

QB  
296  
45  
1958  
c.2

U. S. DEPARTMENT OF COMMERCE

LEWIS L. STRAUSS, SECRETARY

COAST AND GEODETIC SURVEY

H. ARNOLD KARO, *Director*

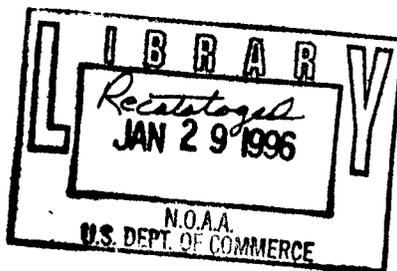
ANNUAL REPORT

OF THE

DIRECTOR OF THE COAST AND  
GEODETIC SURVEY

FOR THE

FISCAL YEAR ENDED JUNE 30, 1958



FOR OFFICIAL DISTRIBUTION

**National Oceanic and Atmospheric Administration**  
**Annual Report of the Director of the Coast and Geodetic**  
**Survey**

**ERRATA NOTICE**

One or more conditions of the original document may affect the quality of the image, such as:

Discolored pages  
Faded or light ink  
Binding intrudes into the text

This has been a co-operative project between the NOAA Central Library and the Climate Database Modernization Program, National Climate Data Center (NCDC). To view the original document, please contact the NOAA Central Library in Silver Spring, MD at (301) 713-2607 x124 or [Library.Reference@noaa.gov](mailto:Library.Reference@noaa.gov).

HOV Services  
Imaging Contractor  
12200 Kiln Court  
Beltsville, MD 20704-1387  
October 1, 2008

## CONTENTS

	Page
Office of Director.....	1
Coastal Surveys Division.....	5
Photogrammetry Division.....	13
Tides and Currents Division.....	17
Geophysics Division.....	20
Geodesy Division.....	25
Chart Division.....	39
Instrument Division.....	49
Technical Services Division.....	53
Personnel and Safety Division.....	58
Budget and Fiscal Division.....	60
Organization and Management Division.....	61
Administrative Services Division.....	63
Appendix.....	64

## OFFICE OF THE DIRECTOR

### PROGRAM PLANNING AND COORDINATION STAFF

The program planning and coordination staff was engaged primarily on program planning, emergency planning, legislative liaison, representation on interagency committees, and various special studies for the Director.

The foreseeable long-range, nautical charting program was extended to 1986.

Emergency planning included coordination of bureau activities with the requirements of the Department, Office of Defense Mobilization, and Federal Civil Defense Administration and participation in "Operation Alert 1957."

Legislative liaison included preparation of proposed legislative program and preparation of required bureau comment on other pertinent legislation.

Principal special studies included: Improvement in rate of processing hydrographic sheets, changes in form of publishing geodetic data and indexes, research and development activities, schedule of compensation and rating structure for vessel employees, and small-boat charts and coast pilots.

The revision of the Coast and Geodetic Survey Regulations was completed and published.

### INTERNATIONAL TECHNICAL COOPERATION STAFF

The international technical cooperation staff performed all liaison activities between the bureau and foreign trainees under sponsorship of the International Cooperation Administration (ICA); the International Educational Exchange Service of the Department of State; the fellowship programs of the United Nations Technical Assistance Administration; and under bilateral arrangements made by the Department of State with participating foreign governments. Operations were carried on under the provisions of Public Law 665, 83d Congress, Mutual Security Act of 1954 and subsequent amendments; Public Law 402, 80th Congress, Informational and Educational Exchange Act; and under the charters of various specialized agencies of the Economic and Social Council of the United Nations.

During the year, 7 ICA participants from various countries reported to the bureau and were given instruction in the following subjects: geodetic surveying--Brazil (1); photogrammetry--Brazil (1); hydrographic surveying--Indonesia (3); urban surveys, geodesy, and photogrammetry--Norway (1); and electronic surveying--Philippines (1).

There were 10 ICA participants, accepted during the 1957 fiscal year, who continued or completed training during this fiscal year: in geodetic surveying--Bolivia (1), Greece (1), Iraq (1); in photogrammetry--Bolivia (1), Ethiopia (2), Jordan (1); in geomagnetism--Chile (1); and in map and chart construction--Thailand (2).

Under the sponsorship of the United Nations, 8 fellows received instruction in the following subjects: hydrographic surveying--India (2); photogrammetry--Panama (1) and Thailand (4); and electronic navigation equipment--Japan (1).

Under bilateral arrangements made between the Department of State and participating foreign governments, 4 foreign nationals were trained in the following subjects: geodetic surveying, photogrammetry, and gravity and astronomy--Portugal (3); map and chart construction and reproduction--Venezuela (1).

ICA secondary participants (accepted from other training agencies) received instruction from 1 to 4 months in the following subjects: photogrammetry--Cuba (1), El Salvador (1), and Haiti (1); reproduction--El Salvador (1), Ethiopia (1), Pakistan (1), and Thailand (1).

ICA secondary visitors were received for a 1-day visit: Brazil (1), China (2), Colombia (1), Cuba (1), Ecuador (1), Haiti (2), Iceland (3), Korea (3), Pakistan (4), Panama (1), Peru (1), Philippines (1), Thailand (6), and Vietnam (2).

In addition to those specified under the preceding programs, the bureau received 69 foreign visitors concerned with observation of facilities and consultation on technical procedures. These visits extended from 1 to 60 days and included representatives from the following countries: Australia (2), Austria (2), Belgium (1), Brazil (3), Canada (3), Chile (1), China (7), Denmark (1), England (7), France (4), Germany (7), Greece (1), Holland (3), Iran (2), Italy (2), Japan (4), Korea (1), Netherlands (6), Nigeria (1), Pakistan (1), Portugal (1), Southern Rhodesia (1), Spain (1), Sweden (1), Switzerland (2), Sudan (1), and Thailand (3).

#### TECHNICAL RESEARCH AND INFORMATION STAFF

The technical research and information staff prepared the bureau portion of the Annual Report of the Secretary, the Annual Report of the Director including activities during the Sesquicentennial celebration, and a report on the bureau activities in Alaska for the Annual Report of the Governor of Alaska.

Journal No. 7 was prepared for publication together with a Cumulative Index for Journals 5 to 7 inclusive.

The publication of The Journal was discontinued with this issue.

A study was made of the advisability of superseding The Journal with a series of Technical Bulletins (each Bulletin containing a single paper) that could be published and be disseminated more expeditiously than The Journal. A comprehensive plan was prepared detailing the nature, scope, format, and procedure to be followed in the processing of such material. Two types of Bulletins are provided for--a numbered series for general distribution on a sales basis, and a lettered series for official distribution only. During the year four Bulletins were issued.

Special studies were made and comprehensive memorandums prepared on the following subjects: dividing lines between various categories of water areas and the applicable technical and legal-technical principles for the U. S. Coast Guard; principles to be applied in determining the "littoral line of the Pacific coast" for the National Park Service; the bureau's association with the establishment of the original boundary line and the probable method used in drawing the subsequent boundary between the United States and Mexico in the Gulf of Mexico for the Department of State; the cartographic history of Earthquake Bay, Calif., for a law firm; and matters dealing with the California and Louisiana "tidelands" cases for a professor of geography.

Other verbal and written information was furnished bureau personnel and others on matters dealing with ownership of lands bordering navigable waters, riparian rights, water boundaries and the problem of establishing a past tidal boundary from existing cartographic data, and the Federal Tort Claims Act.

A detailed outline was prepared for the forthcoming publication on "SHORE AND SEA BOUNDARIES--with Special Emphasis on the Interpretation and Use of Coast and Geodetic Survey Data."

#### DISTRICT OFFICES

District offices were maintained at Baltimore, Boston, Fort Worth, Honolulu, Kansas City, Los Angeles, New Orleans, New York, Norfolk, Portland (Oreg.), San Francisco, Seattle, and Tampa. These provide quarters for the office work and headquarters for the field parties working in the respective districts. They assist parties in obtaining supplies, personnel, and transportation; furnish information for the correction of charts; maintain liaison with Federal, State, municipal, and industrial organizations, and the general public in order to obtain and furnish surveying data and technical information relating to the bureau's work; visit educational institutions for the purpose of recruiting commissioned

and technical personnel; make periodic inspection of sales agencies to insure the faithful performance of their contracts; keep the Director informed of conditions and needs for surveys and make recommendations concerning surveys that should be made; conduct such surveys and examinations as may be practicable, to avoid sending special parties to perform the work. In addition to their general duties, the offices at Norfolk and Seattle process hydrographic surveys; those at Baltimore, Portland, and Tampa process photogrammetric surveys; the New York office processes geodetic data; and those at Kansas City, New York, and San Francisco act as chart distribution centers supplying both the agents and the public in those areas.

## COASTAL SURVEYS DIVISION

### OPERATIONAL ACTIVITIES

#### Atlantic and Gulf Coasts

Hydrographic-survey operations were continued along the Atlantic and Gulf coasts as follows:

The resurvey of Georges Bank which was begun in the spring of 1957 by the ship HYDROGRAPHER was continued, using Raydist and EPI control. The Raydist equipment was first used experimentally and was later purchased. It has been successfully used on large-scale surveys to a maximum distance of approximately 200 miles. The northeastern half of Georges Bank has been completed, including large-scale surveys of Cultivator Shoal and Georges Shoal. The latter survey was required for construction of an approach chart at Texas Tower No. 2. The remaining area is being surveyed at the urgent request of the New England fishing industry. Two measured-mile courses were reestablished in Boston Harbor.

The ship COWIE continued visual- and shoran-controlled hydrographic surveys along the eastern shore of Chesapeake Bay south of Pocomoke Sound. Inshore surveys were completed southward to Occohannock Creek. A special tag-line survey was made at the new ship base acquired from the Navy under a use permit at Norfolk, Va.

The ships WAINWRIGHT and HILGARD, operating as a unit, continued wire-drag surveys in the vicinity of Swans Island and Isle au Haut, Maine. During the period when intensive lobster fishing prevented wire-drag survey work these vessels continued hydrographic surveys, working eastward from Schoodic Point to Petit Manan Island. A special wire-drag investigation was made of a charted 2-foot sounding in Winter Harbor, Vinalhaven, Maine, and a reported midchannel 31-foot sounding in general depths of 47 feet in Buzzards Bay, Mass.

The ship GILBERT continued visual- and shoran-controlled hydrographic surveys east of Nantucket Island and in the eastern approaches to Nantucket Sound. A hydrographic investigation was made of a reported 31-foot sounding in Buzzards Bay. This sounding was later investigated by wire drag as reported above. In the spring of 1958, a current survey was conducted in Winyah Bay and Georgetown Harbor, S. C., under cooperative arrangements with the Corps of Engineers, U. S. Army. This survey was required to assist in a study of the unusual shoaling which is taking place in this waterway.

The ship MARMER completed repairs and conversion to a survey vessel in January and was assigned to conduct special circulatory surveys in New York Harbor and Hudson

River. ; Current meters, designed to measure very low velocities, were used for the first time. An inductive conductivity temperature indicator (ICTI) was assigned to this vessel for measuring temperature and salinity once each month at 48 stations in the project area. Current observations were completed at 18 of the stations.

The ship SOSBEE continued surveys in Hillsboro and Tampa Bays, Fla. The unattended shoran equipment was assigned to this party during part of the reporting period for use in controlling surveys at the entrance to Tampa Bay and in the offshore areas in the vicinity of St. Petersburg. Surveys were completed in Hillsboro Bay. A test of Tellurometer equipment was made to determine whether this instrument was adaptable for use in controlling hydrographic surveys. The tests indicated that this equipment could not be used while the ship was in motion.

The East Coast Field Party completed surveys in Narragansett Bay and Sakonnet River, R. I., in October 1957. The party was then transferred to St. Petersburg to assist the ship SOSBEE in the surveying of Tampa Bay. En route to Florida one unit was detached to make a hydrographic survey of a portion of Ashley River near Charleston, S.C. In the spring of 1958, a detached unit completed hydrographic investigation of a portion of the St. Johns River at the request of the Bureau of Aeronautics, U. S. Navy. At the end of the year surveys had been completed in Old Tampa Bay, and were progressing along the waterfront of St. Petersburg.

The ship SCOTT continued Coast Pilot investigation and chart revision along the Atlantic coast south of Sandy Hook. Field work was completed southward from Sandy Hook to Cape May and in the Delaware River from Trenton, N. J., to Cape Henlopen, and through the Chesapeake and Delaware Canal. The party assisted a photogrammetrist in the location of 90 aids to navigation along the Intracoastal Waterway in New Jersey. In addition, several aids were located in Rehoboth Bay at the request of the Coast Guard. After the winter repair period, the SCOTT resumed operations in the vicinity of Norfolk, Va., and is proceeding southward along the Intracoastal Waterway to Key West on revision of the Coast Pilot. At the end of the fiscal year the ship was at Charleston, S. C.

#### Pacific Coast, Alaska, and Hawaiian Islands

The following hydrographic-surveying operations were conducted along the Pacific coast, in Alaska, and in the Hawaiian Islands:

In company with two Navy survey vessels, the ship PIONEER continued offshore EPI-controlled surveys north, east, and southeast of the Hawaiian Islands. These surveys were conducted under the direction of the Navy

Hydrographic Office on a reimbursable basis. This project was terminated in December 1957 and the PIONEER returned to San Francisco in January for overhaul and outfitting. On May 1 the PIONEER resumed operations on a special project for the Navy along the southern California coast. This project was in progress at the end of the fiscal year.

The ship BOWIE continued hydrographic surveys in Prince of Wales and Bainbridge Passages, off Prince William Sound, Alaska, during the first quarter of the year. Surveys were also completed in Icy Bay and Nassau Fiord. In the spring of 1958 this vessel was assigned to duty in the Columbia River, in company with the West Coast Field Party, to accomplish hydrographic surveys in the lower part of the estuary and outside approaches to the Columbia River. Shore control was used for the surveys on the outside coast.

The West Coast Field Party completed surveys in Nehalem River, Netarts Bay, and Tillamook Bay on the coast of Oregon in October 1957. The party was partially disbanded and spent the winter in Seattle processing hydrographic records. This unit was reorganized in March 1958 and assigned to a survey in the Columbia River. This survey is being made partially at the request of the Corps of Engineers, U. S. Army, to provide data for the construction of a model of the lower Columbia River. At the end of the fiscal year, approximately 50 percent of the survey had been completed.

The ship PATHFINDER continued her program of surveys along the north coast of the Alaska Peninsula, and completed surveys in the approaches to Bechevin Bay. The scene of operations was then transferred to Port Heiden. Surveys were completed of this harbor and approaches. Shore control was used where possible for ship and launch hydrography. At the request of an oil company, the PATHFINDER accomplished a special wire-drag survey of Guemes Channel, Washington. This investigation was required to assure safe passage of deep-draft tankers bringing oil from the Far East. This ship was then assigned an early season project in Kasaan Bay in Clarence Strait, southeast Alaska. Some triangulation, reconnaissance, and hydrography were accomplished prior to her departure to the Alaska Peninsula working grounds. En route to Seward deep-sea dredging was accomplished on Pamplona Searidge, Gulf of Alaska. A new standard tide gage was installed at Seward and the ship proceeded to Dutch Harbor, arriving early in June. Surveys were resumed on the north side of the Alaska Peninsula and are progressing northeastward along the coast from a junction with surveys completed in 1956 in the vicinity of Amak Island.

