Aviation Week

Including Space Technology

March 31, 1958 75 cents

A McGraw-Hill Publication

Republic Aims Alouette at Civil Market

Lockheed's First Two Electras

Electra Design Stresses Medium Ranges

AVIATION CALENDAR

Apr. 8-10—Eighth International Symposia, Electronic Waveguides, Engineering Societies Bldg., 29 W. 39 St., New York City.

Apr. 8-11—National Aeronautic Meeting, Society of Automotive Engineers, Inc., Hotel Commodore, New York, N. Y.

Apr. 10-11—Aeronautical Training Society Annual Meeting, Mayflower Hotel, Washington, D. C.

Apr. 16-19—14th Annual National Forum, American Helicopter Society, Sheraton-Park Hotel, Washington, D. C.

Apr. 17-18—Institute of Environmental Engineers, Second Annual Technical Meeting, New Yorker Hotel, New York City.

Apr. 21-23—14th Annual Meeting Metal Powder Assn. and Powder Metallurgy Show featuring applications of powder metallurgy parts in nuclear, jet and rocket engine fields. Sheraton Hotel, Philadelphia, Pa.

Apr. 22-24—1958 Electronic Components Conference, Ambassador Hotel, Los Angeles, Calif.

Apr. 22-24—1958 Annual Convention, International Airline Navigators Council, Picadilly Hotel, New York, N. Y.

Apr. 24-26—Joint Meeting, International Scientific Radio Union and Institute of Radio Engineers, Willard Hotel, Washington, D. C.

Apr. 28-30—Second Annual Astronautics Conference, sponsored by Air Force Office of Scientific Research and Institute of Aeronautical Sciences, Shirley Savoy Hotel, Denver, Colo.

May 4-7—Fourth National Flight Test Instrumentation Symposium, Park Sheraton Hotel, New York City.

May 5-7—1958 National Symposium, Professional Group on Microwave Theory

(*Continued on page 6*)

AVIATION WEEK Including Space Technology

March 31, 1958
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AVIATION CALENDAR

(*Continued from page 5*)

and Techniques of the Institute of Radio Engineers, Cubberley Auditorium, Stanford University, Stanford, Calif.

May 12-14—National Conference on Aeronautical Electronics, sponsored by Institute of Radio Engineers, Biltmore Hotel, Dayton, Ohio.

May 14-16—Spring Meeting, Society for Experimental Stress Analysis, Hotel Manger, Cleveland, Ohio.

May 19-22—17th Annual National Conference, Society of Aeronautical Weight Engineers, Inc., Belmont Plaza Hotel, New York, N. Y.

May 25-31—1958 Aviation Writers Assn. Convention, the Shamrock Hilton, Houston, Tex.

June 2-4—National Telemetering Conference, Lord Baltimore Hotel, Baltimore.

June 4-5—West Coast Magnesium Symposium, correlated program by the Society of Aircraft Materials and Process Engineers and the Magnesium Assn., Institute of Aeronautical Sciences Bldg., Los Angeles, Calif.

June 9-12—Materials Handling Conference, sponsored by American Society of Mechanical Engineers, Public Auditorium, Cleveland, Ohio.

June 9-13—Fourth International Automation Exposition and Congress, Coliseum, N. Y., N. Y.

June 16-18—Second National Convention on Military Electronics, Sheraton Park Hotel, Washington, D. C.

June 23-July 3—Special Summer Program on Random Vibration, an introduction to the vibration problem in missiles and jet aircraft, Massachusetts Institute of Technology, Cambridge 39, Mass. For details write: Dr. Stephen H. Crandall, Associate Professor of Mechanical Engineering, M. I. T.

June 24-26—31st Meeting, Aviation Distributors and Manufacturers Assn., Mount Washington Hotel, Bretton Woods, N. H.

June 25-27—Air Transportation Conference, sponsored by American Institute of Electrical Engineers, Hotel Statler, Buffalo, N. Y. For information: S. H. Hanville, Jack & Heintz, Cleveland 1, Ohio.

July 14-15—Triennial Inspection, National Advisory Committee for Aeronautics, Ames Aeronautical Laboratory, Moffett Field, Calif.

Aug. 6-8—Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, sponsored by the American Institute of Electrical Engineers, Hotel Statler, Los Angeles, Calif.

Aug. 19-22—Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

Sept. 6-14—International Aviation Show, Coliseum, New York, N. Y.

Sept. 8-13—First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid, Spain.

Sept. 22-24—1958 Meeting, Professional Group on Telemetry and Remote Control, Americana Hotel, Bal Harbor, Miami Beach, Fla.

Oct. 27—14th Annual General Meeting of the International Air Transport Assn., New Delhi, India.

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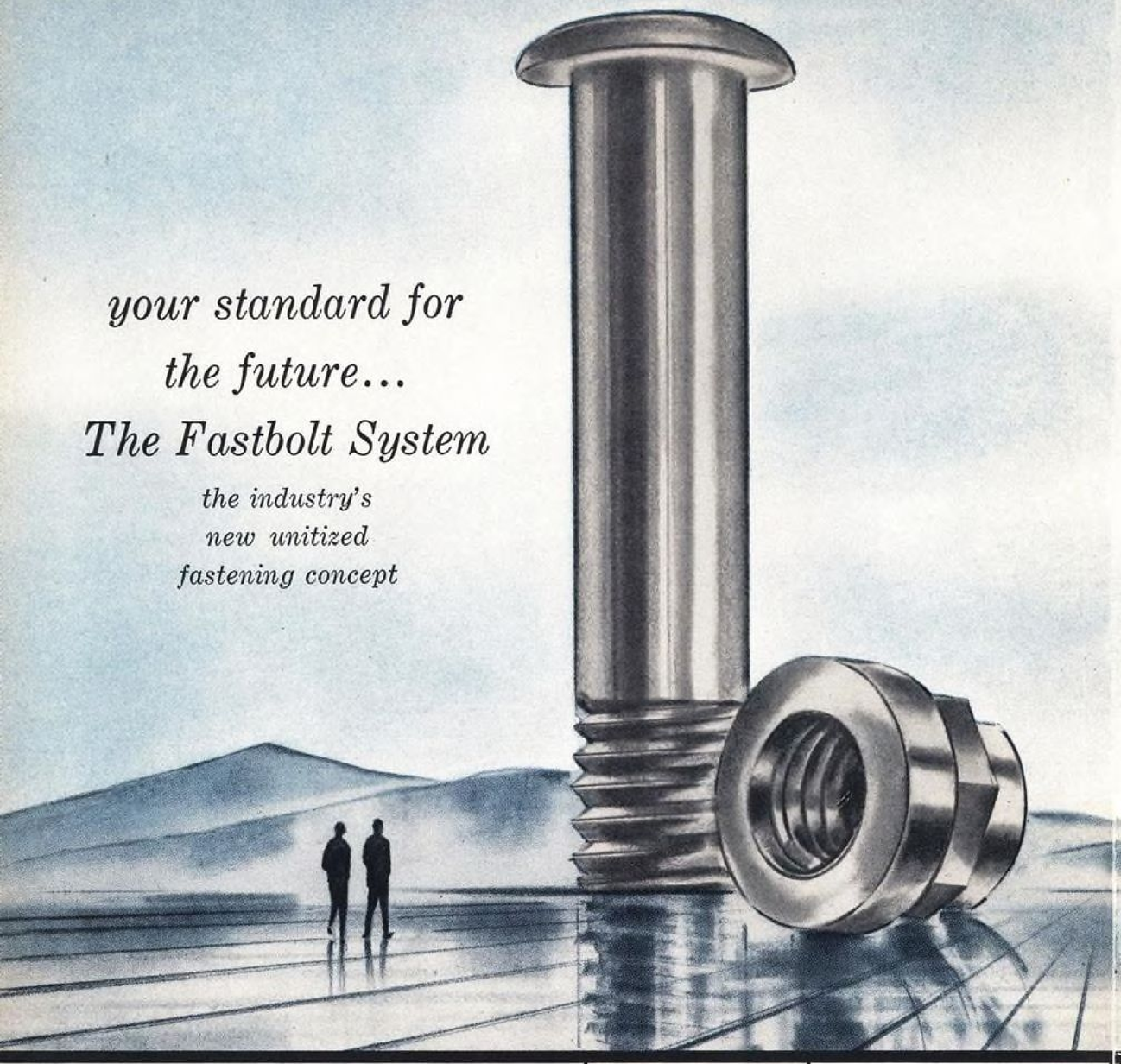

