gence information to operational headquarters. As a tactical reconnaissance vehicle, it could be catapulted from the ground, vectored over the proposed target area, and brought back for parachute recovery of the plane and its intelligence data without risking the loss of an expensive plane or an irreplaceable flight crew. For long-range reconnaissance, its scope could be extended by air launching from a mother plane.

Northrop Aircraft, Inc., and its subsidiary, the Radioplane Co., are active in several types of guided missile work which continue to grow in importance in the national defense program.

Although most of the work in this field is necessarily secret for reasons of military security, it can be said Northrop's program is one of the most advanced in the field. Official announcement has been made that the company is engaged in development of the *Snark* SM-62, a long-range pilotless bomber with atomic capabilities. Other details concerning the *Snark* and other missile projects assigned to Northrop and the Radioplane Co. have not been released.

Radioplane's pioneering experience in the target drone field has enabled the company to extend its activities to substantial guided missile projects. As the builder of more than 40,000 radio-controlled target drones, Radioplane Co. possesses one of the nation's most talented teams in the design, development and production of unmanned aircraft.

As Northrop's guided missile program has advanced, the company has devised new types of production machinery, accurate within millionths of an inch and capable of performing production jobs not possible with standard machines.

In one case a series of five machines, known to Northrop missile men as the "precision quintet," were designed and built to machine *Snark* missile castings.

One of these machines holds to angular tolerances of one second of arc—3,600 times more precise than customary airframe tolerances of plus or minus 30 minutes of arc.

On another, several different surfaces may be milled in sequence and two or more compound angular surfaces may be milled at the same time. On still another of the five machines parallelism of two surfaces can be held to .0002 of an inch within a 10 inch span, or 20 millionths of an inch per inch.

To illustrate the effect of precision of this type, Northrop engineers cite the fact that a rocket or missile aimed at a spot on the Earth's surface 5,000 miles distant and traveling at no greater deviation from true course than one second of arc would hit within 120 feet of its target.

Although it is too early to tell at this point the exact expenditure for guided missiles in 1955, the planned allocations called for $254.1-million. The 1956 estimate is $242.4-million. The biggest problems right now seem to be consolidation of proven developments and how to meet the increasing demand for more engineers.

Concerted efforts to improve the over-all reliability of missile weapons

systems through improved component reliability are being made by the major designers and producers of guided missiles, reliability being the greatest single problem facing the missile industry.

Component reliability is a limiting factor in today's missiles. The AIA Guided Missiles Committee, working with the military services and the suppliers of equipment, particularly electronic components, will seek to establish new standards for missile equipment. These standards will necessarily be considerably higher than the most stringent requirements of other industries.

In a missile no human is along to monitor and make adjustments. Therefore, the failure or malfunctioning of any single part among the thousands needed to make a missile can mean total failure of the missile. Component reliability is the key to greater reliability in the missiles themselves.

The pyramiding effect of "failure probability" can quickly lead to the point where the probability of a successful flight can reach the zero point unless missile components are refined until their reliability rate nears the absolute. If, for a simple example, the average failure expectancy in electronic tubes, resistors was one per thousand and a missile contained 1,000 electronic components, successful flight probability would be zero.

Good advances have really been made in the missile field in the past ten years. The greatest immediate progress could probably be made through improvements in reliability. Such improvements would be beneficial not only to present missiles but also to missiles not yet off the drawing boards.

CHAPTER SIX

Government and Aviation

Agricultural Research Service

AIRCRAFT AND EQUIPMENT SPECIALISTS in USDA's Agricultural Research Service gave technical assistance in the supervision of approximately 100 aircraft in 31 States during 1955 in treating about 1,600,000 acres for control of grasshopppers, 97,600 acres for Mormon crickets, 1,370,000 acres for gypsy moths, and 1,549,000 acres for spruce budworms. In cooperation with nine states, these specialists made experimental field applications from the air of granulated insecticides for control of soil-inhabiting pests (Japanese beetles, European chafers, white fringed beetles) and reported excellent results.

Agriculture advisors cooperating overseas with U. N.'s Food and Agriculture Organization met with the Desert Locust Control Committee in Syria to plan this year's aerial attacks in the Near East against grasshoppers, which have plagued this area throughout history.

In another overseas project, Operation Gyroscope, a U. S. Army regimental combat team being rotated by air from Japan to the mainland went through pre-departure quarantine clearance by a combined Customs and Agriculture team. Compared with the usual method—inspection upon arrival in the United States—this pre-clearance at point of departure provided better protection against spread of plant and animal pests and diseases at less cost in manpower, and also expedited the military movement.

During typical U. S. quarantine activities in 1955, Agricultural Research personnel examined nearly 90,000 transport aircraft for materials that might contain plant pests; nearly a third of these airplanes carried prohibited or restricted plant materials.

Livestock inspections also were carried out, since nearly 73 percent of all poultry, 53 percent of all horses, and 16 percent of all other animals,

such as cattle, swine, sheep, and goats, coming from other countries (exclusive of Canada and Mexico) arrived in this country by air. USDA scientists are developing special procedures to be used in detection of destructive pests around airports to reduce their spread or establishment elsewhere.

Another USDA study group met informally late in 1955 to outline research needs in agricultural aviation. Among the needs: engineering innovations (as in the shape, size, and position of nozzles and spray booms); fertilizers formulated for aerial application; better guidance system for directing pilots; an agricultural aviation handbook for industries, applicators, farmers, and others.

ARS engineers who designed a fluidizer that expands dust to an easy-flowing, liquid-like mass (through air pressure) now are experimenting with different numbers of dust-spray tubes in various positions on the plane, to determine which combination is best under specified conditions. The work also includes design and development of equipment for application of sprays and granular materials.

In experiments successfully closed in 1955 on the island of Curacao, USDA scientists saturated the wild population of screwworm flies (maggots from the fly eggs grow in open wounds, may kill livestock) with many thousands of laboratory-reared male flies made sterile by exposure to gamma rays from radioactive cobalt. These flies were spread by airplane. Since female screwworm flies mate only once, the population soon dwindled to nothing. The entomologists now believe they might rid Florida of this pest through the same method. But, whereas the island of Curacao measures 170 square miles, the peninsula of Florida contains some 58,000 square miles. Designing the equipment for covering the vast southern areas of Florida with male sterile screwworm flies dropped from the air—if this is ever tried—will offer an interesting challenge to the agricultural aviation engineer.

In eight western states, some six million acres have been infested by halogeton, an annual noxious weed that has killed thousands of sheep and cattle. During 1955, plant pest control personnel of USDA cooperated with the Department of the Interior in trials in Nevada and Idaho of various formulations of herbicides and use of aircraft to control the weed.

