divisions during the fiscal year. However, this is only a small part of the total work accomplished:

Name	Quanity
Mechanical Branch	
Alidade	8
Amplifier (split-beam)	6
Barograph	2
Barometer	15
Binoculars	18
Camera	4
Chronograph	2
Chronometer	86
Clock	178
Collimator (vertical)	14
Compass	17
Declinometer (compass)	2
Divider	24
Gage, tide	
portable	53
standard	25
Galvanometer	10
Geodimeter	2
Graver	15
Keyer, Raydist	2
Lamp, signal	76
Level	57
Machine, ruling	1
sounding	4
Meter, current	18
Roberts radio	32
other (light)	2
Name plates	134
Plotter	5
Projector	2
Psychrometers	15

Name	Quanity
Mechanical Branch (contd.)	
Protractor	149
Recorder	5
Rod, level	25
Chicago	8
Scale	14
Sea wave warning system	6
Seismograph	14
Sextant	48
Sheave, registering	10
Stereoscope	1
Stretcher, tape	14
Switches, sequence	7
Tape	33
Target, traverse (set)	7
Theodolite	130
Thermometer	100
Timer, photographic	2
Tripods	34
Watch	55
Tribrach	16
Woodworking Shop	
New	
Backing boards	6
Bulletin boards	15
Cabinets	40
Chart carriers	15
Clock cases	6
Display panels	2
Drafting tables	6
Half round moulding	37'
Hand trucks	20
Instrument cases	81
Level rods	8
Light boxes	2
Light tables	7
Mailing tube plugs	1300
Map cases	1
Map frames	42
Name plate blocks	26
Observation stands	1
Office furniture	3
Paper weight blocks	2
Pattern and core box	4
Picture frames	107
Storage bins	14
Stamping blocks	6
Tables	27
Tent frames	2
Tide staff backing	33

Name	Quanity
Woodworking Shop (contd.)	
New	
Tide staffs	23
Tide gage base	1
Tube racks	10
Umbrella extension	109
Tripods	19
Stadia rods	5
Repair	
Book case	1
Chairs	16
Desks	2
Drafting tables	12
Instrument cases	48
Light tables	7
Office furniture	3
Pattern and core box	1
Stands	6

NATIONAL AND INTERNATIONAL COOPERATION

As part of the Bureau's policy, cooperation was extended to other Government agencies, national societies, and private concerns of national scope. On the interagency level, this was in addition to the usual liaison, reimbursable work, and the normal exchange of maps.

These activities included the provision of aeronautical chart bases to numerous other agencies and cooperation in the form of geographic consultation to the Office of the Geographer of the State Department and to various Members of Congress. Special service was provided the American Congress on Surveying and Mapping in the serving and the chairing of its Publications Committee.

Hydrographic Office personnel conferred with personnel of the Instrument Division regarding improvements in the use of the portable tide gage clocks as initiated in the Mechanical Branch. These improvements were expected to be adopted for use in the Hydrographic Office.

Air Force personnel from Dayton, Ohio, received instruction on the maintenance and repair of theodolites, and the Army Map Service received assistance in measuring the crystals for and the calibration of geodimeters.

Geodetic party personnel were trained in the use of the geodimeter and the necessary computations in conjunction with Pennsylvania State road surveys.

As a mutually beneficial service, all advance quadrangles of the Geological Survey covering coastal areas were reviewed in the Technical Services Division for agreement in geographic nomenclature. Of 210 sheets reviewed, some 30 were returned with corrections, effecting consistency in name usage. A similar service was performed for the Shipping Branch of the Census Bureau, and the proofreading of Coast Guard Light Lists for correctness and agreement in geographic nomenclature constituted another such mutually beneficial service.

The Bureau continued to be represented on the interagency Board on Geographic Names. Through the efforts of this group, existing differences in nomenclature between the various Federal maps of domestic areas were considerably diminished. This included such important agreements as the uniform naming of the principal channel in Chesapeake Bay.

Special cooperation with the Department was extended in many ways by the Technical Services Division. In addition to those items already mentioned, an employee of this division wrote the Bureau's portion of the Secretary's Annual Report to Congress, as well as certain other integral parts of that report. To assist the Department's claim on portions of Federal urban development work, an employee of this division, with the aid of the National Institute of Urbiculture, provided the Department, through channels of the Bureau, with a map and supporting material showing projected areas of urban development in the United States.