The ship EXPLORER resumed combined operations in the Aleutian Islands, and completed hydrographic surveys

between Great Sitkin and Atka Islands. In order to establish horizontal control for photogrammetric and hydrographic surveys in the Atka and Amlia Islands area, an officer was assigned to accomplish Tellurometer traverse surveys along the south coast of Atka Island and around the perimeter of Amlia Island. Control was successfully established at a great saving in time and money when compared with the ordinary procedures of triangulation which would normally have been used. In May 1958, the EXPLORER resurveyed Alcan Harbor at the request of the Commandant, 17th Naval District. The standard tide gage and Seismic Sea Wave Warning System on Attu Island were transferred from Massacre Bay to Casco Cove, where they are being cared for by Coast Guard personnel.

The ship PATTON continued hydrographic surveys in the San Juan Islands, Wash., and completed work in Haro Strait in the vicinity of Waldron Island, and in East Sound, Orcas Island. Current observations were completed in East Sound, Upright Channel, and Harney Channel. In April 1958, the PATTON returned to her working grounds on the west coast of Prince of Wales Island in the vicinity of Hydaburg, southeast Alaska. Triangulation, photogrammetric, and hydrographic surveys are in progress in Soda Bay and Tlevak Narrows. A survey of Netzuhini Bay was completed.

The ship LESTER JONES accomplished photogrammetric and hydrographic surveys in Dickman Bay, Frederick Cove, and Moira Sound, southeast Alaska. Offshore work in Clarence Strait was completed from Kendrick Bay to Ingraham Bay, and an 88-fathom bank was discovered in general depths of about 220 fathoms. At the end of the year, hydrographic surveys were in progress along the west side of Clarence Strait.

The ship HODGSON continued combined operations on the west coast of Prince of Wales Island. Hydrographic surveys were completed in El Capitan Passage, Sea Otter Sound, and on the south side of Tuxekan Island. A special investigation was made of a charted rock on the north end of Tuxekan Passage, but no trace of the rock was found. Field inspection was completed of Coronation Island, Spanish Islands, Tonowek Bay, and the Maurelle Islands. Shoreline inspection was completed at Sarkar Lake. The nautical chart agencies at Juneau, Hoonah, Tenakee Springs, and Sitka were inspected. The standard tide gages at Juneau, Skagway, and Sitka were inspected and serviced. Hydrography continued along the west coast of Heceta Island and in Iphigenia Bay. A tagline survey was completed around the piers in the vicinity of New Tokeen. Triangulation was completed for locating aids to navigation. Magnetic observations were completed at one station on the north shore of Heceta Island. A 93-hour current station was observed. Recovery and identification of horizontal control in Lebenkof Bay, Chatham Strait, were completed.

Statistical Summary of Coastal Surveys

Locality	Hydrography				Topography		Triangulation		
	Sound- ing lines	Area	Wire drag	Area	Shore- line	Area	Length of Schemes	Area	Geo- graphic posi- tions
	Miles	Square Miles	Miles	Square Miles	Miles	Square Miles	Miles	Square Miles	Number
Maine to New York	14,257	2,478	156	71	-	-	-	-	2
Chesapeake Bay	3,157	128	-	-	137	-	-	-	4
Cape Henry to Florida	243	14	-	-	-	-	-	-	3
Gulf of Mexico	3,602	209	-	-	-	-	-	-	-
West Coast	2,842	128	48	16	4	1	-	-	2
Hawaiian Islands	33,003	105,683	-	-	-	-	-	-	-
Alaska	8,375	763	-	-	338	160	20	23	80
Gulf of Alaska	5,861	-	-	-	-	-	-	-	-
<b>Total</b>	<b>71,340</b>	<b>109,403</b>	<b>204</b>	<b>87</b>	<b>479</b>	<b>161</b>	<b>20</b>	<b>23</b>	<b>91</b>

## Coast Pilot

The ten Coast Pilots published by the bureau provide a verbal description of United States coasts, harbors, and connecting waterways that is mostly impossible of presentation on the nautical charts. Subjects include landmarks, navigation regulations, channels, anchorages, dangers, routes, weather, ice, pilotage, customs, and port facilities. New editions of each book are published at intervals of about seven years. Supplements, containing changes reported between date of edition and effective date of supplement, usually are issued early each year. During the year, supplements were issued for eight Pilots. The remaining two were combined in one manuscript and sent to press as UNITED STATES COAST PILOT 5 (Gulf Coast, Puerto Rico, and Virgin Islands) 1958. Shore inspection was completed for a 1959 edition of COAST PILOT 7 (Pacific Coast, California, Oregon, Washington, and Hawaii). Ship inspection was about 40 percent complete for a 1959 edition of COAST PILOT 4 (Atlantic Coast, Cape Henry to Key West).

### COOPERATION WITH NATIONAL AGENCIES

For the Navy Hydrographic Office, the following work was accomplished: Basic offshore hydrographic surveys around the Hawaiian Islands--terminated at the end of January with 105,683 square nautical miles of offshore hydrography completed; a special project on the California coast was in progress during the last quarter; hydrographic surveys on Georges Bank, along the coast of Massachusetts, were continued; the positions of Texas Tower No. 2 and Texas Tower No. 3 were determined; and a special wire-drag survey was completed in the vicinity of Culebra Island, Puerto Rico. A hydrographic survey of part of the St. Johns River, Fla., was made at the request of the Bureau of Aeronautics. A special hydrographic survey was accomplished in Alcan Harbor, Shemya Island, Alaska, at the request of the Commandant, 17th Naval District.

For the Corps of Engineers, the following work was accomplished: A special current survey was completed in Winyah Bay and Georgetown Harbor, S. C.; standard tide gages were installed at the Beaver Army Terminal opposite Oak Point, Oreg., and at Altoona, Wash., on the Columbia River; and new basic hydrographic surveys are in progress in the Columbia River estuary and approaches.

For the Coast Guard, 90 aids to navigation were located in the section of the New Jersey Intracoastal Waterway between Townsend Inlet and Cape May, and several additional aids were located in Rehoboth, Del. Circulatory surveys of New York Harbor are in progress for the Atomic Energy Commission; Department of Health, Education, and Welfare; and Maritime Administration.

A special wire-drag survey in Guemes Channel, Wash., was accomplished for an oil company. A hydrographic survey of the Ashley River, S. C., was completed at the request of several commercial establishments.

#### RESEARCH AND DEVELOPMENT

Tests were conducted on a Decca system navigator. This electronic equipment is a radiolocation system enabling an accurate determination of position to be made at long and short ranges. The basic principle employed is that of measuring the phase difference of the radio waves received from three continuous wave-transmitters. The Decca navigator receiver was installed aboard ship and tested for suitability as a survey instrument. The location of the stations with respect to the working grounds precluded accomplishment of a satisfactory evaluation of this equipment.

Tests continued on a newly developed distance-measuring Raydist equipment. A new printer was installed in the equipment and has operated satisfactorily. The former printer was quite large and complex. The new printer was designed in the electronics laboratory at one-fourth the cost of the earlier model and is a small table model unit. Another improvement was combining, or "duplexing," the antenna systems at shore stations. Three 100-foot towers were previously required at these stations for the various transmitters and receivers. With the "duplexing system" only two towers are required and there is the added advantage of canceling the eccentricity error. Prior to duplexing the antenna systems at shore stations, the distance information was received by one tower and transmitted to the ship by another tower. This caused a distance correction which would vary with the angle of the ship to the line between the two towers. With the duplexing system, the distance information is received and transmitted by the same tower.

Development of several types of nonconventional electronic devices for use in the collection and processing of hydrographic survey data was begun and carried on in conjunction with the electronics laboratory. At the end of the year a Digital Depth Recording System had been developed and construction had been contracted for. Development of Programmed Automatic Steering Control equipment had progressed to the point of a field test. Development of the Semiautomatic Data Recording and Processing System had advanced to the extent that negotiations for its construction were in progress.

The keel of the new ship SURVEYOR was laid on March 22, 1958, at San Diego, Calif. She has been designated the prototype of new Class I construction. Preliminary specifications and arrangement drawings were prepared for Class II and Class III prototype ships. At the end of the year an engineering study of optimum dimensions and

characteristics for Classes II and III ships was being conducted by a firm of naval architects and marine engineers.

An extensive study of the feasibility of converting existing naval and merchant ships for use as hydrographic surveying ships was completed.

A condition survey to determine the current condition and replacement needs of all Coast and Geodetic Survey ships was completed.

The procurement of launches and small boats with hulls constructed by plastic laminate fabrication was continued. Three 26-foot hydrographic launches, three 26-foot motor whaleboats, and seven 16-foot dinghies of this type have now been procured and are in service. Work was begun on design modification of three types of standard wooden-hull boats to adapt them to plastic laminate fabrication. These standard types are the 16-foot knuckle skiff, the 20-foot dory, and the 25-foot Chesapeake Bay skiff.

The launch replacement program previously initiated was continued, with replacement launches for the ship PATHFINDER under construction.

Work on design modifications for 36-foot launches for the new ship SURVEYOR was begun. Redesign of a 30-foot hydrographic launch to adapt it for use aboard seagoing ships was completed.

## PHOTOGRAMMETRY DIVISION

### OPERATIONAL ACTIVITIES

One of the most important applications of photogrammetric mapping in this bureau consists of furnishing secondary control for inshore hydrography and providing the basic land information to be shown on the charts. By supplying this advance information, the hydrographic survey operations can proceed at once with its sounding work. In the United States and Alaska, 2,735 linear miles of photography were taken during the year in support of hydrographic surveys and 1,990 linear miles of photography were taken for general coastal chart construction.

A somewhat different application of photogrammetry allows changed areas to be photographed, and the charts to be corrected directly from the new photographs without any field operations other than the flying. In this category, 86 nautical charts and 17 topographic sheets were revised.

Mapping for aeronautical charts includes large-scale mapping and map revision of airport obstruction charts. Airport obstruction charts are constructed at a scale of 1:12,000 showing the runways and flight paths for landing and takeoff, together with the positions and elevations of objects which are potential hazards to air traffic near airports. They are used to determine the maximum safe takeoff and landing gross weight for civil aircraft, and for determining instrument approach and landing procedures at airports. In addition, they provide data for engineering planning relative to removing obstructions and improving facilities. Resurveys and revisions of airport charts are essential parts of the program. Field surveys at 50 airports were completed during the year, of which 11 new obstruction charts were published and 39 existing charts were revised. A total of 421 obstruction charts are now on issue.

The air facilities location program (VOR) is an allied operation. The facility consists of a building containing radio broadcasting equipment. The problem is to determine the latitude and longitude of the center of the building within a small tolerance. It is solved photogrammetrically, if applicable, by flying a strip of photographs which show the building and also three or more existing triangulation stations--some strips are nearly 100 miles long. The photographs are aerotriangulated (accurately connected) by the use of a first-order stereoscopic mapping instrument, and the positions are adjusted systematically through the use of an electronic computer program. During the year 105 facilities were located in this manner, 81 others were located by conventional surveying methods, in addition to those located by the geodesy division.

The same aerotriangulation technique was used in determining the positions of 90 aids to navigation in the Intracoastal Waterway in southern New Jersey, and over 200 aids in the Florida Keys. The latter were marked with white boards, 2 feet square before the 10,000-foot photography was flown.

A summary of coastal mapping accomplishments is given in the accompanying table.

#### COOPERATION WITH NATIONAL AGENCIES

Basic surveys consisting of 21 sheets (23 square miles) at the scale of 1:2,400, showing 2-foot contours were prepared for the Civil Aeronautics Administration for the proposed Chantilly Airport Site near Washington, D. C. Planimetric control was distributed by the use of the aerotriangulation methods already mentioned, and contouring was done by a combination of planetable in the field and Kelsh plotter in the office. The efficiency of the system and organization was demonstrated inasmuch as the entire survey, from aerial photography to the delivery of the printed maps, was completed in only 5½ months.

A special low-water line compilation consisting of 42 sheets and showing most of the Gulf coast of Louisiana was made in cooperation with the State of Louisiana and the Bureau of Land Management for use in the administration of the offshore oil leases.

#### RESEARCH AND DEVELOPMENT

Aerotriangulation adjustment was programmed for automatic computer through the cooperation of the geodesy division. The program incorporates a least-squares adjustment among all the control points utilized and eliminates all graphic and precomputational operations. The method is reported in the bureau's technical bulletin No. 1, and the results of tests were reported at the annual meeting of the American Society of Photogrammetry. These tests consisted of aerotriangulating seven times a flight strip 90 miles long located in Florida and containing 15 control stations, and was conducted for the purpose of determining the magnitude and character of errors. Further tests were subsequently made to improve instrumental techniques, reduce the residual errors, and in an effort to determine the principles of three-dimensional instrument error propagation. Analytic aerotriangulation continues to be developed and is ready for testing, coding, and instrumentation.

A precision reduction printer was purchased for use with the Wild A-5 plotting instrument using avioigon aerial photography to give more accurate lens distortion compensation and maximum image resolution. A new and improved automatic dodging Log-E printer was purchased to replace the older original model for making dispositives

Summary of Coastal Mapping

Locality	Aerial photog- raphy	Photogrammetric field surveys		Manuscripts completed		
		Hydro support (Shoreline)	Coastal mapping (Area)	Hydro support (Shoreline)	Coastal mapping (Area)	Number
	Linear miles	Linear miles	Square miles	Linear miles	Square miles	
Maine, New Hampshire, and Massachusetts.....	95	92	55	18	125	12
Rhode Island, Connecticut, New York, and New Jersey...	236	102	124	11	249	....
Delaware, Maryland, Virginia, and North Carolina.....	189	75	10	28	75	28
South Carolina, Georgia, and Florida.....	1,559	170	90	110	547	22
Alabama, Mississippi, Louisiana, and Texas.....	1,087	....	630	240	349	18
California, Oregon, and Washington.....	850	188	204	65	348	27
<b>Alaska</b>						
Southeast Alaska.....	142	....	....	203	25	....
Alaska Peninsula.....	567	....	....	46	....	....
Aleutian Islands.....	....	....	....	166	274	4
Bering Sea.....	....	....	....	36	498	34
<b>Total.....</b>	<b>4,725</b>	<b>627</b>	<b>1,113</b>	<b>923</b>	<b>2,490</b>	<b>145</b>

for the planigraphs and Kelsh plotters and contact prints from aerial film. Four new Kelsh plotters were procured during the year: their distribution is now five in Baltimore, two in Tampa, two in Portland, one in production in Washington and one for foreign training purposes in Washington. Two coordinatographs were purchased, one each for the Baltimore and Tampa photogrammetric offices. Their principal use is to plot photogrammetric control from coordinates supplied from computationally adjusted aerotriangulation by the Washington office. In the Washington office, there are also three first-order plotters used chiefly for aerotriangulation, and two Reading plotters used for compiling contours and planimetry from nine-lens photographs.

## TIDES AND CURRENTS DIVISION

### OPERATIONAL ACTIVITIES

#### Tidal Surveys

The system of control tide stations distributed along the coasts of the United States, its Territories, and including some island stations in the western Pacific was maintained on a continuing basis. New stations were established at Galveston (outer coast), Sabine Pass, Port Aransas, and Padre Island, Tex.; and San Clemente Island, Calif. The stations at the Battery, N. Y.; Avila Beach, Calif.; and Attu Island, Alaska, were relocated. The station at Seward, Alaska, was reactivated. Observations at Eastport, Maine, and Texas Tower No. 2 on Georges Bank were temporarily suspended. Supplementing the information from the control tide stations, records were also received and processed for 38 places in Latin America through cooperative arrangements with the Army Map Service. Shorter series of tide records were obtained at 54 additional places in connection with hydrographic surveys and other projects.