Air Coordinating Committee

The Air Coordinating Committee, established in 1946, Executive Order 9781 of the President to coordinate Federal policy in the field of aviation, is composed of the following members of the eleven Government Agencies having an important interest in aviation: Louis S. Rothschild, Under Secretary of Commerce for Transportation, Chairman; Chan Gurney, Member, Civil Aeronautics Board, Vice Chairman; Herbert V. Prochnow, Deputy Under Secretary of State for Economic Affairs; George H. Roderick, Assistant Secretary of the Army; James H. Smith, Jr., Assistant Secretary of the Navy for Air; Bradley D. Nash, Acting Deputy for Civil Aviation, Office of the Assistant Secretary of the Air Force; David W. Kendall, As-

sistant Secretary of Treasury; E. George Siedle, Assistant Postmaster General; Robert E. Lee, Commissioner, Federal Communications Commission; Percy Rappaport, Assistant Director, Bureau of the Budget (non-voting); and Colonel Alvin B. Barber, Consultant for Transportation, Office of Defense Mobilization (non-voting). The Executive Secretary is William E. Neumeyer.

The Committee, during 1955, developed, coordinated and recommended to the Department of State the United States position for the Agenda of the Ninth Session of the ICAO Assembly dealing primarily with financial and administrative matters. Recommendation was made for approval of the application for membership in ICAO of the Federal Republic of Germany.

In the technical field, the Committee approved the United States position for six international technical conferences concerned with the work of the International Civil Aviation Organization.

Also during 1955, amendments numbered 15 through 21 were made to Annex 10 (Aeronautical Communications), were approved by the Contracting States and became effective. In addition, recommendations were made with regard to amendments to the ICAO approved phonetic alphabet.

The Committee approved revision of the Terms of Reference for the Air Traffic Control and Navigation Panel which provided that the Navy Panel would guide the combined efforts of the voting membership of U. S. Government agencies with primary aviation interests and the non-voting aviation industry membership toward the development and implementation of programs to meet the air traffic demands on the common system. The Committee also approved "Civil Aeronautics Administration's Proposed Federal Airway Plan, Fiscal Years 1957-1961"; approved a program for immediate first-stage integration of air defense and air traffic control functions by expanded use of long-range military radar; approved a program on electronic short-distance navigation systems to minimize disruption of use of all aviation interests—this program will provide a common civil-military system of navigation to the extent possible for basic tactical operations as well as civil-military non-tactical operations. Effective August 1, 1955, a trial high-density zone in the immediate area of Washington National Airport was delineated and appropriate rules promulgated in order to determine methods for reducing the mid-air collision hazard in metropolitan areas of high-density air traffic and in an effort to accommodate the needs of military air operations; approved criteria for the use of frequencies and operational facilities in the limited radio spectrum between 200 and 415 kilocycles to be applied to any proposed aeronautical facility operating in this band; requested the CAA to make a policy study of the extent to which the ground radio navigation and other non-visual aids are being used or needed; accepted the Radio Technical Commission for Aeronautics' Special Committee 57 report on Instrument Landing System (ILS), Visual Omni Range (VOR), and Distance Measuring Equiupment (DME) frequency channel utilization as a guide in implementing frequency plans for those

types of navigation facilities; determined that altitude input information was important to further development of airborne pictorial computers, transmitting this information to the Air Navigation Development Board for its guidance in developing the equipment.

The Committee continued the development of a proposed National Search and Rescue Plan to insure the effective utilization of all available facilities for all types of search and rescue missions.

The Committee continued its examination and review of U. S. regulations and administrative practices in order to simplify and expedite international border crossing procedures relating to the entrance and clearance of air passengers, crew, cargo and aircraft. Such review resulted in elimination and clarification of U. S. derivations from ICAO standards contained in Annex 9 to the Chicago Convention. In addition, numerous actions for the facilitation of international air travel were taken during the year. The Committee also approved and recommended policy instructions to the Department of State for the use of the U. S. Delegation to the Fourth Session of the Facilitation Division of ICAO, held in Manila, Philippines, October 10-24, 1955.

In the Economic field, the Committee completed a study of international airport charges and approved the U. S. position that the international conference planned for the fall of 1956 on this subject should not attempt to reach conclusions regarding standardization of levels, but should discuss and exchange views on the more technical and specialized aspects of the problem; approved U. S. positions for the use of the U. S. Representative to ICAO in discussions by ICAO of the study of the financing of air route navigation facilities and services, suggesting that it be directed toward the development of broad principles on which to base charges rather than the presentation of detailed techniques for institution of charges. The Committee reviewed the North Atlantic Ocean Station Program and agreed that the existing program was a minimum which would furnish the meteorological information communication services, navigational aid and search and rescue capability required by the United States; this action had the effect of approving the extension of the program automatically till June 30, 1957. Also approved was the position for a meeting with Canada to discuss the Pacific Ocean Stations Program in response to a Canadian proposal that the program be expanded in both terms of stations and participating countries. The Committee submitted to ICAO eight reports covering deficiencies of air navigation facilities and services in various regions. Further coordination was effected during the year for domestic and foreign civil aviation requirements for priorities for the production of civil transport aircraft; four such programs were approved during the year covering the construction and delivery of 592 multi-engine civil transport aircraft during the years 1955, 1956, 1957 and the first and second quarters of 1958. In the non-transport category, manufacturers' planned production for 1955 through the second quarter of 1958 indicated construction of 17,516 aircraft which are not included under the Defense Materials Systems.

In another Economic phase, the Committee approved a proposal by the Navy to lease for commercial operation a limited number of aircraft already owned. The Committee also undertook a study of the need for financial assistance by the Federal Government in the design, development and service testing of transport aircraft suitable to the needs of the local service air carriers.

In the legal field, the Committee coordinated preparation of the U. S. position for the International Conference at The Hague to finalize the protocol to the Warsaw Convention. The Committee advocated an increase in the limit of liability of international air carriers for personal injury or death of passengers from $8,300 to $25,000. The U. S. delegation succeeded in achieving agreement on an increase in the limit to $16,500.

Airport matters considered by the Committee during the year consisted largely of problems resulting from expanded Reserve training and Air National Guard programs authorized by the Congress.

Civil Aeronautics Administration

Early in 1955, F. B. Lee, Administrator of Civil Aeronautics, forecast that 50 million passengers would be carried on U. S. airlines in 1960, and added that "the biggest job ahead is the further improvement of existing facilities for handling these passengers with the utmost safety."

By the end of the year, the CAA had issued a forecast of air transportation growth which indicated 55 million passengers by 1960, and 70 million by 1965, and several projects for airways and safety improvement were occupying CAA's planning and operations.

Domestic air carriers went right on with the trend in producing more and more converts to air travel and the use of air cargo and air mail each year, exceeding last year's 32.3-million passengers by an estimated 19.2 percent for a total of 38.5-million. International air travel increased also to an estimated 3.4-million passengers, and traffic over the North Atlantic produced the surprising statistic in July of one airplane taking off every 17 minutes, or a total of 2,559 crossings in that seasonal month.

Safety figures took a turn for the worse, with an estimated .62 fatalities per 100-million passenger miles recorded as compared to the all-time best figure of .1 per 100-million passenger miles for domestic and international service in 1954. Despite the 1955 record, however, the trend over the years toward safer and still safer air transportation continues.

The 1955 figures do not include the fatalities which resulted from the explosion of a bomb in an air carrier in November, nor the death of a stewardess by shooting on board an air carrier. Both incidents were deemed outside the range of air accidents.

