

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, 1962



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National Oceanic and Atmospheric Administration

**Annual Report of the Director of the Coast and Geodetic
Survey**

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OFFICE OF THE DIRECTOR

The Director attended a number of scientific and engineering meetings in this country and abroad among which were the following: Two meetings of the United Nations Intergovernmental Oceanographic Commission in Paris as member of the U. S. delegation; the preliminary meeting in Washington and the sessions in Bangkok of the United Nations Regional Cartographic Conference for Asia and the Far East as head of the U. S. delegation; the United Nations Pilot Course on Aerial Survey Methods in Tokyo at which time he presented two papers; meetings of the Interagency Committee on Oceanography in Washington, D. C., and Seattle; a colloquium on detection of underground nuclear explosions at the California Institute of Technology in Pasadena; and the Regional meeting of the Institute of Navigation at La Jolla, Calif.

The Director and the Deputy Director made personal inspections of most of the ships and fixed offices and observatories. As a member of the Mississippi River Commission the Director participated in both the high and low water inspection of the river.

The Deputy Director attended the Eighth International Hydrographic Conference in Monaco as an official U. S. delegate.

On July 31, 1961, Admiral Pierce retired after 38 years of service. Admiral Tison was sworn in as Deputy Director on August 16, 1961.

PROGRAM PLANNING COORDINATION STAFF

The Program Planning Coordination Staff was engaged in the following activities: coordinating Bureau program planning, with special emphasis on hydrographic and shoreline surveys to meet priority nautical charting requirements; representing the Bureau and participating in interagency committee work on oceanography at the working level; formulating requirements and specifications for a ship base in the Pacific Northwest area; evolving procedures to provide top management with required cost data for specific operational field projects; and making special studies which included a detailed study of facilities, ashore and afloat, for surveying and charting the continental shelves and slopes.

Programing for emergency planning was concentrated primarily on improving the security storage program and the emergency facilities at the relocation site. These facilities are used for storing essential priority charts, reproduction material, and a radio communication station. Studies were made for the development of a more realistic emergency readiness program which included the presentation of a proposal to establish an auxiliary reproduction plant at or near the relocation site.

Comdr. H. D. Nygren served as U.S. representative with the British Antarctic Surveys. From December to April, he observed their work on land and sea in the Palmer Peninsula area and made official visits to their Falkland Islands headquarters.

The Bureau sponsored bill S. 685, amending the Coast and Geodetic Survey Commissioned Officers Act of 1948, was approved by the President on September 14, 1961, as Public Law 87-233. The bill H. R. 7719, authorizing ROTC graduates to accept a commission in the Coast and Geodetic Survey, was passed by the House of Representatives and ordered favorably reported by the Senate Armed Services Committee. Companion bills S. 3318 and H. R. 11392, relating to medical care for Coast and Geodetic Survey vessel personnel, and H. R. 9981, designating the Bureau as the United States depository for geodetic and seismological data, were introduced during the second session but no final action was taken on any of these.

OFFICER PERSONNEL STAFF

The fifth, sixth, and seventh officer training classes were completed during the year. The eighth and ninth classes began in the last quarter of the year.

One commissioned officer received a master's degree in geodetic science from Ohio State University; another completed all required courses at the University of Washington for a master's degree in oceanography to be awarded upon presentation of a satisfactory thesis. Three officers were selected for advanced study--two in oceanography, and one in photogrammetry.

The increased emphasis on the recruitment of promising college graduates for appointment in the commissioned corps resulted in greater response from well qualified applicants. A total of 31 appointments were made. A commercially developed brochure was widely used for the recruitment of both officers and civilians.

Action for the revision of the Bureau activity film was initiated. Guidelines were prepared for delineating responsibilities and for establishing a framework in which representatives from the various Bureau offices would work.

The annual report of the Bureau's participation in the Retired Serviceman's Family Protection Plan (formerly the Contingency Option Act) was completed.

A number of management improvement procedures were adopted, among which were the following: a policy that dependent identification cards will be issued, whenever possible, by military facilities in the locality where they reside, such requests to be verified in the Bureau; a new card index file system to maintain control over appointments, promotions, resignations, and retirements; and new procedures to govern selection of applicants for appointment in the Survey. The Department assisted in designing new forms to accomplish these changes.

A complete outline of methods used for qualifying officers in the Survey for advancement and assumption of ship operational duties was prepared for the Canadian Hydrographic Service, which is considering the possibility of developing a commissioned corps similar to the Bureau's to replace their divided responsibility set-up.

The Chief served on the following boards and committees: Board of Directors, Local Post, and Interagency Liaison Committee of the Society of American Military Engineers; Panel member, Per Diem Travel and Transportation Committee; Engineers Joint Council Committee; and Bureau coordinator for the annual report on Professional Income of Engineers for the Engineering Manpower Commission.

NEW SHIP STAFF

Members of the New Ship Staff were engaged in the primary functions of monitoring all aspects of new hydrographic ship replacement and new oceanographic research ship construction, including the acquisition of items of government-furnished equipment for the outfit of these ships. The Staff cooperated with member agencies of the Ship Panel of the Interagency Committee on Oceanography in matters of mutual interest.

Preliminary design studies were conducted for the construction of a Class I oceanographic survey ship which were reviewed at a 1-day conference attended by representatives from private institutions and Federal agencies interested in oceanographic ship design. After modifications, the preliminary design was furnished the Maritime Administration for preparation of contract plans and bidding specifications. Bids were received from 11 shipyards, the fixed price of \$6,597,440, submitted by Gibbs Shipyards, Inc., of Jacksonville, Fla., being the lowest responsive bid. The award of the contract was pending at the end of the year.

The general characteristics of the Class I oceanographic survey ship are as follows: Overall length 303 ft., beam 52 ft., draft 18 ft., displacement 3,800 tons, sustained sea speed 16 knots and cruising range approximately 17,000 nautical miles. Propulsion will be twin diesel-electric and bow thruster. Special features include an aloft conning station, bulbous bow, underwater viewing station, center well with underwater viewing ports, stabilized transducer, deep sea anchoring and coring winch located aft, and approximately 4,000 sq. ft. of laboratory space. Accommodations will be provided for 13 officers, 11 scientists, 12 technicians, and 60 crew, plus additional accommodations for visiting scientists and unassigned crew, for a total of 115. This ship when completed and commissioned will be designated OSS-01 and will be named USC&GSS OCEANOGRAPHER.

From preliminary design plans prepared by members of the Staff, the Maritime Administration began preparation of contract plans and bidding specifications for a Class II hydrographic survey replacement ship. These specifications are prepared with an alternate price item for the complete automation of the machinery plant. It will have the following general characteristics: overall length 221 ft., beam 42 ft., draft 13 ft., displacement 1,615 tons, and designed sea speed 14½ knots. Propulsion will be twin-screw diesel with controllable pitch propellers and bow thruster. Accommodations will be provided for 12 officers (plus 3 spares), and 64 crew (plus 2 spares). This ship when completed will

replace the USC&GSS BOWIE. Its designation will be MSS-20 and will be named USC&GSS FAIRWEATHER.

Construction of two Class III hydrographic survey replacement ships was underway at the shipyard of the Marietta Manufacturing Co., Point Pleasant, W. Va. Almost parallel construction progress was made on these ships, and at the end of the year were approximately 55 and 51 percent completed. The first of the Class III ships will replace the USC&GSS GILBERT and will be designated CSS-28 and named the USC&GSS PEIRCE, after the noted logican Charles Sanders Peirce, a long-time employee of the Bureau and son of Benjamin Peirce (Superintendent of the U. S. Coast Survey from 1867 to 1874). The second ship will replace the USC&GSS COWIE and will be designated CSS-29 and named the USC&GSS WHITING, after Henry L. Whiting, one of the foremost topographers of the Bureau.

INTERNATIONAL TECHNICAL COOPERATION STAFF

During the year, 7 Agency for International Development (AID) primary participants reported to the Bureau and were given instruction in the following subjects: In photogrammetry and geodetic surveying--Cambodia (1); in seismology--Chile (1), and Israel (1); in geodetic surveying--Liberia (1), and Sudan (1); in map and chart construction--Liberia (1); and in tides and currents--Venezuela (1).

From the previous fiscal year, 4 primary participants continued or completed their training programs as follows: In aeronautical chart information--Argentina (1); in map and chart construction--Colombia (1); in photogrammetry--Egypt (1); and in hydrographic surveying--Indonesia (1). In the current fiscal year, 9 secondary participants received training as follows: In hydrographic surveying--Indonesia (1); in Photogrammetry--Colombia (2), and Indonesia (1); in aeronautical charts--Spain (2); in aeronautical charts and photogrammetry--Argentina (1); in geodetic surveying--Indonesia (1); and in tides and currents--Venezuela (1).

The Bureau received 114 foreign visitors from 36 countries concerned with observation of equipment, operating methods, and technical procedures in the scientific, engineering, and cartographic activities. These visits extended from 1 to 10 days and included representatives from the following countries: Afghanistan (2); Argentina (4); Australia (2); Burma (1); Canada (1); Ceylon (1); Chile (1); China (19); Colombia (4); Denmark (1); El Salvador (2); England (2); Finland (2); Germany (2); Indonesia (5); Iran (2); Israel (1); Japan (8); Jordan (1); Korea (3); Liberia (3); Mexico (1); Nigeria (1); Pakistan (1); Panama (1); Peru (3); Philippines (4); Russia (1); Somalia (4); Spain (2); Sudan (3); Thailand (8); Turkey (12); United Arab Republic (1); Venezuela (4); and Yugoslavia (1).

The Chief, as Chairman of the Committee on Surveys of Urban Areas, Commission on Cartography, Pan American Institute of Geography and History (PAIGH), attended the

IX Consultation of the Commission on Cartography and the VII General Assembly of the PAIGH held in Buenos Aires, Argentina, August 1-15, 1961. Other conferences attended by the Chief included: The National Conference on International Training Programs of AID, Department of State, June 25-26; and several meetings of the Department of Commerce on International Technical Assistance.

In cooperation with the U. S. Geological Survey, the Bureau arranged a film program with the Philippine Government. A schedule of films in the broad field of cartography was sent over a period of six months. The films were viewed extensively in the Philippines and reports were received describing the type of audience and number of persons attending each showing. Translations of correspondence in the Spanish language were continued throughout the year for various Divisions of the Bureau.

TECHNICAL RESEARCH AND INFORMATION STAFF

The major activity of the Technical Research and Information Staff was the completion and final editing of the manuscript for Volume One of "Shore and Sea Boundaries," the preparation of copy for the printer, and carrying the publication through the various stages of the printing process. At the close of the year, the publication was in the final page-proof stage. Volume One comprises 444 pages and 53 illustrations. It contains information on boundary problems associated with the Submerged Lands Cases and the Submerged Lands Acts (including recent developments in the international law of the sea), and gives special emphasis to the interpretation and use of Coast and Geodetic Survey data. Work on Volume Two was resumed late in the year.

Other activities comprised the preparation of the Annual Report of the Director, and the editing and processing of five technical bulletins.

The Chief participated in several conferences relative to procedures to be adopted in establishing tidal datum planes in the Gulf of Mexico. A memorandum was prepared for Bureau use on a recent Supreme Court decision reaffirming the use of mean high water, as defined by the Coast Survey, for the boundary of riparian lands along the coast of Washington.

Verbal and written information was furnished Bureau personnel and others relative to the interpretation of the high-water line in marsh areas, the legal significance of the charted lines separating areas where Inland and International Rules apply, the principles involved in delimiting the territorial sea, the application of straight baselines to a coastal configuration, the legal and technical background of the "tidelands" controversy, and the limits of international waters around the Hawaiian Islands.

DISTRICT OFFICES

District Offices, thirteen in number, were maintained at Baltimore, Boston, Fort Worth, Honolulu, Kansas City (Mo.), Los Angeles, New Orleans, New York, Norfolk, Portland (Oreg.), San Francisco, Seattle, and Tampa. Primary functions of these offices are to supervise and direct all fixed Bureau activities located in the district except observatories and laboratories; process field records of field parties as required, maintain liaison with governmental and private organizations and individuals for collecting and disseminating data, make recommendations for new surveys, maintain a library of charts and publications for public reference, and supervise the establishment and operation of chart agencies. In addition, they contacted educational institutions for recruitment of officer candidates and technical personnel; gathered data for correction of nautical and aeronautical charts; assisted field parties and vessels operating in the respective districts; directed programs for orderly recovery and maintenance of geodetic control marks; inspected and serviced primary tide stations; and maintained stocks of Bureau charts, data, and publications for sale to the public and for official issue. Also, supervision and direction were provided photogrammetric processing units at Baltimore, Portland, and Tampa; nautical chart 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 computation unit at New York; and seismological field survey unit at San Francisco.

Special projects in progress under District Office supervision were: preparation of a new ship base at Seattle; ship base construction at Norfolk; coordination of geodetic, photogrammetric, and hydrographic surveys in the Hawaiian Islands; and storm damage surveys and processing of resulting records along the Atlantic coast as an aftermath of the March 1962 extratropical storm.

OFFICE OF OCEANOGRAPHY

OPERATIONAL ACTIVITIES

Atlantic and Gulf Coasts and Puerto Rico

The ship GILBERT completed Raydist controlled hydrography at the end of July on Nantucket Shoals. En route to the ship's base at Woods Hole from the working grounds, a reported wreck was located on Horseshoe Shoal in Nantucket Sound. Shore-controlled hydrography was resumed east of Muskeget Channel in Nantucket Sound with shore stations established at Muskeget Island, Edgartown, and Gay Head. Two bubbler-type tide gages were installed on Nantucket Island. On September 21, gale winds tore out one portable tide gage and one bubbler gage situated on the south shore of Nantucket Island. Hydrography continued until late October when the ship sailed for the Norfolk Ship Base, arriving October 25. Processing the field season's records, ship repairs, and overhaul were completed during the winter months. In the early spring, the ship sailed for the working grounds, arrived in Atlantic City, N. J., on April 15 and commenced basic surveys of areas where severe storm damage had greatly changed the shoreline. These inshore surveys were in progress at the end of the fiscal year.

The hydrographic surveys conducted by the ships WAINWRIGHT and HILGARD, progressing through Fishers Island Sound, were interrupted for the purpose of wire dragging a reported obstruction south of Goat Island at Newport, R. I. This obstruction was not found. Wire-drag investigations of obstructions off Point Judith were completed with 9 large boulders discovered and reported. SCUBA divers proved invaluable in obtaining least depths and investigating wire-drag hangs. A least depth of 33 feet was obtained on the southerly boulder in general surrounding depths of 40 feet. Surveys continued in Fishers Island Sound until the season closed, October 12, 1961.

En route to Norfolk, reported soundings in Block Island Sound were cleared by wire drag to 61 feet in general depths of 85 feet, and an investigation of a reported obstruction in Branford, Conn., was completed with no obstruction being found. A field examination of the Intra-coastal Waterway between Manasquan and Cape May, N. J., was accomplished. The ships arrived in Norfolk on October 18. All processing of the seasons records was completed and the data forwarded to the Norfolk District Office during the winter period. The vessels sailed from Norfolk on April 26 and on May 3, commenced reconnaissance hydrographic surveys in the approaches to New York Harbor and inlets along the south shore of Long Island. It had been reported that east coast storms had caused changes in shoreline and charted soundings in these areas, although none were found. Wire-drag investigation at Stepping Stones Light, East River, N. Y., was completed and no obstruction found. The ships arrived at Mattituck Inlet, Long Island, on May 15 and completed a wire-drag investigation off the inlet and a shoaling in Flanders Bay.

A least depth of 27 feet was obtained in surrounding depths of 70 feet on an uncharted shoal off the Inlet. Hydrography between Fishers Island and Montauk Point, Long Island, continued and temperature and salinity observations were made to 100 feet.

The ship EXPLORER continued Raydist-controlled surveys on Nantucket Shoals. The Bureau's new underwater camera and sonar thumper were tested along the Continental Shelf in the vicinity of Hydrographer Canyon off the New England coast. There were eight lowerings of the camera, both day and night, in depths from 20 to 1,260 fathoms, using black and white and also color film. Thumper tests consisted of comparison between the "hull type" and the "V-fin" thumper and three different hydrophones. It was found that the noise level created by the EXPLORER limited towing speed of the hydrophone to 3 or 4 knots. Records of the thumper tests indicated satisfactory penetration of the substrata. Evenly spaced oceanographic stations were observed, and a Varian proton magnetometer was towed on nine tracklines run between Nantucket Shoals and Virginia Capes. At the end of the season, the ship ran a zigzag line over the nine magnetometer tracks. Deep sea photographs of the bottom and Phleger sediment cores were taken in addition to the Nansen bottle casts at these stations. A special project on sand wave research was completed on August 14 along the coast in the vicinity of Indian River Inlet, Del. Field work included launch hydrography, bottom sampling, underwater photography, and 75 bottom dives with the divers operating in pairs to depths of 5 or 6 fathoms. Two charted wrecks and one obstruction in the vicinity of Nantucket Shoals were investigated. One of these, the ANDREA DORIA, was found to be 1-1/2 miles from the charted position. All hydrography on the Nantucket Shoals project was completed by September 30. A special project for the Atomic Energy Commission was completed on October 18. This survey was for the purpose of waste disposal and extended seaward from the New Jersey coast for about 200 miles. Observations were made in two disposal areas consisting of 54 gravity cores to a maximum depth of 2,120 fathoms, underwater photography to an extreme depth of 1,960 fathoms, and oceanographic stations. The field season was closed, and the ship arrived at the Norfolk Ship Base on October 19. The processing of field records progressed, and all sheets were turned over to the Norfolk District Office prior to the ship's departure for Puerto Rico on February 19, 1962. En route to and from Puerto Rico, deep sea sounding lines were run and controlled by Loran A and Loran C. A proton-type magnetometer was towed 450 feet astern on four tracklines between the Virginia Capes and Puerto Rico, a total of 4,724 nautical miles. Along these tracklines, 35 oceanographic stations were observed, most of which were in depths of about 3,000 fathoms; more than 17 deep sea cores taken with the Phleger corer were in depths of 3,000 fathoms; and 471 bathythermograph casts, 105 water samples, 840 oxygen and salinity analyses, and underwater photography were obtained. The Puerto Rico Trench and Brownson Deep were developed by running a zigzag line across the trench.

The maximum field corrected depth found was 4,545 fathoms. Launch hydrography along the southeastern end of Puerto Rico was controlled by visual fix and soundings were taken with the Raytheon DE-723. One current station was observed in Vieques Pass for 111 hours. Bottom samples and water samples were furnished to the University of Kansas Department of Geology. The Eighth Officer Training Class was on board for the second Puerto Rican trip.

A skiff and a launch operating from the ship COWIE continued hydrography in the vicinity of Cobb Island, Potomac River. Four magnetic stations and two 100-hour current stations were occupied. Tide gages were installed at Colton Point, at Wicomico River, and at Colonial Beach. Hydrography was completed in the Wicomico River and progressed in the Potomac to Colonial Beach. On October 14, the field season was closed and the ship returned to Norfolk. Processing of field records was completed, and all sheets and records forwarded to the Norfolk District Office for smooth plotting. During April 1962, reconnaissance hydrography of storm damage in a 200-square mile area of lower Chesapeake Bay was completed. Basic hydrographic surveys were started in Chincoteague Inlet, Va., where charted soundings were affected by storm damage. Work on the project continued to June 12 when all records were transferred to the shore party ALPHA which was organized for storm damage surveys. The ship COWIE completed a chart inspection of Crisfield Channel, Md., and departed from Chincoteague for Dahlgren, Va., inspecting the tide gage at Piney Point en route. On June 16, hydrography was started in the Potomac River in the vicinity of Colonial Beach.

The field party ALPHA was organized for the purpose of conducting inshore surveys of storm damage areas. This unit took over the project started by the ship COWIE in Chincoteague Inlet, Va., on June 12, 1962. The remaining portion of the month was concentrated on soundings at piers, bottom samples, development of shoals, and, in general, completing the survey sheet started by the ship COWIE.

The field party BETA was organized on June 1, 1962, for the purpose of conducting inshore surveys of storm damage areas. Surveys were commenced in Oregon Inlet, N. C., and were continuing at the end of the month.

The ship MARMER was recommissioned in October 1961 and sailed on October 30 for Washington, D. C. Current observations were begun on November 13, in the vicinity of Washington, D. C.; Indian Head, Md.; and Dahlgren, Va. Temperature and salinity series, Phleger core samples, and bathythermograph observations were completed. All field work in the Potomac River was completed on December 3, and the ship returned to Norfolk on December 4. After preparations were completed for new surveys in Charleston, S.C., the ship departed from Norfolk and arrived at Charleston on January 19. Good progress was made during the winter months. One 29-day station was observed off Fort Sumter.

The work completed consisted of 56 current stations, 19 temperature and salinity series, 56 bottom samples, and 19 bathythermograph observations. Field work was completed on June 25, and operations were shifted to Winyah Bay, S. C., where currents were observed until July 1.

The ship HYDROGRAPHER continued Raydist-controlled hydrography in the Gulf of Mexico north of Key West, Fla., and in Santaren and Nicholas Channels in the Straits of Florida. One hundred and eight oceanographic stations were observed, 30 of which were repeat stations. Results of these observations were sent to the Marine Laboratory at the University of Miami. A special hydrographic survey was completed south of Key West, Fla., for the purpose of comparing previous shoran and Raydist projects in the area. Field work was completed on October 22; and the ship returned to St. Petersburg, Fla. Processing of survey records was completed at the end of March 1962, and the ship sailed April 3 to undertake surveys of coastal storm damage in the vicinity of Delaware Bay entrance. On May 5, surveys were completed at Delaware Bay entrance and at Indian River Inlet, and on May 21, storm damage surveys in the vicinity of Ocean City, Md., were completed. En route to St. Petersburg, a reconnaissance survey was completed near Diamond Shoals, Cape Hatteras, N. C. While passing through the Straits of Florida, the ship made an evaluation of the Miami consol signals obtaining satisfactory results. A trial run was made in Tampa Bay to test a geological echo profiler. Fair results were obtained while the ship ran at various speeds up to 7 knots. At speeds greater than 7 knots, the noise level of the towed hydrophone became excessive. At the end of the fiscal year, the ship was at St. Petersburg preparing for survey operations on Sabine Bank, Tex.

The inshore hydrographic survey project progressing southerly along the west coast of Florida was continued by the ship SOSBEE basing out of Fort Myers. Hydrographic sheets were completed in Redfish Pass and in Pine Island Sound. A least depth was obtained by SCUBA divers on the submerged wreck south of Venice, Fla. The reported wrecked barge off the north end of Captiva Island was investigated, but no trace was found. The wreck off Wulfert in Pine Island Sound was investigated and located. The field season was closed on September 20, 1961, and the ship SOSBEE sailed for Tampa, Fla. On September 28, the SOSBEE was decommissioned and all vessel employees were transferred to the ship MARMER.

Hydrographic surveys in Mobile Bay, Ala., were completed on July 24 by the East Coast Field Party, and the hydrographic units commenced surveys at the easterly end of Mississippi Sound. Processing of field records continued on the Mobile Bay area boat sheets. The photogrammetric unit assigned to this project continued the location and building of hydrographic signals in advance of the hydrographic party. Two 100-hour current stations and two magnetic observations were completed. Hydrography progressed westerly through Mississippi Sound to the vicinity

of Biloxi Bay entrance, completing the project area. The photogrammetric and hydrographic units proceeded to the new project area at Galveston Bay, Tex., May 14 to 17. Two Raydist shore station sites at Freeport and Sabine Pass, Tex., were selected for the ship HYDROGRAPHER's project on Sabine Bank. Hydrography in Galveston Bay was in progress at the end of the fiscal year.

The ship SCOTT continued field inspection and chart revision for a new edition of U. S. Coast Pilot 5. Chapter 7, Mobile Bay to Mississippi River; chapter 8, Mississippi River, chapter 9, Mississippi River to Sabine Pass, chapter 10, Sabine Pass to San Luis Pass; chapter 11, San Luis Pass to Rio Grande; and chapter 12, Gulf Intra-coastal Waterway, were completed. The ship departed from New Orleans on November 1, 1961, and arrived at Norfolk on November 22. All equipment and supplies were removed on November 30, and the ship was decommission and moored at Great Bridge, Va.