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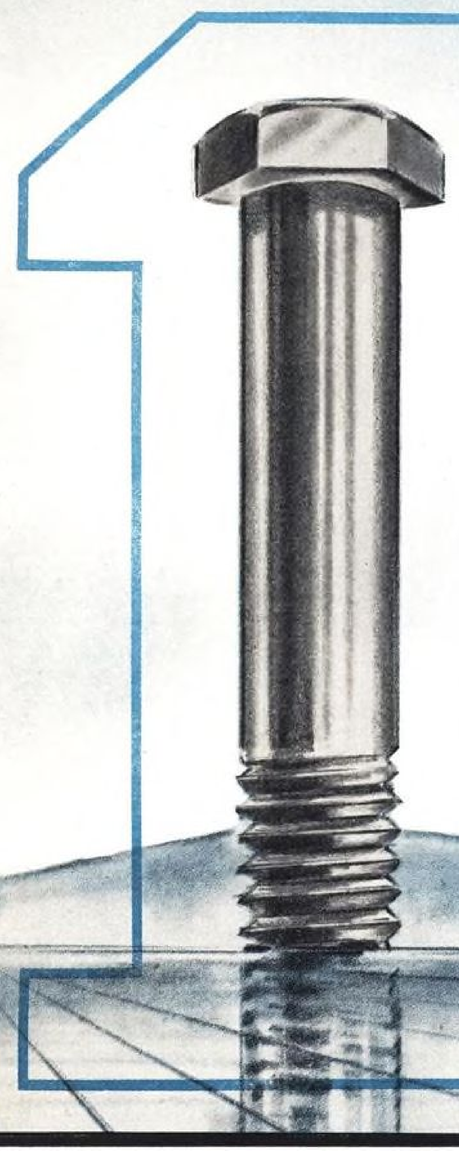

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2. After hot forging
3. Machined and centerless ground
4. Thread pre-roll
5. Completely rolled and finished part

March 31, 1958

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Including Space Technology

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COVER: Second Lockheed Electra makes first flight accompanied by first turbo-propeller transport, shown making 49th flight. First test Electra has attained maximum flight speed of 478 mph. at 90,000 lb. gross weight in slight dive ending at 8,700 ft. Maximum straight and level speed is 458 mph. at 86,000 lb. gross weight at 21,000 ft. Maximum Mach number is .66 at 103,000 lb. at 21,400 ft. Maximum G-load to date is 2.2G at 393 mph. at Mach .54. First of two articles on the Electra begins on p. 46.

PICTURE CREDITS

19—Avro Aircraft Ltd.; 21—NACA; 23—Pacific Semiconductors, Inc.; 24—North American; 26—United Press, Arrowhead Products; 27, 28, 29—USAF; 40, 41—U. S. Navy; 43—Convair; 46, 47, 51, 53, 60—Lockheed; 64, 65, 67—Saab; 77—Gloster Aircraft Co., Ltd.; 79, 81—Republic Aviation Corp.; 83—Piper, Monte-Copter, Inc.

73,099 copies of this issue printed

EDITORIAL

A Sound Security Pattern

We have never been reluctant to plunge our editorial lance into the hides of government bureaucrats—military and civilian—who have used the cloak of phony military security to further their personal ambitions or to conceal what they are doing with taxpayers' money. Over the years we have learned to sniff this sort of administrative chicanery at long range. We are proud of the part this publication has played in exposing some of these activities that were unable to survive long in the pitiless glare of publicity.

We have also been firmly on the record for a more realistic approach by the military to their security problems with adequate consideration for the requirements of legitimate technical security and the American public's need to know how its tax dollars are being spent and the adequacy of the national defense they are buying. Therefore we feel it appropriate to discuss in some detail the pattern of security and working press relations now operating at the Air Force Missile Test Center at Cape Canaveral, Fla. This pattern has been vigorously attacked by some doughty battlers for freedom of the press who have seen eye to eye with us on most of the censorship and phony security issues that have emanated from the Pentagon and White House in recent years. But in the case of Cape Canaveral we must take issue with them.

Healthy Public Curiosity

We believe that the pattern developed there by Maj. Gen. Donald N. Yates, Test Center Commander, and his public relations staff headed by Lt. Col. Sid Spear is a sound, realistic approach to the problem that could well be utilized everywhere there is a combination of legitimate military security problems and a healthy public curiosity about what is happening to tax dollars and national prestige.

The security problems presented by the geography and environment of Cape Canaveral were detailed by AVIATION WEEK's Space Technology Editor Evert Clark in a report from the Cape in our Oct. 7 issue on page 26. Nobody will question the fact that the Missile Test Center operations involve some legitimate military secrets. But it is unrealistic to assume that nobody would know when 165,000 lb. rocket engines were being fired in test operations that produced fiery trails and sometimes spectacular explosions for half the population of Florida to see.

Air Force's original policy of burying its head in the Florida sand and pretending nobody would notice these spectacular controlled and uncontrolled explosions was an abject failure. The missile watchers established camps on the public beaches, observed firings through binoculars and photographed missile flights with telephoto lenses and poured out a flood of accurate pictures and inaccurate stories on the activities at the Cape. This policy concealed nothing essential and because of technically naive and incomplete reporting began to convince the American public its missile development program was a costly failure. Further police methods such as bulldozing sand barriers to screen cameras, erection of barbed wire barriers and bullying the working press by Pan American Airways security guards failed to improve the situation.

Press Briefings Valuable

Sometime during the early Vanguard failures a more realistic and sensible policy switch was made. Gen. Yates offered to lay it on the line with the Cape press contingent, explaining the legitimate security problems involved and providing all of the useful and technically accurate data possible. A grandstand on the Cape was provided for the press to witness satellite firings and was equipped with outside telephones and loudspeakers that relayed countdown information.