Major events in airways, airports and air safety took place during the year within the CAA.

Congress passed an amendment to the Federal Aid to Airports Act which made available some $63-million a year of matching federal funds for 1955 through 1958. The original appropriation of airport funds for fiscal

1955 was $20-million, to which $42.5-million of the new funds was added. At the same time, the criteria for federal participation in airport improvement and construction was changed by the amendment, and federal funds were made available to aid in construction of most buildings at airports except hangars, for automobile parking lots and the acquisition of land to provide clear approach areas. Most important result of this amendment, according to city and CAA authorities, was the opportunity it allows for long-range planning in airport improvement, an important feature in the enlarging aviation picture.

In view of the new criteria, communities were requested by the CAA to submit entireliy new applications by Dec. 1, 1955, and a program for using the $42.5-million was promised for Jan. 1, 1956.

Improvements and changes along the airways were constant throughout the year to keep these facilities ahead of the steady growth of air commerce. In August the CAA initiated a study of airways requirements for a period of five years ahead, and, after coordinating this plan with the government agencies concerned and with the industry, had it ready for approval by the Air Coordinating Committee late in the year.

Important elements of this plan are radar beacons for better control of faster air traffic and a doubling of the navigation aid installations so that "tomorrow's growth will not be throttled by limitations of the airways system." To prevent a log jam developing on the ground, the plan involved also an expanded airport program.

The possibiilty of the growth of air traffic outgrowing its navigation aids on the ground excited the industry late in the year, and industry collaborated closely with the CAA in planning solutions to all anticipated problems.

To expand and increase the airways service to air commerce, the CAA began a 90-day evaluation program of operating certain Interstate Airways Communications Stations from nearby stations. At busy terminals the CAA installed "repeater" radar scopes in 38 airport towers, making a total of 81 such scopes, to speed aircraft safely in and out of busy terminals. The CAA was replacing radar equipment inherited from the military after the war with new and better surveillance radar at 18 terminals.

An experiment was conducted at Washington National Airport by designating it as a high density area, and placing all traffic under more complete control. If successful, the plan probably will be adapted to other busy terminals where the density of air traffic justifies added control.

In Aviation Safety, the CAA continued its intensive studies of the problems which will be posed by the adoption of jet planes by the airlines. Forty-five more CAA workers, this time air traffic controllers, aircraft communicators and certain specialists, took the jet indoctrination course which 40 CAA officials previously had taken at Moody Air Force Base at Valdosta, Ga.

The first formal step toward airworthiness certification of a U. S. jet transport was taken in the fall with the convening of a preliminary type

board meeting. This was a culmination of long study and observation by the CAA of jet plane characteristics begun several years ago when CAA officials went to England to see the first jet-powered transports. This advance planning and study made easier the work of the CAA in connection with Capital Airlines, which had four of its Viscount turbine-powered planes in service by the end of the year. In that operation, the CAA and all airline operators learned helpful lessons in maintenance of this new plane during the year.

In its concern for air safety, the CAA moved on a broad front during 1955. Its goal of turning over to industry certain responsibilties for certifying the safety of its products was pursued, and the practice of designating responsible individuals in the industry to carry on certain inspection and certifying activities continued. One manufacturer certified that a new model plane met CAA requirements for safe design and construction, and two other builders certified the same about several models of their planes after the prototype had been certificated by the CAA.

Problems of certification of U. S. built jet transports occupied much of the time of the CAA's aircraft engineers and flight engineers. Although the problems are so new as to give little guidance, the CAA Safety Agents and the Civil Aeronautics Board, which issues the civil air regulations, continued their close study and observation alongside the industry firms that were building new jet transports. A rash of advance buying of these new planes featured the history of airlines during the year, with a total of $1-billion orders recorded. This activity paralleled CAA advance planning.

Sixteen foreign planes were submitted during the year for CAA certification, one foreign engine was approved and application was made for four others.

Sharing the concern of pilots about mid-air collisions, the CAA staged a major symposium on the problems late in the year, attended by a wide representation of the industry. A week-long study of procedures for getting passengers out of a land plane ditched in the water was staged. A new handbook on weather for all pilots was issued. In cooperation with the Texas Aerial Applicators Association and Texas A & M College, the CAA staged a school for agricultural pilots, hoping to lessen the hazards of this kind of flying. It is hoped that other land grant colleges will repeat the course if it proves helpful in promoting safety.

In the neighborhood of busy air terminals, CAA communicators reminded pilots at the close of every communication about the congested traffic area toward which they were flying, using such catch phrases as "Look out, traffic is heavy." "Heads up, watch for the other fellow," as reminders.

The Administrator held up before the airline industry the prospect of 130-million new passengers when rotorcraft of proper kind can be put into service. That many passengers, he said, take intercity trips of 150 to 700 miles, and today are using other forms of transportation. Convenient heliports and efficient aircraft will make possible their conversion to air travel, he said.

The parade of foreign aviation officials and trainees to the United States continued during 1955, and the CAA, taking stock of the results of this observation and practical training, pointed out that we are nearer than ever before to standardized airways over the world. U. S. methods and U. S. equipment were sold widely in European, Asian and South and Central American countries. The CAA supervised training and visits by aviation leaders, most of which were financed by International Cooperation Administration funds.

As part of its promotion of civil aviation, the CAA launched its Aviation Incentive Movement in 1955, designed specifically to capture and hold the interest of youngsters between 7 and 15 years of age in aviation pursuits. Schools, service clubs and other organizations have begun to follow the suggestions for AIM, and local sponsors of groups of youngsters have appeared in many parts of the country.

Steady progress was made during the year in the installation of new markers, and evidence piled up proving the effectiveness of these simple ground aids to the pilot.

Civil Aeronautics Board

Many new policy-making decisions were issued by the Civil Aeronautics Board in 1955 that will significantly assist the growth and development of American civil aviation.

In three major route cases Board decisions reflected a new and liberal policy that resulted in granting the largest expansion of domestic air service in any year since the Board began. In the New York-Chicago case, in the Denver Service case, and in the Northeast-Southwest case, the Board authorized new competition in all three areas of operation, which will result in making new and improved services available to the public.

In the New York-Chicago case, the Board made possible new nonstop and turn-around service between cities already receiving service in this area, making possible more convenient and expeditious service on the routes of Capital, Northwest, TWA, United and Eastern Air Lines.

In the Denver Service case, the Board certificated competitive transcontinental air service for Denver, Colo., Kansas City, Mo., and Pittsburgh, Pa., for the first time, and also authorized a third nonstop trunkline service between the San Francisco Bay area and Chicago and improved the existing services between the Bay area and points east of Chicago such as Detroit, Washington, New York, Hartford, Springfield, and Boston. In the same case, the Board also improved the regional air services to Chicago, Los Angeles, and San Francisco, and authorized improved service between Kansas City, Mo., and the West Coast and the Pacific Northwest.