The East Coast Tidal Party inspected and serviced control tide stations along the Atlantic and Gulf of Mexico coasts during the fiscal year. During January 1962, an auxiliary tide staff, for use in observing storm water heights, was installed at Myrtle Beach as requested by the Charleston, S. C., Office of the Weather Bureau. A program of tidal bench mark recovery between Freeport and Port Isabel, Tex., was completed during April and May. Portable tide gages were installed in the Hackensack River, N. J., upon the request of the New Jersey Department of Conservation and Economic Development.

Pacific Coast, Alaska, and the Pacific Ocean

Hydrographic and wire-drag surveys by the Ship PATTON were concentrated in the shoal area west of Smith Island, Strait of Juan de Fuca, in the vicinity of the reported grounding of the S.S. ISLAND MAIL on May 29, 1961. SCUBA divers on the PATTON discovered a rock with least depth of 23 feet in surrounding depths of 36 feet and pieces of steel plate which indicated that the rock had been struck by a ship. The reported grounding of the ISLAND MAIL is under investigation by the U. S. Coast Guard. A decision as to the probable cause of the grounding hasn't been announced. A special project consisting of 60 days of tidal observations in the vicinity of Pleasant Harbor, Hood Canal, was completed. Hydrographic operations in Saratoga Passage were terminated and the season closed on October 27. Processing of field records, ship's accounts, maintenance, and preparation for the coming field season continued until April 4 when the ship sailed to Possession Sound to conduct current observations with the FM equipment and to evaluate methods of servicing deep meter sets. The ship arrived at Ketchikan, Alaska, on April 21 and commenced work at the north end of George Inlet, southeast Alaska on April 24. One magnetic station was established. Launch and ship hydrography continued to the end of the fiscal year.

The ship BOWIE continued hydrography in Prince William Sound, Alaska, basing at Whittier. Hydrography was completed on five sheets in Port Nellie Juan and through Culross Passage. Operations were suspended on September 17 and after tide gage inspection at Cordova, Yakutat, and Juneau, and a position determined off Gibby Rock Day-beacon, near Juneau, the ship arrived at Seattle on October 1. Processing of field records and general maintenance continued until April 13 when all project data were turned over to the Seattle District Office and the ship sailed for Oakland, Calif. In cooperation with the Navy Hydrographic Office, a sea gravity test area survey was started off San Francisco Bay entrance using shoran control. Observations were made with the LaCoste-Romberg remote control gravity meter. At the end of May, the meter was lost when the lifting cable became entangled with rocks and broke. The Coast Guard buoy tender set a buoy over the lost meter to assist in its future recovery. Shoran-controlled sounding lines were run in the vicinity of Cordell Bank to satisfy a prior disagreement in control of sounding lines. The BOWIE departed from San Francisco on June 8 and arrived at Seattle on June 12. Preparations were made for work in Port Susan, Puget Sound, Wash.

The ship HODGSON continued shoran-controlled hydrography in Sumner Strait, southeast Alaska. Five 100-hour current stations were observed, two temperature and salinity measurements observed, shoreline inspection, and processing of records continued. On October 5, the ship closed the field season, inspected the tide station at Sitka, stored the launch at Ketchikan, and arrived at Seattle on October 15. The processing of records continued and sheet H-8605 was completed and forwarded to Washington. Sheet H-8604 and data were transferred to Seattle District Office prior to the ship's departure on April 4. Field work was started on April 23, in Sumner Strait, Alaska. Field work on one boat sheet was completed, and another was 90 percent completed at the end of the fiscal year.

The ship LESTER JONES was based at Wrangell, Alaska, until July 17, engaged in bathymetry and current observations in the vicinity of Wrangell Harbor, at which time all field work was completed and the ship sailed for Ketchikan. Processing of field records on the Wrangell Harbor survey was completed. Visually controlled launch work was started on the continuing project in Clarence Strait and in Cholmondeley Sound. One 100-hour current station was observed in Clarence Strait, and one magnetic station. Launch hydrography was completed on two sheets, and a third was partially completed in Cholmondeley Sound. Thirty-four bathythermograph observations were made, and, at four stations, lowerings did not reach bottom because of depths in excess of 900 feet. One temperature and salinity observation was made, and a steel microwave tower located on Annette Sound for charting. The field season was closed on October 6, and the ship arrived in Seattle on October 10. The processing of field records, general ship maintenance, repairs, and preparations for the coming season continued until April 9 when the ship sailed for

Alaska, arriving April 12. Work in Cholmondeley Sound was started after the Chart Agency and tide station inspections were made at Ketchikan. Hydrography was completed on two boat sheets, and two others were approximately 40 percent completed. Two magnetic observations were made, temperature and salinity casts were taken before and after hydrography, and 58 bottom samples were taken.

At the beginning of the fiscal year, the ship PATHFINDER was at Kodiak Naval Station, Alaska, to rendezvous with the ships PIONEER and SURVEYOR. On July 26, the ship departed from the working grounds in Cook Inlet for Dutch Harbor to service and inspect the tide gage and Seismic Sea Wave Warning Station. One officer was detached by Coast Guard plane to service the tide gage and Seismic Sea Wave Warning Station at Massacre Bay, Attu Island. Visually controlled launch hydrography, wire-drag, and shoran-controlled ship hydrography continued in Cook Inlet and in the Barren Islands. Corvanesque Rock, about six miles southeast of Amatuli Island Light, was found to have a least depth of 15 feet in surrounding depths of 22 fathoms. A reported rock northwest of Dora Reef was not found. Five oceanographic stations were observed, three of which were repeat stations. A 25-hour series of current observations was made at the dock at Homer, Alaska. The ship ended field work in Cook Inlet, and departed on September 29. Southwest gales encountered en route prevented observations at oceanographic stations in the Gulf of Alaska. The ship arrived in Seattle October 6. The processing of field records and preparation for the coming field season continued until February 13 when the ship departed from Seattle. A deep sea sounding line was started off Tatoosh Island and terminated at San Francisco on February 18. The ship departed from San Francisco on February 20, continuing the deep sea sounding line and arrived at Pearl Harbor, Hawaii, on the 27th. Bathythermograph and magnetometer observations were obtained along the line. On March 1, the ship departed from Pearl Harbor to occupy the 15 oceanographic stations east of the Hawaiian Islands requested by the Bureau of Commercial Fisheries. On March 21, the ship departed from Honolulu, running a deep sea sounding line from Honolulu to Christmas Island. A total of 1,170 miles of deep sea sounding lines was run, 3,100 miles of towed magnetometer observations were completed east and south of the Hawaiian Islands. Hydrography was completed and oceanographic stations were observed on a special project at Christmas Island. The ship sailed on April 6, arrived at Honolulu on April 10. Work commenced on inshore hydrography at Maui Island on April 16. Portable shoran stations were used for control of ship hydrography in Auau Channel. Three current buoys each with three current meters were observed in Kealaikahiki Channel and Alalakeiki Channel. The ship departed from Honolulu on May 31, completed 2,505 miles of deep sea sounding lines, and arrived in Seattle on June 10.

The Ship PIONEER departed Kodiak on July 6 to start Aleutian Trench bathymetry and oceanography. The ship arrived at Adak on July 11, after completing a line of bathymetry linking oceanographic stations while en route.

A gravity tie was made to shore stations at Adak. Drogues were released in approximate latitude $53^{\circ} 00'$, longitude $159^{\circ} 22'$, in four groups about 5 miles apart. They were set at 15, 300, 600, and 900 feet. After tracking for a 48-hour period, a spiral drift pattern developed at most buoys. Two sets of parachute drogues were released at approximate latitude $54^{\circ} 30'$, longitude $158^{\circ} 00'$. Tracking revealed a definite westerly set. The proton magnetometer was towed on all lines, and the gravity meter was in operation 97 percent of the time while engaged in bathymetry. Due to failure of a Loran C receiver, a line was run southerly along the 158th meridian west, making bathythermograph observations at 900-foot depth every 4 hours in addition to the regular 450-foot observations every 2 hours. Weather balloons were released daily, and meteorological data transmitted at 6-hour intervals. A gravity tie was made between the Bishop Museum and Pearl Harbor while the ship was in Honolulu for the meeting of the Tenth Pacific Science Congress on August 25 through 29. The PIONEER sailed from Honolulu on September 7, taking up Phase II operations of the project between the Hawaiian Islands and the Aleutian Islands. Twenty-two sea mounts were discovered rising 500 fathoms or more from the general ocean floor depth of 2,850 fathoms. Approaching the Hawaiian Archipelago from the north, gravity free air anomaly values rose rapidly from +59 milligals in waters of 346 fathoms near La Perouse Pinnacle. Continuing southerly, the anomaly dropped back to -56 milligals in depths of 2530 fathoms.

Several types of plankton (free drifting organisms comprising primary food for fish) nets and fish catching trawls were towed to sample productivity of waters for the salmon investigations of the Bureau of Commercial Fisheries. The Scripps Institution of Oceanography representative collected special water samples to evaluate Japanese reports of a sudden major rise in radio activity of waters purportedly attributable to Russian A bomb tests. The Geological Survey had two scientists aboard conducting basic research in marine sedimentary processes, marine aerosols and rain water radio activity. Numerous manganese nodules were obtained from core samples in the western portion of the project area.

The PIONEER arrived in Honolulu on October 12 and departed on October 18, to run a deep sea sounding line to California. One oceanographic station was observed en route, and the ship arrived at Alameda on October 25. The processing of records, general ship maintenance, ship overhaul, and preparation for the coming season were continued until February 21 when the ship sailed, running a deep sea sounding line to Hawaii. One oceanographic station, total field magnetics, and gravity were observed en route. On March 16, the ship departed from Pearl Harbor to continue work on the Pacific Ocean survey. One line was run north to latitude $35^{\circ} 30'$. A deep sea sounding line was run on the return trip to San Francisco, arriving on March 25. Twenty officers and men attended Radiation and Decontamination School. The ship sailed on April 20, and was engaged in scientific investigations in

an area of recent nuclear blasts. The work consisted of water sampling for temperature, chemical analyses, radioactive measurements, and continuous measurements of the different elements making up the radioactive water in the area of an underwater nuclear explosion. The work included determining the effects of radiation on plant and animal life in and near the hot water. On June 25, the project was completed and the ship returned to Oakland.

The ship SURVEYOR finished a trackline between Hawaii and the Shumagin Islands, Alaska, on July 4, and held a rendezvous with the PATHFINDER and PIONEER, and representatives of the Navy and Coast Guard at Kodiak, Alaska. On July 10, the ship sailed and anchored on July 14 off Point Hope, when survey operations were begun in Chukchi Sea. Raydist-controlled hydrography continued with control carried 263 miles or as far north as latitude $73^{\circ} 01'$. Two magnetic stations were occupied, and the magnetometer was towed while engaged on bathymetry. Ten oceanographic stations were observed, one of which was within sight of the ice pack. Oxygen determinations were made, bathythermograph tests were made at 2-hour intervals, and one 100-hour current station was observed. On September 9, the ship was refueled at sea by the Navy tanker CHEMUNG. Work was completed on all sheets, and the ship departed on September 19 for Dutch Harbor. A deep sea sounding line was run from Unimak Pass to Cape Flattery. The ship arrived in Seattle on September 30. The processing of field records and preparations for the 1962 season were continued until February 14, when the ship sailed on a deep sea sounding line run to Point Arena, Calif. En route, bathythermograph, magnetometer, gravity meter, and depth finder observations were made. A sea gravity meter test run was made off San Francisco on February 18. The first leg of a cable route survey was begun on February 19 at Point Buchon, Calif., and completed at Honolulu on February 28. The ship left Honolulu on March 12, resuming the cable route survey off Kapuhi Point. On the morning of March 16, the wind and sea picked up and finally reached gale force. No attempt was made to follow the cable route. Therefore, this section of 180 miles was covered on the return trip. Visual fix ties were made at Midway, Wake, and Guam, and the ship was secured at Guam on March 31. An official call was made on the Commandant of the Naval Headquarters, and all Navy facilities were made available. The SURVEYOR departed from Apra Harbor on April 4 and secured at Naha, Okinawa, on April 12. An opportunity was available for some of the crew and officers to visit Tokyo, Japan, while on liberty. Departure from Okinawa was on April 20, and arrival at Guam on April 25. The cable route survey was resumed on April 27. Following a tie by visual fixes to Wake Island on May 3, the ship continued on to end the survey with a visual fix at Kepuhi Point on May 9. The ship departed on May 17 under amended instructions covering a cable route from Kakua, Oahu, to Port Alberni, Vancouver Island, British Columbia. On May 20, a development was made across the Murray Fault from latitude $29^{\circ}.1$ N. to latitude $30^{\circ}.1$ N. with towed magnetometer and gravity observations. The cable route survey was ended on May 26, in the vicinity of

Statistical Summary

Location	Hydrography				Topography		
	Miles of sounding lines	Square miles	Miles wire drag	Square miles	Miles of shoreline	Miles inspection shoreline	Control stations identified
Maine to Cape Henry	9,049	763	36	18	-	-	-
Cape Henry to Florida	287	20	-	-	-	-	-
Chesapeake Bay	1,912	39	-	-	-	-	-
Gulf Coast	11,608	4,268	-	-	-	-	-
Puerto Rico	1,826	49	-	-	-	27	-
West Coast	1,086	375	11	2	-	4	-
Western Pacific	17,764	124,770	-	-	-	90	85
Alaska	15,482	7,882	64	16	9	147	251
Total	59,012	138,166	111	36	9	268	336

Deep Sea Sounding Lines: The following nautical miles of deep sea sounding lines were run.

EXPLORER--North Atlantic, Virginia to Puerto Rico	4,222
PATHFINDER--North and Central Pacific	8,135
PIONEER--North Pacific, California to Hawaii	5,995
PIONEER--North Pacific, offshore California	1,498
SURVEYOR--North Pacific	4,172
SURVEYOR--North Pacific, California to Hawaii	20,717
Total	44,739

Statistical Summary

Locality	Triangulation			Oceanography					
	Towed magne- tometer	Scheme	Geo- detic posi- tions	Bathy- thermo- graph lower- ings	Oceano- graphic sta- tions	Drift bottles re- leased	Biolog- ical samples	Water samples analyzed	
	Miles	Square miles	No.	No.	No.	No.	No.	Salin- ity	Dis- solved oxygen
Maine to Cape Henry	2,062	1	2	232	32	-	-	357	-
Chesapeake Bay	-	-	-	3	3	-	-	-	-
Cape Henry to Florida	-	-	-	19	17	-	-	-	-
Gulf Coast and Straits of Florida	-	1	-	93	108	576	-	-	-
Puerto Rico and Atlantic	4,049	44	1	327	28	280	-	975	648
West Coast	268	-	15	180	68	3,913	29	214	205
Western Pacific	16,851	15	54	629	77	-	352	1,356	1,143
Alaska	6,460	350	1	366	26	-	-	172	104
Total	29,690	411	73	1,849	359	4,769	381	3,074	2,100
Sounding Lines									
PATHFINDER	8,077	-	-	196	9	-	-	138	198
PIONEER	5,910	-	-	198	2	245	-	154	36
SURVEYOR	22,109	-	-	88	-	-	-	-	-
Total	36,096	-	-	482	11	245	-	352	234

Cape Beale, British Columbia. A sea gravity test run was completed from Tatoosh Island Light through the Strait of Juan de Fuca, and the ship continued to Lake Union, Seattle, Wash. Preparations for the Arctic field season continued until the end of the month.

The Pacific Tidal Party inspected and serviced 15 control tide stations along the North Pacific islands including Guam; Moen Island, Truk Atoll; Wake; Canton; Samoa; Enewetok; Kwajalein; Johnston; Midway; Christmas Islands; and five stations on the Hawaiian Archipelago. A remote recording tide gage was installed at Hilo during March with the recorder located in the Hilo Police Department for immediate verification of alarms from the seismic sea wave detector.

Marine Data Division

The central office of the Marine Data Division, in addition to its administrative and supervisory functions, continued its direct associations with the general public. These associations comprised, essentially, correspondence with: engineering firms and Government engineering departments regarding datum planes and tidal fluctuations, law firms, and governments concerning datum planes and tide and tidal current information bearing on litigation, oceanographic research laboratories regarding the exchange of data, private enterprises for tide publication permission, and the general public for advanced predictions and cultural information on tides.

Formal relationships with the oceanographic community were largely maintained by the assistant chief's memberships on the Committee of Tides of the Pan American Institute of Geography and History, as well as the Committee on Tides, Committee on Mean Sea Level, and Permanent Service for Mean Sea Level of the International Association of Physical Oceanography.

Captain Ulm attended the keel laying ceremonies of the *PEARCE* at Pt. Pleasant, W. Va. Captain Ulm, Messrs. Zetler and Starr attended a meeting of the Oceanographic Task Team, National Security Industrial Association in Washington on April 20. Captain Ulm and Mr. Starr were also present at the joint meeting of the American Society of Limnology and Oceanography and The Instrument Society of America (Marine Sciences Division) at Woods Hole, Mass., in September.

Mr. Shofnos attended meetings of the Pan American Institute of Geography and History at Buenos Aires in July, International Association of Physical Oceanography at Paris in November, American Congress of Surveying and Mapping at Houston in March, Committee on Tidal Hydraulics of the Corps of Engineers in Washington in March, and American Society of Civil Engineers in Washington in May. Messrs. Shofnos and Zetler attended the First National Shallow Water Conference at Baltimore in October.

Oceanographic Analysis Branch

The principal activities of the Oceanographic Analysis Branch centered around the observation, processing, analysis, and interpretation of oceanographic and geophysical phenomena. The oceanographic work involved water mass analysis using serial observations of temperature, salinity, and dissolved oxygen; the study of diurnal and seasonal temperature cycles from bathythermograph lowerings, sediment distribution interpretation through coring, and Geological Echo Profiling (GEP) investigations. A continuing drift bottle program was sustained as well as our responsibilities for the construction of Seismic Sea Wave Warning System traveltime charts and hydrographic verifications. In geophysics, the effort involved observation and reduction of gravity observations to free air anomalies, and magnetic field surveys. Complete utilization of the facilities of the National Oceanographic Data Center (NODC) was made by the Branch.

The in situ measurements were mainly carried out by members of the Branch temporarily assigned aboard the ships EXPLORER and HYDROGRAPHER in the Atlantic, and SURVEYOR and PIONEER in the Pacific.

In a cooperative effort with the U. S. Navy Hydrographic Office, a gravity test range was established for operating units in the Pacific Ocean. The area covers approximately 750 square miles adjacent to the coast off San Francisco. Establishment of the range involved the occupation and reduction of 127 LaCoste Romberg gravity meter stations. In preparation, Mr. R. B. Jones, Jr., spent 11 days as an observer during surveys for the establishment of a U. S. Navy gravity calibration range in Long Island Sound.

Under the supervision of Dr. Stewart, the Branch assisted in the final preparation of oceanographic data for the publication, "Oceanographic Cruise Report - USC&GS Ship EXPLORER - 1960".

Standard shipboard procedures were developed for dissolved oxygen determinations, magnetometer observations, and for velocity reductions in refraction and reflection profiles of the geological echo profile instrument. Gravity correction tables were computed for the effects of compensation and topography in the Hayford Zones.

The location and depth of earthquake epicenters in the northeast Pacific were tabulated and plotted for correlation with bathymetry and gravity. These correlations will be used in the interpretation of the tectonic pattern.

The Branch provided sound velocity corrections for vessels engaged in hydrographic surveying when current oceanographic stations were impractical.

Processing of the serial temperature and salinity observations of the MARMER in New York harbor progressed during the year. An attempt was made to determine seasonal variations in temperature and salinity, and the relationships between these two parameters and tidal currents.

A comparison was made between some PIONEER 1961 and HUGH M. SMITH (USF&WS) 1955 oceanographic stations for use in a paper presented by Captain Conerly at the December 1961 American Geophysical Union meeting, Los Angeles, California. The Branch supported inclusion of Legaspi (Philippine Islands), and Hachinoke and Shimizu (Japan) in the Seismic Sea Wave Warning System.

The following is a summary of the work accomplished:

Oceanographic stations processed	210
Temperature, salinity, and density sections constructed	20
Bathythermograph sections constructed	50
Drift bottle cards returned	248
Free air gravity anomaly charts constructed	11
Magnetic survey charts constructed	17
Verifications of hydrographic surveys	27
Oceanographic stations sent to NODC	194
Bathythermograph slides sent to NODC for processing	2,606

Mr. Starr attended the Interagency Committee on Oceanography Government-Industry Symposium of Oceanographic Instrumentation, and virtually all members of the Branch attended sessions of the American Geophysical Union meetings in Washington, D. C. In addition, Mr. Zetler attended the Pacific Science Congress in Honolulu.

Tides and Currents Branch

The Tides and Currents Branch (through its Tides, Currents, and Prediction Sections) was engaged in the supervision of observations, processing, harmonic analyses, reductions, and predictions of both tides and tidal currents. In addition, the establishment of mean sea level and its variations was carried out on a routine basis. These activities were directed toward the publication of tide and tidal current tables for navigational purposes, establishment of chart datums, and basic physical oceanographic research.

The Branch established a program for reporting daily sea water temperatures at local resort areas for dissemination to the local press, radio, television, and Weather Bureau.

A detailed study was made of the tidal current pattern in Tampa Bay.

Throughout the year, tide and tidal current data were furnished to the Nautical Chart Division for the Small Craft chart series.

High water levels, due to a severe storm in early March, were determined for eight stations on the Atlantic coast. In addition, a table was prepared of highest recorded tides above mean sea level for all primary tide stations on the Atlantic and Gulf coasts. Monthly sums and means from 1898 to 1925, and annual sums for the entire series were computed.

Mr. Robert Cummings, detailed to the U. S. Weather Bureau, undertook a study of tide predicting procedures using IBM computers.

A statistical summary of the work completed during the year is as follows:

Tide records processed (station months)	1,347
Leveling records processed (stations)	526
Bench marks recovered	1,256
Bench marks established	130
Bench marks destroyed	33
Tide notes prepared (locations)	570
Tide notes prepared (hydrographic sheets)	70
Planes of reference verified (volumes of records)	560
Descriptions and elevations of bench marks	73
Density and temperature records processed (station months)	1,711
Current observations processed (meter days)	707
Harmonic analyses	16
Tide predictions	29
Special tide predictions	7
Special current predictions	3
Datum plan and tide range determinations	10

Coast Pilot Branch

The activities of the Branch were directed toward the publication of new editions and supplements of the various U. S. Coast Pilots. In addition, corrections were submitted to the Navy Hydrographic Office for publication in their Notice to Mariners.

Shipboard activities consisted of a navigational intelligence survey of the Gulf coast by the ship SCOTT. This survey supplied corrections and additions for U. S. Coast Pilot 5, Gulf coast, Puerto Rico and Virgin Islands (5th edition 1962), which is in preparation by the Branch

Shore inspections covered Washington and Oregon for the 9th edition (1963) of U. S. Coast Pilot 7, and Puerto Rico and the Virgin Islands for U. S. Coast Pilot 5, (5th edition 1962).

Facilities Division

In August 1961, the MARMER was drawn from the Maritime Administration's James River reserve fleet and after extensive repairs was put in service on Chesapeake Bay. The ships SOSBEE and SCOTT were decommissioned at the conclusion of the field season. The SOSBEE was sold and the SCOTT held in reserve.

The appearance of the Bureau's fleet was greatly improved by painting all of the ships, except the HYDROGRAPHER, white instead of gray. In addition to routine repairs of all vessels, the following special projects were completed.

HILGARD /	Installed new propulsion engines and exhaust system.
PATHFINDER	Modifications to the ventilation system.
PIONEER	Installed deep sea anchoring equipment, major overhaul of machinery, equipment installed for AEC operation.
SURVEYOR	Installed deep sea anchoring equipment, installed new feed water pumps, and added gravity meter room.

The deep sea anchoring equipment installed aboard the PIONEER and SURVEYOR provides the capability of anchoring and taking bottom samples and cores from the greatest ocean depths, as well as the capability for electrical or electronic instrumentation for depths up to 10,000 feet.

NATIONAL AND INTERNATIONAL COOPERATION

For the U. S. Weather Bureau, the release of daily weather balloons and the recording of meteorological data every 6 hours were accomplished. For the Charleston, S. C., office an auxiliary tide staff was installed at Myrtle Beach for use in observing storm water heights.

For the Atomic Energy Commission, an environmental survey was made of two waste disposal areas approximately 100 and 200 miles off the Atlantic coast, including oceanographic stations, bottom cores, under water camera lowerings, and a profile of 37 gravity cores; the oceanography of proposed disposal areas for radioactive wastes off the Pacific coast was investigated; a classified project for making scientific investigations in the area of a nuclear blast in the Pacific Ocean.