The demand for tidal information continued to be large. The most frequent requests involved boundary problems, damage suits, and storm surge studies.

One tide station servicing party operated on the Atlantic and Gulf coasts, and another in the Pacific Islands area. Tide stations on the Pacific coast were serviced by parties operating through the district offices, and Alaskan stations were serviced by ship parties. The East Coast party also carried out benchmark recovery operations in Delaware and Florida.

#### Current Surveys

Observations of the current during the year were augmented by special surveys--one in New York Harbor for the Atomic Energy Commission and the Maritime Administration, and another in Winyah Bay, S. C., for the Corps of Engineers. Eighteen stations were occupied in the New York Harbor project and 9 stations in the Winyah Bay project. Observations by hydrographic parties were obtained at 24 stations distributed in Alaska, the San Juan Islands, Georges Bank, Chesapeake Bay, and Tampa Bay, Fla. Current observations were also continued at two lightships off the coasts of New Jersey and North Carolina.

#### Predictions

Four volumes of annual tide tables and two volumes of annual tidal current tables were published. Special tide tables for the Arctic were also published for the official use of the Navy Hydrographic Office. The revision

of the format of the tables of differences in the tide and current tables to provide additional information was completed.

#### Related Oceanographic Work

Records of daily sea water temperatures and densities were received from 125 stations, 83 of which were in the United States and possessions, and 42 in foreign countries. In conjunction with the current observations in the New York Harbor area, 13 hours of half-hourly serial temperature and salinity observations were obtained at one current station in each cross section, and serial observations at each of 46 stations were obtained once each month.

The Seismic Sea Wave Warning System is expected to be expanded on an international basis as the result of negotiations initiated during the year. Wave reporting stations at Valparaiso and Easter Island will bring Chile into the system and it is proposed to use a British tide station in the Fiji Islands. During the year a seismic sea wave detector was installed at Murder Point, Attu, Alaska, to replace a discontinued station at Massacre Bay.

### NATIONAL AND INTERNATIONAL COOPERATION

#### National Agencies

A special tide table for the Arctic was published for the official use of the Navy Hydrographic Office. Processing of tide records and determining tidal datum planes for places in Latin America were carried out for the Army Map Service. Tide observations were obtained in Long Island Sound under a project for the Corps of Engineers pertaining to hurricane protection studies. In connection with hurricane warning investigations, basic tidal data were furnished and close liaison was continued with the Weather Bureau.

A circulatory survey of the New York Harbor area was begun for the Atomic Energy Commission and the Maritime Administration. A current survey was conducted in Winyah Bay, S. C., for the Corps of Engineers to provide data for studies of shoaling problems. Assistance was also provided the Corps of Engineers in processing data on currents for calibrating a model of San Francisco Bay.

#### International Agencies

Participation was continued in a program of international exchange of tide and current predictions with a number of maritime nations. Arrangements were under way with Chile for including Valparaiso and Easter Island as wave-reporting stations in the Seismic Sea Wave Warning System. A similar arrangement was under negotiation for

a British tide station in the Fiji Islands.

Under activities associated with the International Geophysical Year special efforts were made to keep key tide stations in operation and to maintain close liaison with the U. S. Technical Committee on Oceanography through a consultant to that committee from the bureau.

#### RESEARCH AND DEVELOPMENT

New automatic readout equipment was installed on the tide predictor to expedite the preparation of copy for the tide and tidal current tables. This equipment will tabulate hourly heights or velocities as well as times and heights of high and low waters, or times and velocities of strengths of current and times of slack water. A semiautomatic tide roll scanner, used for tabulating hourly heights, was also put into operation. This machine, developed in this division, reduces the time normally required to tabulate hourly heights. It will also put the tidal data on one sheet, which is less than half the space previously required.

To obtain low velocity measurements of the current required for circulatory surveys, the Roberts current meter was modified. Greater sensitivity of the instrument was achieved by enlarging the impeller and fin areas. Greater utilization of the increased sensitivity of the modified meter has been obtained by providing more definite identification of signals. This was accomplished by a newly designed FM radio transmission system which separates velocity and direction impulses. The new transmitters send the signals only when triggered, rather than continuously as in the old type transmitters, a feature which presumably will reduce the battery cost of current observations. During the Winyah Bay survey, current observations were obtained from meters attached to an experimental frame resting on the bottom, and the modified current meter recorder was field-tested.

Long-period records of sea water temperature and density obtained by the bureau were utilized in an investigation of unusually high water temperatures and sea level from California to southeast Alaska. These were correlated with wind anomalies to develop a relationship which helped to explain the unusual phenomena.

## GEOPHYSICS DIVISION

### OPERATIONAL ACTIVITIES

#### Geomagnetism

During the year, magnetic field observations were made at 118 stations distributed in the United States and Alaska. Of these, 81 were repeat stations for measurement of secular-change rates and 37 were secondary stations for increasing the general store of distribution data. The repeat observations were brought to a new level of accuracy by the inauguration during the year of a program whereby a portable temporary recording station is maintained in operation for an interval of several days while the field work proceeds in the same region. The recording equipment is advanced from one region to another so that it is always near enough to afford good control for eliminating the transient fluctuations from the spot observations.

Basic control for the field work continues to depend on the permanent magnetic observatories. The fundamental import of the record of magnetic fluctuations so obtained is brought out in a broad spectrum of technological and scientific activities such as exploration geophysics, air navigation, radio propagation studies, cosmic-ray investigations, and research on the phenomena of the upper atmosphere and of the little-known zone of space beyond, where the interplanetary medium impinges on the earth's magnetic field. The bureau's seven fixed magnetic observatories are at Fredericksburg, Va.; Tucson, Ariz.; San Juan, P. R.; Honolulu, T. H.; and Sitka, College, and Barrow, Alaska.

Work is well advanced on the compilation of data for the 1960 edition of isogonic charts of the United States, Alaska, and the world. An active exchange of data with the Astronomer Royal of Great Britain has been carried out, and further collaboration is in prospect to guard against meaningless disparities of the world charts to be issued by the United States and Great Britain.

#### Seismology

In the earthquake-locating program, the bureau continued to operate 9 stations and collaborated with 12 others in universities, government agencies, and other institutions. Hundreds of other stations located in all parts of the world cooperated by furnishing earthquake data through communication facilities made available by military and non-military agencies of our government. Through the medium of this program locations of 1,266 earthquakes were determined, and the pertinent data furnished to all interested persons on a biweekly schedule. In addition, requests for information about earthquake

geography were filled for 104 domestic and 14 foreign areas. Special earthquake readings and nearly a thousand seismograms, primarily for use in research projects, were supplied seismologists in the United States, Australia, Canada, England, France, Italy, Russia, and Western Samoa.

Operation of the seismic telemetering system at the Tucson Magnetic Observatory during the year has proven its practicability under rather adverse conditions. Variable reluctance Benioff seismographs were installed at Boulder City and Eureka, Nev., to furnish relative calibrations for existing Benioff equipment. At Page, Ariz., a site was tested and recommended for a station to be erected at the Glen Canyon Dam. Instrumental assistance was also rendered Georgetown University, Rensselaer Polytechnic Institute, University of North Carolina, Loyola University, University of Arkansas, University of Wisconsin, University of Puerto Rico, Syracuse University, and Fordham University. The bureau assumed full operational responsibility for the Hungry Horse station, employing a part-time geophysicist as operator.

In the strong-motion program 64 stations, exclusive of 7 in Central and South America, continued to operate in the western earthquake areas of the United States. No records of particular significance were obtained, but extensive use was made of data compiled from earlier work for use in advisory reports to the Atomic Energy Commission in conjunction with many atomic explosions fired during the year. Several vibration measurements were conducted on public schools and large office buildings in the San Francisco Bay area. A large quarry blast at Corona, Calif. was monitored for ground displacement data.

The Seismic Sea Wave Warning System continued to operate efficiently and to expand its service to the many islands in the Pacific Ocean area and the bordering countries. Every continent bordering the Pacific is now actively participating in this service. Four alerts for earthquakes in Ecuador, Mexico, New Hebrides, and Santa Cruz Islands were initiated but no damaging sea waves resulted from the earthquakes. Considerable improvement and simplification of the communication channels through the Civil Aeronautics Administration, Navy, and Federal Civil Defense Administration were affected.

## NATIONAL AND INTERNATIONAL COOPERATION

### National Agencies

Advice was given on the seismicity of the Long Beach Naval Shipyard, and structural geology and seismicity of Terminal Island. Microseismic data were compiled for the Naval Research Laboratory.

The Corps of Engineers was supplied 1955 earthquake data for Alaska, Mediterranean, and Middle East areas.

Air Materiel Command, Wright Patterson AFB, Dayton, Ohio, requested estimates of relative background noise due to microseisms and artificial disturbances for all areas of the United States. Magnetic observations were made to test the suitability of compass testing platforms at 51 airfields in the United States and at 3 others in the Territories. Most of this work was done on behalf of the United States Air Force.

For the Atomic Energy Commission, extensive consulting work about relative energy yields from earthquakes of varying intensities were submitted; temporary seismograph stations were operated in southern Missouri and Mammoth Cave, Ky., for the Rainier explosion; atomic explosion information, including time of detonation, exact position and energy yield, was disseminated to seismologists and other research groups.

Department of State was furnished seismicity data for Rangoon, Burma, and New Delhi, India.

The Geological Survey was assisted in the calibration of their equipment used on the Rainier explosion, and was loaned copies of all seismograms for this explosion.

The Bureau of Reclamation was given data relative to ground effects resulting from nuclear explosions.

U. S. Coast Guard was given seismicity data for the North Atlantic, the Mediterranean, southern Spain, France, Italy, and Turkey.

Maritime Administration was furnished seismicity information for the Philadelphia-Camden area.

Information about the purchase, construction, and operation of seismographs was supplied to: Stanford Research, Panama Canal Co., Oregon Museum of Science and Industry, LeMoyné College, University of Puerto Rico, Harvard University, University of Cincinnati, and others. In addition, cooperation was extended to 6 universities, 1 state agency, and 13 firms engaged in geophysical or navigation activities.

Earthquake information was given to General Electric Company, American International Underwriters Corp., Kaiser Steel Corporation, W. R. Grace & Co., Allis-Chalmers Mfg. Co., and Moran-Proctor-Mueser and Rutledge & Co.

#### International Agencies

Information about seismographs and earthquake motions was supplied to agencies in Wellington, New Zealand;

Salisbury, Southern Rhodesia; Suva, Fiji; Santiago, Chile.

Instrumental calibration was performed for agencies of Ethiopia and the Belgian Congo. Periodic magnetic activity reports were rendered to the International Association of Geomagnetism and Aeronomy.

#### INTERNATIONAL GEOPHYSICAL YEAR

On behalf of the U. S. National Committee for the International Geophysical Year, special magnetic observatories with standard facilities have been established at Healy and Big Delta, Alaska; on the islands of Guam and Koror in the western Pacific; and at three sites in Antarctica--Little America, Marie Byrd Base, and Wilkes Base. At all these stations, as well as at most of the bureau's permanent magnetic observatories, the standard recordings will be supplemented throughout the IGY period by high-resolution records obtained with instruments of a new and improved design. Other special equipment includes a differential magnetograph, developed in the bureau for recording space gradients of the magnetic field at College, Alaska; a chain of unattended recording stations across northern Alaska and another in the western United States; installations of similar type on a drifting station on the ice of the Beaufort Sea, at three equatorial stations on Pacific islands, and at two stations in Antarctica; and a number of visible recording magnetographs to be operated in conjunction with ionospheric sounding equipment at various stations.

It has already become evident from the differential magnetograph records that the spatial patterns of the short-term fluctuations have a wholly unforeseen degree of local complexity, owing possibly to inhomogeneity in the electrical conductivity of the earth's crust. Another interesting development, arising from the IGY program in the equatorial region, is a new emphasis on the manifestation of the equatorial electrojet as a strong midday enhancement of short-period activity.

Seismograph stations, established as part of the IGY program, in Antarctica at the South Pole and Marie Byrd Base, in western Pacific Ocean on Truk, Guam, and Koror, and in Greenland at Thule, were successfully operated. Results from all these stations, usually available within a few days, have greatly assisted in the location of earthquakes in remote areas of the world. In addition, they have supplied data for seismicity studies in their immediate vicinity.

Office processing of field and observatory data is a continuing activity which has been substantially augmented during the International Geophysical Year. A related activity is the operation of a section of the World Data Center, which catalogs and stores in microfilm form

the IGY data from all over the world, making them available for use by scientists of the Western Hemisphere at a convenient, central location. The bureau is conducting this center for the disciplines of geomagnetism, seismology, and gravity.

#### RESEARCH AND DEVELOPMENT

Development of a proton-precession magnetometer for measuring components of the field is in progress. Work has begun on another experimental instrument making use of optical pumping and the absorption of light in the vapor of rubidium. In the office processing phase of our work, a new method has been developed and is under trial for mapping geomagnetic secular change in the polar regions.

A research project on travel times of seismic waves originating from nuclear explosions on the Nevada and Pacific Islands Proving Grounds was completed.

A survey of the Navy Microseismic Project conducted by the bureau indicates that storms at sea can be sensed by seismic techniques employing tripartite arrays. Under favorable circumstances when the seismic stations face the open sea, the storm parallels the station arrays and adequate time lag is allowed, storms may be detected.

A study of seismic waves resulting from the Rainier underground explosion raises some question as to the existence of the Sierra Nevada mountain roots, and gives a slower velocity for longitudinal waves in Nevada compared to California.

Benioff moving coil seismometer was redesigned permitting greater precision in mounting the leaf spring suspensions, providing for more than one galvanometer tap, and several portable features.

Conventional seismograph recorders were made more adaptable by redesigning the lead screw and gear box for dual motor drive. The changes provide variable speeds for rotation and variable pitch for translation of drums on a single shaft and base.

## GEODESY DIVISION

### OPERATIONAL ACTIVITIES

#### Field

##### Triangulation

Horizontal control surveys consisted primarily of triangulation in areas requested for mapping and triangulation supplemented with Tellurometer traverses for highway surveys. On an average, six triangulation parties of about 25 men each were engaged on triangulation, and three smaller parties of about 10 men each on the highway work and special projects. An additional small party was organized the latter part of the year for highway work. The recovery and maintenance of control marks was continued by an average of 10 men during the year. Details of work accomplished appear in tables that follow.

##### Precise Leveling

Three main multiple-unit parties completed 103 unit-months of leveling in the Western, Central, and Eastern States.

Releveling of old first-order lines was undertaken in Florida, Georgia, Montana, Nebraska, New Mexico, South Dakota, Texas, and Wyoming. Leveling was undertaken in Maryland, Nevada, Virginia, and Washington as part of the interstate highway program. Leveling was continued in the San Joaquin Valley, Calif., where an extensive study is being made of changes in elevation.