We listened to Gen. Yates handle a series of press briefings recently for a large contingent of visiting press representatives from Washington, most of whom had only a vague idea of the problems and purpose of the development test phase of the missile business. In addition to giving them a factual and accurate account of how the Missile Test Center runs its business Gen. Yates succeeded in dispelling, for all time we hope, the misconception that operational missiles require all of the complex equipment and procedures required for development testing. We have watched the stories appearing in the daily press since this briefing and notice a much higher degree of technical accuracy and understanding of the missile test program than was evident in the catch-as-catch-can type of earlier reporting.

Hopeful Precedent

In our opinion the pattern of USAF-working press relations now operating at Cape Canaveral has set a hopeful precedent in the handling of this type of problem. It should be carefully considered by the Pentagon for use in similar situations where unrealistic security policies and legitimate public interests are still clashing and preventing the American public from getting an accurate and technically sophisticated view of their national defense progress.

—Robert Hotz

WHO'S WHERE

In the Front Office

Don T. McKone, Jr., vice president and general manager, Marman Division, Aeroquip Corp., Los Angeles, Calif. Also: **William F. Rogge,** general manager, Aeroquip's Industrial Division, Jackson, Mich.

Capt. Howard Thomas Orville (USN, ret.), vice president, Instrument and Missile Products Divisions, Beckman & Whitney, Inc., San Carlos, Calif.

Peter J. Wacks, an assistant vice president, Bell Aircraft Corp., Buffalo, N. Y.

Grayson Merrill, general manager, Fairchild Engine and Airplane Corp.'s Guided Missiles Division, Wyandanch, N. Y.

Stanley R. Kochenderfer, assistant to the executive vice president and coordinator of foreign affiliates, and **Rolland C. Swanson,** director of flight coordination, Transocean Air Lines.

Maj. Gen. Frank S. Besson has succeeded **Maj. Gen. Paul F. Yount** as U. S. Army Chief of Transportation, Washington, D. C.

Fred J. Nichols, president, and **Millard Porter, Jr.,** vice president-engineering, Genistron, Inc., newly established subsidiary of Genisco, Inc., Los Angeles, Calif.

Honors and Elections

R. E. Matzdorff and **C. E. Newberry** of Marquardt Aircraft Co. have been selected by the Society of Automotive Engineers to receive the 1957 Manly Memorial Award. The award honors the authors of the "best paper relating to the theory or practice in the design or construction of, or research on, aeronautic powerplants or their parts or accessories . . ."

Changes

W. G. Lundquist, technical consultant and adviser on the Pioneer rocket engine for the X-15, Reaction Motors, Inc., Denville, N. J.

Ray E. Horner, manager-newly created Sidewinder Project, Light Military Electronic Equipment Department, General Electric Co., Utica, N. Y. **J. A. Cadwallader** succeeds Mr. Horner as manager-data processing and scheduling. Also: **Frank Atkin,** manager-manufacturing administration and personnel development, and **Richard Nevers,** superintendent-prototype manufacturing.

Lt. Col. Louis H. Wilson (USAF, ret.) will head the newly activated Colorado Springs, Colo., office of RCA Defense Electronic Products.

Joseph Pares, supervisor-application engineering, Aeronautical and Instrument Division, Robertshaw-Fulton Controls Co., Anaheim, Calif.

Vincent Moore, chief of design, Hamilton Standard, division of United Aircraft Corp., Windsor Locks, Conn. Also: **Donald Millenson,** project engineer-missile development, Electronics Department.

Jack Lewis, director of manufacturing, The Garrett Corp., Los Angeles, Calif. **J. E. Callahan,** manager, Garrett Corp.'s Air Cruisers Division, Belmar, N. J.

INDUSTRY OBSERVER

► Kaman Aircraft Corp.'s VTOL development for Navy is scheduled to fly in about 14 months. Designation of the twin-engine aircraft is K-16. Designed for amphibious airframe, plane will use turbine powered propellers which will be fitted with flaps in each of three blades to allow hovering. Engine now on test stand is Armstrong-Siddeley Mamba, but Kaman officials say prototype will use General Electric T58 engine canted at about 30 deg. VTOL probably will be used as flying test bed. Only two or three prototypes will be built.

► **Total cost of North American X-15 high-altitude research aircraft project probably will be approximately $80 million.**

► Ramjet test vehicles developed by Nord Aviation have made powered flights at speeds of approximately Mach 4. Test data has been obtained on diffuser and combustion performance up to Mach 3.9 in the hot condition.

► **Snecma Super-Atar (Atar 26 series) all-steel engine designed for speeds in the Mach 3 category is rated at 18,000 lb. thrust. Engine development is being supported by the company alone despite the fact that the airplane scheduled to use it is being designed with government support and is expected to fly in three years.**

► Growing Navy confidence in the feasibility of its nuclear submarine launching platform for its Polaris fleet ballistic missile is forcing it to accelerate its search for new techniques capable of detecting submerged missile-carrying enemy nuclear submarines at distances of 1,000 to 2,000 mi. Navy is now investigating a number of radically new techniques, but the problem appears far more difficult to solve than detection of in-flight intercontinental ballistic missiles at ranges of 3,000 mi.

► **Missile manufacturing requirements now include sheet steel in lengths of 30 ft., widths of 10 ft. and gages extending from .060 to .125.**

► North American Saberliner utility trainer is scheduled for completion in May, with first flight sometime in August. Pressurization tests already have been completed, and wing will be mated to fuselage within the next two weeks. Air Force source selection board is considering the aircraft along with an amphibian proposal by Air Craft Marine Engineering Co. and Beech Aircraft Corp. entry.

► **Production of Lockheed Jetstar jet executive transport could begin on July 1 at the firm's Marietta, Ga., division if an Air Force order is received in time. First rollout of the transport would be 17 months later, in November, 1959. Production would accelerate to 10 a month about two years after the initial go-ahead date. Indications are that USAF prefers four-jet configuration with General Electric J85 turbojets. Lockheed also holds reserve delivery positions for more than 50 commercial firms.**

► Grumman Aircraft Engineering Corp. has decided to place its new agricultural biplane (AW Nov. 25, p. 32) into production, with the first units probably coming off the line in June or July. Company is now talking to firms regarding distribution and service.

► **Navy has under research and development an air-launched rocket designated Gimlet.**

► First three Hawker Hunters for the Swiss air force are scheduled to be delivered in May. Transition from current de Havilland Vampires will be via standard Link AT50 jet trainers. No two-seat Hunters or Hunter simulators have been ordered. Swiss-operated Hunters will have no Machmeters and limited radio equipment with only VHF communications gear.

► **Latest potential use of galvanic skin resistance meter is to rouse radar observers at remote locations should they become drowsy. A development of Wright Air Development Center's Aero Medical Laboratory, the meter detects any trend towards inactivity by changes in the resistance of a very small electric current passing through the observer's skin.**

Washington Roundup

USAF, Army Get Moon Roles

White House and Defense Department last week ordered work begun on the nation's first real space projects under the direction of Advanced Research Projects Agency.