The Coast Guard was provided with special current predictions for North Charleston Harbor, S. C.

For the Bureau of Commercial Fisheries, Honolulu Biological Laboratory, 15 oceanographic stations were observed east of the Hawaiian Islands along the 150th and 153d meridians, spaced at 90-mile intervals between latitudes 15° N., and 25° N. That Bureau was also furnished sea surface temperatures from tide station locations on the Atlantic Coast

The Corps of Engineers was furnished tide marigrams from Alaska, tidal current data for launching site studies at Cape Canaveral, and Phleger cores taken in the Potomac River.

For the Geological Survey, bottom sediment core analysis and preservation, aerosol and rain precipitation collection, and saturometer determinations were made.

For the Navy Department, a survey was made to extend the present anchorage limits along the west coast of Christmas Island in the South Pacific Ocean for the

purpose of support in future operations; a joint drift bottle program was carried out which involved the release of survey drift bottles from naval vessels on radar picket duty off the Pacific coast.

With the U. S. Navy Hydrographic Office, a Sea Gravity Test Area was established off San Francisco Bay entrance. The purpose of this area is to provide a systematic evaluation of shipboard gravity and navigation equipment. Tidal current information on Charleston Harbor was furnished the Hydrographic Office.

The Office of Naval Intelligence was provided with tidal data for the Indian Ocean. Tidal data was also furnished the Bureau of Yards and Docks.

For the Naval Ordnance Laboratory, investigations were made of the distribution of radio-energy among the elements found in sea water by depth and by space. Measurements were made in situ.

The Panama Canal Company was furnished tidal data.

For the State of New Jersey Department of Conservation and Economic Development, portable tide gages were installed at Port Newark, Kearney Point, Secaucus, and Little Ferry in the Hackensack River.

Tidal datum plane data were sent to the Texas General Land Office in Austin.

For Scripps Institution of Oceanography, two deep sea lines were run for depths and magnetics, in a magnetic field where it was thought a submarine escarpment existed. Distribution of cesium radioactivity in the sea water as a study of recent (post-Russian) tests, contamination, and oceanic circulation problems. The water samples were concentrated aboard, but they were analyzed at the Institution.

For the Lamont Geological Observatory of Columbia University, the sedimentary layers in the subbottom were measured by seismic reflection techniques.

The Institute of Polar Studies, University of Connecticut Marine Laboratory was furnished tidal data.

For the University of Hawaii, productivity stations were observed at sunrise and noon.

For the Marine Laboratory at the University of Miami, oceanographic observations were made at ten stations across the mouth of Florida Bay, consisting of temperature, water and bottom samples, and bathythermograph observations. Oceanographic observations were made in the Straits of Florida between Cay Sal Bank and the Florida Keys. Cores and bottom samples from these stations were turned over to Florida State University and University of Miami.

For the Department of Geology, Texas A. & M. College, a total of 159 bottom samples, mostly in the form of cores, was furnished from the inshore area in Vieques Pass, P. R. Water samples from two oceanographic stations were also furnished.

For Woods Hole Oceanographic Institution, a study of the uptake of and the concentration of radioactive elements by marine organisms was made. Studies were made on productivity of organisms in an environment with an unnatural radioactivity. Utilizing a system of current meters suspended from anchored buoys, measurements were recorded at ten depths, from surface to near bottom, in about 1,800 fathoms.

For the American Telephone & Telegraph Co., a hydrographic sounding line was run along a proposed cable route between Point Buchon, Calif., and Okinawa Island by way of Midway, Wake, and Guam Islands. Another route was run between Oahu Island and Port Alberni, Vancouver Island, Canada.

OFFICE OF PHYSICAL SCIENCES

OPERATIONAL ACTIVITIES

Geodesy Division

The Geodesy Division plans, writes the instructions, and supervises the execution of the geodetic control field surveys and their office computations including triangulation, traverse, leveling, base measurements, and astronomic and gravity determinations; operates latitude observatories; compiles, publishes, and distributes geodetic control data for the use of the Government and the public; compiles and publishes other matter relating to geodesy; performs studies and collects data relating to astronautics and astrophysics; cooperates with other governmental agencies concerning control surveys and state coordinate systems; performs precise geodetic surveys for missile systems, satellite tracking and trajectory studies, highway surveys related to interstate highway programs.

Field

Triangulation

Horizontal control was established for mapping, general survey operations, and, in addition, for interstate highways, defense, and other engineering projects. Three parties, averaging 24 men each, were on the regular projects and eight parties of 24 men each were engaged in special-purpose work. There was an increasing demand for very high-precision surveys, and several different types and ranges of electronic distance-measuring instruments were used in addition to conventional taping equipment. Special-purpose and high-accuracy determinations were coordinated with our national network in order to strengthen and add to existing control where practical. The Bureau also cooperated with other organizations, especially State governments, in providing technical assistance, adjusting, and publishing precise control data for general use.

Electronic distance-measuring instruments have provided much needed, fast and accurate tools for measuring longer base lines, and better spaced to strengthen the triangulation more than taped bases do. A combination of electronically measured traverses and triangulation provided a flexible and faster method of establishing accurate control than previously.

One four-man party operated the large Geodimeter continuously, measuring precise base distances and super-precise base line type traverses. The lighter type distance measuring instruments, such as the Tellurometer, Electrotape, and Model 4 Geodimeter, were operated by the triangulation parties.

Leveling

Three main multiple-unit parties, averaging 18 men each, completed 99 unit-months of leveling in the Western, Central, and Eastern States in extending the basic control net and releveling. A party of one unit completed 12 unit-months of leveling along the Eastern Coast in connecting tidal bench marks to the level net. Leveling was also run as part of the survey at Malmstrom AFB, Mont.; Dyess AFB, Tex.; Plattsburg AFB, N. Y.; Walker AFB, N. Mex.; Davis-Monthan AFB, Ariz.; and McConnell AFB, Kans.

Releveling of old first-order lines was undertaken in California, Georgia, Illinois, Montana, and West Virginia.

Leveling was undertaken in Arizona, Illinois, and Tennessee as part of the interstate highway program.

During the year, 12,014 miles of single-line leveling were completed. Elevations were determined for 11,913 bench marks, of which 8,008 were new marks.

Astronomic Observations

Astronomic positions and azimuths were observed at many U. S. Air Force rocket launch sites in various sections of the United States. Astronomic determinations were also made in conjunction with triangulation control, geodetic development of the Atlantic and Pacific Missile Ranges, and the testing of inertial navigation devices and gyroscopic compasses. An astronomic unit observed positions and azimuths over a precise long-line traverse extending from the southern end of Hawaii Island westward to Kauai Island, to provide azimuth control for the Hiran arc along the Hawaiian archipelago.

Gravity Observations

Base net operations included a complete rerun in both directions over the Mid-Continent Gravity Calibration Line between Brownsville, Tex. and Winnipeg, Manitoba. Direct connections were measured from Washington, D. C. to Dallas, Tex. and Seattle, Wash., using commercial air transport.

In the summer of 1961, gravity traverses were run at 5-mile station spacing over primary level bench mark lines around a closed loop in the mountainous region of Colorado, then extended northward to North Dakota and eastward to a junction with the midcontinent calibration line at Fargo, N. Dak. A similar traverse was run between Jacksonville, Fla. and Fort Worth, Tex., completing the second transcontinental connection of this type. In connection with a study of the relation between gravity values and ground movement in disturbed areas, a series of gravity traverse loops were run over bench marks in the region between Los Angeles and San Luis Obispo, Calif. In April 1962 operations were begun over primary level lines between Fernley, Nev. and Seattle, Wash.

The first surface-ship gravity meter acquired by the Survey, a LaCoste-Romberg type, was operated nearly

continuously on the ship PIONEER from April to November, 1961. As part of the oceanographic survey program, gravity measurements were taken on a series of track lines running southward from the Aleutian peninsula and between the meridians 155° W. and 160° W. Also, a number of diagonal lines were run over the Aleutian Trench from Kodiak to Adak, and readings taken at oceanographic stations along two meridians west of 160° W. Gravity values were obtained for about 85 percent of the time the ship was at sea.

A second LaCoste-Romberg sea gravity meter was installed on the ship SURVEYOR, which departed Seattle, Wash. in mid-February 1962. Gravity measurements were taken while the ship proceeded on a submarine-cable survey project extending westward to Okinawa via Hawaii, Wake, and Guam. Gravity was observed on the PIONEER in connection with the 1962 oceanographic survey program in the north Pacific until late March.

In order to evaluate performance of surface-ship gravity meters under actual sea conditions, a gravity test area was surveyed out to the 60-fathom curve off San Francisco. The project comprises 118 sea gravity stations at a rectangular spacing of 3 miles. Observations were taken from the Survey ship BOWIE with a LaCoste-Romberg underwater gravity meter on temporary loan from the U. S. Navy Hydrographic Office.

Gravity values were measured at several industrial facilities.

Variation of Latitude

The variation-of-latitude observatories at Ukiah, Calif., and Gaithersburg, Md., continued in operation throughout the year. At Ukiah, 4,055 star pairs were observed on 247 nights with complete observations on 195 nights. At Gaithersburg, 3,449 star pairs were observed on 260 nights with complete observations on 103 nights. Early in 1962, transmittal of weekly latitude observing records to the Central Bureau in Mizusawa, Japan, was instituted to aid in the rapid processing and dissemination of polar motion data.

Special Projects

Interstate highway control surveys by two parties were continued in Arizona and were completed in Illinois, Pennsylvania, and Tennessee. Highway control surveys in Minnesota, Kentucky, Mississippi, and Tennessee were made to conform with standard specifications by the States for acceptance as part of the national network.

Two 14-man parties provided leveling, and one 3-man party made astronomic observations for defense projects. Approximately three horizontal control parties of 24 men each were on defense work. In addition, one party averaging 14 men provided surveys for Vandenburg AFB and Point Mugu Pacific Missile Range, and one party of 22 men did similar work for Patrick AFB Atlantic Missile Range.

A precise Geodimeter traverse was run from the vicinity of Vero Beach to Homstead, Fla., to provide a high-accuracy base connection between Cape Canaveral and tracking facilities. This unique project, in addition to providing very precise necessary data, adds strength directly to our horizontal network. It also serves as a very valuable and useful test project of long range value in strengthening the control network. Control was also established for the Fort Greeley, Alaska, test area for the Geodesy, Intelligence and Mapping Research and Development Agency (GIMRADA).

Our geodetic work included horizontal and vertical control for a large number of various types of defense missiles, satellite and tracking facilities, and for testing facilities and various other Federal projects.

The north-south boundary line, established by Mason and Dixon, between Maryland and Delaware was resurveyed. All recoverable boundary monuments were located, and a study made of the results so the States could determine if any of the monuments were moved and to replace those which were missing. The reconnaissance was done for a survey of the Colorado River boundary between California and Arizona.

A severe storm along the upper Atlantic Coast in March, coupled with previous damage, required replacement of the horizontal control from Little River Inlet, N. C., to Eastern Long Island for new hydrographic and shoreline surveys. A total of five parties were engaged on a crash program on the recovery, replacement, and strengthening of this coastal control.

Releveling was undertaken in the Tulare-Wasco and Arvin-Maricopa areas, Calif., where a study of changes in elevation was being made in cooperation with the California Department of Water Resources.

Leveling was done in Washington along the Snake River at the request of the Walla Walla District Engineer for use in connection with the Ice Harbor Dam.

Two difficult leveling assignments were undertaken in Arizona. The first, in the southern part of the State, was undertaken at the request of the U. S. Geological Survey in connection with a mapping request from the military. This is a remote region in an area of bombing practice. It is located south of U. S. Interstate Highway No. 8 and east and west of Ajo. The second difficult assignment was in the vicinity of the Glen Canyon Dam and reservoir at the request of the Bureau of Reclamation. Control was established for the purpose of studying settlement and sedimentation. On both of these assignments the leveling could best be undertaken by camping, and the use of helicopters and 4-wheel drive trucks was necessary.

Reobservations were made for horizontal earth movement in the Avenal-San Luis Obispo area, Monterey Bay area, and the vicinity of the Taylor Winery in California.

1962

Recovery and Maintenance Program

An average of 13 men were on geodetic mark recovery and maintenance in Alabama, Arkansas, California, Florida, Georgia, Indiana, Kansas, Louisiana, Massachusetts, Mississippi, Missouri, North Dakota, Oregon, Texas; Virginia, and Washington. Assistance was also obtained from state and local organizations and the public in protecting and reporting on geodetic marks.

Witness signs mounted on metal posts were 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
Arizona.....	101	295
Illinois.....	26	60
Kentucky.....	25	55
Minnesota.....	60	145
Tennessee.....	181	359
Total.....	393	914

Leveling ✓

State	First-order	Second-order	State	First-order	Second-order
	Miles	Miles		Miles	Miles
Arizona.....	90	847	New Mexico.....	22	68
Arkansas.....	2	63	New York.....	11	81
California.....	1,106	461	North Carolina...	0	37
Delaware.....	33	100	Pennsylvania.....	9	244
Florida.....	19	0	South Carolina...	2	195
Georgia.....	469	450	Tennessee.....	43	356
Illinois.....	137	47	Texas.....	29	158
Kansas.....	0	169	Utah.....	321	0
Maine.....	1	99	Vermont.....	8	2
Maryland.....	4	90	Washington.....	0	78
Montana.....	312	962	West Virginia....	21	712
New Jersey.....	54	163	Total.....	2,693	5,382

✓

Triangulation, First- and Second-Order

State	Number of stations	Area
	Marked and intersection	Square miles
Alabama.....	2	
Arizona.....	139	1,027*
Arkansas.....	3	
California.....	171	7,850
Connecticut.....	3	104
Delaware.....	25	40
Florida.....	87	270*
Georgia.....	24	25
Idaho.....	10	65
Illinois.....	272	4,548*
Indiana.....	24	20*
Iowa.....	91	1,940
Kansas.....	231	3,300
Kentucky.....	60	560*
Louisiana.....	2	
Maine.....	1	
Maryland.....	119	237*
Massachusetts.....	9	
Michigan.....	3	
Minnesota.....	111	760*
Mississippi.....	6	
Missouri.....	8	*
Montana.....	48	10,170
Nebraska.....	3	
Nevada.....	3	
New Jersey.....	24	155
New Mexico.....	27	2,345
New York.....	32	450
North Carolina.....	77	977
North Dakota.....	53	1,245
Ohio.....	5	
Oklahoma.....	1	
Oregon.....	146	550
South Carolina.....	18	
South Dakota.....	57	1,775
Tennessee.....	199	647
Texas.....	6	60
Virginia.....	14	
Washington.....	84	449*
West Virginia.....	51	1,530
Wisconsin.....	1	
Alaska.....	14	255
Hawaii.....	6	10*
Puerto Rico.....	5	
Total.....	2,275	41,364

*Tellurometer Traverse not included.

**Geodimeter Traverse not included.

Gravity Determinations ✓

(Including old stations)

	<u>Base net stations</u>	<u>Level line stations</u>
Alabama.....	8	59
California.....	20	973
Colorado.....	11	106
Florida.....	2	8
Georgia.....	13	53
Kansas.....	13	--
Louisiana.....	3	43
Minnesota.....	--	3
Mississippi.....	1	36
Nebraska.....	6	39
Nevada.....	1	19
New York.....	3	--
North Dakota.....	5	87
Oklahoma.....	6	--
Oregon.....	--	100
South Dakota.....	12	57
Texas.....	42	46
Virginia.....	11	--
Washington.....	<u>6</u>	<u>--</u>
Total.....	163	1,629

Earthquake Surveys ✓

	Number of stations		Area
	Old	New	Square miles
Vicinity of Taylor Winery, Calif.....	8	0	
Avenal-San Luis Obispo, Calif.....	60		1,090
Monterey Bay, Calif.....	36	3	1,080
Total.....	104	3	2,170

Triangulation Reconnaissance ✓

State	Area
	Square miles
Alabama.....	2,400
Arizona.....	640*
Arkansas.....	4,039
California.....	6,418
Delaware.....	39*
Georgia.....	26
Maryland.....	490*
Mississippi.....	2,500
New Hampshire.....	110
New Jersey.....	147*
New York.....	300
North Carolina.....	3,780*
North Dakota.....	3,475
Oklahoma.....	2,400
Oregon.....	550
Pennsylvania.....	1,000
South Dakota.....	5,645
Tennessee.....	128*
Texas.....	360
Virginia.....	450*
Washington.....	170*
Wisconsin.....	4,900
Total.....	39,967

*Tellurometer traverse not included.

Astronomic Determinations ✓

(Including old stations)

Locality	Latitude	Longitude	Azimuth
Alaska.....	1	1	1
California.....	4	4	7
Colorado.....	-	-	5
Florida.....	15	15	22
Georgia.....	1	1	1
Hawaii.....	16	16	7
Idaho.....	-	-	1
Illinois.....	1	1	-
Kansas.....	13	13	9
Maryland.....	1	1	-
Mississippi.....	-	-	2
Montana.....	47	48	44
Nebraska.....	-	-	1
New Mexico.....	12	12	-
New York.....	10	10	-
Ohio.....	1	1	1
Pennsylvania.....	-	-	1
Texas.....	12	12	-
Vermont.....	2	2	-
Washington.....	-	-	8
Wyoming.....	-	-	3
Virginia.....	-	-	1
Grand Bahama Islands.....	<u>2</u>	<u>2</u>	<u>4</u>
Total.....	138	139	118

1962

Geodimeter Baseline Measurements

Locality	Length in miles
Boundary West Base - Boundary East Base, Canada.....	8.55
Kuich (USGS) - Carter, Mont.....	9.53
Jette - Elmo, Mont.....	9.35
Bumblebee - Huckleberry, Idaho.....	14.26
Ida 80-66 - Monument, Idaho.....	8.34
Hangar RM 2 - Clearwater, Alaska.....	4.92
Hangar RM 2 - Beales South Base, Alaska.....	6.03
Hangar RM 2 - DD 1 (USE), Alaska.....	14.50
DD1 (USE) - Tanana, Alaska.....	25.57
Beales South Base - Pillsbury, Alaska.....	8.54
Pillsbury - Clear, Alaska.....	18.31
Pillsbury - Home, Alaska.....	16.03
Mound - Clearwater, Alaska.....	5.37
Poor - Pillsbury, Alaska.....	8.46
Pillsbury - Granite, Alaska.....	16.19
Pillsbury - Rhoads, Alaska.....	11.94
Pillsbury - Pan, Alaska.....	12.42
Pillsbury - Clump, Alaska.....	11.96
Pillsbury - Last, Alaska.....	10.38
Beales South Base - Butch (AMS), Alaska.....	5.71
Beales South Base - Slope, Alaska.....	11.11
Beales South Base - Cross, Alaska.....	2.38
Sale - Hall, British West Indies.....	17.06
Azusa - Hall, British West Indies.....	9.60
Ride 2 - Hall, British West Indies.....	9.63
Fish - Pensacola, British West Indies.....	11.24
Fish - Carter RM 3, British West Indies.....	10.19
Walk - Romer, British West Indies.....	12.65
Shark (USN) - Set, British West Indies.....	9.37
Sale - Romer, British West Indies.....	12.86
Sale - Carter RM 3, British West Indies.....	15.59
Pelican - High Rock, British West Indies.....	8.25
Pelican - Carrion, British West Indies.....	8.48
Dan - High Rock, British West Indies.....	4.90
Azusa - High Rock, British West Indies.....	7.28
Jones - Queen 2, Tex.....	14.23
✓Emerson - Boufford, Fla.....	7.66
✓Emerson - Vero RM 8, Fla.....	9.30
✓Lucie - Boufford, Fla.....	10.93
✓Lucie - Owen, Fla.....	7.68
✓Hawk 2 - Radar, Fla.....	9.19
✓Hawk 2 - Allen, Fla.....	9.23
✓Allen - Owen, Fla.....	7.06
✓Froelich - Fergen, Fla.....	8.86
✓Froelich - Hawk 2, Fla.....	9.32
✓Convict - Fergen, Fla.....	9.02
✓Convict - Dell, Fla.....	9.67
✓Hammond 2 - Hawkins 2, Fla.....	6.92
✓Hammond 2 - Dell, Fla.....	9.89
✓Locks - Hawkins 2, Fla.....	7.56
✓Hialeah - Hector, Fla.....	6.94
✓Locks - Red Top 2, Fla.....	8.73
✓Oolite - Hector, Fla.....	9.72
✓Oolite - Waldin, Fla.....	8.23
✓Hialeah - Red Top 2, Fla.....	6.40

20 Lines Deducted from Summary, next page, and counted as G. Trav. 1963 Report (169.71 mi.)
 13 Lines outside US

Aero - Waldin, Fla.....	7.40	↑ 481.03
McClelland - Duquoin RM 3, Ill.....	6.92	
Ganahl - Paterson, Mo.....	10.19	
Halleck - Dickhaus, Mo.....	8.29	
Moreau - Belshe, Mo.....	10.52	
Weddle - Steel, Kans.....	9.13	
Ray - Bearman, Kans.....	7.00	
Houston - Crowder, Kans.....	11.54	
Canyon - Indian Creek, Kans.....	14.64	
Bluff - Santa, Colo.....	11.62	
Total.....	650.74	

Summary of Geodetic Work

	July 1, 1961 to June 30, 1962	Total to June 30, 1962
Triangulation, first-, second-, and third-order stations.....	2,275	168,530
Leveling, first- and second- order, miles.....	8,075	465,492 193
First-order baselines.....	0	453 206
Geodimeter baselines.....	65.45	264 244
Second-order baselines.....	0	59
Latitude stations.....	127	1,767
Longitude stations.....	127	1,575
Azimuth stations.....	114	1,680
Gravity stations.....	1,663	16,535

Office

Adjustment of Triangulation

~~264~~
 - 35 (1960)
 - 3 (1961)
 = 20 (1962)
 206

The primary function of the Triangulation Branch is the adjustment of surveys made for the extension of the horizontal control network. In addition to these functions, various special computations were made for other Divisions as requested.

Less 13 B.W. =

During fiscal year 1962, major adjustments were completed in Alaska, California, Florida, Minnesota, North Carolina, and Texas. These major adjustments, along with various other projects, accounted for 3,752 points being added to the files.

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The adjustment of surveys resulting from the interstate highway program accounted for approximately 35 percent of the total number of points added to the files. In connection with this program, adjusted data were completed for surveys in Arizona, District of Columbia, Idaho, Illinois, Kentucky, Minnesota, Pennsylvania, and Tennessee. The surveys for some of these projects were done by the States and our responsibility was to review the records and adjust the observations.

The processing of special surveys made for the Department of Defense was given a high priority. These surveys were in the vicinity of Cape Canaveral, Vandenberg AFB, and various air force bases, where missile sites were being established. Adjusted data for a majority of the points in these surveys were classified and therefore not added to our regular files.

Two high-precision geodetic surveys were completed in Florida (1) a triangulation net in the vicinity of Valkaria, and (2) a traverse scheme along the coast from Vero Beach to Homestead, Fla. The specified accuracy of these surveys was to be one part in 400,000 relative to Cape Canaveral. Adjusted results indicated that accuracies of better than one part in 1 million were obtained. Reconnaissance survey operations are now underway to extend the high-precision traverse scheme from Cape Canaveral to Savannah, Ga.

At the request of GIMRADA, a precise survey was made in the vicinity of Fort Greeley, Alaska. This survey was done for the purpose of establishing precise distances to be used for testing electronic distance measuring equipment. For precise length control in the area, 18 distances were measured with the Geodimeter. Adjusted results of the survey indicated that distances determined from previous surveys were approximately one part in 40,000 too long.

In order to strengthen the old third-order scheme along the Florida Keys, a second-order Tellurometer traverse was run from Sand Key to Dry Tortugas. Some of the adjusted positions from this survey differed by as much as 30 meters from positions determined in the original survey. The old survey, established primarily for chart control, was a scheme with short third-order base lines used for length control.

Two adjacent area nets in northern New Mexico were adjusted and corrections to the observations were excessive. In order to obtain better results, it was decided to make a simultaneous adjustment of the two areas along with some of the previous surveys. This readjustment was not completed at the end of the fiscal year.

An area net in south-central Kansas was adjusted to furnish control for a missile site survey. The adjusted results indicated a weakness in the previously adjusted net. A few years ago the same difficulty was encountered in an area net in central Oklahoma. This net is directly south of the Kansas area. Because of excessive corrections to the observations, adjusted results of these surveys were not published. Plans were made for additional first-order arcs to strengthen the primary net in these areas. After the new surveys are completed, investigations will be made to determine the extent of a major readjustment in this part of Kansas and Oklahoma.