Whenever feasible, our main level parties set benchmarks consisting of copper-coated steel rods at 5-mile intervals along the level lines. These rods are driven to refusal. Rods have been driven to a depth of 110 feet. Supplementary marks consisting of copper-coated nails and brass washers are now being placed in roots of large trees.

The recovery of benchmarks was continued in California, Florida, Georgia, Kansas, Kentucky, Louisiana, Mississippi, Missouri, and Texas. The stamping of adjusted elevations on benchmark disks was continued in Kentucky.

##### Astronomic Observations

Astronomic operations were continued westward along the 35th parallel as far as the Texas Panhandle, comprising 4 first-order and 39 second-order position determinations. A total of 43 astronomic positions and 11 azimuths were observed in various localities in connection with special defense projects.

### Gravity Observations

During the summer of 1957, area gravity surveys were extended northward over an area of about 16,400 square miles in central Minnesota at an average station spacing of 6 miles. The new area was connected by gravity traverse to the midcontinent baseline in North Dakota.

The gravity traverse between the national bases at Washington, D. C., and Ottawa, Canada, was re-run in November 1957 to strengthen datum and calibration comparison between the American and Canadian systems. During this operation a connection was made to the Montreal International Airport, the western terminus of a recently completed trans-Atlantic gravity meter tie. Early in 1958 operations were resumed on the east coast base network between Washington, D. C., and Key West, Fla. About 165 pendulum stations were recovered and connected to the network. Wherever possible, nearby permanent points of known elevation were tied to the pendulum stations to aid in future recovery.

Special gravity measurements were made at instrument test facilities of manufacturers in Denver, Colo., and Bristol, Tenn.

A new gravity meter calibration base was established in the vicinity of Sperryville, Va. This new base, consisting of two stations having a gravity difference of about 74 milligals, provides better calibration data than the longer base previously employed.

### Variation of Latitude

The variation-of-latitude observatories at Ukiah, Calif., and Gaithersburg, Md., continued in operation throughout the year. At Ukiah, 3,557 star pairs were observed on 233 nights with complete observations on 144 nights. At Gaithersburg, 2,571 star pairs were observed on 241 nights with complete observations on 50 nights.

### Special Projects

Positions of Nike installations in the Washington-Baltimore, Detroit, and the Buffalo-Niagara areas were determined at the request of the U. S. Engineers. Surveys consisted of location of a master installation in each area and the surrounding Nike facilities. The azimuth requirement between the master and the surrounding installations was within 5 seconds.

Observations and computations were made in a northern Virginia instrument test area for the U. S. Engineer Research and Development Laboratories. High accuracy

triangulation of a small net with several astronomic stations and lines measured with the Geodimeter were required.

The program of determining positions for the VOR's and VORTAC's for GAA was continued. This was a cooperative program with the photogrammetry division. Position locations are by triangulation, traverse, Tellurometer, or air photographs.

Positions of requested air navigation facilities were determined for Air Force Bases at Altus, Okla.; Lake Charles, La.; and Marshall Field, Kans. Special surveys were also conducted for the Air Force at Cape Canaveral, Fla., and Cook Air Force Base, Calif.

#### Tabulation of Field Activities

The field activities during the year, including reimbursable projects, are summarized in the following tables.

##### First-Order Baseline Measurements

Locality	Length
	Miles
Eleuthera Island Strip, B.W.I.....	1.64
Leesburg, Va. (Check measurement).....	1.77
Jones Point, Va.....	0.32
San Salvador I., B.W.I.....	1.82
Total.....	5.55

##### Geodimeter Baseline Measurements

Locality	Length
	Miles
Fitchburg-Burke, Wis.....	12.34
Circle-Collar, W. Va.....	9.69
Greybull-Germania, Wyo.....	12.89
Railroad-Squaw, Idaho.....	13.40
Reservoir-Wild Horse, Utah.....	9.80
Robinson-Clark, Va.....	12.62
Robinson-Fork Mountain, Va.....	12.68
Paris-Jackson, Va.....	18.61
Leesburg Base, Va.....	1.77
Maryland Heights-Sugar Loaf (SRDL), Md.....	18.11
Kerrville-Raleigh, Tenn.....	10.12
Sunny-Dancy, Tenn.....	8.66
Dry-McCool, Miss.....	10.24
Fisher-Red, Pa.....	9.36
Divide-Bald, Pa.....	11.02
Frankfort-Oakland, Mo.....	7.28
Total.....	178.59

Triangulation—First- and Second-Order

Locality	Number of stations	Area
	Marked and Intersection	Square miles
California Hwy. Survey.....	64	360
Millbrae to San Jose, Calif.....	25	330
City College, San Francisco, Calif.	3	6
Santa Ana to Inyokern, Calif.....	50	3,050
Delaware Hwy. Survey.....	6	160
Salmon to Stanley, Idaho.....	62	1,300
Chariton to Creston, Iowa.....	33	550
Maine Hwy. Survey.....	22	150
Boston Navy Yard, Mass.....	29	25
Detroit area Nike.....	83	760
Pascagoula to Gainesville Hwy. Survey, Miss.....	60	370
Hollendale area, Miss.....	29	325
Fearns Springs to Thornton, Miss...	26	795
Louisiana to Paris, Mo.....	21	400
Big Horn Mountain area, Mont.-Wyo..	156	12,500
Vicinity of Keene Airport, N. H....	7	70
Vicinity of Cape May, N. J.....	3	3
Rio Puerco area, N. Mex.....	44	1,925
Hwy. 40 & 91 Survey, Nev.....	361	1,530
Lovelock-Mill City area, Nev.....	40	400
Newkirk-Medford area, Okla.-Kans...	123	2,100
Wilmer-Miami area, Okla.....	39	770
Vicinity of Burns, Oreg.....	23	600
Williamsport area, Pa.....	146	3,675
Northeast Philadelphia and Keystone Shortway Hwy., Pa.....	20	300
Western Tennessee area.....	358	3,200
Carthage-Jefferson-Minola-Troupe area, Tex.....	231	7,650
Fillmore to Ely, Utah-Nev.....	51	4,930
Franklin-Marlinton area, W. Va.- Va.....	67	1,600
Madison-Beaver Dam area, Wis.....	257	4,715
Renton area, Wash.....	15	40
South Seattle Freeway, Wash.....	37	35
Washington Hwy. 10 Survey.....	134	395
Washington, D.C.-Baltimore Nike Sites, Md.-Va.....	102	310
Washington to Baltimore, Md. Hwy. Survey.....	77	115
Egerstown to Frederick, Md. Hwy. Survey.....	43	115
Washington to Frederick, Md. Hwy. Survey.....	23	40
Washington Circumferential Hwy. Survey, Md.-Va.....	71	145
Virginia Hwy. Surveys.....	254	2,260
Fort Belvoir ERDL, Va.....	16	110

Triangulation--First- and Second-Order -- Continued

Locality	Number of stations	Area
	Marked and Intersection	Square miles
N. Virginia ERDL Test Area.....	15	1,390
Alexandria to Falls Church Hwy. and Burke Area, Va.....	53	110
Chantilly Airport, Va.....	48	220
Woodrow Wilson Bridge, Va.-Md.....	3	3
Grand Bahama and Eleuthera, B.W.I.	37	1,400
Cape Canaveral area, Fla.....	12	12
Total.....	3,379	61,549

Earthquake Surveys

	Old	New	
Vicinity of Hayward, Calif.....	22	18	3,400
Vicinity of Palmdale, Calif.....	25	2	70
Total.....	47	20	3,470

Astronomic Determinations

(Including old stations)

Locality	Latitude	Longitude	Azimuth
Arkansas.....	2	2	.....
California.....	16	16	1
Florida.....	1	1	.....
Georgia.....	1	1	.....
Maryland.....	3	3	1
Nevada.....	1	1	.....
New York.....	2	2	2
North Carolina.....	2	2	.....
Oklahoma.....	25	25	.....
South Carolina.....	7	7	.....
Tennessee.....	2	1	1
Texas.....	5	5	.....
Virginia.....	10	10	4
Territory of Hawaii..	1	1	.....
British West Indies..	6	6	2
Ascension Island.....	3	3	.....
Total.....	87	86	11

Gravity Determinations

(Including old stations)

Locality	Area coverage stations	Base net stations
Colorado.....	.....	12
Florida.....	.....	107
Georgia.....	.....	51
Maryland.....	.....	3
Minnesota.....	523	15
New York.....	.....	8
North Carolina.....	.....	75
Pennsylvania.....	.....	8
South Carolina.....	.....	13
Tennessee.....	.....	2
Virginia.....	.....	84
Foreign.....	.....	7
<b>Total.....</b>	<b>523</b>	<b>385</b>

Leveling

State	First-order	Second-order	State	First-order	Second-order
	miles	miles		miles	miles
California..	1,526	948	Pennsylvania...	5	38
Florida.....	45	2	South Carolina..	0	15
Georgia.....	600	86	South Dakota...	65	12
Kentucky....	56	2	Tennessee.....	14	30
Maryland....	0	253	Texas.....	681	312
Mississippi..	39	48	Utah.....	0	5
Montana.....	167	59	Virginia.....	6	564
Nebraska....	28	0	Washington.....	1	181
Nevada.....	32	887	West Virginia..	42	936
New Mexico..	361	211	Wyoming.....	257	8
New York....	0	5	<b>Total.....</b>	<b>3,957</b>	<b>5,330</b>
Ohio.....	32	728			

Tellurometer Traverse

Locality	Number of New Stations	Length Miles
Virginia Hwy. Survey	*	299
Maryland Hwy. Survey	*	105
Andreanof Islands, Alaska	12	97
<b>Total.....</b>	<b>12</b>	<b>501</b>

\*Included with Triangulation

Reconnaissance

Locality	Area
	Square miles
Rio Puerco area, N. Mex.....	7,285
Portage-Beaver Dam area, Wis.....	2,160
Hwy. 40 Survey, Nev.....	2,075
Vicinity of Burns, Oreg.....	600
Washington Hwy. Survey.....	160
Big Horn Mtn. area, Mont.-Wyo.....	10,980
Pascagoula to Gainesville Hwy. Survey, Miss,	370
Phillipsburg-Lock Haven area, Pa.....	200
Boston Harbor, Mass.....	25
Delaware Hwy. Survey.....	190
Chantilly Airport, Va.....	220
Earthquake Re-investigation, Calif.....	100
Mojave-Barstow, Calif.....	2,300
Cape Canaveral, Fla.....	1
Rehoboth Beach to Hog I., Del.-Va.....	85
Louisiana to Paris, Mo.....	400
Kosciusko to Fearn Springs, Miss.....	600
Maine Hwy. Survey.....	1,200
Cape Cod area, Mass.....	1,365
ERDL Long Line Test, Fla.....	410
Buffalo Nike area, N. Y.....	380
Keystone Shortway Hwy., Pa.....	350
Pennsylvania Hwy. Survey.....	90
Washington Circumferential Hwy., Md. & Va...	145
Virginia Hwy. Survey.....	3,800
Maryland Hwy. Survey.....	677
Lovelock to Mill City, Nev.....	4,700
British West Indies.....	1,400
South Seattle Freeway, Wash.....	35
Renton area, Wash.....	40
Burke area, Va.....	12
Okmulgee area, Okla.....	4,000
Eureka Springs-Arcola Area, Mo.-Ark.....	3,550
<b>Total.....</b>	<b>49,905</b>

Summary of Geodetic Work, June 30, 1958

	July 1, 1957 to June 30, 1958	Total to June 30, 1958
Triangulation, first- and second-order.....stations.	3,411	152,563
Leveling, first- and second-order.....miles....	9,287	431,465
First-order baselines.....	3	453
Geodimeter length measure- ments.....	16	70
Second-order baselines.....	0	59
Latitude stations (New)....	67	1,395
Longitude stations (New)...	66	1,207
Azimuth stations.....	11	1,429
Gravity stations (New).....	733	11,923

## Office

### Adjustment of Triangulation and Related Activities

In recent years the problem of fitting new surveys into the existing or previously adjusted network has become extremely critical. In many instances the adjustment of a new survey would give corrections as large as 15 seconds on an observed angle. Rather than distort new observations by placing such large corrections on them, it has been found more satisfactory to readjust portions of the existing network simultaneously with the new survey and thus have a larger area over which to distribute the closures.

This technique, frequently referred to as "relaxation," has been used for the adjustment of several large projects during the past year. When the new surveys on the Olympic Peninsula were adjusted, it was necessary to revise the existing network along the Pacific coast from the Columbia River to the Straits of Juan de Fuca; even the arcs along the straits were revised. It was also necessary to revise all of the secondary control along the canals, inlets, and bays in this region. This is a major project and almost all of the revision work was completed at the end of the fiscal year.

A comparable project was in northern Indiana where 6 area networks were adjusted simultaneously with 3 first-order arcs, 1 extending east to west and the other 2 extending north to south. The maximum corrections to angles were approximately one-half the size that they had been when the 6 area networks were adjusted separately. The improvement in the adjusted results more than justifies the additional effort required to make an adjustment of this size.

Similar techniques were used in the adjustment of the triangulation in the Red River area of Texas and Oklahoma. In this case, 4 area networks were combined with 2 first-order arcs crossing east to west and north to south.

Another large project involved the adjustment of an area network in northern Illinois. This network includes the area west of Chicago and Cook County with many urban and industrial sites.

Other major projects completed include the triangulation in the Everglades of Florida, the Petosky area in northern Michigan, the Quitman-Butler area in Mississippi, and the Mountain Home area in Arkansas.

The special project completed during the year for the Engineer Research and Development Laboratories at Fort

Belvoir was the establishment of a precise geodetic network in northern Virginia. This project was primarily a reobservation of the triangulation along the oblique arc from Sugar Loaf Mountain to Clarke Mountain. Three Geodimeter baselines, each measured with two Geodimeters, and three Laplace azimuths were included. The observations were adjusted on an individual datum in order to eliminate the distortion which might result if they were adjusted into the existing network.

Special surveys for the control of Nike installations in the Washington and Baltimore areas and in the Detroit area were adjusted. While these surveys did not involve extensive networks, the specifications relating to the accuracy of the military installations required detailed attention in planning and adjusting the field surveys.

The adjustment of the surveys resulting from the interstate highway program has become a major phase of the work of the triangulation branch and will continue to be for many years. In a few states the projects have been completed. In several others, field surveys are still underway. Adjusted results have been furnished for the sections of the highway surveys as rapidly as possible. This type of operation has been carried on in Washington, Oregon, California, Nevada, South Carolina, Virginia, and Maryland. Similar surveys have been made in Mississippi, Pennsylvania, and Maine, but no office computations were made on any of these surveys.

Considerable effort has been required in the computation of the survey data for the location of the VOR's or other air navigation facilities. This branch has been responsible for computing the results of surveys made by both geodetic and photogrammetric parties.

During the year, the unit which had been engaged on processing horizontal control records of Thailand completed that assignment. This particular project, undertaken at the request of the Army Map Service, required a great deal of effort and patience because of the interpretation of the records and language difficulties. The total project involved adjusting a primary network of triangulation, a supplemental network of triangulation, many intricate traverse networks connected to both primary and secondary points, and numerous points determined by resection.

#### Adjustment of Leveling

As of June 30, 1958, the total amount in the level net was 431,465 miles of first- and second-order leveling along which 358,757 benchmarks had been leveled over.