They include three Air Force moon probes, one and possibly two Army moon probes and two or three more Army earth satellites.

The President also will send his plan for a civilian space program to Capitol Hill this week—apparently recommending National Advisory Committee for Aeronautics as the nucleus of a new agency.

The President ordered ARPA to coordinate its space projects with NACA, National Academy of Sciences and National Science Foundation and indicated that the new civilian agency will review the moon and satellite projects to see whether they should remain under Defense or go under the new agency's direction.

ARPA already has $8 million to begin work on the space projects.

Significant pattern was established when ARPA sent its directives straight to the three service agencies involved rather than through service secretaries. A Defense spokesman said the secretaries were aware that ARPA's charter provides for this direct line of transmission to USAF, Army and Navy installations. Ramifications of this type of operation will be widespread and are almost certain to bring private, if not public, objection from the services.

USAF's lunar probes will use a Douglas Thor as the first stage, Aerojet-General's second-stage Vanguard engine as its second stage and a third stage yet to be developed (AW Jan. 20, p. 26). Vanguard guidance also may be used.

Army Ballistic Missile Agency will use modified Jupiter-C rockets for its lunar probes and satellite launches.

Naval Ordnance Test Station at Inyokern, Calif., was ordered to develop a mechanical ground scanning system for use in lunar probes, possibly later models than those approved last week. First indications were that this will be developed in NOTS laboratories and not by industrial contractors.

No timetable was given for these space programs. ARPA Director Roy Johnson said "we would prefer to announce these programs when we are sure of success" rather than now, but that public interest was too high.

Probes apparently will be circumlunar. There was no indication in the initial announcement that attempts would be made to impact on the moon with these first rockets.

Goal of the programs is to "determine our capability of exploring space in the vicinity of the moon, to obtain useful data concerning the moon and provide a close look at the moon."

USAF's work will be directed by Ballistic Missile Division of Air Research and Development Command. BMD has had personnel in the Douglas Thor plant for more than two months to study the probable use of Thors as space explorers. USAF once had a target date of this April for its first moon shot, but had no authorization to go ahead.

Lt. Gen. Donald L. Putt, USAF deputy chief of staff for development, said recently that Air Force could make its first moon rocket launch this year if it gets the go ahead within a few weeks (AW Mar. 3, p. 330).

Defense refused to define "vicinity of the moon" specifically but said useful data could be obtained from as far away as 10,000 mi.

ARPA Chief Scientist Dr. Herbert F. York said many test launchings probably will be required before a probe is successfully placed near the moon.

Space program "contemplates a look" at the far side of the moon, Defense said, but there is no specific timetable for such an experiment.

Military Assistance

Approximately 85% of the money spent on military assistance programs this year will go to U. S. manufacturers for the purchase of material, Mansfield D. Sprague, assistant Secretary of Defense, told the Senate Foreign Relations Committee.

Sprague says there also is hope that an increasing proportion of military assistance can be shifted to military equipment sales. He told the committee that, in 1956, equipment sales under the military assistance program amounted to $79 million; in 1957, the sales were increased to $312 million.

Congress and Space

Activities in both the House and Senate Special Select Committees on Astronautics and Space Exploration were accelerated last week after a period of relative inactivity.

Allen W. Dulles, Central Intelligence Agency director, appeared before the House committee to brief the group in a closed-door session.

Sen. Lyndon B. Johnson, chairman of the Senate Special Committee on Space and Astronautics, notified the President that the committee is opening its doors for business and would welcome White House views. He said the committee is looking forward to the wholehearted cooperation of the Executive agencies in "what we anticipate will be a joint enterprise."

Johnson said the subject under the committee's jurisdiction is too complex to wrap into a single package and added: "It reaches into practically every aspect of human endeavor," he said, "and it is going to require an extraordinary effort to bring together information that is scattered in bits and pieces throughout the government and industry."

Appointments made to the Senate committee last week include: Dr. Glen P. Wilson, coordinator of technical information; Mrs. Eilene M. Galloway, special consultant; Edwin L. Weisel and Cyrus R. Vance, consulting counsels, and Dr. Homer Joe Stewart, scientific consultant.

CAB Disavowal

Civil Aeronautics Board members have disassociated themselves from the recent letter written to editors and commentators by the Board's chief information officer, William Kloepfer, Jr., criticising the press for its handling of the General Passenger Fare Investigation (AW March 24, p. 17). The Board said in a joint statement that the action taken by Kloepfer was made without its knowledge and consent. The members admitted that it seemed to them that the press had given the investigation "inaccurate and incomplete" treatment of the investigation of the Board's attitude toward airline fares but emphasized their belief in the right of the press to cover the issues involved as it sees fit. —Washington staff

USAF Studies Ramjet Bomber Proposals

Manned bomber, reconnaissance system would have design speed of Mach 4 plus; follow B-70 program.

Washington—Air Force is studying design proposals for a new ramjet powered, manned bomber aimed at speeds above Mach 4. The ramjet bomber would fit in the USAF development scale between the North American B-70 chemically fueled bomber program already under development for the Mach 3 speed range and the Dyna-Soar hypersonic glider program aimed at speeds from Mach 8 to 10.

Air Force interest in a manned ramjet-powered bomber system was recently expressed by Lt. Gen. Clarence S. Irvine, deputy chief of staff for materiel, during a visit to the Boeing Airplane Co. plant in Seattle. Gen. Irvine said such a bomber "would be a relatively easy step, not a long step, from the Boeing Bomarc missile."

Companies interested in the ramjet system, which is now at the preliminary proposal stage, are North American Aviation, Boeing and Convair. North American gained experience with its Navaho, Boeing with the Bomarc, and Convair has its own proposal as an adjunct to its B-58 Hustler bomber (AW Feb. 17, p. 23).

Mach & Delivery

In a manned strategic bomb delivery and reconnaissance system, USAF would like a craft capable of speeds of better than Mach 4, normal operating altitude close to 100,000 ft., range of more than 10,000 nautical mi. An unmanned reconnaissance system would travel approximately the same velocity and altitude, but range would be less, perhaps 8,000 to 9,000 nautical mi.

Use of boron-type fuel is probable. Additionally, a rocket boosted launch technique such as that planned for the Navaho would be used, with mobility increased by use of storable rocket propellants rather than the less flexible low temperature oxidizer and hydrocarbon combination.

Besides its capability as a bomb delivery or reconnaissance weapon, such a system would be invaluable in electronic countermeasures or counter-ECM efforts. In the unmanned reconnaissance version, with its higher attendant ratio of payload to start-cruise gross weight, complex guidance could be carried that might be capable of following intricate flight paths to conceal launch sites and terminal points.

Acceleration Rate

In both manned and unmanned systems, ratio of gross weight at launch to start-cruise weight would be of the order of three. Ratio of payload to start-cruise weight would differ with manned and unmanned systems, with unmanned having the better ratio. In the manned system, accelerations would be held to within 5G, well within human tolerance and envelope wherein man still can function in control loop.