A large project in southern Iowa and northern Missouri was started in 1959. Adjusted results for all stations are available, but final data sheets have not been completed. From time to time work on this project has been discontinued because of the high priority of other surveys. An attempt will be made to complete this project during the next fiscal year.

The program of measuring base lines with the Geodimeter continued. These bases are being established at uniform intervals in the national net. On a majority of the lines measured, checks against the adjusted values were better than one part in 100,000. In a few cases the discrepancy was on the order of one part in 40,000 or 50,000. When checks against the adjusted values were not considered adequate, investigations are made to determine if the weakness is in the primary net.

Field surveys were completed for three earthquake investigation surveys in California. A preliminary study of the observations indicated that some movement had taken place in the vicinity of Hollister. Final adjusted data for these surveys were not completed.

Listing of final data for the Blue Nile River Area of Ethiopia was finished. A complete report of this project was submitted with the adjusted data.

Near the end of the fiscal year the Data Processing Section was separated from the Branch and the Electronic Computing Division was formed. Since the original installation of IBM equipment in the Bureau, the Data Processing Section had operated as a unit of the Triangulation Branch.

Adjustment of Leveling

As of June 30, 1962, the total amount in the level net was 185,488 miles of first-order and 280,298 miles of second-order leveling, along which 411,675 bench marks have been leveled over.

The following computations and adjustments were completed during the year: preliminary computations for 5,120 miles of first-order and 5,869 miles of second-order leveling; 34 least-squares adjustment comprising 3,470 miles of first-order and 3,152 miles of second-order leveling; and the distribution of closing errors on 3,806 miles of first-order and 5,962 miles of second-order leveling.

Astronomic Computations

Astronomic data processing was maintained essentially current with field work during the year. A total of 162 positions and 153 azimuths were computed. Processing was completed for the Danjon astrolabe observations at the IGY station in Honolulu.

Gravity Reductions

Positions, elevations, and anomaly data were compiled for gravity traverses observed over primary bench mark lines from Kansas City, Mo., through New Bern, N. C., to Jacksonville,

Fla.; and from Jacksonville westward to Fort Worth, Tex. Similar data were compiled for traverses in the mountainous region of Colorado, from Colorado northward and eastward to Minnesota, and special surveys in the disturbed region of central California. Gravity data were processed for a new survey of the calibration base between Brownsville, Tex. and Winnipeg, Manitoba.

Geoid heights and deflections of the vertical were determined at various locations in conjunction with geodetic requirements of the Department of Defense. Anomalies in intensity and direction of the gravity field were calculated for several ballistic trajectories on the Atlantic Missile Range.

Gravity intensity data were furnished for a large number of physical laboratories as requested throughout the year.

geodetic
New York Computing Office

The New York Computing Office continued operation during the fiscal year with an average personnel of 20. The work accomplished included the computation and adjustment of triangulation and leveling, and the editing and typing of geodetic data for reproduction. Mr. Earl S. Belote, who was in charge of the New York Computing Office for many years, retired on November 30, 1961, after 30 years with the Bureau. Mr. Joseph F. Dracup was appointed in charge of this office, which is under the administrative supervision of the New York District Office.

Geophysics Division

The Geophysics Division plans, writes the instructions, and supervises the execution of magnetic and seismological investigations; conducts magnetic and seismological observatories and laboratories; determines the location of earthquakes and analyzes earthquake wave motion; investigates the relationship between seismological or magnetic phenomena and other geophysical phenomena; calibrates magnetic instruments and maintains the international magnetic standards; calibrates and standardizes seismological instruments; analyzes, compiles, and publishes the results of its activities for use by the Government and the public for charting, engineering, scientific, and defense purposes; 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 other divisions in maintaining the Seismic Sea Wave Warning System.

Geomagnetism

Monitoring the earth's magnetic field is an important and continuing Bureau responsibility, calling for a substantial effort commensurate with the complexities of the

phenomenon 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, observations were made at 59 magnetic repeat stations. Following a plan that proved effective in recent years, a portable magnetograph was used at selected locations to provide data for more accurate reduction of field observations to mean values. Magnetic observations were also made at 25 other stations by personnel of another division.

Plans were well underway for establishing a cooperative magnetic observatory at Dallas, Tex. The Coast and Geodetic Survey will furnish the instruments and personnel to operate the observatory; Texas Instruments, Inc., will underwrite the cost of constructing the buildings, providing access roads, and utilities; and the Graduate Research Center of the Southwest will furnish the needed land and coordinate subsequent research projects. This observatory will be a welcome addition to the observatory program in contiguous United States where coverage is inadequate.

Worldwide data received through correspondence and exchange were accumulating at a very satisfactory pace for the forthcoming 1965 magnetic charts. Recent additions to our records include values for approximately 37,000 stations, derived largely from vector airborne magnetometers of the Navy Hydrographic Office, the Dominion Observatory of Canada, and shipborne magnetometers of both Japan and the United States. The study of analytical techniques for improving magnetic charts continues.

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, continued in operation with improved instrumentation. Also, an interim magnetic observatory was established on the Eights Coast and operated for 6 weeks. This station will be permanently installed in the latter part of 1962. The Bureau participated in the Antarctic Peninsula Traverse, thus obtaining badly needed ground magnetic data. Instructions for navigation and magnetic observing on this type traverse were prepared by this Bureau.

The magnetic standards were established at Fredericksburg Magnetic Observatory largely through the routine use of a proton vector magnetometer. This will enable future calibration and testing of all kinds of magnetic instruments to be put on a common basis with the greatest absolute accuracy yet attained at a magnetic observatory. Similar instrumentation was being prepared for the observatories at Tucson, and College.

Seismology

During the year, seismologists from the Survey and technicians from Texas Instruments, Inc., began installation of standard seismographs in a net of 125 stations extending from the South Pole to the Arctic Circle. This is a project sponsored by the Advanced Research Projects Agency (ARPA), whereby basic seismological data of high quality would be available to seismologists and other scientists interested in conducting basic research in the field of seismology. The net, even though it is only one-half established, has provided unique information regarding the wave characteristics and the energy release of a number of earthquakes in certain areas of the world and large explosions in this country and on other continents.

As part of the ARPA program, the Survey is establishing an archives and data analysis center in Washington. Some of the immediate responsibilities will be to improve computer methods for epicenter determinations, investigate traveltime anomalies, revise velocity curves for different focal depths, study magnitude and energy determinations, and evaluate methods for distinguishing earthquakes from artificial explosions.

The Seismological Investigation Section, working in close collaboration with the Electronic Computing Division, continued its efforts to improved computer programs for the prompt location of earthquake epicenters. New programs were written for the IBM 1620 that will shift much of the routine work from professional personnel to the data processing machine. For example, the seismologist previously had to evaluate the preliminary epicenter determinations using data from a limited number of seismograph stations. With the 1620, the computer will do the evaluating according to the criteria established by the seismologists. The computer will also provide a complete printout of all data pertinent to the solution of an earthquake epicenter. This printout will include station readings, earthquake positions, distance from epicenters to stations, and accuracy of epicenter determinations. This will greatly reduce the compilation and processing of data for the monthly Seismological Bulletin.

In the study of earthquakes, the Survey maintains and operates 29 stations. These stations with modern, sensitive seismographs annually detect about 50,000 earthquakes, and daily report their observations by telegraph to the Washington Office. In addition, about 200 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 2,200 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 were 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 181 domestic and 52 foreign areas. Special

earthquake readings and seismograms, primarily for use in research projects, were supplied to seismologists in the United States, Argentina, British Solomon Islands, Canada, Chile, England, New Zealand, Nicaragua, Portugal, Territory of Papua and New Guinea, and West Indies.

In the engineering seismology field, the Survey operates a network of 69 strong-motion stations in the area west of the Rocky Mountains and 7 in Latin America. The instruments at these stations operate only during an earthquake, since they are activated by the first motions of the tremor. Their purpose is to record the principal ground motions that can be measured in the physical terms of displacement and acceleration. Both measurements are needed by engineers for the design and construction of earthquake resistant structures, by public and private officials in drafting building codes and safety regulations, and by insurance companies providing earthquake coverage.

The Weed strong-motion seismograph at Monterey, Calif., was removed and the station secured on February 14. Corrosion had rendered the instrument useless.

At the end of the fiscal year, 55 seismoscope stations were implemented in southern California, 36 in northern California, and 2 in Arizona, making a total of 93 stations, exclusive of 20 purchased, installed, and maintained by the Los Angeles Department of Water and Power. By informal agreement, the instruments will become a part of the existing network of such stations. The seismoscopes are inverted pendulums with characteristics similar to those of an average commercial building and are designed to make records equivalent to the response of the building to earthquake motions.

Since the Seismological Laboratory buildings in Albuquerque, N. Mex., were accepted by the Survey excellent progress was made in converting them into a working laboratory, instrument shop, and a first-class observatory. All of the equipment and furniture transferred from Washington had to be placed and much of the surplus shop equipment had to be overhauled and replacement parts installed.

A set of worldwide seismographs was installed in the underground vault in September and the results from these instruments proved very satisfactory. A second set, to be used for training and testing of individual units, was installed in the spring. Special seismographs provided by the California Institute of Technology and the Sandia Corp. were placed in the same underground vaults for test and experimental operation.

Numerous field trips were made during the year to service seismographs in western United States and to lend assistance in the study of ground motion problems. Test equipment was provided several seismograph stations to evaluate the ground noise level and adequacy of the structures to house the standard seismographs. The six mobile trailer units, in

operation at the Nevada Test Site for nearly two years, were checked and calibrated at the Laboratory following the GNOME experiment in December 1961.

In the spring of 1962, arrangements were initiated for the Laboratory to assume responsibility for the maintenance, development, and support program for the World Standardized Seismograph Network. The new building to house this activity was under construction.

The field party of the Special Projects Branch recorded earth surface motions induced by the nuclear detonation program at the Atomic Energy Commission's Nevada Test Site (NTS). Six mobile seismograph trailers and one data reproduction trailer participated in the program with seismic data recorded in terms of transitory earth particle displacements and velocities on radial lines from 30 to 350 km. from NTS. A network of strong-motion seismographs operated in conjunction with the mobile units to record transitory earth particle displacements and accelerations at distance ranges of 0.4 to 21 km.

At Tucson, a contract was awarded on June 26 for the construction of a new outpost seismological facility on land obtained from the U. S. Forest Service. Upon completion, instruments of the Worldwide Standardized Seismograph System will be installed.

The Chief of the Seismology Branch attended a meeting of the International Seismological Summary in Paris, France, July 7-15, to evaluate the publication program for reporting earthquake data from worldwide seismograph stations. In addition, plans were formalized for establishing an international seismological center which would include an electronic computer system for locating earthquakes and printing out data that could be reproduced by photo offset procedures for distribution. Other related functions to be performed included compilation of mathematical tables, preparation of pertinent data for all stations, and the conducting of limited research that is closely related to earthquake locating procedures.

Later, Mr. L. M. Murphy conferred in Boston, Mass., with Dr. John Hodgson of the Dominion Observatory, Ottawa, Canada, and representatives of the Itek Corp. relative to programs for microfilming seismograms. This meeting was held to insure the fact that the proposed Coast Survey retrieval and microfilming programs would be compatible with the Canadian system and the system proposed at the International Seismological Summary meeting.

Chief of the Branch attended the Pacific Science Conference at the University of Hawaii, Honolulu, August 21 through September 2. During this conference, several meetings on tsunamis, sponsored by the special committee of the World Meteorological Organization and the International Union of Geodesy and Geophysics were attended. It was evident from these meetings that the Seismic Sea Wave Warning service should be expanded to many additional countries around the Pacific, and that there is a definite need for improving the system for prompt earthquake locations by the Honolulu

Observatory. It was felt that the observatory should be prepared for extreme emergencies when communications might fail in several regions of the Pacific, and under such conditions, it should have the capability of locating the earthquakes from its data only. A very interesting experiment is now being conducted by the Hawaii Institute of Geophysics, whereby a pressure gage is being installed about 400 miles off the Hawaiian Islands to determine wave characteristics unimpeded by coastline reflective and refractive effects. The knowledge of wave actions at sea and along the coasts is the major void in providing a more effective warning system.

Dr. D. S. Carder and Mr. L. M. Murphy attended a colloquium on "Detection of Underground Nuclear Explosions" at the California Institute of Technology on December 14 and 15. Conferences were held with scientists interested in all phases of the Bureau's earthquake and engineering seismology programs. Mr. Murphy reported briefly on the preliminary results of the Survey's seismic operations during the GNOME experiment.

Mr. L. M. Murphy attended a symposium on the UNESCO Mediterranean Seismic Mission in Rome. The participants were leading seismologists from Mediterranean countries and members of the UNESCO Seismic Mission who have been visiting countries around the Mediterranean for the purpose of evaluating the status and scope of seismic work in the respective countries. The objectives of this mission and seminar were similar to those conducted in Tokyo and Santiago following UNESCO missions throughout southeast Asia and South America. The success of these two missions was evidenced by a strong preliminary recommendation by UNESCO to assist financially in improving the stature of seismology in many of the earthquake-torn countries.

A meeting of the Eastern Section of the Seismological Society of America held in Cincinnati, Ohio, on November 10, was attended by Bureau seismologists. Also, most of the professional people in the Branch attended the sessions of the annual meeting of the American Geophysical Union in Washington, D.C., on April 25-28.

Dr. D. S. Carder, Messrs. L. M. Murphy, J. N. Jordan, and W. K. Cloud represented the Bureau at the annual meetings of the Seismological Society of America at the University of Southern California at Los Angeles, April 16-18. Dr. Carder, retiring president of this organization, presided at the Board meeting and at a special symposium on Project GNOME.

Seismic Sea Wave Warning System

The dissemination of tsunami warning information was expanded to include Taiwan, Philippine Islands, Fiji Islands, Chile, and Hong Kong. One seismograph station at Hong Kong and three tide stations at Legaspi, Philippine Islands, and Hachinohe and Shimizu, Japan, were added to the System.

The 4th edition of the Communication Plan for Seismic Sea Wave Warning System was prepared and issued.

A complete review of the communication methods of the SSWWS was made by the Defense Communications Agency under the direction of the Joint Chiefs of Staff. Several areas for improvements were noted and the necessary changes made.

Work was also begun on a comprehensive annotated bibliography of tsunamis in conjunction with the International Committee on Tsunamis of the International Union of Geodesy and Geophysics. The bibliography will have approximately 2,000 entries and will be of value to research studies now being conducted in this relatively new field of scientific interest.

In view of the growth of this warning system in the Pacific Ocean area, several international scientific organizations, including the World Meteorological Organization, the International Union of Geodesy and Geophysics, and the United Nations Educational and Scientific Cooperative Organization, have expressed interest in fostering this very humane effort by the United States under the administration of the Coast and Geodetic Survey.

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. Its principal activities include surveys and maps of the coast line to obtain control for hydrographic operations, locate aids to navigation, obtain terrain data for the construction and maintenance of nautical charts; participation with other divisions in measuring tidal currents, in developing and operating deep sea cameras for photographing the ocean floor, and in developing and operating of special ballistic cameras in the satellite tracking program.

Photogrammetric surveying and mapping activities were in progress throughout the United States (including the States of Alaska and Hawaii), American Samoa, and Puerto Rico, in support of the Bureau's hydrographic and nautical charting programs, the aeronautical obstruction charting program for the Federal Aviation Agency, and other national cooperative programs.

New developments and applications of photogrammetric techniques in the Division are providing new instrumentation and procedures for increased precision and economy in our surveying and mapping operations; these techniques have been and are being evolved from development studies in the fields of analytical photogrammetry, satellite triangulation, bathymetric photogrammetry, tidal current surveys, aerial color photography, and other photogrammetric systems.

In the early fall, tests were made aboard the ship EXPLORER with the first 35 mm. deep-sea camera system. Stereoscopic

panchromatic and color photography was obtained at a depth of about 600 meters. The photography was excellent and led to the development of the first operational procedures for precise microrelief mapping of the ocean's floor. Late in the year, a series of tests were made with a second deep-sea camera system in the Caribbean Sea off Puerto Rico. During the tests, training was provided to several oceanographers in the operation of the system.

A field inspection trip was made by the Chief of Division; Aeronautic and photogrammetric parties, and the Portland and Seattle District Officers were visited, including a conference with the U. S. Army Engineer officials at Walla Walla, Wash.

The Chief of Division attended the VII General Assembly, Pan American Institute of Geography and History (PAIGH), and the IX Pan American Consultation on Cartography in Buenos Aires, Argentina. The American Society of Photogrammetry's semiannual convention in New York City was attended by the Assistant Chief.

Exhibits on analytic aerotriangulation and the deep-sea camera system were prepared and displayed at the annual meeting of the American Society of Photogrammetry in Washington. Guided tours through the Division were arranged for approximately 200 delegates attending the meeting.

Two photogrammetrists were attached to the Honolulu District Office to execute photogrammetric field surveys on Maui and Molokai Islands, to provide photo-hydro support on hydrographic operations, and to complete airport obstruction chart surveys. Their operations were inspected by the Chief, Operations Branch, attached as an observer on a photographic mission assignment to Hawaii.

Training of new field and office employees in photogrammetric procedures was continued in the Washington office, the photogrammetric offices, and the field. One commissioned officer was assigned to fixed wing flight training and another completed advanced fixed wing training at Fort Rucker, Ala.

A photogrammetric research laboratory was established. It will be used for testing and calibrating the nine-lens camera, single-lens cameras, aerial film bases, and photographic emulsions, lenses, etc. When instrumentation is completed, it will make possible improvements in the metric and photographic quality of our aerial and underwater photography, and will facilitate the development and applications of other photogrammetric systems.

In connection with the Satellite Tracking Program, personnel from the Division studied the operation of the Wild BC-4 tracking camera system at the Ballistics Research Laboratory Aberdeen, Md., and attended a conference on optical tracking for Project ANNA at the Air Force Cambridge Research Laboratories in Bedford, Mass.

The major programing of the Clary desk-size electronic computer was completed; 18 programs were wired and tested, e.g., airline distances, intersection and resection problems, inverse solutions, traverse, and other related programs. The computer provided a means of rapid solutions to a large number and variety of computational problems. Computer downtime was surprisingly small. Its acquisition was more than justified economically and productively.

Aerial and Laboratory Photography

Two photographic missions were active during the year to obtain panchromatic, infrared, and color photography at various scales for charting, special surveys, and research and development work. The volume and types of photography are indicated in the attached statistical summary.

Air Photographic Mission 701 is a cooperative arrangement with the Coast Guard which provides the aircraft and flight crew, and the Coast Survey provides the navigator, photographer, and all the photographic supplies and equipment. The aircraft has been modified for tandem operation, if required, of the nine-lens and single-lens cameras. The mission was active on photographic assignments in Alaska, Hawaii, American Samoa, Puerto Rico, and in conterminous United States during seven months of the year. For a brief period in mid-January for additional photography in Hawaii, a private modified aircraft was rented locally and the photographic assignment successfully completed.

Air Photographic Mission 702, flying a leased aircraft and manned by a Coast Survey crew, operated throughout conterminous United States and Puerto Rico. This mission was active nine months during the year.

To evaluate the feasibility and adaptability of small-scale photography for charting and other mapping applications, high altitude aerial photography was obtained of a selected test area with the Wild RC-9 wide-angle (120°) single-lens camera.

The Division's redesigned and modernized air photographic laboratory, with its new facilities for color processing, produced outstanding results, especially in the new and growing applications of color photography in the areas of surveying, mapping, and research. This is understandable since color photography, in utilizing a partial range of the color spectrum, records detail of definitive and varied shadings or intensities which help to increase the accuracy of photogrammetric identification and interpretation.

An effective training program was in operation for aerial photographers; they will be rotated with our active photographers on photographic missions and used as replacements.

A statistical summary of the Aerial and Laboratory photography follows:

Summary

<u>Type of Rolls of Film Exposed</u>	<u>Quantity</u>
Nine-lens.....	7
Panchromatic.....	115
Infrared.....	20
Color.....	<u>67</u>
Total.....	209

<u>Laboratory Processing and Printing</u>	<u>Quantity</u>
Aerial negatives developed.....	37,600
Nine-lens prints.....	400
Single-lens prints.....	64,000
Photographic plates.....	<u>2,200</u>
Total.....	104,200

<u>Activity</u>	<u>Linear Miles of Photography</u>	
	<u>Mission 701</u>	<u>Mission 702</u>
Nautical charting program	6,200	8,600
Aeronautical charting program	2,500	12,600
Miscellaneous projects	<u>400</u>	<u>1,200</u>
Totals	9,100	22,400
Grand Total	31,500	

Field Surveys for Nautical Charting

Photogrammetric field parties, operating along the coastal areas of the continental states, Hawaii, and Puerto Rico, executed photogrammetric surveys in connection with the revision and basic mapping for the construction and up-to-date maintenance of nautical charts, located navigational aids and landmarks, established supplemental horizontal control which was photo-identified along with recovered control for aerotriangulation bridging, and furnished photo-hydro control in support of hydrography. In Alaska, this work was accomplished by personnel from the ships operated by the Office of Oceanography.

The field inspection work on the special Cape Cod project was completed and the field edit phase was in progress. This project consists of 11 charts that were photogrammetrically compiled on chart drawings; this method reduced the lead time previously required for new survey data to appear on the published charts. To conform to the charting requirements, close liaison and coordination were maintained with the Nautical Chart Division.

This method of photogrammetric charting is continuing. Field inspection for one chart along the Delaware Coast was completed. Field surveys for 5 charts were in progress on the Buzzards Bay project. On this project, tidal controlled photography--panchromatic, infrared, and color--was obtained at the MHW and MLW stages of the tide; tide staffs were established at 5 existing tide stations, and the photography controlled by radio communications between the flight crews and the manned stations.

Field photogrammetrists provided photo-hydro support to 6 ships, 2 launches, and 1 shore based party engaged in hydrographic operations.

Following the disastrous Atlantic storms of early March, which wrought extensive coastal changes and property damage, emergency plans were immediately drafted to provide photogrammetric field surveys and photo-hydro support to a crash hydrographic program. Practically, all Atlantic coast activities were channeled to expedite the Storm Damage Surveys. Two Air Photo Missions were assigned the immediate task of acquiring storm damage photography; their combined operations totaled 2,150 linear miles of flight lines extending from Cape Fear, N. C., to Cape Cod, Mass. On completion of the photography, six field units provided photo-hydro support and completed field surveys in Shinnecock Inlet, Long Island, N. Y.; Little Egg Inlet, N. J.; Cape Henlopen, Del.; Indian River Inlet, N. J.; Ocean City Entrance, Md.; and Chincoteague, Va.

Office Photogrammetry

Photogrammetric office activities continued to provide detailed map information (shoreline, foreshore, offshore, and inland features of interest to the mariner), for the construction and maintenance of regular and small-craft charts, special shoreline surveys and supplemental control in support of hydrography, the location of navigational aids and landmarks, and other special photogrammetric operations consisting of the reduction of tidal current measurements, ocean floor mapping, star plate measurements, water depth determinations, and other technical services.

During the year, office work was in progress on 40 mapping projects (a total of 630 maps), in various areas along our coastline which included Alaska, Hawaii, and Puerto Rico. A total of 202 specially prepared map sheets with aerial photographs were furnished to 12 ships, 2 launches, and 1 shore-based hydrographic party. A summary of field and office accomplishments on Coastal Photogrammetric Surveys is attached.

Summary of Coastal Mapping

Locality	Field surveys (Including hydrographic support)		Map compilation		Maps registered
	Shoreline (Linear miles)	Area (Sq. miles)	Shoreline (Linear miles)	Area (Sq. miles)	Number
Atlantic Coast:					
Maine to Cape Henry	310	450	575	625	34
Cape Henry to Key West		15			6
Puerto Rico & Virgin Islands	125	165	60	55	
Gulf Coast	190	10	235	200	22
Pacific Coast:					
California		135	55	65	
Oregon and Wash.	65	45	145	110	27
Alaska:					
Gulf of Alaska	200	65	100	150	2
Western and Northern					2
Hawaii	150	100	105	120	
Total	1,040	985	1,275	1,325	93

Several instruments were acquired to facilitate the processing of the Division's increased workloads: Three Kelsh plotters for stereocompilation; a coordinatograph for control plotting; a Log-E-Printer to process photography; a scanning oscillograph for the Mann Comparator. Our first nine-lens stereoscopic "A" plotter was donated to the Smithsonian Institution and replaced by a Wild B-8 wide-angle plotter to permit stereocompilation using wide-angle RC-9 photography.