The following computations and adjustments were completed during the year: preliminary computations for

4,807 miles of first-order and 2,810 miles of second-order leveling; 21 least-squares adjustments comprising 2,807 miles of first-order and 3,544 miles of second-order leveling; and the distribution of closing errors on 1,537 miles of first-order and 3,569 miles of second-order leveling.

#### Astronomic Computations

Processing of first- and second-order astronomic data was kept nearly current with the field observations, comprising a total of 113 latitudes, 111 longitudes, and 16 Laplace azimuths. A number of sun azimuths were determined in connection with the CAA VOR program. Star-place reduction tables were prepared to facilitate the evaluation of latitude observations at Ukiah and Gaithersburg. Other processing included chronograph tapes for observations with the Danjon astrolabe at the bureau's IGY station in Honolulu and astronomic positional data obtained at the South Pole station by the American Antarctic team.

#### Gravity Reductions

Position, elevation, and anomaly data were processed for the 1957 gravity survey in Minnesota. All area gravity survey data observed in the 1951-1956 period, totaling about 6,200 stations, were compiled in a uniform list on the IBM equipment in conformity with a numerical system for designating stations. Data were processed for the gravity base traverses Washington-Ottawa-Montreal and Washington-Miami-Key West. Special gravity computations and isostatic reductions were continued for the Air Force Missile Test Range and other agencies in connection with national defense projects.

#### New York Computing Office

The New York computing office has been operating a number of years. Consisting of about 22 employees, this office supplements the Washington office in several phases of the work including the processing of triangulation and leveling observations; maintaining the triangulation diagrams; and editing and typing of geodetic information for reproduction and distribution.

### NATIONAL AND INTERNATIONAL COOPERATION

#### National Agencies

Field gravimetric and astronomic surveys and office reductions were continued in connection with geodetic development of the Air Force Missile Test Range originating at Cape Canaveral, Fla. First-order astronomic positions were determined at three stations on Ascension Island to improve geodetic coordination with Cape Canaveral. Deflections of the vertical were observed at

various missile test facilities in California and Nevada. Several Laplace azimuths and deflections of the vertical were observed for control of geodetic triangulation in the ERDL northern Virginia test area. In connection with gyroscope development, gravimetric and astronomic data were obtained at laboratories in Bristol, Tenn.; Denver, Colo.; and Owego, N. Y.

### International Agencies

Personnel of the geodesy division have taken an active part in the program of the International Association of Geodesy. In addition to the triennial meetings, there are symposiums on various geodetic subjects held during the three-year interval between the general assemblies. This bureau has a direct interest and responsibility in most of these activities. The last meeting held in Toronto, Canada, September 1957, was well attended. The next general assembly will be held in Helsinki, Finland, in July 1960.

Participating in the longitude and latitude program of the IGY, an observatory was established on U. S. Navy property at Honolulu, T. H., in September 1957. Since January 1958, a continuous observing program has been maintained with the Markowitz dual-rate moon camera and the Danjon impersonal astrolabe. Time control is provided by a quartz clock monitored by signals from WWVH on the Island of Maui. Astrolabe observations are recorded directly on tapes fed through a digital printing chronograph.

## RESEARCH AND DEVELOPMENT

### Geodimeter and Tellurometer

The Geodimeter has been continued in use as the instrument for measuring first-order baselines. Experience has shown that it is very reliable and can be used for baseline work in first- and second-order triangulation. The only limitation is the length of line. The optimum length of line is between 10 and 15 miles. We have never been able to measure a line greater than 25 miles in length.

The Tellurometer is being used extensively in extending second-order surveys along the proposed routes of the interstate highway system. This instrument gives satisfactory second-order results on lines 3 miles or greater in length. On shorter lines, particularly when they are less than  $1\frac{1}{2}$  miles, we have encountered considerable uncertainty. When Tellurometer measurements have been combined with triangulation, it has been found necessary to adjust triangulation first and then fit the Tellurometer measurements to the triangulation. Whenever simultaneous adjustments of triangulation and Tellurometer measurements have been tried, it has been

found that the triangulation is distorted unduly. Generally, in these cases where the Tellurometer measurements cannot be combined with the triangulation, a review of the Tellurometer records has disclosed that the "swing" is abnormally large; i.e., a range of 24 to 30 inches. A complete set of observations consists of 12 measurements, each of which is to the nearest millimicrosecond or approximately 6 inches. When the range of the measurements is 4 or 5 millimicroseconds it is obvious that the arithmetic mean could be uncertain by 2 or 3 millimicroseconds. It is believed that when an observer encounters conditions of the atmosphere or ground coverage which produce these large "swings" that the station location should be changed in an effort to reduce the "swing" and increase the accuracy of the line measurement. Research will be continued in an effort to improve the quality of the measurements obtained with this instrument.

#### Programs for High Speed Calculator

Excellent progress has been made for developing programs for the high speed calculator which are needed in the adjustment of triangulation and related computations as well as for processing computational work required in the activities of other divisions.

All of the operations required in the adjustment of triangulation and traverse have been programmed including the transformation of state plane coordinates, either from geographic positions to plane coordinates or plane coordinates to geographic positions.

During the year, there have been special requests for the computation of projections for nautical and aeronautical charts. The required programs have been written and the projections computed.

Programs were written for the processing of the geomagnetic observatory data as well as the reduction of worldwide geomagnetic data for the 1960 isogonic chart series.

A program was developed for the analytical adjustment of aerial triangulation for the photogrammetry division. This program determines the coordinates of picture points on a photostrip which has several identified control points. An adjustment is made to fit the strip to these control points. The program is unique in that it includes the transformation of the ground coordinates of control points to the axis of flight system, the transformation of machine coordinates of the picture points to the axis of flight system, the formation of the observation equations, the solution of the resulting normal equations, the computation of the residuals, and the computation of the final adjusted coordinates of all ground points.

A program was developed for processing VOR flight test

data for CAA. This problem involves reducing slope distances measured electronically to sea level distances and then computing the ground position of the plane by trilateration. There are additional requirements for bearings to other VOR's giving consideration to the magnetic declination at each VOR. It is anticipated that this reimbursable work will increase many times during the next fiscal year.

#### Space Adjustment of Triangulation

One of the special study groups working within the International Association of Geodesy has been investigating techniques for adjusting large networks of triangulation giving consideration to the relation of the geoid and the ellipsoid. Brigadier H. Hotine, the Director of British Overseas Surveys, has served as chairman of this study group. About two years ago he proposed a method of adjusting triangulation in space with a technique based upon vectors and direction cosines. The first plan was to use condition equations but because of the bureau's experience in computing, using condition equations and observation equations, it recommended the application of observation equation techniques. Following these suggestions, he made further developments and was able to make a preliminary report at the Toronto Meeting (September 1957), of the International Union of Geodesy and Geophysics.

The bureau agreed to work with Brigadier Hotine and his assistants on this new technique. The necessary programs for making adjustments of this type on an electronic calculator were developed in this bureau and computations made on the observations of the network of triangulation at White Sands, N. Mex. The technique requires trigonometric leveling of high precision if an accurate figure of the earth or undulations of the geoid are to be determined. The results from the White Sands Test indicated that these observational data were inferior. It demonstrated the general usefulness of the space technique, however.

Following this, a test computation was made of the Pasadena base net using observations made 35 years ago. There were no astronomical longitudes determined on this project, but the quality of the trigonometric leveling over the north-south lines, i. e., the lines from the points along the baseline to the mountain stations, was superior. The deflection of the vertical computed from the trigonometric leveling and the horizontal directions agreed very closely with the deflections as determined from the astronomic latitudes.

Additional tests are being made on the Pasadena base net, as time permits on our calculator. A full report will be published upon the completion of these tests. These studies have shown that this space technique has

a very practical application in the adjustment of base nets in mountainous areas. The adjusted lengths or sides of a large figure in mountainous regions may be more accurately computed from a base measured in the valley through the use of this special technique.

#### Earthquake Investigation

Following the earthquake of March 22, 1957, an area network of triangulation covering the San Francisco Bay region was reobserved. Two identical adjustments were made using observations of 1951 for comparison with observations of 1957. The results did not disclose any major horizontal displacement which might have resulted at the time of the earthquake. However, the results did show the same creeping movement in a horizontal direction that has been disclosed by many earlier resurveys. The magnitude of this movement was larger than would normally be expected in a 6-year period.

Because of limited time available for investigations of this type, no further studies were made. It is believed, however, that further investigation should be made of observations in this region, both prior and following the earthquake of 1957.

#### Instrument Improvements

New equipment was adopted for recording first-order astronomic longitude observations, resulting in simpler operation, better performance, and reduction in weight. An electric-driven drum chronograph replaced the conventional weight-driven type, reducing total shipping weight from 150 pounds to 15 pounds per unit. The vacuum-tube amplifier was replaced by a more compact transistor amplifier-filter having about 90 percent less battery drain and greatly improved response and stability.

## CHART DIVISION

### OPERATIONAL ACTIVITIES

#### Nautical Charts

Compilation work was accomplished on 559 nautical charts. These included 14 new charts, 7 reconstructed charts, 16 new editions, 468 new prints, 24 reprints, and 30 overprints. Nine hundred and three items regarding dangers which required hand corrections, as well as other navigational information were reported to the Coast Guard and Hydrographic Office for publication in the weekly Notice to Mariners.

A total of 812 nautical charts were on issue at the end of the year. To produce the 940,993 copies issued, 475 printings were necessary. Military requirements were less than in the previous year, but issues to the public increased by 67,784 copies--an increase of 12 percent over fiscal year 1957 which in turn showed an even greater increase over the year before. The increase in civilian requirements is undoubtedly caused to a great extent by a greater nationwide interest in pleasure boating.

The following new unclassified charts were published during the year:

#### New Nautical Charts Published

No.	Title	Scale
456	Canaveral Harbor, Fla.....	1:10,000
4134	Kaneohe Bay, Oahu, Hawaiian Islands...	1:15,000
4197	Apra Harbor, Marianas-Guam.....	1:10,000
8834	Port Heiden, Alaska.....	1:80,000
9369	Port Clarence and Approaches, Alaska..	1:100,000

The following unclassified nautical chart was canceled during the year:

#### Nautical Chart Canceled

No.	Title	Scale
9385	Port Clarence and Grantley Harbor	1:80,000

## Aeronautical Charts

It was necessary to produce 1,492 aeronautical charts, in several series, to meet civil and joint civil-military requirements during fiscal year 1958. This represents a net increase of 55 charts over the previous year, as follows: 11 Radio Facility charts added, 18 Terminal Area Holding and Departure charts added, 36 Instrument Approach Procedure charts added, and 10 auxiliary charts discontinued.

Maintenance of the following charts was accomplished during the year: 194 standard series charts with 303 issues, 44 Radio Facility charts with 309 issues, 86 Terminal Area Holding and Departure charts with 335 issues, 1,137 Instrument Approach Procedure charts with 2,121 issues, and 31 auxiliary charts with 4 issues.

The recompilation of the Sectional series was continued, incorporating in these compilations new concepts of what is necessary in visual flight. Eleven charts were recompiled, making a total of 17 now being issued on the new format.

The conversion of the Radio Facility charts to the new folded format adopted in fiscal year 1957 was completed, and now the United States, Alaska, Hawaii, Puerto Rico and the Virgin Islands are covered by the new series. The increased installation of navigational aids and controlled airspace caused a marked increase in publication of new editions and supplementals of this series. All Radio Facility charts were converted to show the nautical mile as a unit of distance. This change was in conformance with a decision of the Subcommittee on Aeronautical Charts and Maps of the Air Coordinating Committee. The Civil Airways and Mileage chart was reconstructed to give greater clarity and to give greater assistance in plotting new facilities and in scaling distances.

Five positive control corridors within the United States from 17,000 to 22,000 feet above mean sea level, which became effective on June 15, 1958, are now shown on 12 Radio Facility charts and on the Civil Airways and Mileage chart. A special notice outlining the Civil Air Regulations effecting the positive control airspace was issued with the June 9, 1958 Civil Airways and Mileage chart.

Aircraft Position chart No. 3071 was reconstructed to give a better presentation of consol, loran, isogriv, isogonic, and air-sea rescue navigational information.

The Aeronautical Planning chart, AP-9, was reconstructed to give a clearer portrayal of the airways in congested areas.

No flight checking of aeronautical charts was accomplished this year. This is regrettable for several reasons: (1) Flight check is one of the most important phases in the preparation of an aeronautical chart because it not only insures the incorporation in the chart of the latest changes, but also gives the compiler the airman's view of what should be emphasized on the chart. (2) No flight check has been accomplished since fiscal year 1954. (3) There has been an accelerated rate of construction in the United States during recent years, such as highways, dams, manufacturing plants, and suburbs, all of which affect the aeronautical charts.

The following table is a summary of aeronautical charts published during the year:

Summary of Aeronautical Charts Published

Series	No. of charts in series, July 1, 1957	New charts	New editions	Re-prints	No. of charts in series, June 30, 1958
U. S. WAC.....	43	.....	71	.....	43
Alaskan WAC.....	19	.....	17	.....	19
Sectional.....	88	.....	143	5	88
Jet Navigation...	4	.....	5	.....	4
Local.....	23	.....	44	.....	23
U. S. RF.....	17	15	138	2	22
Terminal Area....	68	18	313	4	86
Alaskan RF.....	1	.....	4	.....	1
U. S. RF-VOR.....	15	15	133	2	21
Instrument Approach Procedure.....	1,101	54	1,363	704	1,137
Route.....	11	.....	11	.....	11
Planning.....	2	.....	2	.....	2
Aircraft Position	4	.....	4	1	4
Outline Map.....	15	.....	.....	2	11
Iscgonic.....	11	.....	.....	.....	10
Azimuthal.....	3	.....	.....	1	3
Miscellaneous....	12	.....	.....	1	7
Total.....	1,437	102	2,248	722	1,492

## Chart Reproduction

Demands on reproduction services during the year required the production of 37,188,000 copies of the bureau's nautical and aeronautical charts and related miscellaneous data. This represents an increase of 68,000 copies of nautical charts and an increase of 292,000 copies of aeronautical charts to the public, but a considerable drop in both nautical and aeronautical charts to the military. A total of 61,000,000 close-register press impressions were necessary to produce these chart requirements.

The requirement for the number of editions of nautical charts to be processed and printed has increased steadily for several years. In fact, the demand for nautical charts was so great that there was neither compilation nor reproduction capacity to meet the demand, and, as a result, 25 charts were on back order and 24 charts had excessive corrections requiring printing at the end of the year.

The expanded Radio Facility chart program was started and it is estimated that this program will increase press impressions approximately 200,000 per month.

Acceptance of a change in specifications for aeronautical chart paper from high wet strength map paper to chemical wood map paper effected a saving of approximately 13 percent in the cost of aeronautical chart paper.

## Chart Distribution

Nautical charts and related publications as well as aeronautical charts continued to be sold through authorized agents located at principal seaports and airports throughout the United States, Alaska, Hawaii, the West Indies, and a few foreign countries. In order to furnish more efficient distribution, chart distribution centers continued to be maintained in New York, Kansas City, and San Francisco, to supply agents and the public in those areas. In addition, charts are also available in the Washington office and in designated bureau district offices.

At the close of the year, the bureau was represented by 328 nautical and 488 aeronautical chart agents--an increase of 38 over the previous year. Agents and distribution centers are informed when charts become obsolete and must be withheld from sale. Chart agencies are inspected to promote the standard of distribution desired by the bureau. During the year, 43 percent of the nautical agencies and 48 percent of the aeronautical agencies were inspected. Of these, 92 percent of the nautical agencies and 91 percent of the aeronautical

agencies were found to be performing their duties in an efficient manner.