Activities in international cooperation through the practice of international exchange of maps and publications and through other media were continued. Nearly 100 letters concerning this exchange were prepared in the Technical Services Division, and numerous special services were performed along this line. Among these were assistance in the preparation of the Pan American Institute of Geography and History report for the United States on Cartography and the instruction of foreign nationals on the division's aspects of Bureau work. The exchange of charts with member maritime nations was also beneficial.

The Chief of the Instrument Division completed a European trip, including the investigation of hydrographic, oceanographic, geodetic and geological instruments and systems in England, Sweden, Germany and France.

APPENDIX

PUBLICATIONS ISSUED

Geodesy

The following publications containing Plane Coordinate Intersection Tables (2½ minutes) were printed:

Alaska, Zone 1, Publication 65-1, Part 49.
Alaska, Zones 2-9, Publication 65-1, Part 50.
Idaho, Publication 65-1, Part 10.
Iowa, Publication 65-1, Part 13.
Kansas, Publication 65-1, Part 14.
Massachusetts, Publication 65-1, Part 19.
Michigan, Publication 65-1, Part 20.
Mississippi, Publication 65-1, Part 22.
Tennessee, Publication 65-1, Part 40.
West Virginia, Publication 65-1, Part 46.

Other publications issued during the year were:

Tellurometer Manual, Revised edition by Austin C. Poling, Publication 62-1.
Plane Coordinate Projection Tables, Puerto Rico and Virgin Islands, Publication 65-2.
Control Leveling, Revised edition, Special Publication No. 226.
Horizontal Control Data, Revised edition, Special Publication No. 227.

Hydrographic Surveying

The following publication was issued:

Hydrographic Manual by Karl B. Jeffers, Publication 20-2.

Tides, Currents, and Oceanography

Six volumes of tide and tidal current tables for the year 1962 were prepared as follows:

Tide Tables, Europe and West Coast of Africa Including Mediterranean Sea.
Tide Tables, East Coast North and South America Including Greenland.
Tide Tables, West Coast North and South America Including the Hawaiian Islands.
Tide Tables, Central and Western Pacific Ocean and Indian Ocean.
Tidal Current Tables, Atlantic Coast, North America.
Tidal Current Tables, Pacific Coast, North America and Asia.

The following other publication was issued:

The Tsunami of May 22, 1960 as Recorded at Tide Stations, Preliminary Report by J. M. Symons and B. D. Zetler. (This report was later included in "Hilo Harbor, Hawaii, Report on Survey for Tidal Wave Protection and Navigation" by the U. S. Army Engineers.)

Geomagnetism and Seismology

The following geomagnetic publications were issued:

Seventeen volumes of magnetograms and/or hourly values have been completed as follows: College 1956; Fredericksburg 1956, 1957; San Juan 1956, 1957; Honolulu 1957; Sitka 1957; Guam 1958; Jarvis Island 1958; Koror 1958; Little America 1958; Wilkes 1958; Healy 1958; Big Delta 1958; Anchorage 1958; Beloit 1958.

Seismological publications issued, or in press, included the following:

United States Earthquakes, 1959, by R. A. Eppley and W. K. Cloud.
Seismological Bulletin: September 1959 through May 1960.
Seismological Bulletin: (IGY) September 1958 through December 1958.
Abstracts of Earthquake Reports for the Pacific Coast and the Western Mountain Region: 3d and 4th quarters 1959 and 1st quarter 1960.
Earthquake History of the United States, Part II--Stronger Earthquakes of California and Western Nevada.

Coast Pilots

United States Coast Pilot 1, Atlantic Coast, Eastport to Cape Cod, Sixth (March 26, 1960) Edition, was issued September 6, 1960.
United States Coast Pilot 2, Atlantic Coast, Cape Cod to Sandy Hook, Sixth (September 10, 1960) Edition, was issued March 6, 1961.
United States Coast Pilot 3, Atlantic Coast, Sandy Hook to Cape Henry, Seventh (June 17, 1961) Edition, was in press.
Cumulative Supplements, all dated January 7, 1961, for Coast Pilots 4, 5, 7, 8, and 9 were issued March 3 to 9, 1961.
Coastline of the United States, Fourth (April 1, 1961) Edition, was issued June 15, 1961.