In connection with the emergency storm damage surveys on the Atlantic Coast, requests for photographs and information from the press, other Government agencies, and the public were unprecedented; over 2,500 photographs were processed to comply with these requests. In a coordinated support of the storm damage program, the office accomplishments were:

1. 17 planimetric and 18 shoreline maps revised.
2. 105 chartlets and 20 charts revised.
3. Exhibits--62 slides, 18 revised map displays, and 5 mosaics prepared.

Up-to-date maintenance of the nautical charts, as a major and important phase of the Bureau's nautical chart program, has become increasingly vital because of the rapid industrial development in our harbors and along much of our coastline as the result of cultural and natural changes. In cooperation with the Nautical Chart Division, our maintenance section corrected photogrammetrically 132 regular charts, 14 small-craft charts, 68 basic drawings, and processed 39 chart letters for the position location of 113 landmarks. By the utilization of color photography, 228 aids to navigation were located.

Special Surveys

An exhaustive experimental tidal current survey of Charleston Harbor, S. C., was completed by photogrammetric methods. The results were excellent and demonstrated the practicality of aerial photography and photogrammetric measuring techniques, for rapidly providing a detailed synoptic current survey of an entire harbor area.

Electronic Computing Division

For the major part of this year, the activities relating to electronic computing and data processing were accomplished within the organizational framework of the Triangulation Branch in the Geodesy Division. Even though plans were underway for the creation of a new Division early in calendar year 1962, the final departmental approval was not obtained until June 1.

The acquisition of a second computer for the work of the Bureau required considerable planning, first, for the

feasibility study, second, the development of new programs, and third, the organization of the new Division.

The major part of the work relates to the scientific and engineering activities of the Bureau. A new computer, an IBM 1620 with 100,000 decimal storage, was purchased by Advanced Research Projects Agency for this Bureau primarily for epicenter reduction and associated seismological research. This latter phase of the work has been expanding rapidly and will continue to do so for the next year or two.

Assistance has been given toward the development of techniques for the analytical reduction of geomagnetic data in connection with the preparation of the 1965 isogonic chart series.

The major programs for analytical aerotriangulation were completed during the year and put into operation. The Coast and Geodetic Survey is the first Federal agency to use such programs on a production basis.

While no major changes were made in the program for computing and adjusting geodetic surveys, a major part of the scientific computing was for this purpose.

The Office of Oceanography requested programs for preparing input for the automatic plotter using the output of the automatic hydrographic recorder, a program for computing Loran C intersections, special studies in tidal analysis, and the computation of velocity corrections.

The data processing activities for administration work increased considerably during the year. Plans were initiated for a new system of time and attendance reporting; leave accounting, etc., to be made effective January 1, 1963. Other related changes in the personnel records systems and cost accounting systems are being developed to be fully coordinated with the new time accounting.

Even though the Division has a new computer which more than trebles our former capabilities, studies are under way to determine its needs through the next two or three years. The increasing workload placed on this Division indicates that a third computer, faster and larger than the two we now have, will be needed by the end of fiscal year 1964. In the meantime, time will be purchased on a larger computer as needed.

The personnel of the Division took a very keen interest in their new responsibilities. Several additions to the staff were made, and efforts were continued to recruit others in order to bring the Division to a full complement of 30 for fiscal year 1963.

NATIONAL AND INTERNATIONAL COOPERATION

International Agencies

The variation-of-latitude observatories at Ukiah, Calif., and Gaithersburg, Md., continued in operation as a part of the International Polar Motion Service.

The Coast and Geodetic Survey, with some support by the National Science Foundation, continued to operate one of the subcenters of World Data Center A, for the collection and exchange on a worldwide basis of data in geomagnetism, seismology, and gravity. This activity, begun as a part of the International Geophysical Year, continued to play a very active part in the subsequent use of the geophysical data.

Magnetic activity reports from all the Bureau's magnetic observatories were prepared and forwarded to the international permanent center in the Netherlands, as part of our cooperation with the International Association of Geomagnetism and Aeronomy (IAGA) of the International Union of Geodesy and Geophysics (IUGG).

A member of the Geomagnetism Branch represented the Bureau at a symposium on Earth Storms (Magnetic Storms) and Cosmic Rays, held in Kyoto, Japan, under the sponsorship of IAGA.

Magnetic observations were made at Fredericksburg as part of the international comparison program of magnetic standards.

At the request of the University of Mexico's Institute of Engineering, following the damaging earthquakes of May 11 and 19, 1962, the Seismological Field Survey made a number of building period observations in Mexico City and Acapulco. It is hoped that this constitutes the beginning of a continuing program of research in structural dynamics as related to earthquakes.

Information about seismographs and earthquake motions was supplied to seismologists in the following countries: Argentina, British Solomon Islands, Canada, Chile, England, Guam, New Zealand, Nicaragua, Peru, South Africa, Territory of Papua and New Guinea, and West Indies.

National Agencies

A new series of combined horizontal and vertical control diagrams at a scale of 1:250,000 is being published in cooperation with the Geological Survey. The Coast and Geodetic Survey control is shown in black and the Geological Survey control is shown in red on a blue base. The base maps for this series are modified copies of topographic maps extending 1° in latitude and 2° in longitude. Forty-one of the proposed 467 diagrams are completed.

The Bureau cooperated in extending interstate highway control surveys with Arizona, Illinois, Pennsylvania, and

Tennessee. Inspection of similar surveys accomplished by state or private organizations was made in Minnesota, Kentucky, Mississippi, and Tennessee.

Work continued for the Air Force in providing all types of geodetic control at the Atlantic Missile Range, the Pacific Missile Range, and many operational launching sites mostly throughout the western half of the United States. Astronomic observations for precise azimuth control along the main islands of the Hawaiian Archipelago were provided as our part of a cooperative project with the Navy, Army, and Air Force in the Eastern Pacific survey.

The north-south boundary line between Maryland and Delaware was resurveyed in cooperation with those states.

The following leveling was accomplished under cooperative projects: releveled in certain parts of California to detect changes of elevation in cooperation with the California Department of Resources; leveling along the Snake River in Washington at the request of the Walla Walla District Engineer; leveling at the request of the Geological Survey in the region of Ajo, Ariz., in connection with a mapping request by the military; leveling in the vicinity of the Glen Canyon Dam and Reservoir at the request of the Bureau of Reclamation.

The control surveys on the access highway and the boundary survey work for the Federal Aviation Agency at the Dulles International Airport, Va., were completed.

Part two (Atchafalaya Bay and vicinity, La.) of the cooperative project, with the Bureau of Land Management and the State of Louisiana, was completed. The project was carried out cooperatively between the Photogrammetry Division and the Operations and Marine Data Divisions of the Office of Oceanography. This project provided tidal data and basic maps for use of the Coast and Geodetic Survey, and a special series of maps showing the low-water line for the use of the Bureau of Land Management and the State of Louisiana in administering the leasing of offshore areas in accordance with the Submerged Lands Act of 1953 (Public Law 31).

Field surveys were completed on the reimbursable project with the Walla Walla (Wash.) District of the Corps of Engineers for the mapping and charting of the Ice Harbor Pool on the Lower Snake River, Idaho. Bridging was completed in June and the office compilation programed for next fiscal year.

The cooperative project, covering the Chesapeake Bay area, with the Maryland Department of Tidewater Fisheries was completed. It provided surveys for the revision of nautical charts and a special series of maps to denote the limits of oyster bed areas for the State of Maryland. A new but similar cooperative agreement was made for surveys of the Chincoteague and Assawoman Bays, Md. The new agreement called for the completion of the field surveys

this year which was accomplished and the office work next year.

Beginning with fiscal year 1962, the fiscal responsibility for the entire Airport Obstruction Charting Program was transferred from the Coast and Geodetic Survey to the Federal Aviation Agency; this decision was made by the Budget Bureau in the fall of 1960. However, the Coast and Geodetic Survey continued the program for the Federal Aviation Agency on a reimbursable basis. The program provides for the preparation of special airport obstruction charts, the location of air facilities (omni directional ranges, tacans, and similar electronic aids to navigation), and the preparation of mosaics for noise abatement studies at airports. Airport obstruction charts (piston and turbine) are special purpose charts used by the Federal Aviation Agency and the airlines to administer and comply with safety regulations pertaining to the gross takeoff and landing weight of aircraft with respect to the length and gradient of a runway, obstacles along the takeoff and landing flight path, and other factors. The air facilities program provides for the location or position of newly established facilities and for the relocation of those that are occasionally moved. Aerial photography for this program in the conterminous States and Puerto Rico was obtained by Air Photo Mission 702, and by Air Photo Mission 701 in Alaska and Hawaii. Eleven 2- and 3-man aero parties were assigned to airport obstruction chart surveys and the location of air facilities in the conterminous States, Alaska, Hawaii, and Puerto Rico. Accomplishments during the year were as follows:

Summary of Airport Obstruction Charting Program

<u>Type</u>	<u>Airport surveyed</u>	<u>New charts published</u>	<u>Charts revised and reissued</u>
Airport obstruction charts (piston)	4	4	36
Turbine data sheets	124	136	
Air facilities located	35		
Noise abatement mosaics completed	18		
Airports photographed	165		

At the end of the year, 473 airport obstruction charts (piston) and 160 airport obstruction charts (turbine) were on issue, a total of 83 noise abatement mosaics were completed, and the positions of 789 air facilities determined.

On a cooperative basis, aerial photography in the American Samoa was obtained by Air Photo Mission 702 for the preparation of topographic maps by the Geological Survey and the revision of nautical charts by the Coast and Geodetic Survey.

Aerial photography was obtained for the Colorado River Boundary Commissions of California and Arizona, in connection with a proposed survey of the Colorado River boundary.

The Civil Aeronautics Board was furnished 669 computed airline distances between domestic or foreign airports.

The use of the Laboratory facilities at the Fredericksburg Magnetic Observatory by other agencies continued and also increased. The National Aeronautics and Space Administration (NASA), the National Bureau of Standards, the U. S. Navy Hydrographic Office, and the U. S. Army were particularly active. Some use of the installation was also made by private firms in connection with their research and development contracts with the Defense Department and NASA.

Magnetic surveys were made to test the suitability of compass swing areas at 17 airfields within the United States, most of which were at Air Force Bases. 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.

The Bureau participated in a 3-day seminar sponsored by the University of Pittsburgh by sending a representative and presenting a description and discussion of the Survey's geomagnetic charting program.

The Seismological Field Survey in cooperation with the Los Angeles Department of Water and Power, the Earthquake Engineering Research Institute, the California Institute of Technology, and the University of California at Los Angeles conducted vibration measurements at Dry Canyon Dam, 7 miles north of Saugus, Calif., during May 1962. This hydraulic core earthfill dam, damaged during the 1952 Kern County earthquakes, was tested to determine if the dam had natural periods in the range of 0.1 to 1 second which might explain damage, and if microtremor techniques developed by the Japanese could detect structural periods without the use of shaking machines. Records are being analyzed for a report on this project.

Preliminary vibration observations were made on the 145-foot intake tower at Encino Dam in southern California. The fundamental period was 0.58 second and damping 8 percent critical. Shaking machine studies of the tower's vibrational characteristics will be made by the California Institute of Technology. Vibration observations were also made on the following buildings: In San Francisco, the Southern Pacific Building (prior to removal of a huge sign on top of the tower); in Los Angeles, the Barrington Plaza, Pacific Employers' Group Insurance Building, and Union Bank Building.

At the request of the Bureau of Reclamation, a series of high explosive underwater detonations in Lake Mead were monitored at Hoover Dam by a Seismological Field Survey party in November. This work was initiated to determine whether underwater explosions (up to 6,000 pounds), as detonated by the Geological Survey in connection with their crustal study program, would cause excessive accelerations at the dam. Recorded accelerations and displacements were minor, even as compared with a previously recorded earthquake which caused no damage to Hoover Dam.

The Bureau of Reclamation, Denver, Colo., was furnished preliminary arrangements for providing necessary specifications for strong-motion equipment, assistance in purchasing the instruments, and testing the installation of respective sites at their San Luis Project, Calif.

The Survey participated in the U. S. Navy operation HYDRAL1, with six mobile seismic recording stations, for the purpose of studying the seismic signal characteristics from high explosive detonations at varying depths in the Pacific. Charges of 10,000-pound high explosives were detonated at depths of about 6 to 220 feet near San Clemente Island, Calif.

A seismic background noise survey was made at the Pensacola Naval Air Station, Fla., to evaluate vibrations induced by industrial machinery and other sources. A gyro test facility was planned for the area and design criteria had to be developed to reduce the noise level to an acceptable magnitude for the installation and testing of very delicate instruments. A prototype test pedestal was constructed and seismic measurements were made to determine the response characteristics as generated from earth motion.

For the Bureau of Yards and Docks, the Charleston, S. C., office was furnished seismological publications, references, and information about the Uniform Building Code; the Washington, D. C., office was furnished a list of earthquakes that occurred near Okinawa since 1923 that were strong enough to have caused structural damage; the San Francisco, Calif., office was furnished information relative to acceleration levels of background vibration in the San Francisco Bay area. The Navy Hydrographic Office was furnished the epicenter, origin time, depth, and magnitude of an earthquake felt on board a ship south of Panama on September 19, 1961.

At the request of the Directorate of Range Development at Cape Canaveral, Fla., a monitoring program was initiated to record the seismic signals generated by missile launches. The objective was to obtain data on the seismic environment generated within the Cape Canaveral Missile Test Area and immediate vicinity by current missile launches, thereby permitting extrapolation to the seismic environment generated by advanced missile system launches. These predictions will be used by the Air Force Missile Test Center, National Aeronautics and Space Council, the Range Contractor, and other agencies to develop design criteria for the control of hazards to life and property.

The Claims Officer, Luke Air Force Base, Ariz., was furnished seismological publications and seismic information on earthquakes in Arizona. The Claims Officer at Robins Air Force Base, Ga., was furnished information on an earthquake near Macon, Ga.

At the request of the Atomic Energy Commission, Capt. P. A. Weber, Dr. D. S. Carder, and Mr. L. M. Murphy represented the Bureau at the GNOME underground nuclear event on December 10 at Carlsbad, N. Mex. They participated in the scientific

briefing on December 9, witnessed the explosions the following day, and then at the AEC Headquarters, reviewed the preliminary records from the strong-motion and teleseismic stations operated by government and private organizations. In monitoring this event, the Bureau operated 12 strong-motion, 6 safety, and 6 intermediate-range seismograph stations with 136 recording seismometers and 21 seismoscopes at the explosion site. Records from these instruments and from the Survey net and cooperating stations throughout the world were gathered and utilized in writing a comprehensive report on various facets of seismic phenomena.

Army Engineer District, Omaha, Nebr., was furnished seismicity map of the U. S. for 1959 and seismological references.

The Weather Bureau was furnished a list of seismological centers that could serve as a reference for weather observers to obtain information on local earthquakes.

Information about the purchase, construction and operation of seismographs was supplied to: Exploration Logging, Inc., National Radio Observatory, R. C. Rising Machining Co., Space Technology Laboratories, Stanford University, United ElectroDynamics, Inc., and University of Utah.

Earthquake information was given to the following: American International Underwriters, Inc., Argonne National Laboratory, Bell Telephone Laboratories, Inc., Conway Publications, Inc., Dartmouth College, Ebasco Service, Inc., Field Enterprises Educational Corporation, Hudson Engineering Corporation, Lamont Geological Observatory, Lehigh University, Marsh & McLennan, Inc., Mohawk Rubber Co., Michigan State University, Mandrel Industries, Inc., Radio Corporation of America, Rohr Aircraft Corporation, Southern Methodist University, Sandia Corporation, St. Louis University, University of Utah, University of Oklahoma, University of California, University of North Carolina, and Vestal Central School.

OFFICE OF CARTOGRAPHY

A steadily growing workload forced the Office of Cartography to seek more positive coordinating policies, examine and strengthen the organizational structure of the operating divisions, consider automatic data processing for the keeping of statistics, and press for a job order accounting system to provide the necessary information for management and production control purposes. Although good progress was made in this fiscal year, these are long-range objectives which will extend well into next fiscal year before accomplishment.

OPERATIONAL ACTIVITIES

Nautical Chart Division

Two new branches were established within the Nautical Chart Division. A Small-craft Chart Branch replaced the Special Projects Section, and the Standards Section and Aids to Navigation Section were combined to form the Nautical Data Branch.

To produce and maintain an adequate supply of the 831 nautical charts on issue, 460 drawings were forwarded to Reproduction, as follows: 4 new charts, 3 reconstructions, 82 new editions, 316 new prints, 31 reprints, and 24 overprints. Two charts were canceled by improved coverage. A total of 1,159 articles, relative to navigational dangers originating with surveys and reports from this Bureau, the Corps of Engineers, and others, were compiled for inclusion in the weekly Notice to Mariners. During the year, 4,930 items (surveys, letters, etc.) were received and all critical information shown thereon was immediately furnished the mariner.

Immediately after the record-breaking storm on March 7 and 8, 1962, all available Bureau facilities were assigned to obtaining and charting the tremendous changes along the coasts of New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina. First priority throughout the remainder of the year was given to the issuance of correction chartlets and emergency chart printings to furnish the mariner with post-storm conditions. Over 40 emergency chart printings and 35 chartlets of the area were published.

The practice of submitting, where feasible, advance prints of new compilations for examination by our District Officers, the Corps of Engineers, and the Coast Guard was continued.

Two new small-craft charts were published: No. 117, New Haven Harbor Entrance to Throgs Neck, Long Island Sound; and No. 165, San Francisco Bay to Antioch, Calif. This brought the total to five small-craft charts on issue. Small-craft charts Nos. 101, Potomac River, and 184, Puget Sound, were brought up to date and printed.

New chart 857A/B, Charlotte Harbor to Tampa Bay, Fla., published in February, represents the first major alteration in the Intracoastal Waterway chart format since the inception of the series 25 years ago. The new chart, accordion folded and offered in a handy folio jacket, is especially suited for plotting in close quarters. It is planned to convert all Intracoastal Waterway charts to accordion fold as soon as practicable.

Twenty-four charts were forwarded to Reproduction for overprinting. This method of applying excessive hand corrections eliminated the need of either destroying 36,111 copies of the charts or the addition of 1,201,298 hand corrections to them by the Distribution Division.

The following new unclassified charts were published:

New Nautical Charts Published

No.	Title	Scale
117	Long Island Sound, New Haven Harbor Entrance to Throgs Neck.....	1:40,000 (1:40,000)
165	San Francisco Bay to Antioch, Calif.....	(1:80,000)
857A/B	Intracoastal Waterway, Charlotte Harbor to Tampa Bay, Fla.....	1:40,000
6161	Columbia River--Thanksgiving Island to Coyote Island, Oreg. and Wash.....	1:20,000
6162	Columbia River--Blalock Island to McNary Dam, Oreg. and Wash.....	1:20,000
8086	Clarence Strait and Moira Sound, Alaska	1:40,000

The following unclassified charts were canceled:

Nautical Charts Canceled

No.	Title	Scale
8076	Harbors in Clarence Strait--Prince of Wales Island, Alaska (3 plans).....	(1:20,000) (1:10,000)
8306	Glacier Bay, Alaska.....	1:160,000

The Hydrographic Branch completed review of 37 hydrographic surveys, and verified and inked 7 trackline and wiredrag surveys. Eight hydrographic surveys were available for review at the close of the year, one less than on July 1, 1961. The plotting of two cable route surveys made for the American Telephone & Telegraph Co. was reviewed.

Mr. L. V. Evans III, vice chairman of the course committee, supervised the laying out of the course for the President's Cup Regatta held in September 1961.

In accordance with Bureau policy to provide training in the nautical chart program for professional employees, 3 cartographers were assigned to field hydrographic

surveying duty and 10 others received organized training in the Washington Office.

Aeronautical Chart Division

Civil and joint civil and military demands required the production of 1,805 aeronautical charts in several series. This represents a net increase of 82 charts over the previous year. Added were 4 Enroute High Altitude charts, 2 Enroute charts (Miami to Nassau, and Puerto Rico and Virgin Islands), 31 Area Arrival and Departure charts, 33 Standard Instrument Departure charts, and 197 Instrument Approach Procedure charts.

The following charts were maintained: 189 standard aeronautical charts with 296 issues; 130 Radio Facility charts with 1,403 issues; 1,458 Instrument Approach Procedure charts with 3,553 issues; and 28 auxiliary charts with 2 issues.

The Division continued the recompilation program of the Sectional chart series on a limited basis. Three charts were recompiled under this program which began in fiscal year 1956, making a total of 42 now being issued on the new format.

One hundred and ninety-seven new procedures were added to the Instrument Approach Procedure chart series, 9 were reinstated, and 138 dropped, making a total of 1,458 active procedures on issue at the end of fiscal year 1962. These charts were published in four separate series, as follows:

- 209 low frequency radio range (RNG)
- 354 automatic direction finding (ADF)
- 298 instrument landing system (ILS)
- 597 very high frequency omnidirectional radio range (VOR)

Each chart is designed to provide data for instrument approach and letdown procedures for use with specified types of electronic navigational aids.

Thirty-three Standard Instrument Departure charts (SID) were produced for 14 airport terminals. These charts were designed to give graphic portrayals of standard departure clearances, the texts of which are also printed on the chart.

On 18 of the 48 Area Arrival and Departure charts, transitional data were applied for transiting the intermediate and high altitude route structures to or from the terminal area.

All but five of the Terminal Area charts were discontinued and replaced by Area Arrival and Departure charts.

Special notices were produced and distributed as follows: 36 new Oil Burner Route charts, showing routes used by the Strategic Air Command for target runs; 1 Notice of Military Climb Corridor; 6 special notices concerning

areas in which hazardous conditions will exist; and 30 Graphic Notams depicting temporary changes in airway routing due to inoperative navigational aids.

The following table is a summary of aeronautical charts published:

Summary of Aeronautical Charts Published

Series	Number in series 7-1-61	New charts	New edi- tions	Re- prints	Number in series 6-30-62
U.S. WAC	43	.....	47	.....	43
Alaskan WAC	19	.....	20	.....	19
Sectional	88	.....	161	3	88
Jet Navigation	4	.....	3	4	4
Local	23	.....	46	.....	23
Route	5	.....	5	.....	5
Planning	1	.....	1	.....	1
Aircraft Position	6	.....	4	2	6
Radio Facility:					
Low Altitude	29	.....	364	.....	28
Int. Altitude	8	.....	104	.....	8
High Altitude	8	4	96	.....	4
Alaskan	1	.....	9	.....	1
Hawaii	1	.....	10	.....	1
Fed. Airways and Mileage	2	.....	.....	.....	.....
Terminal Area	45	.....	182	7	5
Area Arrival and Departure	22	31	406	1	48
Miami to Nassau ....	.....	1	1	.....	1
Puerto Rico and Virgin Islands ...	.....	1	5	.....	1
Standard Instrument Departure .....	.....	33	147	1	33
Instrument Approach Procedure	1,390	197	2,349	1,007	1,458
Outline Map	10	.....	.....	.....	10
Geomagnetic	9	.....	.....	.....	9
Azimuthal	3	.....	.....	.....	3
Projection	4	.....	.....	1	4
Miscellaneous	2	.....	.....	1	2
Total.....	1,723	267	3,960	1,027	1,805

The publication of several series of aeronautical charts had to be reprogramed due to limitations placed on the aeronautical charting program.

Reproduction Division

The Reproduction Division used 12,349,800 sheets of paper which, due to multicolor and backup printings, multiplied into 27,893,000 sheets through the press, to produce 56,424,971 copies of 4,731 charts, maps, and related data. It also processed 11,412 jobs through such operations as

type composition and photography in support of various Bureau activities or as reimbursable services to other Government agencies, non-government organizations, and individuals.

Chart and map production for fiscal year 1962 is tabulated below with comparative data for the prior year. Carefully planned use of the five-color press was largely responsible for the increased efficiency of press production.