In the Northeast-Southwest case, the Board certificated new, additional and competitive air service between the principal cities in the southwestern and northeastern areas of the nation and to certain midway cities lying between these two areas. This rearrangement of the route structure made possible new or additional air service between major cities in the Northeast (Pittsburgh and Philadelphia, Newark, New York, Baltimore and Wash-

ington) and in the Southwest (Tulsa and Oklahoma City, Dallas, Fort Worth, and San Antonio, Houston and New Orleans) and midway cities between these areas (Atlanta, Chattanooga, Knoxville, Memphis and Nashville). In this case the Board recognized the need to strengthen the smaller trunk airlines so they will be able to operate without subsidy and at the same time compete effectively with the larger trunk carriers. Braniff Airways and Delta Airlines were both authorized for the first time to extend their operations into New York City and Newark, N. J., via Washington, D. C., and other points.

The Board also announced a new policy defining the role of large irregular air carriers and their position in the nation's air transport system. The Board's decision followed a 4-year investigation of approximately 50 large irregular carriers, commonly referred to as non-skeds. The Board adopted a policy in this decision that would strengthen these carriers and foster their continued growth. In achieving this, the Board redesignated these carriers to be Supplemental Air Carriers and decreed they would no longer be confined to irregular and infrequent flights by authorizing a specific maximum of 10 flights per month between any single pair of points, which makes it possible for the Supplemental Carriers to offer regular scheduled service so long as the 10-flight limitation is not exceeded. The Board's new policy also decreed unlimited charter operations on a plane-load basis in domestic, overseas and territorial operations, excepting Alaska, and also would permit the carriage of cargo in international operations, and carriage of passengers in international charter operations on an individual exemption basis.

In 1955, the Board also completed the issuance of permanent certficates to the 14 local service air carriers which are now authorized to serve 398 citiest in 42 states over more than 35,000 certificated route miles. These local air carriers are presently operating 175 twin-engined transport aircraft and carried approximately three million passengers in the current year, an increase of nearly 26 percent over 1954. Although all local carriers are presently receiving subsidy, several appear to be close to achieving self-sufficiency before subsidy aid.

In September, 1955, the Board issued the fifth in an annual series of reports identifying the service mail pay and subsidy mail pay received by U. S. certificated air carriers. This report revealed that in fiscal years 1956 and 1957, subsidy will have been reduced to $48.5-million for the certificated air carrier industry as a whole. This is a decrease of $23.5-million —or 33 percent—from the subsidy for fiscal 1954, and is a decrease of $7.2-million—or 13 percent—from the subsidy for fiscal 1955.

The Board's estimates for fiscal 1956 revealed that all 14 certificated local service airlines are subsidized and that all three certificated helicopter operators are subsidized. On the other hand, only two of the 13 domestic certificated trunk airlines required subsidy. At the same time, the Board's subsidy estimates for fiscal 1956 showed that all carriers engaged in states-Alaskan and intra-Alaskan operations required subsidy, as well as the two carriers operating in the Hawaiian Islands. The report estimated that only one of the two American carriers in trans-Atlantic operations required sub-

sidy while all three U. S. certificated carriers operating in the trans-Pacific area were subsidy-free. In Latin American operations, all four U. S. carriers still require subsidy.

Federal Communications Commission

On June 30, 1955, the Aviation Services of the Federal Communications Commission had a total of 43,855 stations which provide radio facilities for communication essential to aircraft operation and safety of life and property in the air.

More than 29,900 aircraft radio stations are authorized for installation on both air carrier and private aircraft.

Enroute and fixed aeronautical radio stations provide the necessary communication for the safe, expeditious, and economical operation of aircraft. Aeronautical land stations are used for communicating with aircraft whereas aeronautical fixed stations engage in point-to-point communications.

The more than 11,000 Civil Air Patrol radio stations are used during missing aircraft search missions, training missions, air shows and as communication systems at encampments, base, and official meetings.

Airdrome control stations transmit control instructions to arriving and departing aircraft to prevent collision and to provide efficient flow of air traffic into and out of airports. Control station operators direct the movements of crash, maintenance, and fire vehicles through mobile utility stations installed aboard the vehicles.

Special radio signals which enable an aircraft to determine its position with reference to the navigational facility involved are transmitted via nearly 300 navigational aid radio stations.

In order to deal with the many new problems which arise as a result of increasing telecommunications developments, the Federal Communications Commission, during 1955, continued active participation in various interagency radio coordinating and policy groups. Among these groups were the Air Coordinating Committee, the International Civil Aviation Organization, and the Radio Technical Commission for Aeronautics.

Fish and Wildlife Service

The Fish and Wildlife Service uses aircraft both in Alaska and the United States on wildlife and fishery enforcement patrols; waterfowl nesting and population surveys; big game and fur animal inventory surveys; predator control operations; waterfowl depredation control activities; as well as agricultural operations on national wildlife refuges which include spraying for the control of noxious vegetation, and the seeding of waterfowl foods.

During fiscal year 1955 the Service owned and operated 50 aircraft. The fleet was composed of: 27 Pipers (Supercubs, Pacers, and J 3 C's); nine Grumman Geese; eight Grumman Widgeons; two Boeing YL 15 ob-

servation planes; one Stinson V 77; two Cessna 180's; and one Twin Beechcraft.

Sixty-eight personnel held letters of flight authority during the fiscal year. These pilots flew more than 12,000 hours and the territory covered included Alaska, Canada, Mexico, Cuba, Puerto Rico, Haiti, and the Dominican Republic, as well as the United States.

The maintenance and repair of Service aircraft operating in the United States are handled through commercial shops. In the Territory of Alaska, however, where 34 Service aircraft were used during the fiscal year, the Service maintains overhaul and repair shops of its own.

Forest Service

The Forest Service uses aircraft in connection with the protection and management of 149 national forests, located in 39 states, Alaska, and Puerto Rico. Chief uses include the transportation of men and supplies during forest fire emergencies, fire detection and aerial reconnaissance of going fires, supplying remote and inaccessible stations, aerial survey, reseeding or revegetation of burned-over and denuded areas, surveying and spraying for insect control, and search and rescue.

The Forest Service fought 9,976 fires in the national forests during the fiscal year ended June 30, 1955. A total of 203,973 acres were burned, which was below the annual average of 285,230 acres for the preceding five-year period. California, however, later in the summer of 1955, experienced its worst fire season in many years. Forest Service forces during a period of a few weeks had to fight 16 major fires in California national forests. While so engaged they also controlled more than 900 smaller fires in California, Oregon, Montana, and Idaho.

The Forest Service in 1955 owned and operated 21 fixed-wing aircraft. These includedf 14 single-engine airplanes and four twin-engine planes previously owned, and three twin-engine planes acquired through transfer from another agency. These planes have been equipped for transporting personnel, cargo parachuting, and smokejumper work. Some single-engine planes and one DC-3 are equipped for seeding and spraying.

Latest yearly figures (1954) show use of fixed wing aircraft by the Forest Service totaled 9,698 hours. This included 2,558 flights, totaling 3,476 hours, by Forest Service airplanes; 2,876 flights, 6,202 hours, by commercial planes under charter contract; and 12 flights for 20 hours flown by the armed services for the Forest Service. Use of helicopters (commercially operated under contract) amounted to 765 hours (Not included in the above figures is certain contract flying for aerial photography and insect control work.)