Nine hundred and forty-one thousand nautical charts and 34,903,000 aeronautical charts were issued during the year. Although military requirements for charts produced by the bureau fell off during the year, civilian requirements increased, and receipts from the sale of charts to the public reached an alltime high of \$655,651.

The issue of Radio Facility charts showed a big increase over the previous year; approximately 1,400,000 more copies were distributed than in the year before. At the end of the year, 7,065 subscriptions to aeronautical charts were being maintained.

The practice of printing certain nautical charts on schedule was discontinued, because it is more practical to print them upon exhaustion of stock. Nautical charts with 40 or more hand corrections are now placed on the Exhaustion Report and are printed regardless of stock. It is more economical to obsolete a chart with 40 or more corrections than to hand-correct it.

The program of hand-correcting nautical charts to prevent large stocks from becoming obsolete was continued in the Washington office and in the New York and San Francisco district offices. Over eight million hand corrections were made during the 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	1956	1957	1958
Nautical and Tidal Current Charts.....	762,384	1,034,926	940,993
Standard aeronautical charts.....	9,562,996	9,891,123	7,990,070
Instrument Flight Charts.....	33,086,405	43,720,580	26,912,902
Miscellaneous maps and charts.....	52,859	53,771	51,043
Coast Pilots.....	9,309	10,994	9,633
Tide and Current Tables.....	72,205	73,437	70,991

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

Distribution of Nautical and Aeronautical Charts

NAUTICAL		
	Number	Percent
Sales.....	502,840	53.44
Official Distribution:		
Coast and Geodetic		
Survey.....	14,256	1.51
Coast Guard.....	8,627	.92
Other Executive		
Departments.....	16,789	1.78
Congressional.....	3,297	.35
Foreign Governments..	2,098	.22
Miscellaneous.....	1,012	.11
	46,079	4.89
Reimbursable:		
Department of Air		
Force.....	1,910	.20
Department of Navy...	318,895	33.90
	320,805	34.10
Condemned.....	71,269	7.57
Total.....	940,993	100.00
		940,993

STANDARD AERONAUTICAL		
	Number	Percent
Sales.....	1,161,830	14.54
Official Distribution:		
Coast and Geodetic		
Survey.....	21,194	.26
Civil Aeronautics		
Administration	127,686	1.60
Other Executive		
Departments.....	31,423	.39
Congressional.....	609	.01
Foreign Governments..	4,518	.06
Miscellaneous.....	1,150	.02
	186,580	2.34

Distribution of Nautical and Aeronautical Charts--Con.

	Number	Percent	
Reimbursable:			
Department of Air Force.....	4,923,006	61.61	
Department of Army...	4,289	.05	
Department of Navy...	1,250,144	15.65	
Special printings....	102,325	1.28	
	6,279,764	78.59	
Condemned.....	361,896	4.53	
Total.....	7,990,070	100.00	7,990,070

INSTRUMENT FLIGHT

Sales.....	3,694,128	13.73	
Official Distribution:			
Coast and Geodetic Survey.....	41,147	.15	
Civil Aeronautics Administration.....	1,489,650	5.53	
Other Executive Departments.....	79,852	.30	
Miscellaneous.....	1,659	.01	
	1,612,308	5.99	
Reimbursable:			
Department of Air Force.....	20,782,650	77.22	
Department of Navy...	1,800	.01	
	20,784,450	77.23	
Condemned.....	822,016	3.05	
Total	26,912,902	100.00	26,912,902

AIR FORCE AERONAUTICAL

Total issue.....	539,880
Grand total.....	36,383,845

## NATIONAL AND INTERNATIONAL COOPERATION

### National Agencies

Thirty-two classified charts were maintained and 11 printed; 9 special purpose charts were maintained; compilation of 29 special purpose charts was completed, 11 of which were started in fiscal year 1957; 1 chart was revised and printed; and 7 charts were overprinted, for the Hydrographic Office. Two Cronar film positives of the projection and type, drainage, and contours of the Atlanta Local chart were produced for the Naval Photographic Interpretation Center. A rectangular grid for use on the Navy's special experimental "Polaris" rocket project was produced for the Naval Ordnance Laboratory. A "Daylight Computer," consisting of two polar stereographic base maps and a series of overlays, was produced for the Navy Bureau of Aeronautics.

The long-range program of compilation of shoreline and depth curve changes, as part of beach erosion studies, was continued for the Corps of Engineers. Color separation and engraving of negatives for maps of various locations were accomplished for the Army Map Service.

The following work was accomplished for the Geological Survey: The application of hydrography on 68 quadrangles was verified or reviewed; negatives were corrected and lithographic copies furnished of 49 TVA maps; film positives and negatives of 9 Sectional Aeronautical charts were produced for use on a special map under construction; and various type composition and stripper film positives, and film positives of 43 World Aeronautical charts were furnished.

The service of engraving, processing plates, and printing Post Route and Rural Delivery Maps for the Post Office Department was continued.

The Government Printing Office was furnished printed copies of Coast Pilots, Adiabatic charts, nautical chart symbols, World Aeronautical chart No. 407, and Route chart No. 2219.

For the Civil Aeronautics Administration, the following was accomplished: A schematic airways map depicting United States air navigation and communications system was produced for the CAA Aeronautical Center, Oklahoma City, Okla.; 17 pictorial computer charts were produced for the Technical Development Center for use in a pictorial computer under development; 15,000 copies of the Cleveland sectional chart were furnished the Examination Branch for use during pilots' examinations throughout the United States; 10 Preferential Route charts were produced for the Office of Air Traffic Control for publication in the Airman's Guide; and photographic copies

of 5 World Aeronautical charts were furnished for use in court.

A Pressure Reduction Calculator was produced for the Weather Bureau in accordance with specifications furnished by the Observation and Station Facilities Division.

One thousand and eight hundred film negatives of grid maps were furnished the Bureau of Census.

One paper print of 207 maps and enlargements of two Sectional Aeronautical charts were furnished the Airways Modernization Board for a study of airways and charting.

Assistance was given the research staff of the Lithographic Technical Foundation in the preparation of resolution targets of extreme accuracy for studies in halftone photography. Twelve targets consisting of concentric circles from 0.0176 inch to 0.220 inch in diameter were produced by engraving and photographic reduction methods. Six have met the rigid tolerance of  $\pm 0.0001$  inch, and the other six are undergoing tests.

Various aeronautical compilation, photolithographic services, and printings were furnished various commercial agencies.

#### International Agencies

Fifteen thousand copies of maps of Liberia were furnished that country.

Reproduction material for 28 World Aeronautical charts was furnished the War Office, London.

#### RESEARCH AND DEVELOPMENT

Basic oceanographic research on submarine formations and processes along the continental margins was carried on in seven areas for scientific purposes. Three reports on submarine physiography were compiled for publication.

The development of nautical charts to meet the changing needs of mariners was continued.

Improvement of aeronautical charts to meet requirements brought on by the modernization of the Federal airways system and by high performance aircraft was carried forward. In addition to developing new charts to meet new requirements, experiments were made with existing charts to reduce clutter. As an example, experimental WAC 404 incorporating six major changes was developed and distributed for user evaluation. Also, an experimental Terminal Area chart was produced which combined selected low frequency with all the very high frequency information on the same side of the chart to simplify

the pilot's chart requirements when mixed clearances are given by Air Traffic Control.

Drawings of Terminal Area charts were converted to the actual size of the chart which reduced drafting time and also permitted the drawings to be contact printed.

Special protractors in two sizes were developed on thin plastic in order to reduce errors and expedite compilation and review of the Instrument Approach Procedure charts.

A more efficient method of distributing Instrument Approach Procedure charts was devised by stocking the charts by states instead of numerically.

Other research and development resulted in improvements in engraving coatings for plastic sheets, in touch-up paint that is used on Flopaque-coated sheets, in new halftone screens, in new methods of making gradient tint negatives, and in new quality control techniques. The installation of paper dampener covers on all presses was completed in January 1958. The use of these paper dampener covers has improved press efficiency by the use of less water and less ink on the printing plates, resulting in less emulsification of printing inks and subsequent greater stability of color impressions. These new covers are less abrasive and prolong the life of the plate image.

The installation of a new 23" x 36" two-color press has resulted in more efficient printing of some of the smaller size charts and in a better balance of press operation.

## INSTRUMENT DIVISION

### OPERATIONAL ACTIVITIES

A number of old but serviceable NK 7 echo sounders were rebuilt into Type 808's. This takes care of the immediate shortage in this sort of equipment, and will serve until a supply of modern sounding instruments can be procured.

A temperature testing oven was added, which with the refrigeration apparatus now permits the testing of instruments through a temperature range from  $-16^{\circ}$  to plus  $572^{\circ}\text{F}$ .

A large, old, and worn woodworking cutoff saw was replaced with a modern De Walt overhead guide saw, which not only replaces the cutoff machine, but takes over a considerable amount of the work ordinarily done on a table saw. It may be possible to dispose of one table saw in the reorganization of the woodworking facilities.

As of July 1, the instrument division turned over all instrument storage and issuance functions to the administrative services division, so that we may concentrate our efforts on the development of new and improved equipment. This division retains the authority to decide the type, amounts, and the need for additional supplies of this nature, and works closely with the field divisions in determining requirements.

One additional electronic scientist was added to the staff. This employee had considerable experience in the field and was brought into the office for assignment to the laboratory.

Due to changes in the electrical system in the Commerce Building, the woodworking and instrument shops are being relocated, with the instrument shop being removed from the basement and installed on the first floor. Every effort is being made to avoid as much disruption of the work program as possible, and a great deal of care has been given to the layout of the new facilities to make them satisfactory and efficient.

It is believed that the new quarters will prove much more satisfactory than the old, with better lighting and ventilation, and better arrangement of the machinery than was possible at the old location. Tool and stock room facilities will not be as satisfactory, as space was not obtainable for placing these materials contiguous to the shop, and they will have to remain in their present position.

## COOPERATION WITH NATIONAL AGENCIES

The Coast Guard was assisted in evaluating Loran "C", by setting up and operating shoran equipment at Cape Hatteras and Ocracoke Island.

Cooperation was extended to an instrument manufacturer by first examining at its plant and later testing here, an angle measuring instrument used for guided missile control. This was a precision device, and was tested in the same manner as our first-order theodolites.

## RESEARCH AND DEVELOPMENT

A 7-wire strand cable for suspension of the floats for the standard tide gage has been used for several years. While this cable has been more reliable than the solid wire previously used and was made of stainless steel for corrosion resistance, it proved to have an objectionable stiffness which made installation difficult and caused an undue amount of breakage. To overcome these difficulties, a 21-wire strand was adopted after a lengthy test of the two materials proved that the very flexible 21-wire cable would have an almost indefinite life under normal working conditions. A considerable quantity has been purchased and is being issued.

Experiments are being conducted with standard tide gage floats made of rigid polyvinyl chloride plastic, as this material is entirely free from the corrosive effects that have attack floats made of almost all practical metals. If this material proves satisfactory from the corrosion standpoint, it is believed that it will also be attractive pricewise.

Study of current phenomena in connection with harbor pollution surveys requires meters capable of measuring very low velocity currents, down to 0.1 knot or less, as compared with a low of 0.3 knot for other studies. A redesign of the meter, more particularly the impeller and the tail fins, was made, to permit registering these low velocities, and to obtain significant directional control. Substantially larger impeller blades and tail fins gave the desired results, and a simpler method of construction kept the cost down. Some trouble was experienced in cold and rough water, and further experimentation is needed to entirely eliminate this difficulty.

An improved sequence switch for use with the radio current meter recorder was developed by instrument division personnel. This is a more rugged device than the former switch, and makes use of very sensitive switches of commercial design for the electrical switching mechanism.

Very high-frequency telemetering equipment for remote recording of current meter data was developed by the electronics laboratory. The advantages of this apparatus are: it practically eliminates interference, provides clearer records, permits selective recording from the various meter installations at the will of the operator, and permits intermittent operation, so that battery power is conserved.

This division cooperated with tides and currents division in the development of an instrument for scanning tidal records. This device was suggested by a member of tides and currents, the development of the final instrument being a cooperative project.

It is highly desirable that echo-sounding records be of the linear type. While some commercial offerings are of this type, they have not always operated in a satisfactory manner for our purposes; there has been irregular motion in the recording stylus, and replacement has been required of this element too frequently. A new type of mechanism was designed and built which eliminates the undesirable features, and some of our recorders are being altered accordingly. One manufacturer is adopting a somewhat modified form of our design as part of his regular product. Slippage, resulting in incorrect timing, has been eliminated.

The electronics laboratory designed a stable-frequency power supply for echo sounders to insure accuracy of recording.

One of the valuable features of the echo-sounding apparatus is its ability, under certain circumstances, to provide subbottom information in addition to its regular function of determining ocean depths. By using a high voltage electric spark, under water, as a source of sound, it is possible to obtain echoes not only from the bottom, but from layers of different densities several hundred feet below the bottom. Such information is frequently useful, and the division has built, and is experimenting with, such a spark sound-source.

At the Tucson, Ariz., seismological station, it was desirable to have the seismic sensing element located several miles away from the recording station. The electronic laboratory designed, built, and installed telemetering equipment for the remote recording of seismic data at this station.

An experimental nuclear magnetometer was designed and built for the geophysics division. This type of magnetometer measures a magnetic field by recording the frequency of precession of an electron of the hydrogen atom

after its release from a strong polarizing field. A special feature of this instrument is that three channels are provided, enabling the instrument to measure three components of the earth's magnetic field. The source of the hydrogen is water, contained in a sealed, ring-shaped, plastic container, which forms the core of a many-turned coil of insulated wire. The Helmholtz coils constructed for use with this magnetometer have a novel feature in that their construction is almost entirely of plastic, as this material has no effect upon the field generated by the windings. The assembly was mounted on a theodolite base, for accurate angular positioning.

Accuracy of geodetic level rods was improved by constructing the wooden backing element as a lamination of eight strips, carefully arranged to average out all tendencies to warping, the assembly being put together with waterproof glue. Tests indicated that warping had been reduced materially, so that it is well within the allowable tolerance.

Trouble has been experienced with occasional damage to geodetic levels during transit, where rough handling sometimes causes breakage in the means used to secure the instrument in its case. The case was redesigned so that the level is fastened firmly to a board or plate, which slides sideways into the case, by substantial bolts and clamps. All securing elements are such that any shock that will damage them would destroy the entire case.

## TECHNICAL SERVICES DIVISION

### OPERATIONAL ACTIVITIES

The component branches and sections in the technical services division continued and improved basic functional operations during fiscal year 1958.

The bureau collection of map source material was kept continuously in an up-to-date status. Approximately 66,000 new maps were received, more than 60,000 were distributed, and over 26,000 were eliminated from the files as superseded or obsolete. Of those distributed, approximately 50 percent were provided for the cartographic work of the bureau, and the remainder were issued to field parties and for disseminating map information to the Department, other agencies of the Government, and the public. Included among the maps issued to the public, together with letters containing map information, were more than 800 copies of early Coast and Geodetic Survey charts, many for use in litigation.