	<u>Charts delivered</u>		<u>Copies printed</u>	
	<u>1961</u>	<u>1962</u>	<u>1961</u>	<u>1962</u>
Nautical	443	473	1,254,820	1,641,069
Aeronautical	3,085	3,885	45,585,420	53,270,240
Miscellaneous	251	373	607,570	1,513,662
	<u>3,779</u>	<u>4,731</u>	<u>47,447,810</u>	<u>56,424,971</u>
Press production (sheets through press)			29,892,700	27,893,000
Paper used (sheets)			10,362,300	12,349,800

Reorganization plans were formulated for establishing sounder program and production management within the Division. Production demands necessitated the detail of personnel to these phases of management during the development period. Establishment of the positions of Program Manager and Production Manager is anticipated early in 1963. This staffing will assure centralized and coordinated control of operations, with more effective use of production controls already available. A control and machine-load board was devised and put into use. The board depicts a 2 months' schedule for individual presses and provides job identification, quantities required, colors, etc. More efficient work flow, more meaningful forecasts, and closer adherence to schedules and deadlines will result.

Methods and techniques previously developed for or adapted to our needs, and which were effectively extended in use, include the pin register system, plastic negatives for engraving, and film negatives in lieu of wet plate (glass) negatives.

The pin register system for accurate registration of drawings and negatives, and its complement, the layout template, were refined and adapted to virtually all Radio Facility charts and numerous miscellaneous jobs; and the procedure was modified to fit the needs of nautical and aeronautical charts to the extent that some have been converted to film and plastic for reproduction.

The Division pioneered in the use of plastic sheets in the field of cartographic reproduction but, because of the frequent revision of nautical and aeronautical charts, wet plate negatives continued to be the prime medium for their maintenance. During this year, newer materials and techniques indicated the possibility of eventual substitution of plastics for glass in the reproduction of these charts.

One reconstructed Sectional chart was completed entirely on plastics and later revised without reverting to glass; and two reconstructed nautical charts were engraved and reproduced using the plastic medium. Some additional charts are scheduled for production from plastic negative engraving.

Film negatives on a dimensionally stable plastic base were adopted as a replacement for glass for producing the aeronautical data overprints on all standard aeronautical charts, with a reduction in cost and elapsed time.

Testing and actual production proved the practical value of rub-on printing plates for selected work, and more extensive use of this type of plate is planned for the coming year.

More efficient and economical use of manpower and equipment was achieved in several operations by improved planning and scheduling. Overtime required every fourth week for Radio Facility chart production was reduced from 600 hours to about 200, through improved layout procedures and carefully planned around-the-clock operations. Rescheduling of WAC and Local charts permitted printing two charts per press run instead of either "two-up" printing of a single chart or "one-up" printing on the small press, with a reduction in platemaking and press costs and elapsed time. When sufficient pressmen had been trained, second shift operation of the five-color press was instituted in October 1961. Suitable inks for five-color printing have been determined and obtained.

Paper use studies begun late in the year indicate that economies can be effected by a realignment of stock sizes.

Considerable study and development work by the Champion Paper Co., and Hygrodynamics, Inc., resulted in the production of an electronic paper hygroscope. The Reproduction Division worked closely with Hygrodynamics, Inc., during the latter phases of this development, and is now cooperating with the testing laboratory of the Government Printing Office, Hygrodynamics, and paper manufacturers to evaluate the accuracy of the device. Initial results are promising.

Equipment procured and installed included a multilith press, a paper cutter, and an additional Fotosetter composing machine.

Although workloads prevented reactivating in-plant training tours for selected personnel, planned on-the-job training was emphasized. Seven employees completed courses at the Department of Agriculture Graduate School; one attended the Middle Management Institute sponsored by the Civil Service Commission; and two completed a course in Personnel Management for Supervisors. The Division Chief participated in the Research Committee meetings of the Lithographic Technical Foundation. Division personnel attended the Mid-Atlantic Litho Clinic, National Association of Photo-Lithographers convention, and Research and Engineering Council meetings. The Division Chief and a

Technical Assistant spent a week at the Rand McNally & Co. plant in Chicago for exchange of information on methods and techniques.

Distribution Division

The numbers of charts issued and condemned in 1962 showed increases over the previous year in all categories: nautical, approximately 20 percent; standard aeronautical, 9 percent; and instrument flight, nearly 28 percent. Charts sold in the Division sales room totaled about 3,100 more than in the previous year.

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	1960	1961	1962
Nautical and Tidal Current Charts.....	1,125,373	1,243,164	1,475,858
Standard aeronautical charts.....	5,050,717	4,548,438	4,995,986
Instrument Flight charts.....	35,644,537	37,059,574	47,403,945
Miscellaneous maps and charts.....	73,814	75,540	82,989
Coast Pilots.....	16,168	15,305	21,971
Tide and Current Tables	69,590	67,086	67,967

The distribution of nautical and aeronautical charts was as follows:

Distribution of Nautical and Aeronautical Charts

NAUTICAL		
	Number	Percent
Sales.....	595,485	40.35
Official Distribution:		
Coast and Geodetic Survey.....	21,727	1.47
Coast Guard.....	11,464	.78
Other Executive Departments.....	31,743	2.15
Congressional.....	3,880	.26
Foreign Governments.....	15,249	1.03
Miscellaneous.....	1,723	.12
	85,786	5.81
Reimbursable:		
Department of Air Force.....	1,637	.11
Department of Navy.....	718,814	48.71
	720,451	48.82
Condemned.....	74,136	5.02
Total.....	1,475,858	100.00

Distribution of Nautical and Aeronautical Charts--Con.

STANDARD AERONAUTICAL

	Number	Percent
Sales.....	1,471,325	29.45
Official Distribution:		
Coast and Geodetic Survey.....	7,061	.14
Federal Aviation Agency.....	232,408	4.65
Other Executive Departments.....	33,006	.66
Congressional.....	243	.01
Foreign Governments.....	4,173	.09
Miscellaneous.....	1,122	.02
	278,013	5.57
Reimbursable:		
Department of Air Force.....	1,880,627	37.65
Department of Army.....	1,100	.02
Department of Navy.....	539,220	10.79
Special printings.....	103,535	2.07
	2,524,482	50.53
Condemned.....	722,166	14.45
Total.....	4,995,986	100.00

INSTRUMENT FLIGHT

Sales.....	9,647,507	20.35
Official Distribution:		
Coast and Geodetic Survey.....	90,225	.19
Federal Aviation Agency.....	4,426,263	9.34
Other Executive Departments.....	212,515	.45
Miscellaneous.....	5,948	.01
	4,734,951	9.99
Reimbursable:		
Department of Air Force.....	27,896,500	58.85
Department of Army.....	1,147,200	2.42
	29,043,700	61.27
Condemned.....	3,977,787	8.39
Total.....	47,403,945	100.00

AIR FORCE AERONAUTICAL

Total issue.....	954,476
Grand total.....	54,830,265

At the end of the year the Bureau was represented by 1,066 authorized agents, an increase of 61 from a year ago. In accordance with Bureau policy about 45 percent of the

agencies were inspected. Of those inspected, 91 percent were found to be operating satisfactorily.

Work accomplished in the Finishing Branch included trimming 57 million charts, folding 14.7 million, and punching 46 million.

A total of 4,807,560 hand corrections were made to 412,962 nautical charts in the Washington Office, and an additional 3,411,723 corrections to 396,864 charts in District Offices. A policy was established of issuing Intracoastal Waterway charts uncorrected except for those changes resulting from the March storm. Most of those corrections were made through the medium of chartlets. The practice was continued of issuing nautical charts uncorrected in cases where hand correction would appreciably delay their issue. A stamped notice on such charts calls attention to the fact that they are not corrected beyond the print date.

New equipment installed within the year includes a 15-box collator to replace one with 10 boxes; a modern 85-inch paper cutter equipped with automatic stops; and a plastic binding machine. A slitting attachment was added to a KK folder which permits folding two 20- x 20-inch charts and cutting them apart in one operation.

New devices to facilitate work in the Finishing and Issue Branches include partitioned portable cabinets for moving charts from folding machines to collators; an endless belt for assembling charts, eliminating round table collation; tables on rollers for the use of chart pullers, and for moving stitchers and tape dispensers to the work site; and new sorting racks that can be reached without using ladders.

Studies for the improvement of packaging materials were continued. Corrugated boxes are being used for flat charts sent to distribution offices instead of shipping them on skids which required special handling at the destination; multiwall expansible paper bags and newly designed envelopes were adopted for mailing Radio Facility chart subscriptions; and an improved type of binder for RF charts is being sought to supersede the present cumbersome envelopes in ring binders.

The transfer of the Bureau's central mail and messenger service to the Commerce Department in September 1961, resulted in certain changes in the handling of chart orders. Money accompanying orders is received and accounted for by the Commerce mailroom; Government Printing Office coupons may now be accepted; and necessary refunds, formerly made through the Treasury Department, can now be made directly, on a daily basis.

Studies were initiated of the use of IBM equipment for obtaining necessary chart distribution statistics in lieu of the keysort system now in use. They will be continued in the coming year.

Many of the Division's forms and form letters were revised to make them conform to current requirements and procedures. Authorized agents' contracts and instructions were rewritten; and the Dates of Latest Prints of standard aeronautical charts was revised and simplified.

The Chief, Distribution Division, inspected three District Distribution Offices. These inspections provide an opportunity to discuss and resolve problems in chart distribution more readily than can be done by correspondence.

NATIONAL AND INTERNATIONAL COOPERATION

In response to requests from Federal and state agencies, universities, oceanographic institutions, engineers, attorneys, oil companies, and others, 3,135 copies of original hydrographic and topographic surveys were furnished. About 100 copies of surveys and charts were certified for use in litigation. Many requests were filled for information on survey coverage, methods, and accuracy, shoreline changes, bottom characteristics, sources of charted information, interpretation of symbols, and locations and other information of value in salvage of wrecks.

At the national convention of the U. S. Coast Guard Auxiliary in Seattle, Wash., May 4, 1962, Comdr. Marvin T. Paulson, Chief, Nautical Chart Division, presented a cooperative program under which the Auxiliary agreed to furnish periodic reports on facilities and other data for small-craft charts, in exchange for which the Bureau will supply selected nautical charts.

Nautical Chart Division personnel also attended the Coast Guard Auxiliary Third District annual conference in New York; the 20th International Navigation Congress in Baltimore; a meeting of the Council of State Governments, for discussion of state boating laws; and boat shows at New York, Miami, Washington, D. C., St. Petersburg, Fla., and Richmond, Va.

Mr. Wallace A. Bruder, Assistant Chief, Nautical Chart Division, was a member of the U. S. delegation to the VIII International Hydrographic Conference held at Monaco, May 8-18.

In order to acquire the latest information for compilation of topographic and aeronautical data on aeronautical charts, close cooperation and liaison were maintained with the Federal Aviation Agency, Civil Aeronautics Board, Federal Communications Commission, Army Map Service, Geological Survey, and state aeronautical organizations through the National Association of State Aviation Officials.

Key personnel of the Aeronautical Chart Division attended meetings on a continuing basis with the Civil Cartographic Advisory Group, Federal Aviation Agency, throughout the year.

Cooperation was maintained with private organizations such as the Aircraft Owners and Pilots Association, representing private fliers; the National Business Aircraft Association, representing the corporation fliers; Air Transport Association, representing the scheduled airlines; and Aircoach Transport Association, representing the unscheduled airlines. Other organizations were consulted concerning their requirements relative to the type and scale of charts necessary to carry on their individual operations.

At the request of the Aeronautical Chart and Information Center (ACIC), the Bureau began, in June 1962, production of duplicate negatives of the Instrument Approach Procedure charts for the use of a commercial firm with which ACIC had contracted for production and distribution of these charts, formerly supplied by Coast and Geodetic Survey. By the end of the year, duplicate negatives of 545 charts had been forwarded to ACIC.

The Department of the Army was furnished on a 6 months' subscription basis for test and evaluation purposes, 500 copies each of Instrument Approach Procedure Manuals, Enroute Low Altitude and Intermediate Altitude Radio Facility charts, Area Arrival and Departure charts, and a Pre-flight Manual prepared to Army specifications.

A prototype Controller chart and a chart depicting standard instrument departures were developed and constructed for the Federal Aviation Agency.

Other reimbursable work performed for Federal agencies included reproduction copy of the Jet Navigation charts for the Aeronautical Chart and Information Center; printed copies of Route Chart 2209 for the Government Printing Office; reproduction copy for four Sectional charts and one WAC, for the Geological Survey; two highway route maps and translucent overlays of each highway system, for the Bureau of Public Roads; and film positives of selected negatives for WAC 359, for the Army Map Service.

Printed copies of a sectional chart were furnished Pan American Navigation Service for distribution with the book, "The New Pilot," and copies of another sectional chart were furnished Aero Publishers, Inc., for use with their pilot training manuals.

Film positives of various aeronautical charts were made, on a reimbursable basis, for Rand McNally & Co., Swissair, Jeppesen & Co., Douglas Aircraft Co., Aero Service Corp., and Perrygraf Corp.

Photostats of the plotting tables for Loran Rate 114 were furnished Trans-Canada Air Lines.

Aeronautical Chart and Reproduction Division personnel met with representatives of Gilfillan Corp., Bell Helicopter Co., and Army Signal Corps, to discuss furnishing selected color separates from Coast Survey charts for use in a cockpit navigational display system.

Messrs. F. E. McClung and B. F. Cooke met with FAA Air Route Traffic Control personnel at Idlewild Airport, N.Y., to discuss development of Standard Instrument Departure charts.

Mr. G. K. Emminizer, Jr., was the principal U. S. delegate to the first General Assembly of the International Cartographic Association, held in Paris; attended a meeting of Federation Internationale des Geometres in Switzerland; consulted with hydrographic offices in Sweden, Italy, Portugal, and England; and attended the Western Regional Conference of the American Congress on Surveying and Mapping, in Phoenix, Ariz.

Messrs. J. P. Dunich and A. O. Schmitz represented the Bureau at the Ninth Annual Safety Forum, Airline Pilots Association, in Chicago.

Mr. F. E. McClung attended a meeting of the Institute of Navigation Council in New York; and a meeting of the Working Group on Cartography preparatory to the world conference on the International Map of the World to be held in Bonn, Germany, in August 1962.

Dr. Herbert Knorr, Institut fur Angewandte Geodasie, Frankfurt, Germany, visited the Aeronautical Chart Division to review the cartographic techniques utilized.

OFFICE OF RESEARCH AND DEVELOPMENT

OPERATIONAL ACTIVITIES

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

The first model of an automatic standard magnetic observatory was constructed and tested and the specifications for procurement of a production prototype having increased accuracy were drafted. In cooperation with the U. S. Geological Survey, a study of magnetic profiles in the Arctic indicated the Arctic Ocean basin is divided into several distinct magnetic zones which are controlled by the underlying lithology. Cooperation with the U. S. Navy Hydrographic Office was continued in the analysis of around-the-world magnetic profiles. Tentative results indicate Fourier harmonic terms up to order six account for all but about 100 gammas of the observed magnetic field. Design and construction of an underwater stable platform to support a component magnetometer near the ocean surface in deep-sea areas were continued. Systems of this type are being designed for use in remote areas of the Pacific Ocean to gather data during the International Year of the Quiet Sun (IQSY) (1964-65) for studies of the S_c magnetic current system. It was demonstrated that major features of the Great Arctic Anomaly can be reproduced by eight radial magnetic dipoles located at the core-mantle interface.

New navigational systems including the use of artificial satellites were studied as well as participation in the formulation of the optical tracking part of the program of the geodetic satellite project ANNA. A report (unpublished) on the "Impact of the Laser on Scientific Research" by P. D. Thomas, March 1962 was prepared.

A method for the simultaneous analysis of five aerial photographs was being formulated and prepared for IBM 1620 computer programming.

A theoretical study of hydrodynamical problems in transmission of tsunamis across the ocean, including effects of compressibility, viscosity, and curvature of the earth was in progress. In deep water the scouring effect on the bottom and the dissipation of energy prove to be small. Also studies were made of the problem of propagation of surface waves in an elastic medium possessing orthorhombic symmetry; of tsunami waves generated in the circum-Pacific earthquake belt to determine their usefulness in forecasting possible tsunami runup on coastlines; of digital filter functions relating to problems of retrieving data from tsunami and seismic records in a more usable form; and by statistical methods the maximum tsunami wave amplitudes recorded at tide stations in North America and Hawaii. The long-period seismographs at Honolulu (through arrangement with Columbia University) were modified in order to obtain mantle Raleigh-wave records for use in estimating ground motion at tsunami sources. The digitizing of tide gage records having tsunami arrivals was being done by contract.

Physiographic and geologic studies were made of several undersea areas including sedimentation in estuaries, coastal and near-shore changes, characteristic formations on the continental shelf, and a unique formation on the continental slope based on the Bureau's field surveys.

The Bureau maintained liaison with the scientific community through active participation of staff personnel as guest lecturers, program chairmen, speakers, Bureau representatives, U. S. delegates, panel advisors at universities, national and international professional society and association meetings, and National Academy of Sciences-National Research Council sponsored activities. Testimony was given to the House Science and Astronautics Committee on Project ANNA. The Bureau's long-term plans for data processing and computer facilities, and a five-year plan for research and development were formulated. A new project system for implementation at the beginning of fiscal year 1963 to stimulate creative ideas and to permit more precise accounting and reporting of research and development work was designed. Research grants were awarded to Massachusetts Institute of Technology, Johns Hopkins University, and Georgetown University for research in tsunami wave refraction, submarine sand waves, and seismograph instrument constants and focal mechanism of earthquakes. Private research organizations were awarded contracts for an investigation of present nautical chart requirements and research in tsunami wave generation. Plans were made for an expanding university relations program. The importance of systems analysis was stressed in planning research and development projects. The scientific community was provided with data resulting from the research and development activities of the Bureau. A report "Coast and Geodetic Survey Programs for the Promotion of Economic Growth" (unpublished) stressed the role of the Bureau in the total geophysics program of the nation.

COORDINATION ACTIVITIES

The principal 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.--The sea gravity program was expanded: Initiating and evaluating an observing program; analyzing basic equipment and observational data; preparing a report "Gravity Meter Observations Aboard a Surface Vessel and Their Geodetic Applications" (by H. Orlin) for publication in August 1962; and establishing a gravity meter check range in the San Francisco area with navigational control adequate for eliminating the long-period effects of horizontal and vertical accelerations. A satellite triangulation program based on the simultaneous optical-tracking of passive satellites from three or more tracking stations was under development: Receiving the first of three BC-4 satellite tracking systems and placing it in operation at the Ballistic Research Laboratories, Aberdeen Proving Ground, in January 1962, the second and third tracking systems are scheduled for delivery in January 1963; operating a five-man tracking station and obtaining high-quality photographic plates of the Echo I satellite; reduction of tracking data will be based on latest analytical photogrammetric techniques utilizing

high-speed computers; training of personnel of the Geodesy and Photogrammetry Divisions in these techniques at the Ballistic Research Laboratories; and placing orders for delivery in 1964 of four Wild BC-4 ballistic cameras.

Photogrammetry Division.--The Coast Survey system of analytic aerotriangulation to provide for the simultaneous least squares adjustment of a strip of aerial photographs to supernumerary geodetic control points was extended. A superwide angle (120°) aerial photogrammetric camera was tested by analytic methods and placed in operation for aerotriangulation use, and a stereoplotter for use with this camera was evaluated and placed in operation. Aerial film distortion of all available films was investigated in order to select those color and panchromatic films by which the most precise mathematical model for distortion compensation will be formulated. A two-coordinate electronic comparator scanner was being developed under contract. Formulation of comparator calibration with precision glass grid plates for computer programming was in progress. An experimental photogrammetric tidal current survey was made at Charleston Harbor by utilizing floating targets distributed by helicopter and surface vessels throughout a full ebb and flood tidal cycle to obtain an hourly synopsis of surface water currents for the entire harbor area. The EXPLORER obtained deep-sea stereophotographs of the atomic waste disposal areas, for the Atomic Energy Commission, from which microrelief topographic maps of the ocean floor with a contour interval of 1/4 inch were prepared. The Aeronautical Chart Division was assisted in the development of a rapid microfilming and enlarging system for chart construction.

Geophysics Division.--Earth surface motions induced from three basic sources: nuclear and large-scale explosions, missile launchings, and background seismic phenomena from natural and industrial sources were investigated. An empirical formula for predicting earth motion for a given explosion yield under different environment and source media and for establishing the yield of a detonation in terms of an equivalent TNT explosion was evaluated. Redstone, Jupiter, Thor, Titan, Minuteman, Atlas, and Saturn missiles launchings were monitored with seismic instruments recording earth particle displacements and velocities. An empirical formula for predicting the earth motion produced by a missile launching was developed. The investigation on the seismicity of Antarctica and the circum-Antarctic belt based on data obtained from seismic stations during the IGY and post-IGY period was completed. Investigating analytic techniques for improving the treatment of magnetic chart data and studying magnetic storms in high latitudes, and elliptic pole wanderings were continued. Daily magnetic variation patterns registered at the Koror IGY Observatory were studied. Refinements were made in the geometry of the large Braunbek coils at the Fredericksburg Magnetic Observatory. Observations were obtained for a special study of magnetic field patterns on Oahu, Hawaii. A statistical examination was made of magnetic activity at Sitka, Alaska. A transistorized visible magnetic declination recorder was developed and placed in operation.

This auxiliary instrument is used to monitor changes in magnetic declination during magnetic surveys of compass swing areas, and provides immediate data for reducing the observed values. A portable three-component visible-recording magnetograph was developed to replace the photographic-recording variograph used for field work. Unmanned stations are to be equipped with this new instrument during the IQSY. A floating pier top for the Barrow Magnetic Observatory, Point Barrow, Alaska, was designed to overcome tilting caused by frost heaving. A portable proton vector magnetometer for field-party use was under development. The operation of the vertical-intensity variometers at the Fredericksburg Magnetic Observatory were improved by reducing the effects of humidity.

Electronic Computing Division.--Increased research efforts were made in numerical analysis of mathematical techniques used in the scientific work of the Bureau including special studies in fitting polynomials of different types to geomagnetic data, seismic test data, and tidal data. Several different methods of solving nets of equations including a sophisticated program for the solution of analytical aerotriangulation and geodetic networks were programed.

Marine Data Division.--The new Van Dorn tsunami runup prediction method was examined and it was found that the method is not feasible for predictions at the present time. Tsunami traveltime charts were constructed for a number of locations in the Pacific. A continuous subbottom acoustic reflection program was initiated with the development of one geological echo profiling (GEP) unit. Now operational, the unit is compatible with programs of routine hydrography over continental margins in depths exceeding 25 fathoms. In depths less than 25 fathoms, speed of between 5 and 7 knots is necessary. A power spectrum analysis of a 58-day tide record from Philadelphia was completed in cooperation with Lamont Geological Observatory. The Weather Bureau cooperated in a program for predicting tides on the IBM 7090 computer. A one-year cooperative study of new tidal analysis methods was started at the Scripps Institution of Oceanography of the University of California.

Instrument Division.--The hydrographic digital recording system was installed in the HYDROGRAPHER for test and evaluation. This system digitizes and records on punched tape echo soundings and associated oceanographic and hydrographic data. The punched tape can be programed electronically to operate an automatic plotter and printer. Specifications were completed for the manufacture of an automatic plotter, and for both mechanically-steered and electrically-steered narrow-beam stabilized transducers. Contracts were awarded for the manufacture of one of the mechanically-steered transducers and the automatic plotter. The development of a physical oceanographic multisensor measuring system consisting of shipboard recorder, electric bathythermograph unit, pressure-type depth sensor, sound-velocity meter, and equipment for measuring salinity and temperature in situ continued. Specifications were prepared and contracts awarded for the manufacture of an automatic current data system and a water turbulence sensor.

Nautical Chart Division.--The findings of the investigation (under contract) of present nautical chart requirements were analyzed. Areas of greatest interest to fishing fleets were determined and techniques for improving portrayal of relief on charts were evaluated. Experimental Consolan plotting charts were prepared for use in the Caribbean Sea area. Shoreline changes on the Atlantic coast resulting from the severe March storm required the development of a series of chartlets.