In line with the advance of ramjets, USAF and North American Aviation are near the completion of negotiations on a new contract under which the company would fire seven XSM-64 (G-26) Navaho vehicles fabricated prior to the project's cancellation and now mothballed at various locations. Project designation is RISE—Research in Supersonic Environment.

Work envisioned under a new contract would be under a new research and development effort aimed towards gathering essential data for upcoming ramjet systems, which have had their advantages brought into sharper focus through developments in fuels and materials since the original specifications were laid down.

The seven XSM-64 missiles covered in the new contract would be in addition to six which were left over at the Air Force Missile Test Center, Cape Canaveral, Fla., when the Navaho project was terminated. Air Force left enough money for these six to be fired when Navaho was canceled; the other seven were to be mothballed. In addition, there is a possibility that, since tooling exists for this missile, more may be fabricated for additional test work.

Value of using the remaining mothballed XSM-64 missiles in the research program was advanced when one of the six remaining at Cape Canaveral traveled a near-perfect flight profile in its test flight, including acceleration, ramjet ignition, booster separation and travel more than 1,000 mi. downrange at speeds above the Mach 3 design velocity before thrust termination.

The XSM-64 (AW March 24, p. 44) differs considerably from final production missile in several areas in addition to range. Details were delineated after contract was canceled (AW Aug. 19, p. 29), including flight path, rocket boosters.

High Altitude Turbojets

Although ramjets most probably will succeed the WS-110A, extension of turbojet-powered weapon systems is possible using hydrogen or hydrogen vapor in engines.

Use of this fuel would considerably boost the altitude capability of current turbojets, but there would be design penalties in addition to the development time cycle required for this propulsion system.

Conversion of two existing engines, Pratt & Whitney's J57 and the General Electric J79, might be accomplished in a three-to-five year interval and would raise ceilings considerably. The J57, with an approximate ceiling of 55,000 ft., could be extended to more than 75,000 ft., while the J79, just coming into operational use, could be boosted to perhaps almost 100,000 ft.

Complete from-scratch design of a hydrogen or hydrogen vapor turbojet engine would take an additional time cycle, would yield altitudes of 115,000 ft. or higher, speeds of more than Mach 4.

Account Office Asks Contract Restriction

Washington — General Accounting Office has requested Department of Defense to restrict the use of "time and materials" contracting and to require more accurate subcontracting costs from prime contractors under incentive fixed-fee contracts. The requests stemmed from investigations of an Air Force contract with McDonnell Aircraft Corp. and Army Redstone missile contracts with the Chrysler Corp.

GAO's objections in the two cases, as presented in reports to the Congress, were:

• **Chrysler.** "Unnecessary cost was incurred by the government through the extensive use of time and materials subcontracts without adequate cost controls" under Redstone ballistic missile contracts.

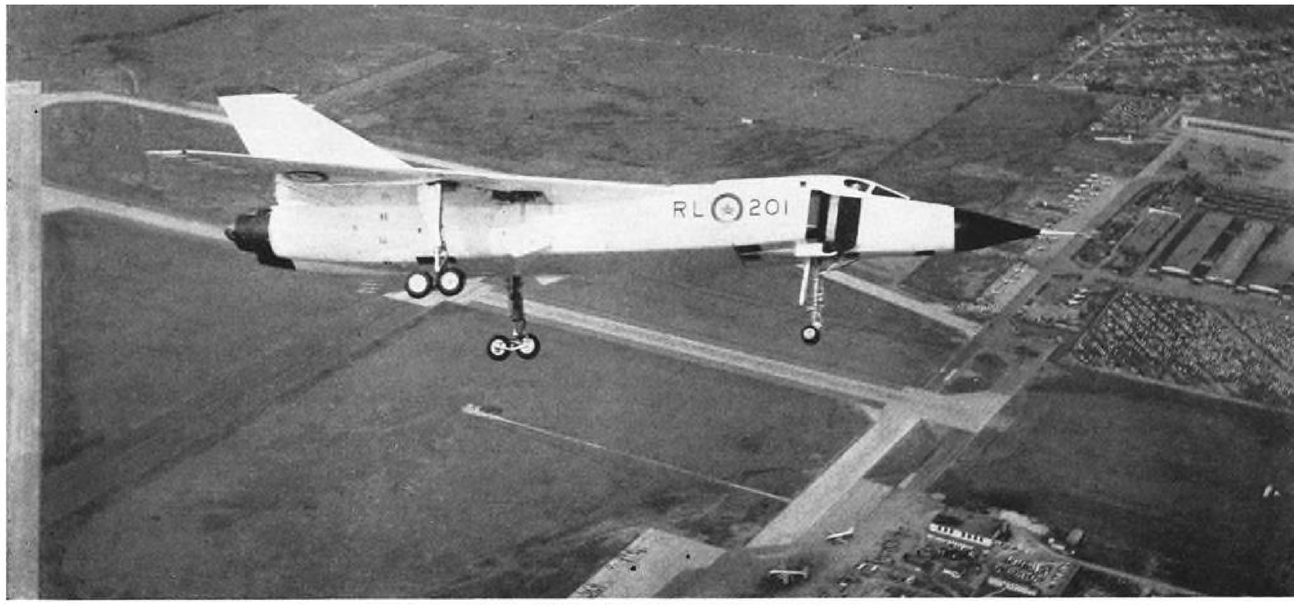
• **McDonnell.** In negotiations to establish a final price on a contract for F-101A airplanes, spare parts and related items, GAO said "the prices of a substantial number of subcontracts had not been finally determined. When the subcontracts were re-priced, substantial price reductions were effected, and, as a result, it appears that costs accepted in negotiations exceeded actual costs incurred by the contractor by approximately $1.2 million. Moreover, almost one-half of these price reductions were known by both the prime contractor and the agency officials at the time of negotiations."

General Accounting Office agreed that "the exigencies of the situation and unique nature of the items made the use of time and materials subcontracting necessary for initial procurement of parts required by Chrysler under its prime contract." It added, however, that "the prime contractor continued to award time and materials subcontracts for the procurement of additional quantities of the same parts although fixed-price subcontracting would apparently have been practicable and more economical."

Following initiation of the General Accounting Office investigations, these actions were taken:

• **USAF ordered renegotiation** of the McDonnell contract in January, and Dudley C. Sharp, Assistant Secretary of the Air Force for Materiel, assured GAO that "we will continue to stress the need for effective administration in this area" of subcontracting costs included in prime price contract negotiations.

• **Army withdrew Chrysler's** authority to enter into time and materials subcontracts last June. "Since then, close surveillance and control of this type of contracting has been exercised by the contracting officer through imposition of a prior approval requirement," F. H. Higgins, Assistant Secretary of the Army for Logistics told the General Accounting Office.



Avro CF-105 Makes First Flight

Avro CF-105 Arrow made its first flight last week at Malton, Ont. Flown by Jan Zurakowski, company's chief experimental test pilot, the airplane was taken to 8,000 ft. altitude. Speeds were around 500 mph. on the flight, which lasted 35 min. First flight had been planned for the previous week, but hydraulic and oil line leaks caused delays. Powerplants of the prototype are two Pratt & Whitney J75 turbojet engines. Production models of the supersonic all-weather interceptor will have the Orenda Iroquois.