Among the recipients of maps and map information outside the bureau were the various state highway departments, the National Geographic Society, and the Florida Development Commission. Those within the Government included the Federal Power Commission, Soil Conservation Service, Geological Survey, Bureau of Public Roads, Army Map Service, and Navy Hydrographic Office.

Geographic names were provided or checked for all charts and other general publications issued by the bureau. This included 124 nautical charts and 66 aeronautical charts, the new Gulf Coast Pilot, and various other publications. In addition, name lists were prepared for 87 new hydrographic survey sheets and 39 topographic or planimetric maps. Close liaison was maintained with the Board on Geographic Names, and other mapping agencies. A unified system of handling geographic names in the Hawaiian Islands was devised, resolving a long-standing problem.

In the process of maintaining complete and accurate information on geographic names, new information derived through research and from field reports were kept current in the files. Work has been started on a new set of geographic names standards.

The research analysis section continued to maintain a file of source material and indexes for the compilation of aeronautical charts. Over 500 new map bases were indexed and approximately 750 photographs were received and processed. During the year source material was provided for the revision of 173 aeronautical charts.

The visual aids activities of the division continued at an accelerated rate. More than 500 photographs and slides were accessioned and placed in the files during the year. Nearly 3,000 photographic prints and slides were issued for presentation uses, and 61 motion picture films representing bureau subjects were loaned. Recipients of these visual aids outside the bureau's district offices included schools, colleges, and publishers, the Navy Hydrographic Office, the Civil Aeronautics Administration, the U. S. Air Force, and the Army Map Service.

Approximately 60 exhibits were prepared and put on display throughout the country. Among these were the International Geophysical Year exhibits at Department field offices and special displays at bureau field offices. Included also were exhibits in the Department of Commerce lobby, the New York Motor Boat Show, the Baltimore Boat Show, the Philadelphia National Airport, the Greater Miami Industrial Exposition, and at numerous conferences including the annual meetings of the American Society of Civil Engineers, the American Congress on Surveying and Mapping and American Society of Photogrammetry, the American Road Builders Association, the Fifth Annual Highway Conference, and the National Rivers and Harbors Congress.

Special cartographic work performed in the division was extensive. Exclusive of reimbursable work, approximately 140 special maps, graphs, signs, and drawings were prepared for a variety of bureau and departmental needs. Included among these were graphs and maps to assist the presentation of the budget, recruiting posters, special maps and drawings for illustrating tides and other phenomena, location maps, and unusual maps such as depicting the status of United States mapping in the Arctic. In addition, nearly 130 certificates were prepared, ranging from departmental awards and officer appointments to bureau commendations.

Approximately 1,800 books and pamphlets were processed into the bureau library, and nearly 1,000 volumes were withdrawn. Book and pamphlet circulation exceeded 3,100, representing a considerable increase over previous years. Comparably, the circulation of field and office reports and records by the archives section increased to nearly 12,000, well above previous years. About 5,800 such reports and records were received and processed, and nearly 10 cubic feet of those records which were deemed of infrequent use were transferred to the Federal Records Center.

As the bureau's publication officer and member of the publications committee, the division Chief expedited the publication of all books and pamphlets. The centralization of the bureau's publication program in one office has resulted in more effective handling of the publications through the printing stage.

## NATIONAL AND INTERNATIONAL COOPERATION

### National Agencies

Cooperation was extended to agencies of the national government, to national societies, and to private concerns. In addition, certain special interagency activities were exercised. Among these were furnishing U. S. Sectional and WAC aeronautical charts without overprints to the U. S. Air Force Aeronautical Chart and Information Center, supplying more than 2,200 aeronautical charts of all varieties to the Central Intelligence Agency, and the presentation of copies of aeronautical chart bases to a variety of other agencies. In cooperation with the National Aeronautical Education Council, 4,000 obsolete aeronautical charts were shipped to selected universities and colleges, and map "kits" were sent to various schools.

A statement concerning the current functions of the bureau was prepared for the Institute of Government, University of North Carolina, and, in cooperation with the Air Force and Geological Survey, the United States statement on nautical and aeronautical charting was prepared for the United States Pan American Institute of Geography and History report. New Coast Guard Light Lists were edited for the correctness of their geographic nomenclature, and the division continued its support of the national "Operation Alert" program.

Cooperation in the form of geographic consultation was provided on occasions to the Office of the Geographer, Department of State and to Members of Congress. Special liaison was extended to the Civil Service Commission in the form of committee action on examinations, and aid was given the George Washington University in the development of its new curriculum leading to the degree of bachelor of science in cartography.

The division continued to be represented on the Board on Geographic Names, and substantial strides were made in this aspect of the work. Partially through the efforts of this liaison a new system of handling domestic names has been devised whereby names submitted to the Board by the bureau will get prompt action in the future.

Full participation was afforded the Interagency Map Procurement Committee which has attachés all over the world. Special loans of foreign charts were made to the Central Intelligence Agency map library and to the Department of State.

### International Agencies

The division continued its activities in international cooperation. In addition to the usual international exchange of maps and publications, approximately 80 letters

concerning this exchange were prepared, and numerous special services were performed along this line. A complete set of aeronautical chart bases was provided the Canadian Government, and more than 100 new or revised nautical charts were furnished various foreign governments. Numerous foreign charts were received from maritime nations; equivalent quantities were sent on exchange. A display panel was exhibited at the 1958 Pan American Institute of Geography and History meeting in Habana. Illustrative matter on the bureau's participation in the International Geophysical Year was prepared in cooperation with other divisions.

#### RESEARCH AND DEVELOPMENT

In the performance of regular functions, a certain amount of research is normally performed. Numerous incidental pieces of geographic research were completed and the results presented in the more than 2,600 letters prepared.

Several reports were prepared on the history and theory of names and presented to the Domestic Names Committee of the Board on Geographic Names with a view to effecting changes in the procedure for handling such names and of making the names work of the division more effective.

Research was made on the oceanographic history of the Coast and Geodetic Survey, and a paper was prepared in conjunction with the tides and currents division for the National Academy of Sciences.

A special investigation was made of the possibility of establishing a file containing 3" x 5" cards depicting microfilm reproductions of the division's voluminous photographic file. When completed it will facilitate the use of these photographs not only in the Washington office but also in the district offices and elsewhere.

A study was made of the physical plant and facilities of a number of libraries, and a plan for the reorganization of the bureau's library and archives developed. With the implementation of this plan, a more effective service was developed. Part of the development was the physical separation of the library from the archives. This resulted in greater accessibility to the archives and a 25 percent increase in its use.

The reorganization of the library and archives was done to facilitate scientific and engineering research within the bureau. Provision was also made for the addition of an assistant archivist, and a research librarian. Other innovations were the creation of a reading room, replacement of wornout furniture, improvement of lighting and wall coloring, and the elimination

of congestion. Obsolete and nonessential books and other materials were removed, including 15 square feet of obsolete books and approximately 1,000 other nonessential volumes. These were replaced by current and essential books and pamphlets. For efficient handling of these materials, selected new file equipment was installed. Nearly 2,000 charts from the map collection and about 10 cubic feet of records from the library and archives branch were transferred to the National Archives.

A new series of exhibit panels fabricated from aluminum was developed. Research into the various types of commercial products available resulted in a new method of constructing lightweight framework of a considerable saving in preparation time for the basic panels. The weight of the new exhibits is only one-fourth that of the wooden panels. In reducing the weight no display space was sacrificed. Substantial savings are being realized on express charges for the exhibits that are continually scheduled throughout the United States. Research into the presentation of visual aids by using highly selective subject material, color, raised effects, and third dimension is effective in announcing our services and products to potential users.

## PERSONNEL AND SAFETY DIVISION

### PERSONNEL

At the close of the year, the Coast and Geodetic Survey employed 2,203 persons. This figure represents an increase of 173 above the 2,030 persons on the roll on June 30, 1956.

Civil service personnel actions included 714 separations, of which 12 were deaths and 32 retirements, and 875 appointments. Commissioned personnel actions included 9 resignations, 10 retirements and the appointment of 31 deck officers and ensigns.

#### Awards

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

Richard J. Hager                      James H. Nelson

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":

Leslie F. Bailey	Austin C. Poling
Granville K. Emminizer	William Shofnos
Wilfred B. Harrison	William M. Smith
William T. McGinnis	Stephen Yachmetz, Jr.
Price L. Neal	

College Magnetic Observatory Group Award, College, Alaska.

Clyde J. Beers	William H. Schmieder
William W. Husemeyer	Claude Swaim
George E. Arthur	Joseph Collins

Lindsay P. Disney, Eustace S. Hart, Wilbur R. Lea, and Douglas L. Parkhurst received Length of Service insignia for 40 years of service in the Department.

#### Retirements

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

Capt. W. H. Bainbridge (34)	Rear Adm. C. A. Schanck (32)
Rear Adm. W. M. Gibson (33)	Capt. Henry O. Fortin (32)
Capt. Ector B. Latham (33)	Capt. P. L. Bernstein (31)

Capt. C. Le Fever (31)      Comdr. G. E. Morris (30)  
Capt. R. C. Bolstad (30)    Comdr. Paul Taylor (27)

The following civil service personnel retired from active duty after indicated number of years of service in the Government:

Timothy Lyons (47)	Thomas Alger (19)
Wilbur R. Lea (40)	Joseph Ray (20)
Mary E. Baker (39)	Vassar Hamilton (18)
Albert H. Coombs (37)	George Conlon (18)
James E. Baker (34)	Louis Kerdock (18)
Lawrence Seamon (34)	Lafayette Chadwick (16)
Ruth Shepard (34)	Ella B. Grimes (16)
Martha Parr (32)	Lucille Bremmer-de Mendz (15)
Daniel B. Howard (32)	Margaret B. J. Day (15)
Philip Cohen (32)	Richard Mansfield (14)
Ruth Riggs (31)	Edmond F. McCarthy (10)
Helena McGraw (23)	Mary C. Zunes (10)
Bernard O'Flaherty (22)	Albert W. Brain (10)
John B. McDonald (21)	Allen R. Griffin (7)
Marjorie Kidwell (21)	John W. Hussey (7)
Vera Wysocki (20)	Pastor Morales (6)

BUDGET AND FISCAL DIVISION

OPERATIONAL ACTIVITIES

Additional action was taken toward the centralization of accounting and providing meaningful fiscal data for management on a timely basis. The bureau's payroll operation with the exception of pay and allowances of commissioned officers, the monthly reports of reimbursable earnings, and the bond allotment reports were converted to a mechanized basis to facilitate preparation and to make the accomplishment more timely. The centralization of accounting was completed for all cost centers except the ships on the west coast. The bureau's Accounting Manual was approved by the Office of the Secretary and transmitted to the General Accounting Office for the approval of the Comptroller General. The procedure for handling the multiple billing covering gasoline consumption in the field was simplified resulting in savings in time and paperwork.

The bureau's 1959 budget estimates were developed and presented on a cost basis for the first time. A report showing workload plans and accomplishments in units and dollars was developed for use of management.

The following funds, from sources indicated, were made available to the bureau during the fiscal year 1958:

Appropriations:

Salaries and Expenses.....	\$11,828,037 <sup>1/</sup>
Salaries and Expenses (advance procurement appropriation, Public Law 472, 85th Congress, approved June 30, 1958)..	400,000 <sup>2/</sup>
Construction of a survey ship.....	6,079,466 <sup>2/</sup>
Total appropriations.....	<u>18,307,503</u>

Reimbursements from other agencies.....	<u>4,228,384<sup>2/</sup></u>
---	-------------------------------

Working Funds received from:

Department of State.....	4,918 <sup>4/</sup>
Total Working Funds.....	<u>4,918</u>

Transfer from:

International Cooperation Administration..	<u>188,100</u>
Total Funds received.....	<u>\$22,728,905</u>

1. Includes \$278,037 for pay increase, Public Law 472, 85th Congress, approved June 30, 1958.
2. Includes prior year unobligated balance of \$3,679,466 made available this year.
3. Includes \$54,544 anticipated for pay increase.
4. Unobligated balance of prior year, available this year.

Collections covering all miscellaneous receipts, including sales of nautical and aeronautical charts and related publications, totaled \$698,807, as compared with \$625,683 during the preceding year.

## ORGANIZATION AND MANAGEMENT DIVISION

### OPERATIONAL ACTIVITIES

The organization and management division activities during fiscal year 1958 involved participation in a variety of studies, analyses, reviews, and reports on organization, workload, procedures, space, etc., ranging in scope from individual positions to bureauwide. The following items are some of the more significant accomplishments during the year:

An internal audit program, specifically aimed at making independent studies, reviews, and appraisals for officials in the bureau on the effectiveness and efficiency with which operations are being performed, was established and placed in effect about January 1, 1958. The guidelines of the program have been fairly well established. Most of the operational aspects of the budget and fiscal division and at least one branch of the administrative services division have been reviewed. Several other miscellaneous reviews were also completed.

Complete and accurate functional statements of all organizational segments in the bureau are one of the basic requirements for effective management at all operating levels, both technical and administrative. For the first time in many years, these functional statements were revised and brought up to date for all organizational units of the Washington office and the district offices. This functional chart will be distributed to the Washington office and the district offices. As functional and organizational changes become necessary, the individual segment involved will be reviewed for approval by the Director, and new sheets printed and transmitted to the holders of the charts.

As a final step in carrying out an organizational and functional change approved sometime ago involving the administrative services division and instrument division, procedures were worked out and placed in effect for the transfer of the instrument storage and issue function from the instrument division to the administrative services division.

A much needed policy on the purchase, repair, and disposal of personal property was developed and approved and the procedures written and disseminated to the field parties to carry out the revised policy. This change in policy involves a much greater utilization of local repair and supply services, thereby reducing to the fullest extent practicable the cost of handling and shipping miscellaneous items between the Washington office and the field installations.

Under the assistant disbursing officer system, each

one of the approximately eighty parties in the field maintained individual accounts with several oil companies. Many billings for small parties were very small, involving only a single or a few deliveries. The centralization of the payment of bills in the Washington office pointed up the need for some consolidation of billing in order to reduce the handling of numerous bills monthly, many of which were from the same company but for different parties. Arrangements were made with the various oil companies to issue bureau credit cards numbered to identify the individual party, thereby consolidating the monthly billings from each company into one bill. This has resulted in a reduction from more than 200 monthly billings from oil companies to about 13.

The division coordinated the Department's Spring Cleaning Campaign in the bureau. This drive, along with the regular records management program, resulted in the disposal of over 1,000 cubic feet of obsolete records and the transfer of approximately 500 cubic feet to the Federal Records Centers.

Six informational issuances were published. Thirty-three permanent issuances were published, and 29 rescinded. In response to requests, 33 special reports or evaluations of proposed issuances were submitted to the Department.

## ADMINISTRATIVE SERVICES DIVISION

### OPERATIONAL ACTIVITIES

Several activities were transferred during the year from the office of the division chief. Preparation of invitations to bid was made the responsibility of the procurement branch. Providing divisions with certain types of office services, maintenance and repairs, essentially a procurement function was also transferred to that branch. Records concerning real property were transferred from several offices and centrally located in the property management branch.

The status of 40 or more tide observers as employees was converted to that of contractors. Additional work in contracting for these services was more than offset by reducing the administrative procedures involved in hiring personnel and maintaining detailed payroll selections for them. Arrangements were made for the purchase and shipping of supplies and equipment for the geodetic program for Ethiopia undertaken by personnel of Coast and Geodetic Survey in connection with technical programs of the International Cooperation Administration.