Aeronautical Chart Division.--A study of the completeness and compatibility with the World Aeronautical chart series of the symbolization use on the International Map of the World was made and submitted to the State Department Working Group on Cartography for use in formulating the U. S. position at the United Nations meeting at Bonn, Germany, for coordinating the International Map of the World and the World Aeronautical chart series. The determination of the immediate needs for radio navigation charts between Miami, Fla. and San Juan, P. R. lead to the production of interim radio navigation charts covering the route between Miami and Nassau and the revision of the Puerto Rico Enroute chart. Experimental chartlets were prepared by means of a four-color process to improve the hypsometric tint system and to reduce the cost of reproduction of visual charts. The New York Area chart was redesigned and compiled to include Standard Instrument Departures (SID). The designing of a flexible format for SID charts reduces chart bulk and production costs. The scale and coverage requirements of the Alaska Radio Facility chart were analyzed; a proposed revised layout of the chart was prepared and submitted to the Federal Aviation Agency (FAA) for approval. The Alaska Instrument chart was evaluated to determine the feasibility of converting it to meet optimum FAA specifications. A study was made of the methods of portraying on charts the various categories of airports having traffic patterns requiring special communication procedures. Development symbolization showing floors and ceilings of controlled airspace on visual charts was developed and the results submitted to FAA for evaluation. The revision of a prototype chart for the Controller chart series was completed and submitted to the FAA for field evaluation. The method of depicting the available air-ground frequencies on Enroute charts was evaluated and the FAA was forwarded the conclusions and recommendations regarding the clarity and completeness of this information. The FAA Enroute High Altitude Symbols Book was prepared for reproduction, and the completed books were delivered to the FAA for inclusion with production specifications. The symbolization of transitioned arrival and departure routes were simplified.

Reproduction Division.--The accuracy of the recently developed electronic paper hygroscope used to determine the differences in relative humidity between paper stock and pressroom air was evaluated. The development was completed for improved techniques for producing vignettes used in the production of radio facility and jet navigation charts. The Aeronautical Chart Division's investigation of possible color improvements for visual charts was supported.

Administrative and Technical Services Division.--Background research and the writing of the text were completed for the various historical maps included in the Bureau's Civil War Map Folio. Mounting and lighting display materials for visual aids were developed and a new type of all-purpose display was constructed showing in three dimensions certain parts of the background material. Research on map source material and related geographic matters in response to congressional requests was accomplished as well as the research on names in Delaware for a names-book project coordinated by the Board on Geographic Names. The areas of potential future urban expansion within the United States were studied.

NATIONAL AND INTERNATIONAL COOPERATION

The Bureau participated in the formulation and preparation of the fiscal year 1963 National Oceanographic Program through membership on the Interagency Committee on Oceanography; assisted in developing a plan for the increased participation of the Department of Commerce in the national program of assistance to the developing nations; and advised the Advanced Research Projects Agency on methods for improving discrimination between earthquakes and nuclear explosions.

Members of the Office contributed to various international programs in the following manner: Meeting with a Japanese representative of the Geographic Survey Institute of Japan on the use of satellites for navigation and geodesy; representing the United States at the VII General Assembly of the Pan American Institute of Geography and History and the IX Pan American Consultation on Cartography both held in Buenos Aires, Argentina; preparing the Bureau's proposed program of geomagnetic observations in support of the International Year of the Quiet Sun program sponsored by the International Geophysics Committee; working with the Panel on Solid Earth Problems of the Geophysics Research Board of the National Academy of Sciences-National Research Council on the development of a three-year United States' program for the International Upper Mantle Project and a ten-year program on the Physics of the Solid Earth; and participating with the Weather Bureau on the interagency committee supporting the President's United States-Japan Committee on Scientific Cooperation in the preparation of the report "Proposed Department of Commerce Contributions to Program of the United States-Japan Committee on Scientific Cooperation."

OFFICE OF ADMINISTRATION

OPERATIONAL ACTIVITIES

Administrative Services Division

Procurement actions processed by the Division amounted to \$4,956,699 exceeding the total of the previous fiscal year by approximately \$600,000. Negotiated contracts totaled \$1,789,429, advertised contract awards were made in the sum of \$1,537,468 and open market purchases accounted for the remainder of \$1,629,802.

Excess property in the amount of \$155,832 was transferred to General Services Administration and other agencies, an increase of approximately \$25,000 over the previous fiscal period. Surplus property received from various agencies of the Government without cost to the Bureau, amounted to a dollar value of approximately \$536,926.

Seven claims for damages totaling \$52,756.03 were settled for \$8,256.03.

Total inbound and outbound shipments amounted to 950 tons, an increase of 37 tons over last year. About 90 percent of the shipments were carried by motor freight and the balance was carried by rail, air, express, and mail.

The Bureau disposed of 46 vehicles during the year and purchased 61. The 357 vehicles in operation traveled a distance of 3,776,253 miles at a cost of \$0.078 per mile. Vehicle-years traveled in 1962 totaled 275--19 less than in 1961. Average mileage per vehicle year, however, increased by 212 miles to a new average of 13,731 miles. Although greater mileage was obtained per vehicle year, fewer vehicle-years were recorded, and total distance traveled was 200,000 miles less than in 1961.

Requisitions for printing processed by the Division amounted to \$116,382. Job orders for housekeeping services totaled an estimated \$76,788.

During the fiscal year, the functions of records management were transferred from the Management and Audit Division to Administrative Services Division. Reduction of files during the year amounted to 5,858 cubic feet. This is about 30 percent above the goal of 4,500 cubic feet established by the Department, and exceeded the previous year by the same percentage.

The number of controlled forms increased by 92 with a total list of 999.

The Bureau released 3,095 square feet of office space in the Commerce Building to the Department. Additional space was assigned to the Bureau during the year, as follows:

2060 West Virginia Avenue, NE.	13,240	sq.	ft.
Curie Hall, West Potomac Park	9,040	"	"
T-31, West Potomac Park	3,810	"	"
Beltsville, (trailer)	500	"	"
	<u>26,590</u>	"	"

Total space of all classes assigned to the Bureau at the close of the fiscal year amounted to 288,793 square feet, an increase of approximately 23,000 square feet over the previous fiscal period.

A number of functions were relocated. Components of the Geodesy Division were transferred from the Longfellow Building to Curie Hall and Building T-31 in West Potomac Park.

Photogrammetry files and the reference files of the Technical Services Division were transferred from the Commerce Building to 2060 West Virginia Avenue, N.E. The Personnel and Safety Division, and components of the Administrative Services Division, were moved from the Commerce Building to the Longfellow Building.

The Division processed 1,279 temporary duty travel orders, 147 travel orders involving a permanent change of station, and 307 other individual travel requests. Requests for approval of foreign travel numbered 71, and 55 passport clearances were obtained.

Budget and Finance Division

Procedures were developed to consolidate funding and procurement of certain types of equipment. This will reduce the paper work in the preparation of requisitions and purchase orders, save many man-hours in typing, posting, etc., and will effect savings in funds through bulk purchases.

The system of depreciation accounting formulated last year was implemented in this fiscal year. A review of this system indicated that statements issued by the Bureau reflect a truer financial condition because costs of fixed assets were distributed in the periods and to the activities benefiting from their use. Also, more realistic charges were made for reimbursable work.

A revised annual leave accounting system was implemented. Under this system the cost of accrued annual leave for employees is charged to projects in the accounting period in which the leave is earned and the accrued annual leave liability is recorded currently in the general ledger.

A new procedure adopted for processing gasoline delivery tickets has eliminated duplicate handling of the tickets and expedited the payment of the invoices. It is estimated that 1,700 man-hours were saved during fiscal year 1962.

A procedure was developed whereby the partial payroll at the end of the month is computed mechanically on a percentage basis of the previous payroll rather than on the basis

of partial time reports. This procedure resulted in the receipt of payroll accounting data five days earlier than in the past and a savings of time in card punching in the Electronic Computing Division.

A procedure was adopted whereby items of \$10.00 or less, are not processed until an invoice is paid. This change in procedure resulted in the elimination of coding and punching cards for the establishment of an obligation when a purchase order was received. Also, this eliminates the reversal of an obligation and the establishment of an accrual at the time a receiving report is received. At the end of a quarter, and at the end of a year, all of these items which have not been paid are recorded as obligations. This procedure resulted in saving the coding and punching of as many as four or more cards for each item.

A new procedure was installed whereby summary liquidations are made on travel orders covering more than one employee. Travel orders which are obligated and liquidated within the same month are processed through automatic data processing by one operation. This change resulted in an undetermined amount of savings in time, coding, and key punching.

The object classification coding needs were analyzed and, as a result, 54 classifications rather than 88 will be used in fiscal year 1963. This will result in a substantial savings of time in processing documents and cards in the Electronic Computing Division.

Fuller utilization was made of the vendor's invoice or bill number as a result of having it typed on the check for identification purposes by the Treasury Department. This step eliminated the necessity for handling extra copies of the invoices submitted by some vendors with a request that a copy be returned with the check.

The use of a check identification slip in connection with the payment of travel vouchers was eliminated except for unusual cases where identification of the purpose of the check would be difficult. This resulted in substantial savings of time in typing these slips.

The use of a duplicate copy of vouchers was discontinued except in the case of transportation vouchers where the original must be sent to the General Accounting Office. This resulted in a substantial savings of time in the audit, scheduling, and filing of vouchers.

Five chapters of the Bureau Finance Manual were completed during the year. These chapters covered the following subjects: allotments of pay, bonding of personnel, recording and reporting obligations, commissioned officers' pay, and civilian travel.

A reporting system was instituted under the appropriation "Construction of Surveying Ships" to provide for

reporting the status of expenditures, obligations, and unobligated balances, by ship.

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

Appropriations:

Salaries and expenses.	\$18,925,000
Construction and equipment (Geomagnetic Station)	27,311 ^{1/}
Construction of surveying ships. . .	15,223,146 ^{2/}
Construction and equipment (Seismological Laboratory)	88,502 ^{1/}
	<hr/>
Total appropriations.	34,263,959
Reimbursements from other agencies	8,097,682
	<hr/>
Total funds received.	\$42,361,641
	<hr/> <hr/>

1/Unobligated balances brought forward from 1961.

2/Of which \$1,038,146 were unobligated balances brought forward from 1961.

Collections covering all miscellaneous receipts, including sales of nautical and aeronautical charts and related publications, totaled \$949,635. Of this amount, \$424,426 was collected by the Department and deposited into the Government Printing Office fund. Similar collections during the last fiscal year amounted to \$883,155.

Personnel and Safety Division

The project of revising all existing chapters and developing new chapters for the Bureau Personnel Manual was continued during the fiscal year. The Manual is designed to be the medium for issuing in concise form, the various programs, regulations, policies, and procedures which all Bureau officials and supervisors are required to follow in the field of personnel. Every effort was made in the Manual to cover all material that operating officials should know, in order to properly counsel employees and to avoid serious administrative difficulties. Manual chapters on Incentive Awards, Training, and Vessel Employees Compensation Plan were in various stages of development.

The Bureau received the Secretary of Commerce Certificate of Merit for Safety. The award was presented to the Bureau for achieving a substantial reduction of accidents, thereby preventing human suffering, economic waste, and contributing to a more efficient public service.

At the recommendation of the Personnel and Safety Division, District Officers and Commanding Officers were delegated authority to hire nearly all types of vessel personnel

except certain department heads.

Classification and Wage Administration Branch

Classification surveys were conducted in the following organizations during the past fiscal year: Photogrammetry (Office of Physical Sciences); Field Survey positions (Geodesy Division); Distribution Division (Office of Cartography); and Finance Branch (Budget and Finance Division).

An increase in pay of 4 percent for vessel employees was requested by the Bureau and approved by the Department to be effective August 6, 1961. An additional 2½ percent increase in wage rates was made effective in June 1962. This increase was based on a similar increase granted to maritime employees of the Atlantic and Gulf coasts.

Revised wage schedules were received for employees under the Interdepartmental Lithographic Wage Board schedule and the pay adjustments were effective November 12, 1961.

In collaboration with the Director and Personnel Officer, a study was made of the Bureau's current and anticipated requirements for super-grade and Public Law 313 positions. As a result, position descriptions and justification statements were prepared for a number of positions and sent to the Department for consideration.

Placement and Employee Relations Branch

Two new recruiting brochures were prepared--one, titled "Career in Coast and Geodetic Survey", was prepared in collaboration with the Officer Personnel Staff and the other, titled "A Civil Service Career in the Coast and Geodetic Survey", was developed by the Placement and Employee Relations Branch.

The Branch participated in Federal Career Days, taking exhibits to four colleges (Cornell, Rutgers, University of Florida, and Ohio State University), and also arranged for a recruiting exhibit to be displayed in the window of the New York City Information Office of the Civil Service Commission. This latter exhibit is now on permanent display in a window of the Inter-Ocean Building, Washington, D. C., now occupied by the Aeronautical Chart Division of Coast and Geodetic Survey.

Training in recruiting techniques continued with attendance at a College Recruiters Workshop at Georgetown University for a member of our staff, and one District Officer attended a similar workshop in one of the Civil Service regions. Also, members of the Branch visited three Coast and Geodetic Survey District Offices to acquaint new District Officers with recruiting information and techniques prior to their fall and spring recruiting trips. A series of recruiting bulletins was issued, and a loose-leaf recruiting booklet prepared containing helpful guides and information

for use of officers assisting in recruiting campaigns. Representatives of the Branch accompanied two District Officers on recruiting trips to four colleges (Cornell, Syracuse, Clarkson Institute of Technology, and University of Florida).

Arrangements were completed and material submitted to three Civil Service regions for two-page spreads describing the Bureau and recruiting needs in their regional publications. These publications will be released to colleges located within the regions in early fall of 1962, and reprints of these articles will be used in recruitment correspondence. The emphasis on professional recruitment furnished sufficient applications from which to effect the following Civil Service appointments:

Engineers	6
Geodesists	7
Geophysicists	20
Oceanographers	12
(including our first geological oceanographer)	
Cartographers	19

Emphasis continued on the student trainee program with the total responsibility for the program transferred to Personnel and Safety Division. In this connection, a conference on Cooperative Student Trainee Programs held in Washington in January 1962 was attended. Coordinators from three colleges visited the Bureau, and four cooperative colleges were visited.

At the close of the fiscal year, 25 student-trainees were participating in the program, 10 more were negotiating for 1963 with two firm commitments already made.

During a visit to Ohio State Federal Career Days in January, the possibility of a cooperative student-trainee program in geodesy with the University was discussed; and material was submitted for inclusion in a University-issued brochure advertising the program. This program will represent a series of "firsts" as it will be the first such program in the field of geodesy, the first cooperative program in which the Ohio State University will participate, and the first time the Survey has collaborated with a university in issuing a brochure which will be distributed to high school graduates.

The summer hiring program was extended to cover the appointment of 22 student assistants in the Washington headquarters. These students were selected from college students majoring in fields of study related to our professional positions. While here, they received special counseling and orientation and an introduction to permanent employment opportunities.

Another position category which has a limited recruitment source is the position of Quartermaster Surveyor aboard the ships. Graduates of the Maine Vocational Schools, Portland, Maine, were considered especially well

trained for our work. As a result, a visiting recruiter arranged to place 11 first-year students in temporary positions aboard our vessels, in an effort to encourage them to seek permanent employment with the Bureau upon graduation in June 1963.

A Secretarial Services Center was established in the Branch as a source of trained typists and stenographers for the Bureau. To staff this center, two Branch members went on a recruiting trip to the Lewisburg, West Virginia area, where they gave Civil Service typist and stenographic examinations to 50 students from three high schools. Of the total students tested, job offers were made to the 19 who passed, and 15 accepted. All personnel selected received approximately three weeks training in the center and were reassigned to permanent positions in the Bureau. This initial effort was so successful, and skilled clerical help continues to be so scarce, that efforts in this area will be expanded in 1963.

The following statistics are furnished:

Total employment on June 30, 1962	2,622
Total appointments during 1962	933
Total separations during 1962	814

Awards

Under the Honor Awards Program of the development, 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:

Jack L. Brown	Benjamin Johnson
Commander Don A. Jones	

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":

Frederick F. Ceeley, Jr.	Hyman Orlin
Rex B. Finley	William A. Pettit
Robert Gunst	Rosemary Riordan
William H. Leimbach	John R. Townshend

The following awards were also granted during the year:

Superior performance awards	86
Suggestion awards	89
Length-of-service awards	419

Retirements

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

Rear Adm. Charles Pierce (38) Capt. John H. Brittain (36)
 Capt. Kenneth G. Crosby (38) Capt. Gilbert R. Fish (36)
 Capt. John Bowie (36) Lt. Cdr. Donald L. Campbell (10)

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

Charters, Emily P. (48)	Berman, Reva K. (27)
Risvold, Oscar S. (36)	Husemeyer, William W. (27)
Eney, Lloyd H. (34)	Zimmerer, Max K. (26)
Weber, Albert M. (34)	Fontaine, Marcel J. (25)
Belote, Earl S. (31)	Bell, Ira E. (22)
Cameron, Bessie (31)	Hardwick, Emma L. (20)
Myers, Patterson (31)	Link, Edwin R. (19)
Wilcox, Burt (31)	Tenaïd, Elias B. (19)
Chester, Thomas (30)	Means, Vance N. (17)
Rilveria, Mariano S. (30)	O'Keefe, John P. (17)
Carnahan, Edna C. (16)	Trono, Honorio T. (14)
Abenojar, Esteban R. (15)	Long, Grace (13)

Board of U. S. Civil Service Examiners

The Coast and Geodetic Survey Board of Civil Service Examiners was actively engaged in conducting four examinations: Geodesist, Geophysicist, Printing Plant and Lithographic Trainee, and Surveying Aid and Technician; and maintaining registers for the same.

During the year, 1,060 applications were processed and 189 certificates of eligibles were issued to various agencies.

Training Branch

A new Quartermaster-Surveyor Training Program was developed in the Bureau for experienced shipboard personnel. The purpose of this program is to develop the competence of Quartermaster-Surveyors on ships of the Coast and Geodetic Survey. In addition, this training is designed to provide flexibility for future assignment which will be very beneficial to the Bureau in its expanded oceanographic activities.

A training program for aerial photographers was developed under a training agreement approved by the Civil Service Commission. This program was designed for the purpose of recruiting and retaining aerial photographers in the Bureau's unique and specialized work in the field of photogrammetry.

The Civil Service Commission recently approved a training agreement designed to recruit and retain cartographic talent to meet the progressively increasing demands for charts and services, and to provide replacement for experienced employees who will retire or otherwise leave the service of the Bureau. It is expected that over 100 new employees in the Office of Cartography will be in this program if proposed plans for expansion are approved.

A training agreement was approved by the Civil Service Commission for Management Interns. The purpose of this program is to systematically train employees recruited from the Civil Service Management Intern register for assignment to progressively responsible administrative positions in the Bureau. This accelerated training will prepare knowledgeable administrative talent, through proper guidance, for administrative positions.

A Basic Electronic Course was developed and conducted for 14 shipboard employees on the West Coast and for 20 employees of the Washington Office. The purpose of this course is to familiarize Bureau technicians, to a greater extent, with the theory of electronics, the use of test instruments, and the operation and maintenance of instruments of the Coast and Geodetic Survey.

Seventy-one employees received training in the effective use of the U. S. Government Correspondence Manual.

Ten Commissioned officers completed a course in Descriptive Oceanography, Theories, and Methods, and three officers undertook full-time graduate studies in Geodesy.

Seven employees completed training in Loran C receivers at ITT Federal Laboratories (Division of International Telephone & Telegraph Co.).

Some 50 other employees during 1962 attended job-related courses in the following categories, conducted by local universities and schools:

Accounting	Magnetohydrodynamics
Business Law	Mathematics
Cartography	Oceanography
Electromagnetic Theory	Physics
Geodesy	Photography
Geography	Supervision
Languages	Visual Communication
Lithography	

Under the Bureau's self-development program, off-campus college course offerings by local universities were made available by the Federal Triangle Education Center, and through cooperative effort of Federal agencies in the Federal Triangle. Employees had the opportunity to register in the Commerce Lobby for courses offered in the 1961 fall and 1962 spring semesters.

A concentrated effort was made to "sell" college students employed during the summer on employment in the Survey after graduation from college. Orientation sessions and seminars were held in cooperation with the Office of Administration and Operating Divisions to supplement the White House and the Department of Commerce programs in this area.

Management and Audit Division

During the fiscal year, greater emphasis was placed on

the internal audit function within the Bureau. On January 9, 1962, a separate Audit Branch, composed of a small but competent audit staff, was established in the Management and Audit Division. The increased emphasis placed on the internal audit function resulted from suggestions made by the General Accounting Office and is consistent with the increased importance being accorded the internal audit function within the Department. Plans are being developed to conduct, on a continuing basis, comprehensive audits of the Bureau's many activities, both in Washington, D. C. and in the field.

Eight separate examinations of Bureau activities were completed during the year, and reports on each of these examinations were submitted to the Director. Two additional reviews were in process.

Of the eight completed examinations, four dealt with the policies and procedures of the following sections of the Finance Branch, Budget and Finance Division: (1) Payroll and Leave, (2) Voucher Examination, (3) Cost Accounting, and (4) Accounts and Reports. The report on the review of each of the above areas contained a number of recommendations designed to improve controls and simplify procedures. Separate examinations were also made of administrative practices at (1) the West Coast district offices and ships, and (2) the Norfolk District Office and Norfolk-based ships. The reports prepared as a result of these two reviews were widely distributed throughout the Bureau's field offices to call attention to the findings contained in the reports, in an effort to prevent the recurrence of similar deficiencies at other field locations. Completed examinations of other activities related to (1) the controls over ship construction funds, and (2) the clothing and small stores fund. The examination of the controls over ship construction funds was to ascertain whether satisfactory controls existed to prevent the overobligation of ship construction funds and to prevent the improper expenditures of the salaries and expenses appropriation for ship construction purposes. Bureau deficiencies in this area were previously reported to the Congress by the General Accounting Office. The report on the examination of the clothing and small stores fund contained several recommendations designed to strengthen the inventory controls, practices, and procedures relating to the fund.

The two internal audit reviews in process were: (1) a review of the organization and operations of the Instrument Division, and (2) a review of management and financial controls, practices, and procedures at selected Bureau field offices. The review of the Instrument Division involved a comprehensive examination of the division's functions, activities, and related policies, procedures, and controls. A report on this review is to be issued shortly. The review of selected field offices involved visits to the Baltimore District Office, the Gaithersburg, and Fredericksburg observatories and selected geodetic and photogrammetric field parties located in Maryland, New Jersey, Virginia,

West Virginia, and North Carolina. One of the purposes of the review was to permit members of the recently established Audit Branch to obtain an understanding of the nature and scope of the Bureau's field activities in order to facilitate the development of effective audit programs for future reviews. A report is forthcoming on the findings disclosed during the review.

Other activities of the Management and Audit Division during the year dealt with organizational studies and changes, realignment of operating space and facilities, activities connected with automatic data processing, analyses of administrative functions and procedures development and coordination and maintenance of administrative issuances.

The following major organizational units were established: (1) the Management and Audit Division, consisting of the Management Branch and the Audit Branch, which replaced the Organization and Management Division; (2) the Electronic Computing Division, consisting of the Planning Branch, Programming Branch, and Operating Branch; and (3) the Administrative and Technical Services Division, which combined the functions of the Administrative Services Division and the Technical Services Division.

Space planning was concerned with: (1) increased space requirements for current activities; (2) the cost of moving certain activities to new locations; (3) determination of the permanent annual costs resulting from the moves; and (4) the preparation of anticipated headquarters space requirements through 1970.

The following was accomplished in connection with automatic data processing activities: (1) an inventory of present and future applications; (2) an evaluation study of the Bureau's seismological computing requirements and the computer systems proposed for satisfying these requirements; (3) recommendations for expanding this activity and for establishing the Electronic Computing Division; (4) a study recommending the purchase of the IBM 650 computer, which was previously leased; (5) studies recommending the continued lease of the Clary DE-60 computer and the punch card equipment, as opposed to purchasing this equipment; (6) development of the depreciation rate for the IBM 650 Computer and the method for charging depreciation and maintenance costs; (7) a report to the Department and the Bureau of the Budget on the utilization of the Bureau's equipment; and (8) assistance in planning further mechanization of the payroll system.

The following programs and procedures were established:

1. A comprehensive Bureau-wide Financial Management Improvement Program for fiscal years 1963 and 1964. Guidelines were developed for 18 areas of potential improvement and included in the published program document.

2. A Manpower Control System, which provides for a central approval and recording of changes in position authorizations.

3. In cooperation with the Department, procedures were developed for the integration of the Bureau's mail system into the departmental system.

4. A Management Intern Program for the purpose of providing knowledgeable talent for administrative positions. In connection therewith, a training agreement was submitted to, and approved by, the Civil Service Commission.

5. Periodic meetings between division chiefs of the Office of Administration and administrative officers from the operating areas were initiated to discuss and to resolve mutual administrative problems.

Actions taken in connection with the new depreciation accounting system included the following: a detailed description of the system was submitted to the General Accounting Office for approval; additional explanatory material was prepared to accompany the Accounting Manual which was to be submitted to the General Accounting Office for approval; and supplemental information on certain aspects of the system was submitted to the Department.