A total of 10,441 fire-fighters and other passengers were transported by air during 1954. Cargo transported totaled 1,087,332 pounds, of which 717,254 was air freight (delivered at nearest airport), and 373,078 pounds was para-cargo dropped by parachute.

The Forest Service's "smokejumper" corps of parachute-jumping fire-fighters, maintained during the fire season for service in national forests

of the western states, totaled 286 men. Smokejumper units were stationed during the fire-danger season at Missoula, Mont.; Grangeville, Idaho City, and McCall, Idaho; Silver City, N. M.; Illinois Valley, Ore.; and Winthrop, Wash. During the year, the smokejumpers made 728 jumps to 235 fires. They worked a total of 3,054 man-days on fires.

An accelerated program of aerial surveys to locate incipient outbreaks of forest insects and diseases was undertaken during the year. A total of 1,271 hours of flying time was devoted to aerial insect surveys and 279 hours to the scouting of oak wilt and other tree diseases. The surveys covered an estimated 100,000 square miles of forest lands in various parts of the country. Forest Service planes and rental aircraft were used in the aerial pest survey program.

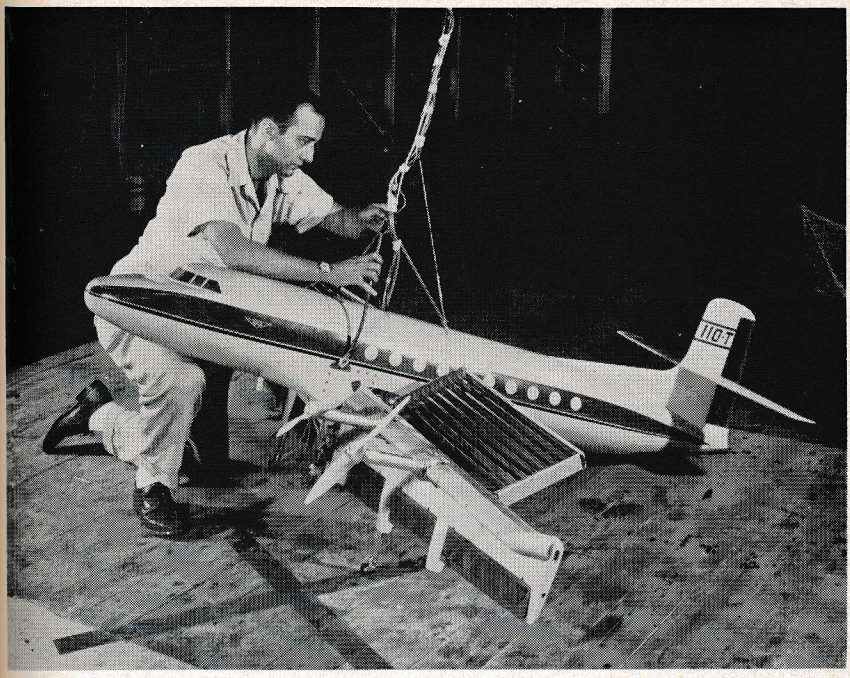
Research on the improvement of aerial insect surveys and aerial spraying also was expanded to develop new methods and extend their use to new areas. The research work on surveys included an evaluation of aerial photography and strip sampling techniques for detection and appraisal of insect infestations, and required 266 hours of flight time.

In the summer of 1955, a total of 2,235,000 acres in Idaho, Montana, New Mexico, and Oregon was airplane-sprayed for the control of epidemics of the spruce budworm. Because these infestations increased so greatly in intensity during 1954, Congress made a special appropriation of $2,570,000 for the 1955 control work. Most of the acreage involved was federal lands. State agencies and private interests, however, contributed $124,000, plus time and facilities, to the work in Idaho, Oregon, and Montana.

"Operation Firestop," the most ambitious cooperative field project so far undertaken in forest fire research, was carried out in California in 1955. This project pooled the interests not only of forest fire fighting agencies but of municipal fire departments and of the Civil Defense Administration and Department of Defense. It was aimed at developing new aids that will be effective in combatting forest fires even under the most difficult conditions. Activities included tests of mass water drops from aircraft, water bombing, application of chemical retardants from the air, and the use of helicopters for laying hose. There is much promise of better forest fire control through development of these and other new techniques.

National Advisory Committee for Aeronautics

During 1955 the research programs of the National Advisory Committee for Aeronautics (NACA) were devoted for the most part to learning how to extend further into the supersonic range the performance of airplanes, and to accumulate the basic information for development of useful military and commercial aircraft with the vertical rising capabilities of the helicopter and the high speeds of conventional airplanes. Beyond this work, of course, were the vigorous research programs to provide solutions to the massive problems, such as aerodynamic heating, leading to achievement of the intercontinental ballistic missile.



NACA scientists study vertical flight problems with airplane models

In 1955 the NACA observed its 40th anniversary as the government agency charged with responsibility "to supervise and direct the scientific study of the problems of flight, with a view to their practical solution."

When the NACA was established, a compelling reason for its creation was the fact that in the United States, birthplace of the airplane, aeronautical progress had been so slow as to fall behind several other nations. Even then, when the potential value of the airplane both in war and in peace was seen but dimly by the public, the importance of aeronautics and what must be done to advance it was recognized by the Congress.

In the years following World War I, definite leadership in aeronautics was regained by the United States. This continuing achievement has been the result of a partnership joining the Congress, the military air services, the aircraft industries, and the NACA. For its part, the NACA undertook research to provide basic information which talented designers in industry used in developing superior airplanes, both civil and military.

The success of this team effort was emphasized by the disclosure in the fall of 1955 of the discovery and experimental verification of a new aerodynamic concept known as the area rule, and of its prompt use by the aircraft industry. A simple method of reducing the sharp increase in drag

heretofore associated with transonic flight, the area rule has led to speed gains of more than 100 mph by supersonic airplanes. At the time of announcement of the new concept, it was disclosed that the Grumman F-11-F1 Tiger and the Convair F102-A, utilizing the area rule, were flown supersonically in 1954.

This accomplishment is credited to the NACA's Richard T. Whitcomb, who received the Collier Trophy for his work. It resulted from the first major research project (begun in 1951) made possible by the new transonic wind tunnels which were first developed at the NACA Langley Aeronautical Laboratory. By mid-1952, the validity of the new design concept was sufficiently vertified by intensive wind tunnel tests to warrant confidential disclosure to the military services and to the manufacturers of high-speed aircraft.

The military services already had committed hundreds of millions of dollars in contracts for supersonic airplanes. From the standpoint of national security, it was imperative that such heavy investments provide superior airplanes. The timely availability of the area rule concept and its prompt application by industry assured to the military services airplanes wth much superior supersonic capabilities.

In 1955, much remained to be done before the airplane could demonstrate its great potential as a supersonic vehicle of commerce and a supersonic weapon of war. Eight years have passed since the first flight at a speed faster than that of sound, but the supersonic airplane is still beset by many troubles.