Army Modifies Arsenal Concept; Pershing Contract Goes to Martin

By Evert Clark

Washington—Army has taken a major step toward modification of its arsenal concept of developing missiles and space vehicles by awarding a multi-million dollar contract to the Martin Co. for research, development, testing and production of the 500-700 mi. Pershing solid propellant missile.

This does not foreshadow complete abandonment of the arsenal concept in favor of the industry development concept practiced by Air Force, Army spokesmen insist. But they concede that the Pershing is something of a test case and that the degree to which the arsenal concept will be modified in the missile-space area depends largely upon the success of this program.

Army says that much of what it calls the arsenal work for the Pershing already has been done in the Redstone. Although Pershing switches from Redstone's liquid propulsion to a solid propellant, Army has consistently described Pershing as a longer-range Redstone surface-to-surface missile.

Successful relationship between the Army Ballistic Missile Agency and the Chrysler Corp. in the Redstone and Jupiter programs has played a large part in the decision to increase interdependence of Army and industry.

Another factor has been the personal convictions of Maj. Gen. John B. Medaris, former ABMA commander who takes charge today of the new Army Ordnance Missile Command.

Gen. Medaris' views—and industry's contribution—will play increasingly important roles in Army's missile, anti-missile and space programs. Elevation of this work to command status gives Medaris direct access to Army Secretary Wilber Brucker and Chief of Staff Gen. Maxwell Taylor on assigned, special-priority projects.

It also gives him direct access to Defense Department's Advanced Research Projects Agency and the Army Missile Committee, which is at the Secretary-Chief of Staff level of organization.

ABMA will continue to handle "any space projects assigned to the Army, boosted into orbit by Jupiter or Redstone systems." It also will monitor development of Pershing, Jupiter, Redstone and other ballistic missiles.

Even the name "arsenal" is being dropped. Redstone Arsenal at Huntsville, Ala., creator of the Redstone and Jupiter, has been renamed the Army Rocket and Guided Missile Agency. It will be responsible for such missiles as Honest John, Dart, Lacrosse, Nike, Hawk and portions of anti-missile work

which may be assigned to it by ARPA.

Although Army is not prepared to say now how far it will go in modifying the arsenal philosophy, it obviously has begun a campaign to credit industry for its contributions to Army programs so far and to encourage an even broader relationship.

"The new command will continue to look to American science and industry for their invaluable contributions in developing Army weaponry," Army said in explaining the reorganization.

"The successful launching of the Jupiter C rocket carrying the first Explorer satellite into orbit is further evidence that this team is meeting the challenges of the new technological age.

"While Army arsenals for generations have developed fine weapons, they have now re-geared their organization and capabilities to the era of atomics, electronics and supersonic rockets and missiles."

Perhaps more significant than these statements is a speech made last week by the Army's Vice Chief of Staff, Gen. Lyman L. Lemnitzer, recognizing that "industry has been a vital element of the military capability of the United States" at least since 1812, and urging even greater Army-industry cooperation.

Although a spokesman for Gen. Lemnitzer said the speech does not reflect a change in policy, Gen. Lemnitzer's words are in direct contrast to Secretary Brucker's statement a few months ago that the industry development concept "can lead to false starts, frequent modifications and unsatisfactory end items. Such procedures are wasteful, costly and time-consuming."

Gen. Lemnitzer called for even closer teamwork than in the past to help with:

- **"Rapid adaptation to military needs** of advances in knowledge and techniques which have been made by industry in its own sphere of activity."
- **"Reduce lead time** to acceptable terms." Gen. Lemnitzer said "our training lead time must be phased in with the manufacturer's production lead time. Obviously, if we were to start training the operator to use the equipment only when it was completed, it would inject an intolerable delay in the process of getting a new item into operational use."
- **Uncertainty of procurement** because of fluctuations in Army's budget. "Uncertainty can surely be reduced to a degree by close cooperation based on prompt exchange of information."

Gen. Lemnitzer also took note of the "telescoping" of the "time-distance factor" and how it has cut industrial mobilization time. This has been a favorite theme of Air Force for years in its defense of its "USAF-industry team" concept. Gen. Lemnitzer attributed the telescoping of the time-distance factor to "advances in the field of military transportation" and said the shortened industrial reaction time outmodes the tendency "to think of the Army-industry partnership too exclusively in terms of industrial mobilization in wartime."

"The danger (now) is far more immediate," Lemnitzer said. ". . . Instead of being held off from us by our allies, an enemy might well strike directly at the continental U. S. itself. That being the case, the Army and the nation must be able to react immediately and effectively.

"Thus, more than ever before, the industry-Army partnership must be an intimate, continuing reality, based on close cooperation which has its roots in a steady exchange of information, a two-way street of mutual assistance."

Army has $20 million available in supplemental Fiscal 1958 funds to initiate the Pershing work, but it did not reveal the amount of the Martin contract except to say that the program will involve "several million dollars immediately" and become a multi-million dollar program over the next few years.

As systems contractor, Martin's Orlando Division will be responsible for research, development, reliability testing and production of both the missile and its ground equipment. It also will furnish engineering, maintenance training and field services. Birmingham Ordnance District will administer the contract, under ABMA.

Goal is a lighter, smaller, more mobile missile to replace Redstone.

Other changes resulting from Army's missile reorganization include elevation of Maj. Gen. H. N. Toftoy, former Redstone Arsenal chief, to deputy commander of the Ordnance Missile Command; promotion of Brig. Gen. John A. Barclay to commander of ABMA; promotion of Brig. Gen. John G. Shinkle to head Army Rocket and Guided Missile Agency. Integrated White Sands Proving Ground is headed by Maj. Gen. Waldo E. Laidlaw and Dr. William H. Pickering heads the Jet Propulsion Laboratory, operated by California Institute of Technology. All these agencies now are a part of the Ordnance Missil Command.

Recoverable Capsule For Satellite

Lockheed's reconnaissance satellite WS-117L will include a recoverable capsule, the company's annual report disclosed last week. Aviation Week learned that the main purpose of it will be to determine whether the equipment can be returned to earth at a selected place.

Recovery would be a big research factor to help manned satellite capsule recovery in the future.

Convair's Atlas intercontinental ballistic missile is definitely chosen as the booster and would be coupled with a solid propellant second stage. This, according to present planning, would be the second stage of the Polaris propulsion system. Speed to be attained would not exceed 18,000 fps.

Slingshot Launching Technique Proposed

San Diego—Proposal for a "slingshot-launched" manned hypersonic glider was outlined here by Ryan Aeronautical Co. structures engineer Vjekoslav Gradecak during a symposium on high speed aerodynamics and structures sponsored by Air Research and Development Command, University of California, Convair and Ryan.

Slingshot method of launching eliminates the tremendous amount of fuel required to get a tail-sitter off the ground and bypasses the need for fuel to attain airborne speed.