The following are some of the more significant statistics in connection with the major activities of the division. Procurement actions processed by the Washington office accounted for a total dollar value of approximately \$1,870,000, or an increase of \$298,000 over the previous fiscal period.

Our total shipments of instruments, equipment, charts, materials and supplies amounted to 795 tons of which 81 percent went by motor freight. Rail, air, express, mail, bureau trucks, and water freight carried the remaining 19 percent, or 147 tons. This compares with total shipments of 1,099 tons in the previous year. The decrease is due principally to a reduction in the total of Sectional and Route charts distributed together with a lesser distribution of a smaller size of the Approach and Landing charts.

The bureau's 348 motor vehicles traveled 4,135,749 miles. Although 106 miles more per vehicle were recorded, the total cost per mile decreased slightly or about 0.03 cents less per mile than it cost the Survey in the previous year to operate 337 vehicles.

Approximately 600,000 pieces of incoming and outgoing mail, including checks, money orders, and cash, were routed through the bureau mail room.

About 649,000 copies from 6,500 hectograph masters were made of memorandums containing information, notices, tabulated data, etc.

## APPENDIX

### PUBLICATIONS ISSUED

#### Geodesy

The following publications containing Plane Coordinate Intersection Tables ( $2\frac{1}{2}$  minutes) were printed:

Arkansas, Publication 65-1, Part 3.  
South Carolina, Publication 65-1, Part 38.  
Virginia, Publication 65-1, Part 44.

Other publications issued during the year:

Gravity Control Measurements in North America, Publication 63-1.  
Geodetic Operations in the United States and in Other Areas Through International Cooperation, 1954-1956, by Charles Pierce, Publication 60-1.

#### Tides, Currents, and Oceanography

Tide and tidal current tables for the year 1959 were prepared as follows:

Tide Tables, Europe and West Coast of Africa (including the Mediterranean Sea).  
Tide Tables, East Coast, North and South America (including Greenland).  
Tide Tables, West Coast, North and South America (including 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.

Other publications issued were as follows:

Special Tide Tables, Selected Places in Greenland, Canada, and Alaska, 1958 (for official use).  
Density of Sea Water at Tide Stations, Atlantic Coast, North and South America. Publication 31-2 (Fifth edition), 1957.

#### Geomagnetism and Seismology

The following geomagnetic publications were issued:

Seven volumes of magnetograms and hourly values (MHV's) from observatories were issued as follows: College, 1952; Honolulu, 1952, 1953; San Juan, 1952, 1953; Sitka, 1953; and Tucson, 1953.

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

- United States Earthquake, 1956, by R. J. Brazee and W. K. Cloud.  
Earthquake Investigation in the United States, Special Publication No. 282 (Revised 1958).  
Earthquake History of the United States, Part I, Continental United States (Exclusive of California and Western Nevada), and Alaska, Serial 609 (Revised 1956).  
Seismological Bulletin--April 1957 through March 1958.  
Abstracts of Earthquake Reports for the Pacific Coast and the Western Mountain Region--four quarters of 1957, and the first quarter of 1958.

#### Coast Pilot

Supplements to the Coast Pilots, containing changes and new information, were issued for eight volumes.

#### Miscellaneous

The seventh and final issue of The Journal of the Coast and Geodetic Survey was issued. A cumulative index of numbers 5, 6, and 7 of The Journal was also issued.

A series of Technical Bulletins was inaugurated to present to the personnel of the bureau and to others the results of research and development in the various fields of the Survey's activities. It is designated for quick publication and dissemination and supersedes The Journal. The numbered bulletins are available for public distribution while those designated by a letter are for official use only. The following were issued during the year:

- Aerotriangulation Adjustment of Instrument Data by Computational Methods, William D. Harris, Technical Bulletin No. 1, January 1958.  
Tellurometer Traverse Surveys, Hal P. Demuth, Technical Bulletin No. 2, March 1958.  
Recent Increases in Coastal Water Temperature and Sea Level--California to Alaska, H. B. Stewart, Jr., B. D. Zetler, and C. B. Taylor, Technical Bulletin No. 3, May 1958.  
The Development of Portable Echo-Sounders in the Coast and Geodetic Survey, Thomas J. Hickey, Technical Bulletin Special A, May 1958.

#### PAPERS PUBLISHED

- Coast and Geodetic Survey Field Demonstration of Surveying and Mapping Operations, Ernest J. Parkin, Surveying and Mapping, July-September 1957.  
150 Years of Nautical Charting Progress, A. L. Shalowitz, Surveying and Mapping, July-September 1957.

Observers, Take Care, Roy M. Sylar, Surveying and Mapping, July-September 1957.  
 Level Vials--Their Manufacture, Use and Peculiarities, Douglas L. Parkhurst, Journal of the Franklin Institute, August 1957.  
 Alexander Dallas Bache--Pioneer American Scientist, A. L. Shalowitz, Journal of the Washington Academy of Sciences, August 1957.  
 Hurricane Effect on Sea Level at Charleston, B. D. Zetler, Paper 1330, Proceedings of the American Society of Civil Engineers, August 1957.  
 Evolution of Coastal Charting, H. Arnold Karo, Sperry-scope, 4th Quarter, 1957.  
 Geodesy, Foundation for National Mapping, A. L. Shalowitz, The Military Engineer, September-October 1957.  
 Intensity Distribution and Strong-Motion Seismograph Results, William K. Cloud, Bulletin of the Seismological Society of America, October 1957.  
 The Coast and Geodetic Survey in the Philippine Islands, Earle A. Deily, The Journal, Coast and Geodetic Survey, October 1957.  
 Angle Measurement With Wild T-2 Theodolite, Gilbert R. Fish and William N. Martin, The Journal, Coast and Geodetic Survey, October 1957.  
 Subtense Bar Traverse, Gilbert R. Fish, The Journal, Coast and Geodetic Survey, October 1957.  
 Louisiana Coast and Offshore Triangulation, Ross A. Gilmore, The Journal, Coast and Geodetic Survey, October 1957.  
 Drum Buggy, S. B. Grenell, The Journal, Coast and Geodetic Survey, October 1957.  
 Accuracy Limitations in Vector Airborne Magnetometer Surveys, James V. Hastings and Wesley M. Butler, The Journal, Coast and Geodetic Survey, October 1957.  
 Application of Electronic Position Indicator to Long-Line Geodetic Measurements, Thomas J. Hickley, The Journal, Coast and Geodetic Survey, October 1957.  
 ER-Type Raydist System of Position Control, Thomas J. Hickley and Roswell C. Bolstad, The Journal, Coast and Geodetic Survey, October 1957.  
 Hydrographic Work of the Coast and Geodetic Survey, Karl B. Jeffers, The Journal, Coast and Geodetic Survey, October 1957.  
 Safety Devices for Leveling Parties, Emerson E. Jones, The Journal, Coast and Geodetic Survey, October 1957.  
 A Sesquicentennial of Public Service, H. Arnold Karo, The Journal, Coast and Geodetic Survey, October 1957.  
 Deflection of the Vertical Above Sea Level, Hyman Orlin, The Journal, Coast and Geodetic Survey, October 1957.  
 A Century and a Half of Scientific Nautical Charting, A. L. Shalowitz, The Journal, Coast and Geodetic Survey, October 1957.  
 Federal Liability for Failure of Navigational Aids, A. L. Shalowitz, The Journal, Coast and Geodetic Survey, October 1957.  
 Scribing Map Details on Plastic, Josef J. Streifler, The Journal, Coast and Geodetic Survey, October 1957.

- Stereotriangulation Adjustment, G. C. Tewinkel, The Journal, Coast and Geodetic Survey, October 1957.
- Modifications in Second-Order Astronomic Position Determinations, Curtis W. Thorson, The Journal, Coast and Geodetic Survey, October 1957.
- The Dixie Valley--Fairview Peak, Nevada, Earthquakes of December 16, 1954, Geodetic Measurements, C. A. Whitten, Bulletin of the Seismological Society of America, October 1957.
- Tsunamis, The Strangest Waves on the Sea, Elliott B. Roberts, U. S. Naval Institute Proceedings, November 1957.
- Extreme Sea Water Temperatures and Densities Along the North Atlantic States During Summer 1955, C. B. Taylor, Journal of Marine Research, November 1957.
- Electronic Distance Measuring Devices, John H. Brittain, Revista Cartografica, 1957.
- Coast and Geodetic Survey Activities in Alaska, H. Arnold Karo, The Arctic Club, Seattle, Wash., 1957.
- A Preliminary Report on a Differential Magnetograph, J. H. Nelson, Annals of the International Geophysical Year, 1957.
- The Differential Magnetograph for the College (Alaska) Magnetic Observatory, J. H. Nelson, Annals of the International Geophysical Year, 1957.
- The U. S. Geomagnetism Program of the International Geophysical Year, J. H. Nelson (in Spanish), Revista Cartografica, 1957.
- Surveys of Urban Areas, Murray Y. Poling (in Spanish), Revista Cartografica, 1957.
- Seismological Activities of the Coast and Geodetic Survey in 1954 and 1955, Elliott B. Roberts and William K. Cloud, Bulletin of the Seismological Society of America, January 1958.
- A Direct Proof for the Least Squares Solution of a Set of Condition Equations, Erwin Schmid, American Mathematical Monthly, January 1958.
- The Tellurometer for Control Surveys, John H. Brittain, The Military Engineer, March-April 1958.
- Ferdinand Hassler's Gift to America, Elliott B. Roberts, Journal of the Washington Academy of Sciences, March 1958.
- They Take the Earth's Measure, Elliott B. Roberts, Think, March 1958.
- The Future of Analytical Aerial Triangulation, G. C. Tewinkel, Photogrammetric Engineering, March 1958.
- Protection Against Seismic Sea Waves, H. Arnold Karo, Shore and Beach, April 1958.
- The Geodimeter and Tellurometer, Austin C. Poling, Paper 1617, Proceedings of the American Society of Civil Engineers, April 1958.
- Tidal Movement in the Cape Cod Canal, Massachusetts, B. W. Wilcox, Paper 1586, Proceedings of the American Society of Civil Engineers, April 1958.
- Upstream Bottom Currents in New York Harbor, H. B. Stewart, Jr., Science, May 9, 1958.

Pamplona Searidge 1779-1957, George F. Jordan, International Hydrographic Review, May 1958.  
Electronics in the Coast and Geodetic Survey, Part 1, H. Arnold Karo, Signal, June 1958.  
Background and Technical Objectives in Geomagnetism, E. B. Roberts and D. G. Knapp, Geophysics and the IGY, Monograph No. 2, American Geophysical Union, 1958.

#### 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 "Surveys, United States Government," "Surveying," and "Tides" for Encyclopedia Americana; "Cartography" and "Geodesy" for Americana Annual; "Seismology" for Collier's Encyclopedia Year Book, New International Year Book, and Britannica Book of the Year. Articles on overall activities of the bureau were also prepared for the Britannica Book of the Year, the Encyclopedia Americana, the Americana Annual, the New International Year Book, the Universal Standard Encyclopedia, the New Standard Encyclopedia, and the Index Generalis.

#### PAPERS PRESENTED

The Coast and Geodetic Survey and ROTC, H. Arnold Karo, Fort Belvoir, Va., July 1957.  
Installation of the Differential Magnetograph, Clyde J. Beers, Eighth Alaskan Science Conference, Anchorage, Alaska, September 1957.  
Hurricane Microseisms in the Western Atlantic, D. S. Carder and R. A. Eppley, 11th General Assembly of the International Union of Geodesy and Geophysics, September 1957.  
Seismic Wave Travel Times from Surface Foci, D. S. Carder, L. F. Bailey, and J. Hershberger, 11th General Assembly of the International Union of Geodesy and Geophysics, September 1957.  
Fifteen Decades of Applied Science and Engineering, H. Arnold Karo, Sojourners Club, Washington, D. C., September 1957.  
Nautical Charts for Safe Navigation, H. Arnold Karo, National Safety Council, Chicago, Ill., October 1957.  
Coast and Geodetic Survey Participation in Interstate Highway Programs, Miller J. Tonkel, Annual Meeting of the National Highway Conference for County Engineers and Officials, French Lick, Ind., October 1957.  
What We Are Doing About Seismic Sea Waves, H. Arnold Karo, Sixth International Conference on Coastal Engineering, Gainesville, Fla., December 1957.  
IGY Operations in Antarctica, Joel B. Campbell, Washington Society of Engineers, Washington, D. C., January 1958, and Geography Department of George Washington University, April 1958.  
Fifteen Decades of Scientific and Engineering Progress,

- H. Arnold Karo, Union College, Schenectady, New York, February 1958.
- Seismic Waves from the Nevada Underground Explosion of September 19, 1957, L. F. Bailey and C. F. Romney, Annual Meeting of the Seismological Society of America, March 1958 and the Annual Meeting of the American Geophysical Union, May 1958.
- Trends in Coast and Geodetic Survey Compilation, John A. McAlinden, Annual Meeting of the American Congress on Surveying and Mapping, Washington, D. C., March 1958.
- Aerotriangulation Tests, G. C. Tewinkel, American Society of Photogrammetry, Washington, D. C., March 1958.
- Geomagnetism in the International Geophysical Year, Elliott B. Roberts, Technical Seminar of National Analine Division, Hopewell, Va., April 1958.
- Challenge of Oceanography, H. B. Stewart, Jr., Hampden-Sydney College, April 1958.
- Applications of the Tellurometer, Hal P. Demuth, Annual Meeting of the American Geophysical Union, May 1958.
- Basic Surveys for Beach and Harbor Studies, H. Arnold Karo, American Shore and Beach Preservation Association, Washington, D. C., May 1958.
- Geomagnetism in the International Geophysical Year, J. H. Nelson, North Carolina Academy of Sciences, May 1958.
- Net Upstream Flow of Bottom Water in New York Harbor, Harris B. Stewart, Jr., Annual Meeting of the American Geophysical Union, May 1958.
- Recent Ocean Temperatures and Sea Level Anomalies on the West Coast, B. D. Zetler, H. B. Stewart, Jr., and C. B. Taylor, Annual Meeting of the American Geophysical Union, May 1958.
- Distortion in Continental Triangulation, C. A. Whitten, Annual Meeting of the American Geophysical Union, May 1958.
- The Australian Seismological Projects, D. S. Carder, Annual Meeting of the Eastern Section of the Seismological Society of America, June 1958.
- Cartographic Compilation Techniques in Use by the Coast and Geodetic Survey, G. K. Exminizer, Jr., Second International Cartographic Conference, Chicago, Ill., June 1958.
- Structural Relationships of the Charleston, S. C. Earthquake, J. N. Jordan, Annual Meeting of the Eastern Section of the Seismological Society of America, June 1958.
- Techniques in Use by the Coast and Geodetic Survey, Gordon B. Littlepage, Jr., Second International Cartographic Conference, Chicago, Ill., June 1958.
- Antarctic Seismicity, L. M. Murphy, Annual Meeting of the Eastern Section of the Seismological Society of America, June 1958.
- The Differential Magnetograph, J. H. Nelson, National Telemetering Conference, Baltimore, Md., June 1958.
- Coast and Geodetic Survey Telemeter for Seismic Recording, F. H. Werner, Annual Meeting of the Eastern Section of the Seismological Society of America, June 1958.