The gap between initial achievement of supersonic performance by a prototype or experimental airplane and day-to-day accomplishment of such performance under the rigors of service operation and maneuver can be very great. In the area of supersonic flight, in addition to problems arising from the demands for faster flight over longer ranges, it has become obvious that more, much more, must be known about the laws of nature to enable more efficient, more satisfactory flight at faster than sound velocities.

In stability analysis, the mathematical formulas employed are the same but the values to be applied have changed so extensively that the designer needs a large amount of new and detailed information to guide his work. Drag caused by interference between wing, body and tail surfaces exists at subsonic speeds but in the supersonic range it appears in new forms, and with different emphasis.

Much research is being done on interference caused by vortexes. Every lifting surface produces a vortex, which is simply a swirling column of air extending rearward. Large amounts of energy may be packed into these rotating columns. If an airplane's tail moves into the path of a vortex, its ability to produce an aerodynamically stabilizing force may be reduced seriously or even reversed so that the tail aggravates any disturbance.

Modern airplane design employing short stubby wings and lengthened fuselages adds complications because a share of the total lift is carried by the fuselage, which in turn creates additional vortexes of real interest

to the designer. Progress is being made in providing information on this type of interference over a wide range of airplane attitudes and speeds.

Precise knowledge of dynamic stability is likewise necessary to design satisfactory maneuvering performance into new aircraft types. Without acceptable dynamic characteristics, an airplane may be unsuitable as a gun or bombing platform, or may be unmanageable under some flight conditions. The problem must be solved afresh for nearly every new design because considerable changes in dynamic stability arise from every change in airplane geometry.

The lengthened fuselages and thin stubby wings favorable for supersonic speeds often serve to reduce damping, the tendency to wipe out an oscillation when it occurs. Subsonic designs usually have high damping qualities, but a new series of difficulties is encountered as designs to achieve supersonic speeds sacrifice damping for performance. Oscillations caused by low damping can take place so quickly and so violently that a human pilot cannot control them. Special corrective devices such as the yaw damper have been used to cope with the problem.

A new form of dynamic instability, traceable to the spreading of the modern airplane's weight along its lengthened fuselage, has appeared recently. When an airplane of this type rolls, centrifugal forces tend to swing the nose and tail outward and the airplane begins to yaw. If it completes a full roll revolution in less time than a single yaw oscillation, centrifugal forces outweigh the stabilizing influences. The likely result is a violent yawing and pitching motion uncontrollable by the pilot. This complicated and dangerous reaction known as roll-yaw coupling, may strain the airplane beyond safe structural limits.

Although ways have been found to alleviate this form of instability, intensive research in wind tunnels, in flight and by theoretical approaches often employing analog computers, is required for a full understanding of the problem.

At the other end of the speed scale, a comprehensive research program is underway to determine ways and means of slowing down landing and take-off. Other goals of this work include the ability to operate from unprepared surfaces, and ultimately, to attain vertical flight itself by aircraft capable of very high speed. Obviously, such goals will be of great value both of civil and military aviation. Some possibilities are evident in the helicopter, the vertical take-off airplane, the seaplane hydro-ski and the thrust vector.

Though control of boundary-layer air is one of the oldest problems of aeronautical research, it appears more promising today because of the growing use of turbojet power and extremely thin wings. The gas turbine is a convenient means either to blow or draw off the boundary-layer; further, the design of flaps as a speed reduction device has become more difficult with the thin wings now being used. This approach is especially attractive to naval aviation, where the reduction in stalling speed of only a few knots

can mean proportionately much more to the capabilities of carrier-borne planes.

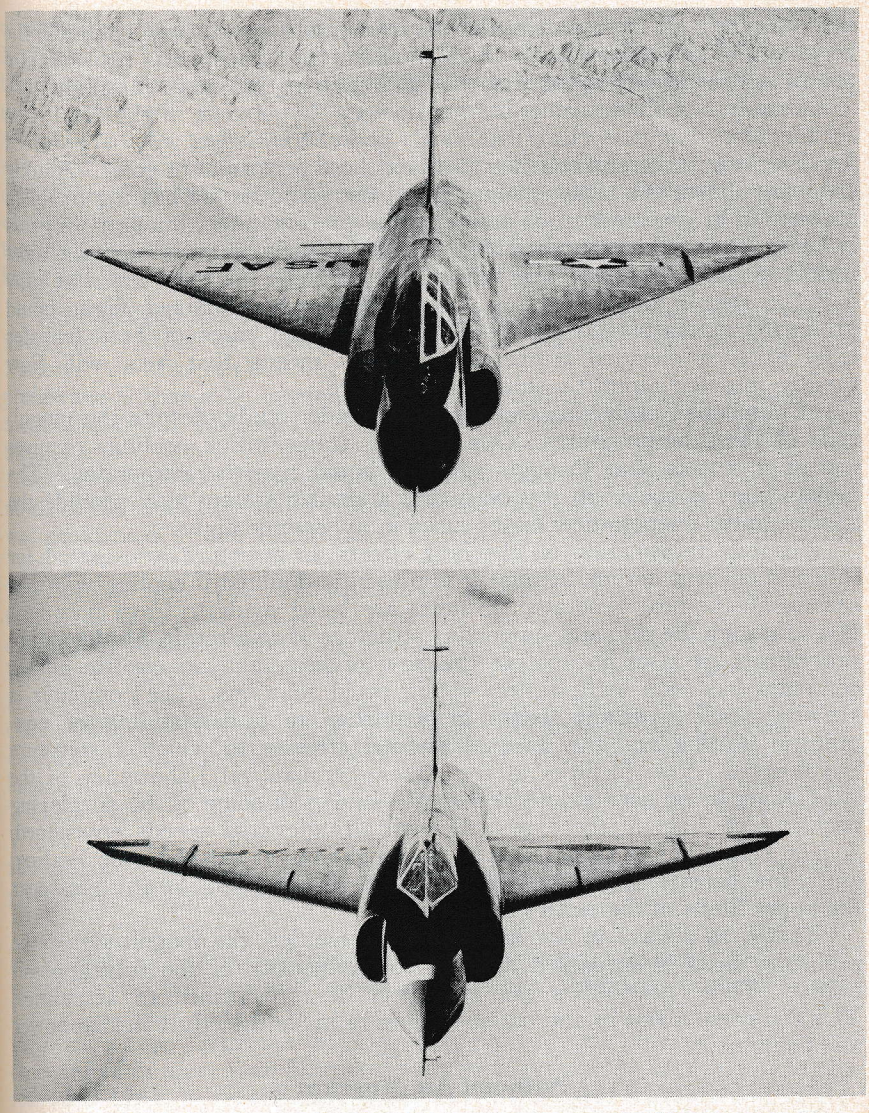
The idea of reducing launch-and-landing speeds is, in the extreme, vertical take-off, which the helicopter does well although it has a limited top speed. The type of vertical take-off or VTO aircraft capable of a wide speed range is one which rests on its tail. Provided with enough thrust to exceed its own weight, the VTO takes off vertically, then tips over to climb and cruise in the normal attitude. It backs down tail-first to land. Chief among VTO problems, once sufficient thrust has been provided, are stability and control in hovering, and transition to forward flight.