Hypersonic glider would be launched from a sled platform on a rail two miles long. Gradecak said rockets on the platform would be fired in sequence by the pilot through an umbilical connection with the glider to provide smooth acceleration to about 500 mph. in approximately 25 sec. at a force of only 1G. When airborne speed is reached, the pilot cuts in the glider's own power, consisting of liquid fuel rockets, and almost simultaneously releasing the latches securing the vehicle to the platform.

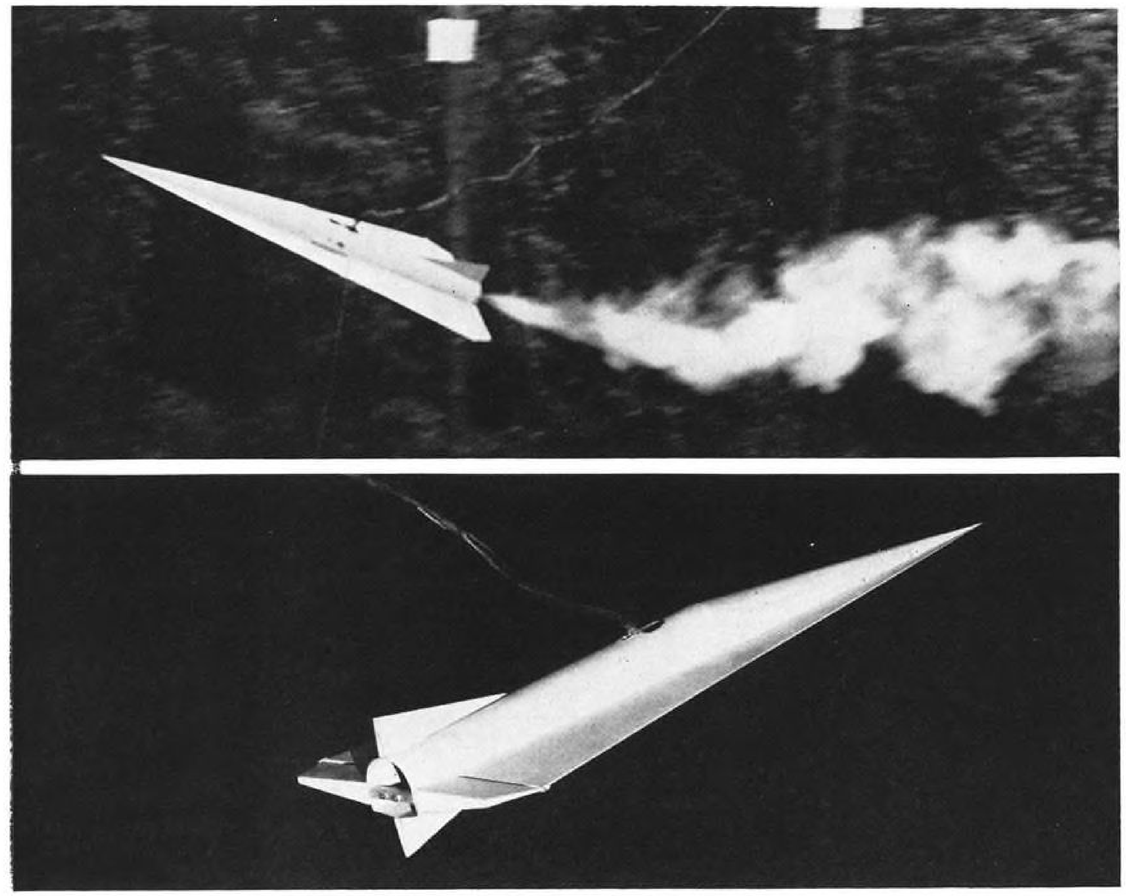
A steep angle of ascent of about 35 to 40 deg. would be quickly attained through pilot control. On its own power, the vehicle would climb to about 100,000 ft., then level off and gain speed in a more gradual climb.

Maximum speed would be attained at burn-out of the rockets at about 200,000 ft. where the glider would be traveling 15,000-18,000 mph.

Aerodynamic controls would be supplemented by jet nozzles to provide adequate attitude control above 100,000 ft., otherwise the glider would follow a ballistic control after the rocket burn-out.

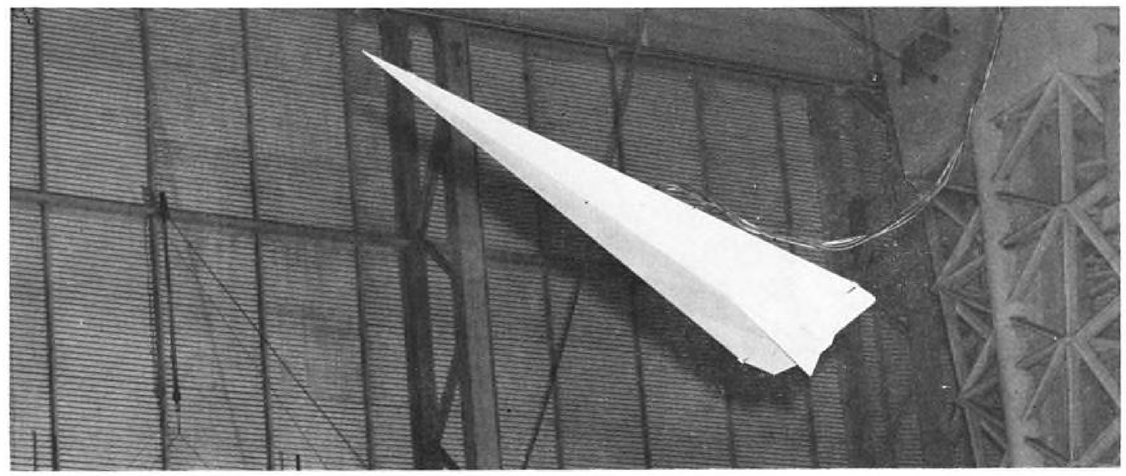
Gradecak estimates that the glider will have slowed to 2,000 mph. by the time it descends to 100,000 ft. This would indicate that the most severe heating situation occurs above this altitude as this is essentially X-2 speed.

Gradecak also described Ryan's "MiniWate" method of fabricating a paper thin skin to be used on hypersonic vehicles to help handle high heat inputs. "MiniWate" is a welded combination of flat and corrugated skins.



NACA Tests Model Of Hypersonic Glider

National Advisory Committee for Aeronautics hypersonic glider model undergoing free-flight test flies around outdoor facility (top) at Langley Aeronautical Laboratory, Va. Wooded area deflects wind. Model is powered by hydrogen peroxide motor, is controlled by operator off to side. Safety cable catches model in case it malfunctions or proves uncontrollable. Dynamic models with compressed air motors fly against air stream produced by full-scale wind tunnel at Langley Field (center, bottom). Tests appear to be aimed at studying landing characteristics, improving lateral control (indicated by differential deflection of horizontal surfaces). Directional control is provided by all-moving vertical surfaces. Flight data is recorded by motion pictures. Note blunt trailing edges, blunt body base.



Space Technology

Military Space Goals Stir Controversy

By Russell Hawkes

Los Angeles—Military and civilian speakers sparred at the Western Space Conference of the Los Angeles Chamber of Commerce over the objectives and management of U. S. military space programs.