Miscellaneous

Use of Artificial Satellites for Navigation and Oceanographic Surveys, Paul D. Thomas, Technical Bulletin No. 12, July 1960.
A Singular Geodetic Survey, Lansing G. Simmons, Technical Bulletin No. 13, September 1960.

Film Distortion Compensation for Photogrammetric Use, G. C. Tewinkel, Technical Bulletin No. 14, September 1960.

Transformation of Rectangular Space Coordinates, Erwin Schmid, Technical Bulletin No. 15, December 1960.

Erosion and Sedimentation, Eastern Chesapeake Bay at the Choptank River, G. F. Jordan, Technical Bulletin No. 16, January 1961.

PAPERS PUBLISHED

Redetermination of Coil Constant of Line Galvanometer No. 1, L. R. Alldredge and L. Hurwitz, Letter to the Editor of the Journal of Geophysical Research, July 1960.

Ground Motions Generated by Underground Nuclear Explosions, D. S. Carder and W. K. Cloud, Proceedings of the 2d World Conference on Earthquake Engineering, July 1960.

Submarine Topography in the Gulf of Alaska, William M. Gibson, Bulletin of the Geological Society of America, July 1960.

Report of Committee No. 1 on Observatories, E. B. Roberts, International Association of Geomagnetism and Aeronomy, July 1960.

Creep on the San Andreas Fault, Analysis of Geodetic Measurements Along the San Andreas Fault, C. A. Whitten and C. N. Claire, Bulletin of the Seismological Society of America, July 1960.

On a Seismic Sea Wave Warning System, E. B. Roberts, International Union of Geodesy and Geophysics, Helsinki, Finland, August 1960.

Simultaneous Adjustment of Angular and Distance Measurements, Frederick F. Ceely, Jr., Journal of Geophysical Research, September 1960.

Horizontal Movement in the Earth's Crust, C. A. Whitten, Journal of Geophysical Research, September 1960.

Use of the Geodimeter by the Coast and Geodetic Survey, Paul D. Thomas, International Hydrographic Review, Supplement Volume 1, October 1960.

Utilization of Electronic Instruments in Geodetic Surveys for Highways, Paul D. Thomas, International Hydrographic Review, Supplement Volume 1, October 1960.

A Proposed Automatic Standard Magnetic Observatory, L. R. Alldredge, Journal of Geophysical Research, November 1960.

Geographic Aspects of Coast and Geodetic Survey Operations, Albert A. Stanley, in Report of Coordinator for Maps, U. S. Department of State, December 1960.

Mapping the Low-Water Line of the Mississippi Delta, Bennett G. Jones, William Shofnos, International Hydrographic Review, January 1961.

Some Aspects of the Chilean Earthquakes of 1960, J. N. Jordan, Geotimes, January-February 1961.

New Charts for the New York Boatman, H. Arnold Karo, New York Times, Special Boat Show Section, January 15, 1961.

Oceanographic Expedition of the Ship EXPLORER, H. Arnold Karo, International Hydrographic Review, January 1961.

The New SURVEYOR, H. Arnold Karo, International Hydrographic Review, January 1961.
Measurement of Tidal Currents at Lituya Bay, Alaska, Introducing Aerial Photogrammetric Methods, Charles B. Taylor, William D. Harris, International Hydrographic Review, January 1961.
The Day the Sea Ran Up a Mountain, E. B. Roberts, Catholic Digest, February 1961.
Geologic Aspect of Coast and Geodetic Survey Operations, H. Arnold Karo, Geotimes, March 1961.
The Coast and Geodetic Survey, H. Arnold Karo, The Military Engineer, March-April 1961.
Is Sea Level Falling or the Land Rising in S.E. Alaska? Charles Pierce, Surveying and Mapping, March 1961.
A Simplified Instrument for Recording Strong Motion Earthquakes, W. K. Cloud and D. E. Hudson, Bulletin of the Seismological Society of America, April 1961.
Man Begins to Explore "Inner Space," Harris B. Stewart, Jr., New York Times Magazine, May 7, 1961.
Operation Drum-drop, Harris B. Stewart, Jr., and A. B. Joseph, Sea Frontiers, May 1961.
Report of Committee of the Upper Mantle and Crust Program, L. M. Murphy, Transactions, American Geophysical Union, June 1961.
Seismological Program of the U. S. Coast and Geodetic Survey, L. M. Murphy, Transactions, American Geophysical Union, June 1961.