Another type of VTO utilizes the principle of deflecting the propeller slipstream downward through sets of large wings or turning vanes. The objective is a system able to produce vertical lift while the airplane remains in the horizontal attitude, or nearly so. Necessary, of course, is the ability to retract whatever turning device is used, so that a clean aerodynamic shape results when forward flight is undertaken. NACA scientists are studying various flap and slot combinations, using models of transport and utility airplanes. Thrust can be provided either by propellers or by turbojets. Still other tests are being conducted with models whose wings and propellers are turned upward 90° from the horizontal. This principle permits hovering and landing and take-off in small space, plus reasonably high performance in cruising flight.

The thrust vetor or "flying platform" principle, first disclosed in 1955, is still another VTO concept, and was first investigated at the NACA Langley Laboratory. Stemming from the idea that a man might be able to fly naturally and control his movements without elaborate training or the use of complex machinery, the principle was studied first with jets of air attached to a man's feet. During the year at least two prototypes, incorporating the thrust vector principle were flown.

Since the war hydrodynamic research has attacked the problems of cumbersome seaplane floats and hulls to find solutions without compromising performance either in flight or on water. From this work has come the hydro-ski, a flotation device which is retracted into the fuselage like a set of landing wheels in full flight. The hydro-ski has been proved capable of attractive performance, reduced landing loads, and offers the added ability to use snow and ice for landing or take-off. In addition, greatly improved hull shapes have resulted from the research programs. Narrow hulls enable reduction of aerodynamic drag simultaneously with lighter landing loads and better hydrodynamic performance.

Today, the nuclear bomb carried now by the airplane, and ultimately by its unmanned counterpart, the guided missile, has become the most powerful military weapon of all time. How to intercept the delivery systems which an enemy might employ if he elected to use nuclear weapons against the United States has become a massive problem demanding solution with compelling urgency. A matching problem no less urgent, is for the United States itself to learn how to deliver such weapons for defense.



NACA area rule application changes shape of Convair turbojet fighter pictured here

The true ballistic missile will be accelerated to hypersonic speeds (as much as 10,000-15,000 mph) in the first 15 or 20 miles of its flight and this initial push will carry it to altitudes well beyond the earth's thin mantle

of atmosphere. It flight path under the influence of gravity will resemble the trajectory of an artillery shell. As it re-enters the atmosphere, resistance of the air will reduce its speed to about 5,000 mph at the end of the flight.

Already, much valuable information on hypersonic flight has been accumulated, but it is clear that vastly more knowledge will be required for designing successful missiles to attain these performance goals. Among the many difficulties of hypersonic flight, the aerodynamic heating problem appears to be the most troublesome at the present time although progress is being made. Temperatures high enough to melt or even vaporize most metals quickly develop in the skin of a hypersonic aircraft. Even at only half the speeds anticipated, or about 7,000 mph, sustained flight could produce temperatures of to 8,000°F. Very high rates of heat transfer exist at such elevated temperatures. This means that heat will flow rapidly into the aircraft's skin and structure.

A number of promising techniques are under study, despite the magnitude of these temperatures. One method, transpiration cooling, requires use of a porous skin through which a liquid may be evaporated. The human body is cooled in this way, and a similar system may provide the answer to the temperatures experienced in hypersonic flight.

Accurate information on the heat effects on structure is essential for safe and efficient design, because it is presently doubted if cooling will take care of all the heat generated. Studies are being made to learn how heat flows through the skin and supporting structure of an aircraft. Mathematical procedures are used to analyze the flow of heat, and an electric analog computer has been built to help obtain rapid solutions. The computer is showing itself especially useful in acquiring an understanding of non-uniform heating and the unequal thermal stresses to which a structure is subjected. New facilities at the Ames Aeronautical Laboratory of the NACA are being used extensively in the studies of some of the perplexing problems of flight at the extremely high altitudes and speeds envisioned. A new heat transfer tunnel aids in investigations of aerodynamic heating, and a low density tunnel enables simulation of conditions at altitudes near the upper limits of the earth's atmosphere.

Today, as always in the history of aeronautics, the magnitude of the problems faced is surpassed only by the immensity of the future possibilities. These possiblities can and must be transformed to actualities. This can come about in any nation willing to make the effort in manpower and equipment.

National Air Museum

The outstanding accomplishment during the year in caring for the national aeronautical collection was the shipment from the Museum's former storage facility at O'Hare International Airport, near Chicago, to the new facility at Suitland, Md., of the full-sized aircraft which, for lack of exhibition space, must be kept in storage. This move, involving more than 100 aircraft, was performed with the assistance of the United States Air Force. The Navy Department continues its cooperative policy

of providing space on several bases for historic aircraft destined for the National Air Museum. In the Suitland facility, prefabricated buildings have been erected for storage, the largest one to be equipped as a shop in which each aircraft will be given interim preservation treatment and restoration so that when the proposed exhibition building is provided, material can be exhibited with minimum delay. Realization that only 30 of this famous collection of aircraft are exhibited while more than 100 are in storage, emphasizes the importance of the preservation and restoration program and the need for an exhibition building in which these aircraft, each one of historical and technical significance, can be made available to the public.

The National Air Museum Advisory Board, composed of leading armed forces and civilian aeronautical experts, has concluded that the proposed National Air Museum building is to be in the Washington, D. C., area. The preference is that it be located adjacent to existing exhibition buildings of the Smithsonian Institution. As evidence of the concern for preserving these aircraft, shown by the areonautical interests, the Aircraft Industries Association and Air Transport Association financed a study of the specific needs of the collection and the design of the proposed building. This study was performed by the architectural firm of McKim, Mead & White, New York City. The proposed building is intended for a site approximately 1,000 by 500 feet. The requirements for exhibition, study, and administrative needs would be met in an imposing structure in which some of the outstanding features would be a full-scale diorama enshrinement for the Wright Brothers' original "Kitty Hawk" flyer, a hall of famous flying firsts, and a grouping, in chronological arrangement, of the other aircraft which embody the tangible evidence of aeronautical progress. Individual unit displays would include sections devoted to the beginnings of human flight, lighter-than-air craft, the "Early Bird" era, World War I, the "Golden Age" of the 1920's and 1930's, commercial aircraft development, World War II, jet and rocket progress in the current age, a rotorcraft, and ex-enemy aircraft. A Hall of Fame honoring those persons who have given wings to man is included.

Meanwhile, progress is being made with the improvement of the existing exhibits housed in a 40-year old temporary hangar-building and the adjacent 76-year old Arts and Industries Building. Additions to the collection during this year include the famous racing plane "Buster" constructed in 1931 by Steve Wittman of Oshkosh, Wisc., and flown by him and other pilots in more than 50 races, winning many events until it was finally retired in 1954. With the cooperation of the Goodyear Corporation, exhibition of the car and canopy of the airship "Pilgrim," first airship designed to use helium gas, 1925, was renovated, while preservative work was completed on a number of the other exhibited aircraft. Several notable engines, numerous scale models, and biographical exhibits honoring General F. P. Lahm, Lieutenant Colonel H. H. Hartney, Captain Vernon Castle, Amelia Earhart, and Harriet Quimby, the first American woman licenesd to fly, were added. The total number of specimens received during the year was

117. Improvements were also effected in the documentary files, which constitute a valuable source of information in conducting the Museum's extensive service to correspondents and visitors.