The following studies, surveys, and reviews were accomplished: a review was made of the staffing requirements in the Archives Section of the Library; a report from the Department on a study made of the Bureau's printing plant was reviewed and comments setting forth the Bureau's position on each of the findings were prepared and coordinated with the other interested activities of the Bureau; a survey was made to find out if headquarters employees preferred to have their pay checks mailed, with the result that procedures were established for the approximately 150 employees who desired this service; members of this Division served on a committee which reviewed the pricing policies for Bureau charts; and special studies were made regarding delegations of authority from the Department to the Bureau and their redelegations within the Bureau and special pay for the performance of diving duty by commissioned officers and vessel employees.

The following information and instructions were disseminated: a new organization-function chart of the Bureau was prepared and distributed to headquarters activities and to district offices; information on revised prices for geodetic control data for sale to the public was published in the Federal Register; a memorandum was issued to supplement previous instructions for handling classified information and material in the Bureau; and additional instructions were prepared for the District Offices on the use of Forms 325A and 325B, which pertain to sale of geodetic data.

Other activities of the Division involved the following: assistance was given to the Distribution Division in installing the Keysort Card Tabulating System, developed in the preceding fiscal year, and in training personnel in the use of the equipment; a report was prepared

for the Director on the status of the recommendations made by the General Accounting Office audit team in its report of May 1961; information was submitted to the Department for the task force study on improvement of management and direction of field activities; procedures were developed and clearance obtained for more centralized funding and procurement of equipment; and 115 items of management improvement for the fiscal year, completed or in progress, were included in the Bureau's annual management progress report submitted to the Department.

Thirty-five special reports and evaluations were prepared for submittal outside the Bureau. Division personnel attended 72 meetings, discussions, seminars, demonstrations, and special training classes, etc., outside the Bureau.

Ten General Circulars or amendments, five Informational Bulletins, and 66 additional or revised pages to the Regulations were issued; and eight General Circulars or amendments and two Office Circulars were rescinded.

Instrument Division

The major effort of the Instrument Division during 1962 was in support of the Research and Development program. A description of this effort is included in the report of that office.

The Division maintained and repaired the following types of instruments for the Bureau: Chronometers, clocks and other timing devices; theodolites, precise levels and similar optical instruments; current meters and tide gages; depth-finders and associated telemetering systems; tellurometers, electrotapes, and geodimeters; and portable radio transmitters and receivers.

Close liaison was maintained with the Navy Hydrographic Office in areas of mutual interest. One area was the preparation of specifications for Oceanographic Synoptic Survey Systems. Numerous conferences were held in relation to the development of automatic digital hydrographic recording systems. Regular contact was maintained during the preparation of requirements for narrow-beam stabilized transducers.

A member of the staff served on the Panel on Facilities, Equipment, and Instruments of the Interagency Committee on Oceanography. This committee is responsible for coordinating the efforts of all Government agencies engaged in oceanography and represents them before subcommittees of Congress.

Personnel of the Division cooperated with the Corps of Engineers, Fort Belvoir, Virginia, by addressing a class of officers in training on the subject of the Development of Tide Gages and Associated Instrumentation.

The Chief of Division served as a member of the Radio Technical Commission for Marine Services. This is an

organization in which government and nongovernment interests participate and have a voice in determining the development of, and adaption to, marine requirements of pertinent radio and electronic techniques.

Technical Services Division

The functions of the Technical Services Division were continued throughout the fiscal year, within the framework of the component branches and sections.

In the course of maintaining the Bureau's collection of map source material, the Division received and processed approximately 82,000 new maps. More than 67,000 maps were distributed from the files, of which about 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 Department, other Government agencies, and the public. Approximately 350 copies of early Coast and Geodetic Survey charts, many used in litigation, were included among the maps issued, and about 900 letters containing map information were sent out to the public.

Among those receiving maps and map information outside the Bureau were various state highway departments, National Geographic Society, Texaco Inc., Auto Club of America, and D. C. Metropolitan Police. Among those within the Government were Navy Research Laboratory, Bureau of Labor Management, Beach Erosion Board, Oceanographic Data Center, Federal Aviation Agency, National Park Service, Weather Bureau, Soil Conservation Service, Geological Survey, Bureau of Public Roads, Army Map Service, and various agencies of the Department of Health, Education, and Welfare.

In keeping the Bureau's collection of map source material up-to-date, about 22,000 maps were eliminated from the files as obsolete or superseded.

Approximately 220 nautical charts and about 90 aeronautical charts, together with various other Bureau publications, were checked or provided place names as part of the geographic names work of the Bureau. In addition, name lists were supplied for 50 new hydrographic survey sheets and 80 planimetric maps. Approximately 110 cases of name conflict were submitted to and decided upon by the Board of Geographic Names, effecting more uniformity among Federal agencies in place-name usage. Over 100 cases of names disputes were settled with the Geological Survey, and other Federal agencies, without recourse to the Board.

A set of geographic names standards for small-craft charts was prepared, and name corrections and additions are being applied as new prints of these charts are scheduled for issue. In reply to requests for names information from the public and other sources, most of which required considerable research, some 120 letters were written.

Special sheets for geographic names field investigations were provided for 22 different areas. In response to this,

20 geographic name field reports were received and processed in the Division. Geographic names standards were made for all the Bureau's tidal current charts, and standard name-correction copies were made and used for Coast Pilots, Tide Tables, Light Lists, and selected geodetic publications.

The card-file of Board on Geographic Names decisions, alphabetized by State, was continued and more than 1,200 cards were added. Another card file of considerable value is an alphabetized file of Atlantic Coast place-name locations for which about 3,200 location cards have already been prepared. Plans were made for publishing these names as State coastal finding lists, and as name finding lists for sections of the Intracoastal Waterway.

Soliciting geographic names information from valuable local sources by mail was continued. Some 50 such solicitations were made, providing many previously uncharted names and verification of existing ones. This supplemented the increased number of new names and name verifications from field parties and ships in an expanded program to collect more such information. This expanded program was begun in response to requests by small-craft owners for more names on charts. Toward this end, supplemental names standards were prepared for critical areas of the coasts on quadrangle sheets or Army Engineer project maps, which will accommodate the many additional names which are likely to be used eventually on charts.

Maintenance of a file on source material and indexes for the compilation of aeronautical charts was continued. Seven hundred and fifty new map bases were indexed and approximately 1,700 aerial photographs were received and processed. Source material was provided for the revision of 270 aeronautical charts, in keeping with the Bureau's increased pace of aeronautical chart revision.

The Chief of the Division, in the capacity of the publications officer for the Bureau's and Department's Publication Committee, expedited final production of all Bureau book and pamphlet publication during the year. This included, in addition to regular publications such as tide tables, the production and issuance of 10 new Bureau Technical Bulletins. As a result of bringing the Bureau's publication program in line with that of the Department, the timely issuance of these publications was effected, expediting printing of the publications on a definite schedule.

More than 700 Bureau activity photographs and slides were accessioned and placed in the files during the year, as part of the Division's visual aids activities. Upwards of 2,000 photographic prints and slides were issued, and motion picture films representing Bureau subjects were loaned to 90 different institutions. The Bureau's district offices, and various schools and colleges throughout the country, were important users of these visual aids. Other recipients included the International Press, General Electric, various magazine and book publishers, Navy Hydrographic Office, Federal Aviation Agency, Air Force, Army

Map Service, Fish and Wildlife Service, and National Academy of Sciences.

More than 30 panel exhibits portraying the Bureau's work were prepared and put on display throughout the country during the year. Exhibits were placed at the Department field offices and at Bureau district offices. Included also were exhibits at the Commerce Department Building, various regional boat shows, the Cincinnati International Airport, and numerous conferences such as the annual meetings of the American Congress on Surveying and Mapping, American Society of Photogrammetry, and the Association of American Geographers.

The illustrative and cartographic work performed in the Division amounted to approximately 250 special maps, graphs, signs, and drawings, prepared for a variety of Bureau and departmental needs. These included graphs and maps to assist in the presentation of the budget, recruiting posters, and special maps and drawings for illustrating Bureau work. More than 350 certificates were prepared, including departmental awards and Officer appointments.

Books and pamphlets processed into the Bureau library during the year exceeded 4,000 and about 700 volumes were eliminated. Circulation of books and pamphlets amounted to more than 7,000, representing an increase for the fifth consecutive year. Field and office reports and records circulated by the Archives Section increased, and Federal Records Center borrowings decreased to less than 1,000 items. About 9,000 reports and records were received and processed by this section during the year, and only those which were deemed obsolete or non-current were transferred to the National Archives.

NATIONAL AND INTERNATIONAL COOPERATION

Cooperation was extended to other Government agencies, national societies and to 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, especially with the Canadian Hydrographic Office and Canadian Department of Defense.

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 Naval Research on Coastal Geography and to various members of Congress. As a mutually beneficial service, all advance quadrangle sheets of the Geological Survey covering coastal areas were reviewed for agreement in geographic nomenclature. Of 900 sheets received, 30 were returned with corrections, effecting consistency in name usage. Special service was provided the American Congress on Surveying and Mapping in the serving and chairing of its publications committee.

The Bureau continued to be represented on the Inter-agency Board on Geographic Names. Through the efforts of this liaison, existing differences in nomenclature between the various

Federal maps were considerably diminished. The Chief of Geographic Names coauthored the American Congress on Surveying and Mapping 20-year Index.

The Technical Services Division continued its activities in international cooperation through the practice of international exchange of maps and publications. More than 100 letters concerning this exchange were prepared, and numerous special services were performed along this line. Among these were participation in several conferences of the Association of American Geographers and the American Name Society, where foreign representatives were guests. The exchange of charts with friendly maritime nations was also mutually beneficial. Instruction was given to foreign visitors in various aspects of Bureau work as part of the Survey's participation in the Government-wide program of international cooperation.

APPENDIX

PUBLICATIONS ISSUED

Geodesy

Plane Coordinate Intersection Tables ($2\frac{1}{2}$ minutes), Alaska, Zone 10, Publication 65-1, Part 51.
Plane Coordinate Intersection Tables ($2\frac{1}{2}$ minutes), Missouri, Publication 65-1, Part 23.
Satellite Triangulation.

Tides, Tidal Currents, and Oceanography

Six volumes of tide and tidal current tables for the year 1963 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:

Manual of Current Observations, Supplement to Special Publication No. 215.

Coast Pilots

United States Coast Pilot 3, Atlantic Coast, Sandy Hook to Cape Henry, Seventh Edition, 1962.
United States Coast Pilot 8, Pacific Coast, Alaska--Dixon Entrance to Cape Spencer, Eleventh Edition, 1962.
Supplements to United States Coast Pilots 1, 2, 4, 7, and 9, 1962.
Distances Between United States Ports, Third Edition, 1961.

Geomagnetism and Seismology

Ten volumes of magnetograms and/or hourly values were completed as follows: College 1957, 1958; Fanning Island 1957-1958; Sitka 1958; Honolulu 1958; Fredericksburg 1958, 1959; San Juan 1958; Tucson 1958; Byrd Station 1957-1958.
United States Magnetic Tables for 1960, by K. L. Svendsen, Publication 40-2.
Magnetism of the Earth, by J. H. Nelson, L. Hurwitz, and D. G. Knapp, Publication 40-1, Revised Edition.

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

United States Earthquakes, 1960, by H. Carroll Talley, Jr., and William K. Cloud.

Seismological Bulletin, June 1960 through March 1961.
Antarctic Seismological Bulletin, 1st quarter 1962.
Abstracts of Earthquake Reports for the Pacific Coast and
the Western Mountain Region, 2d quarter 1960 through
1st quarter 1961.

Miscellaneous

On the Time Interval Between Two Consecutive Earthquakes,
Tokuji Utsu, Technical Bulletin No. 17, February 1962.
Submarine Physiography of the U. S. Continental Margins,
G. F. Jordan, Technical Bulletin No. 18, March 1962.
Analytic Absolute Orientation in Photogrammetry, G. C. Te-
winkel, Technical Bulletin No. 19, March 1962.
The Earth as Viewed From a Satellite, Erwin Schmid, Tech-
nical Bulletin No. 20, April 1962.
Operation Plowshare, Project Scooter, Surface Motions From
a Cratering Shot in Desert Alluvium, W. V. Mickey, Spe-
cial Report, September 1961.
Seismic Background Observations and Measurements at U. S.
Naval Air Station, Norfolk, Va., W. V. Mickey, Special
Report, September 1961.
Preliminary Report of Seismic Effects of Saturn Launching,
Special Report, November 1961.
Ground Motions Induced by Saturn SA-1 Launch at Cape Ca-
naveral, Fla., M. V. Mickey, R. J. Brazee, and J. C.
Stepp, Special Report, June 1962.
Seismic Effects of Saturn SA-2 and Moon Probe Missile
Launches, M. V. Mickey, Special Report, June 1962.
Analysis of Coupled and Hydrodynamic Wave Forms From
Events Antler, Gnome, Fisher, and Hardhat, W. V. Mickey,
Special Report, June 1962.
Operation Hardtack II Surface Motions From Underground Ex-
plosions, D. S. Carder, L. M. Murphy, T. H. Pearce, and
W. V. Mickey, Office of Technical Services, WT-1741,
July 1961.
Gnome Seismic Waves From an Underground Explosion In a
Salt Bed, D. S. Carder, W. V. Mickey, J. N. Jordan, and
D. W. Gordon, Office of Technical Services, PNE-110P,
February 1962.
Selected Civil War Maps Folio, text by A. J. Wraight, Ly-
man D. Lynn, and Elwood Bear, Special Publication,
September 1961.
Experiment in Progress, H. B. Stewart, Jr. and G. F.
Jordan, motion picture script for film on oceanography
sponsored by National Science Foundation.

PAPERS PUBLISHED

Submarine Topography of the Western Straits of Florida,
G. F. Jordan and H. B. Stewart, Jr., Geological Society
of America Bulletin, July 1961.
From Landmarks to Satellites, P. D. Thomas, The Military
Engineer, September-October 1961.
Depth to Sources of Magnetic Anomalies, L. R. Aldredge
and G. D. Van Voorhis, Journal of Geophysical Research,
November 1961.
The Interior of the Earth, R. Stoneley, The Advancement
of Science, November 1961. (Presidential Address: Sec-
tion A, British Association for the Advancement of
Science.)

- Horizontal Intensity Comparisons Between the Sine Galvanometer and the Proton Vector Magnetometer, J. L. Bottum, R. E. Gebhardt, and J. B. Townshend, *Journal of Geophysical Research*, November 1961.
- Settlement Studies by Means of Precision Leveling, James B. Small, *Bulletin Geodesique Nouvelle Serie*, Annee 1961, No. 62, Decembre 1961.
- The Halley Bay Expedition of the Royal Society, R. Stoneley, *Nature*, December 16, 1961.
- Horizontal Movement in the Earth's Crust, Charles A. Whitten, *Bulletin Geodesique, Nouvelle Serie*, Annee 1961, No. 62, Decembre 1961.
- Measurement of Small Movement in the Earth's Crust, Charles A. Whitten, *Annales Academiae Scientiarum Fennicae, Series A. III Geologica--Geographica*, Helsinki, Finland, 1961.
- Ground Effects from Underground Explosions, D. S. Carder and W. V. Mickey, *Bulletin of the Seismological Society of America*, January 1962.
- Modern Charts for the New York Boatmen, H. Arnold Karo, *New York Times*, Special Boat Show Issue, January 1962.
- Underwater Microcontouring, W. B. Hale and C. E. Cook, *Photogrammetric Engineering*, March 1962.
- Analytic Aerotriangulation in the Coast and Geodetic Survey, W. D. Harris, G. C. Tewinkel, and C. A. Whitten, *Photogrammetric Engineering*, March 1962.
- Charts for the Small-Craft Operators, H. Arnold Karo, *Richmond Times-Dispatch*, Special Boat Section, March 1962.
- Symposium on the Reduction of Gravity Data, D. A. Rice, *Bulletin Geodesique, Nouvelle Serie*, Annee 1962, No. 63, Mars 1962.
- A Practical Formula for Accurate Arc-to-Chord Correction in Lambert Plane Coordinates, Erwin Schmid, *Surveying and Mapping*, March 1962.
- Geodetic Positioning of the Hawaiian Islands, P. D. Thomas, *Surveying and Mapping*, March 1962.
- PIONEER'S Recent Surveys in the North Pacific, H. Arnold Karo, *Journal of Navigation*, Institute of Navigation, Spring Issue 1962.
- Source of the Great Arctic Anomaly, L. R. Alldredge and G. D. Van Voorhis, *Journal of Geophysical Research*, April 1962.
- Epicentral Intensities and Damage in the Hebgen Lake, Montana, Earthquake of August 18, 1959 (GCT), K. V. Steinbrugge and W. K. Cloud, *Bulletin of the Seismological Society of America*, April 1962.
- Magnetic Daily Variation at Koror, John W. Gettemy, *Journal of Geophysical Research*, May 1962.
- Large Submarine and Sand Waves, G. F. Jordan, *Science*, June 8, 1962.
- Adjustment of Conditions with Parameters and Error Analysis, J. L. Stearns and R. H. Richardson, *Bulletin Geodesique, Nouvelle Serie*, Annee 1962, No. 64, Juin 1962.
- Surveying and Mapping Twenty-Year Cumulative Index, A. J. Wraight (in conjunction with Robert C. Eller of the Geological Survey), Special Publication of American Congress on Surveying and Mapping, Washington, D. C., June 1962.

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 for the 1962 edition of Americana Annual, on tsunami for the 1962 edition of Yearbook of Science and Technology, on surveying, aerial surveying, transit, maps and map making, and variation in latitude for Harper Encyclopedia of Science. Articles on overall activities of the Bureau were also prepared for the following editions of: Americana Annual (1962), International Year Book (1962), Information Please Almanac (1963), and The World Almanac (1963).

PAPERS PRESENTED

- Report on Problems Associated with the Establishment of the World-Wide Seismic Net, L. M. Murphy, 5th General Meeting of the Ad Hoc Group on Detection of Nuclear Detonations, July 1961.
- Kelsh Plotter Notes, G. C. Tewinkel, Soil Conservation Engineers Regional Conference, Atlanta, Ga., July 1961.
- Major Redistribution of Sediments in Certain Bays and Inlets of Alaska, G. F. Jordan, Tenth Pacific Science Congress of the Pacific Science Association, Honolulu, Hawaii, August-September 1961.
- Photogrammetric Surveys for Aeronautical Charting, L. W. Swanson, VII General Assembly, Pan American Institute of Geography and History, and the IX Pan American Consultation on Cartography, Buenos Aires, Argentina, August 1961.
- Results of Analytic Aerotriangulation, L. W. Swanson, VII General Assembly, Pan American Institute of Geography and History, and the IX Pan American Consultation on Cartography, Buenos Aires, Argentina, August 1961.
- Geodetic Positioning of the Hawaiian Islands, P. D. Thomas, Tenth Pacific Science Congress of the Pacific Science Association, Honolulu, Hawaii, August-September 1961.
- Criteria for Tsunami Evaluation, B. D. Zetler, M. D. Schuldt, and L. F. Bailey, Tenth Pacific Science Congress of the Pacific Science Association, Honolulu, Hawaii, August-September 1961.
- Large Sand Waves in Estuaries and in the Open Sea, G. F. Jordan, First National Coastal and Shallow Water Research Conference, Baltimore, Md., October 1961.
- Coastal Research Program of the Coast and Geodetic Survey, W. Shofnos, First National Coastal and Shallow Water Research Conference, Baltimore, Md., October 1961.
- Is Sea Level Falling or the Land Rising in South East Alaska? W. Shofnos, Third United Nations Regional Cartographic Conference for Asia and the Far East, Bangkok, Thailand, October 1961.
- Source of the Earth's Main Magnetic Field, L. R. Alldredge, National Academy of Sciences Panel on the World Magnetic Survey, Washington, D. C., November 1961.
- Epicenter Computer Program, J. F. Lander, Meeting of the Eastern Section of the Seismological Society of America, November 1961.

- Aerial Surveys for Geology and Geomorphology, H. Arnold Karo, United Nations Pilot Course on Aerial Survey Methods, Tokyo, Japan, November 1961.
- Geologic Aspects of Coast and Geodetic Survey Oceanographic Program, H. Arnold Karo, United Nations Pilot Course on Aerial Survey Methods, Tokyo, Japan, November 1961.
- Improved USC&GS Instrumentation in Observing, Processing and Predicting Tides, W. Shofnos, International Association of Physical Oceanography, Paris, November 1961.
- Electronic Computation in Surveying and Mapping, Charles A. Whitten, Third United Nations Regional Cartographic Conference for Asia and the Far East, Bangkok, Thailand, November 1961.
- Measurement of Small Movements in the Earth's Crust, Charles A. Whitten, Third United Nations Regional Cartographic Conference for Asia and the Far East, Bangkok, Thailand, November 1961.
- Horizontal Crustal Movements in California, E. B. Brown and Charles A. Whitten, Western National Meeting, American Geophysical Union, Los Angeles, Calif., December 1961.
- Modern Oceanography, H. Arnold Karo, U. S. Naval Research Reserve Company, Naval Medical Center, Bethesda, Md., December 1961.
- The PIONEER Surveys--A New Approach to Oceanography, H. D. Nygren, T. V. Ryan, and B. D. Zetler, Western National Meeting, American Geophysical Union, Los Angeles, December 1961.
- The Value of the State Coordinate Systems and How to Use Them, L. G. Simmons, University of Wisconsin, Madison, Wis., December 1961.
- Small Computer Technology in Surveying and Mapping, L. W. Swanson, Annual Surveying and Mapping Conference, University of Idaho, December 1961.
- Areas in the United States Requiring Intensive Surveys for Potential Urban Growth, A. J. Wraight, Annual Convention, National Institute of Urbaniculture, Washington, D. C., January 1962.
- Utilization of the New York State Coordinate System for Land Surveys, Don A. Jones, Annual Meeting of the New York State Land Surveyors, Syracuse, N. Y., February 1962.
- Geodesy in the Missile Age, L. G. Simmons, Houston Convention of the American Society of Civil Engineers, Houston, Tex., February 1962.
- Use of Artificial Earth Satellites for Geodetic and Navigational Purposes, P. D. Thomas, Society of American Military Engineers, Columbus, Ohio, February 1962.
- Report on Analytic Aerotriangulation, W. D. Harris, Annual Meeting of the American Society of Photogrammetry and The American Congress on Surveying and Mapping, Washington, D. C., March 1962.
- Ethiopian Geodetic Control Project, Don A. Jones, Annual Meeting of the American Congress on Surveying and Mapping, Washington, D. C., March 1962.
- Determination of Tidal Datum Planes, W. Shofnos, American Congress on Surveying and Mapping, Houston, March 1962.
- The Computational Relationship of Geodesy to Photogrammetry, Charles A. Whitten, Annual Meeting of the American Society of Photogrammetry, Washington, D. C., March 1962.

The Adjustment of the Blue Nile Geodetic Control Project, Wallace H. Blackwell, American Geophysical Union, Washington, D. C., April 1962.

Ground Effects, Gnome and Hardtack 11, D. S. Carder and W. V. Mickey, Meeting of the Seismological Society of America, April 1962.

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Seismoscope Results and Spectrum Analysis--Project Gnome, W. K. Cloud, Meeting of the Seismological Society of America, April 1962.

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The Engineer in the Coast and Geodetic Survey, H. Arnold Karo, D. C. Society of Professional Engineers, Washington, April 1962.

World-Wide Standard Seismograph Standardization Program, L. M. Murphy, Meeting of the Seismological Society of America, April 1962.

Optical Tracking System for Space Geodesy, Eugene A. Taylor, American Geophysical Union, Washington, D. C., April 1962.

Emergency Charting, James C. Tison, Jr., Lions Club, Washington, D. C., April 1962.

Hydrographic Automatic Data Processing, H. Arnold Karo, VIII International Hydrographic Conference, Monaco, May 1962.

Oceanographic Programs of the Coast and Geodetic Survey, H. Arnold Karo, Anchor Club, Washington, D. C., May 1962.

Plans for Geodesy in the Next Decade, H. Arnold Karo, Annual Conference of Division of Earth Sciences, National Academy of Sciences-National Research Council, Washington, D. C., May 1962.

The Use of Electronic Distance-Measuring Instruments in Geodetic Surveying, B. K. Meade, New England College, Henniker, N. H., May 1962.

Settlement and Vertical Changes, James B. Small, American Society of Civil Engineers, Omaha, Nebr., May 1962.

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