Articles for Reference Books

Several articles dealing with specialized scientific fields related to the work of the Bureau were prepared for publication in encyclopedias and yearbooks. These included entries on cartography and oceanography for the 1961 edition of Americana Annual, on Charts for the Encyclopaedia Britannica and on the Coast and Geodetic Survey for New Dictionary of American History. Articles on overall activities of the Bureau were also prepared for the following 1961 editions of: Americana Annual, Collier's Encyclopedia, Information Please Almanac, New International Year Book, and The World Almanac.

PAPERS PRESENTED

A Proposed Automatic Standard Magnetic Observatory, L.R. Alldredge, 12th General Assembly of the International Union of Geodesy and Geophysics, Helsinki, Finland, July 1960.
The constant-field coil house at Fredericksburg Magnetic Observatory, by J. H. Nelson, R. E. Gebhardt, and J. Bottum, 12th General Assembly of the International Union of Geodesy and Geophysics, Helsinki, Finland, July 1960.
A Geoidal Section in the United States, D. A. Rice, 12th General Assembly of the International Union of Geodesy and Geophysics, Helsinki, Finland, July 1960.

Some Notes on the History of Geomagnetism in the United States, E. B. Roberts, International Association of Geomagnetism and Aeronomy, Helsinki, Finland, July 1960.

Horizontal Movement in the Earth's Crust, C. A. Whitten, 12th General Assembly of the International Union of Geodesy and Geophysics, Helsinki, Finland, July 1960.

Oceanography, Harris B. Stewart, Jr., 18 one-hour lectures, National Science Foundation Institute, Franklin and Marshal College, Lancaster, Pa., August 1960.

Structural Damage and Terrain Effects of the Chilean Earthquake of May 1960, James N. Jordan, National Science Foundation, September 1960.

Meeting the Challenge of Our Professional Responsibilities, H. Arnold Karo, Special Meeting of the Georgia Association of Registered Land Surveyors, Atlanta, Ga., September 1960.

The "Point of Beginning" of the U.S. Public Land Surveys, H. Arnold Karo, 175th Anniversary, East Liverpool Historical Society, East Liverpool, Ohio, September 1960.

Photogrammetric Surveys for Nautical Charting Use of Color and Infrared Photography, L. W. Swanson, Ninth International Congress of Photogrammetry, London, England, September 1960.

What ACSM Means to the Surveyor and Engineer, J. H. Brittain, Texas Surveyors Association and the Southwestern Regional Conference of the American Congress on Surveying and Mapping, Austin, Tex., October 1960.

What ACSM Means to the Surveyor and Engineer, H. Arnold Karo, Texas Surveyors Association and Southwestern Regional Conference of American Congress on Surveying and Mapping, Austin, Texas., October 1960.

Subsidence in the Texas Gulf Coast Area, J. B. Small, Texas Surveyors Association and the Southwestern Regional Conference of the American Congress on Surveying and Mapping, Austin, Tex., October 1960.

Hydraulic Applications to Oceanographic Ships, R. C. Darling and H. W. Rust, Marine and Naval Hydraulics Conference, New York, N. Y., November 1960.

New Concepts in Modern Surveys, H. Arnold Karo, Annual Meeting of Utah Section of American Congress on Surveying and Mapping, Salt Lake City, Utah, November 1960.

U.S. Scientific Research in Antarctica, H. Arnold Karo, Annual Meeting of Utah Section of American Congress on Surveying and Mapping, Salt Lake City, Utah, November 1960.

Coast Survey's Pacific Oceanography, Harris B. Stewart, Jr., Eastern Pacific Oceanic Conference, Lake Arrowhead, Calif., November 1960.

The Coast and Geodetic Survey's Work in Seismology 1925-1960, L. M. Murphy, Symposium held in honor of the 50th anniversary of the Spain Seismic Observatory of Fordham University, December 1960.

High Precision at Cape Canaveral, L. G. Simmons, Department of Commerce Auditorium, Washington, D.C., December 1960.

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