Work is proceeding on several publications describing the national areonautical collection. "Masters of the Air," which was produced with the assistance of the Link Foundation, describes 12 of the outstanding aircraft in the collection. It is available from the Editorial and Publications Division of the Smithsonian Institution at 50¢ per copy. The text and illustrations for the ninth edition of the "Handbook of the National Aeronautical Collection" have been completed, and this narrative history of aeronautics as evidenced by the outstanding specimens in the custody of the Museum will soon be available. A catalog listing all the full-scale aircraft in the collection is in preparation.

Post Office Department

The fiscal year ending June 30, 1955, showed a continued increase in the use of the air services. Almost 1.446-million pieces of domestic letter mail were transported, an increase of approximately 19-million pieces, while there were nearly 21-million pieces of air parcel post carried, an increase of approximately 1.25-million pieces.

The total net weight of air mail including air parcel post was over 84-million pounds, an increase of about 3.6-million pounds over the previous year.

The above figures do not include free air mail letters from armed forces overseas.

During the fiscal year 1955, a total of over 11.7-million pounds of United States mail, including nearly 3-million pounds of air parcel post and other articles, was transported by air to foreign countries, showing an increase of over 2.2-million pounds. These figures do not include the mail exchanged with U. S. possessions and military installations overseas.

Foreign air parcel post service and air service for other articles; that is, prints, samples, newspapers, is now available to more than 100 countries.

Weather Bureau

The continuous broadcast of recorded aviation weather and NOTAMS on the Arcola, Virginia, L/MF radio range (reported in the 1954 YEAR BOOK) completed its first year of operation and received the endorsement of aviation groups and many pilots. A similar broadcast will soon be activated on the L/MF range at Los Angeles. This is a joint CAA and Weather Bureau project and plans call for 20 additional installations during 1956.

A series of aviation weather articles for pilot consumption was issued on a monthly basis throughout the year and will continue into the early months of 1956. Each article is illustrated and gives a brief discussion of a particular weather topic, such as Ice on Aircraft, The Jet Stream, Turbulence, Thunderstorms. Through the cooperation of the CAA a

copy of each article printed in poster form is posted at about 2,500 public airports. The articles are also available in pamphlet form from the Superintendent of Documents, U. S. Government Printing Office.

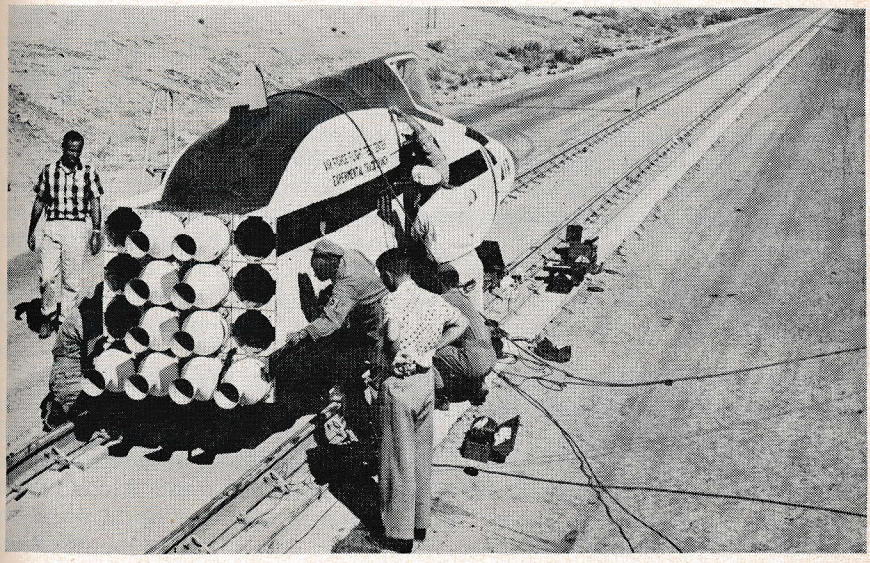
The installation of remote reading equipment for measuring cloud height and visibility in the approach zone of a runway has continued. Twenty stations are now equipped with these instruments. A method of estimating the visibility of an approaching pilot from parameters measured on the ground, developed from a research program conducted by the Weather Bureau and the Sperry Gyroscope Co. is now being given a field evaluation at the Newark Airport.

The operation of six rawinsonde stations was taken over from the military services and 19 additional stations will be transferred to the Weather in 1956.

The first phase of a four-year program of modernizing instrumental equipment and facilities at field stations was initiated. This modernization program will include the installation of new upper-air electronic wind-finding equipment, new radar equipment, remote recording telepsychrometers utilizing the infrared hygrometer, wind speed and direction recorders, and end-of-runway cloud height and visibility measuring equipment.

Additional radar storm detection equipment was placed in operation,

Convair rocket sled is readied for high-speed test of pilot escape system in F-102A



increasing the total number of stations to 48. Notable success was obtained in tracking hurricanes Connie, Diane, and Ione with new radar equipment at Hatteras, N. C.

One new automatic weather reporting station was placed in operation and plans were made to add six more installations in 1956. Components of this equipment will now measure and transmit runway visibility, temperature, dew point, wind, altimeter setting and precipitation. The development of equipment to report cloud height is nearly completed.

An accelerated program of hurricane and severe storm research was outlined for the development of more accurate methods of forecasting these phenomena. Funds were appropriated by the Congress to begin a five-year program. In addition to augmenting the rawinsonde and radar networks, it is planned that other valuable data will be collected by aircraft and rocket reconnaissance. Elaborate tooling up is required for the data collection phase. This will extend through fiscal year 1956. Data processing and related studies will follow, leading into the final phase of research and development.

CHAPTER SEVEN

The Airlines

WITH THE NEW AIRPLANES DELIVERED last year and scheduled for delivery this year and next, the U. S. scheduled airline fleet will have grown by about 16 percent at the end of 1956. By that time, it is estimated that the fleet will consist of more than 1,500 airplanes. At the end of 1953, the fleet total was 1,289. Because they are more efficient than their predecessors, the new airplanes will enable the airlines to offer over 50 percent more service than they did in 1953 in terms of available seat-miles operated.

This addition to the fleet has an even more far-reaching implication. More than 90 percent of the new equipment already in the fleet or scheduled for delivery are four-engine airplanes. All are capable of non-stop over-ocean flight.

Most of them will become a part of the Civil Reserve Air Fleet, which military authorities point out is the country's second line of air defense. The airlines have 290 airplanes in the CRAF today. Twenty-five others are earmarked as a contingent reserve. These aircraft represent a $400-million contribution to the welfare of the U. S. public. It would cost this public about $300-million a year to keep them in operation on a stand-by basis.