Keynote speaker Lee A. Dubridge, president of California Institute of Technology, warned against "wild programs of Buck Rogers stunts and insane pseudo-military expeditions."

Prompt rebuttal of Dubridge's statements was made by USAF's Deputy Chief of Staff for Materiel, Lt. Gen. C. S. Irvine, who pointed out that no one could have foreseen all of the military applications of the airplane at the time of the Wright brothers' first flights. Dr. William H. Pickering, director of Caltech's Jet Propulsion Laboratory, agreed with Dubridge that the value of weapon launching sites in space is limited by the fact that the job can be done better and cheaper from earth. However, he conceded the difficulty of forecasting applications at this early date.

Conference Developments

Other developments were:

• **Warning against wild swings** between despair and complacency about the race with Russia by Rear Adm. Jack P. Monroe, commander of Navy's Pt. Mugu Missile Range.

• **Present contracting** methods were attacked for wasting "25% to 30%" of the technical man-hours available to the nation and the weapon system concept was called invalid as a means of projecting space vehicle development by Dr. Wernher von Braun, director of development for Army Ballistic Missile Agency.

• **Government** was advised to place air weapon system responsibility in the hands of the historic aircraft business or see the character of the business altered to one less adaptable to military demands by Courtlandt S. Gross, president of Lockheed Aircraft Corp.

Dubridge said American industry and technology must not lose sight of the vital goal of building ballistic missiles which can strike any point on earth more reliably, more effectively and more cheaply. Satellites equipped with suitable optical and telemetering instruments will be valuable reconnaissance and weather observation platforms, but "that is about the end of the story on the military value of earth satellites." He called surface-launched ballistic missiles "a lot more accurate, cheaper, more reliable, more flexible and more instantly available than any satellite (launched weapon) could be."

Dubridge ridiculed Sunday supplement stories that the moon would be a good observation post and launching site. He pointed out that it is a bit optimistic to plan on detecting man-made objects from a distance of 240,000 mi., especially since the side of the earth facing the moon is in darkness a good part of the time and covered by cloud another part of the time.

Three Reasons

He called the use of the moon as a launching site "utter nonsense" and advanced three reasons for this opinion:

• **Hydrogen warhead** with all the men and equipment needed to establish and maintain a base would have to be transported 240,000 mi. only to shoot the warhead 240,000 mi. back to earth when the target is only 5,000 mi. away in the first place. "I can think of no gain that is worth the colossal cost."

• **To launch a warhead** along a minimum fuel orbit to a target on the earth would require five days from firing to impact, while an ICBM can reach any target on earth in 20 min.

• **If our rockets** are good enough to put men and equipment on the moon, the enemy's will surely be good enough to put a hydrogen warhead on the same spot.

Gen. Irvine called his theme, "the Air Force today is the space force of tomorrow."

Gen. Irvine said that USAF intends to project itself into space operations at the earliest possible time. Manned vehicles may be equipped with fantastically improved space-launched weapons. Space intercept weapons may play their present role but be deployed thousands of miles above the earth rather than thousands of feet. Unmanned space vehicles controlled from earth or from space stations will perform reconnaissance and strategic missions.

Irvine cited work begun a year ago on a one million pound thrust rocket and study of a type employing propellants not yet isolated. He told manufacturers that USAF "cannot afford the luxury of buying excessive quantities of any particular system. It would be much healthier if companies would use their energy to develop better systems." He said that a company which is relatively unknown today could become a major space vehicle contractor tomorrow.

Dr. von Braun, in attacking application of weapon system thinking to early space flight projects said, "I'd rather see manned orbital flight in a less-than-optimum-performance vehicle three years from now, instead of having to wait for five years to see it accomplished in an optimized design which is obsolescent because the Russians have again beaten us to the punch. Let's get a good, big rocket engine adequate to power a manned orbital rocket, even if the latter does not qualify as an integrated weapon system and is nothing but a glorified test bed." He called it ridiculous to try to clarify military requirements in areas which are still in the stage of fundamental pioneering and applied research. He said establishment of firm and inflexible paper requirements designed to fill an immediate military need is holding up decisions and funding.

Von Braun conceded the value of the weapon system concept in its proper role in development of weapons for large scale production and field deployment. But he called for renovation of our bidding and contract assignment methods.

Role of Scientist

Dr. Pickering cited replacement of solo research, symbolized by the work of Newton, by team research like Manhattan Project as reason for the greater demand for scientists. He called for a balanced understanding of the value of studies whose only pay-off is knowledge. This research is not necessarily expensive. The scientist needs only an acceptable living standard, status in the community and peace in which to work. Education should emphasize the life sciences as well as the physical sciences as eventually they are likely to prove the more important. Conquest of space is not the only great scientific achievement which deserves public support.

Of space rocketry, he said we have not yet caught up with the opposition and "it is obvious that the Russians will be able to trump every ace we play for some time to come."

Adm. Monroe cited these technological developments needed by the services:

• **Lightweight,** high potential power supply.

• **Lightweight,** high resolution television cameras with a long range, high signal-to-noise ratio transmitter for use in unmanned satellites.

• **Compact, low current** video tape recorders for recoverable satellites.

• **New materials** and fabrication techniques to improve electronic reliability.

• **Desperately needed** is a method or device for passive ranging on targets.

• **Method of increasing** radar reflectivity of small, high speed, expendable targets.

• **Gyro that is** not critically sensitive to changes in environment for inertial guidance systems.

• **Automatic system,** possibly tied to a computer on the ground, which displays on the fighter radar scope his required course of action or actually controls him through early phase of attack. This eliminates fighter controller faced with 3,000 kt. closing speed. Many experts believe that head-on attack is only one possible when Mach 2 fighter faces Mach 2 target.

• **Single point miss** distance indicator within the missile rather than the target. Present method is not sufficiently accurate and will be useless in evaluating anti-missile missiles.

New method should give such items as missile acceleration and velocity, precise miss distance and point of closest approach.

• **Three-dimensional** pictorial display of missile trajectory to ease problem of range safety officer now faced by two dimensional-display of a three-dimensional problem on at least four panels.

• **Equipment for the** solution and correction of missile trajectory compact enough "to be carried in one van or at least few enough vans so they can all take the same road the same day."

Monroe also described the National Pacific Missile Range now being built around his command at Naval Air Missile Test Center, Pt. Mugu, and the naval facility Pt. Arguello (former Camp Cooke). He said missiles will ordinarily only be tracked as far as the burnout point. Ships stationed in the target area will locate the point of impact by the sonar technique in which the explosion of a charge in the missile nose is ranged on by highly accurate sonar.

Space Technology

Space Avionics Challenges Designers

By Philip J. Klass

New York—Challenging problem of designing microminiature-size and ultra-reliable communication-navigation equipment for space travel will be complicated by the relatively miniscule amount of electric power available in the vehicle, engineers attending the Institute of Radio Engineers convention here were told last week.

An estimated turnout of several thousand engineers heard a seven-man panel discussion of electronics in space indicating impact of space technology in the avionics field. Panel was coupled with formal papers on related subjects.

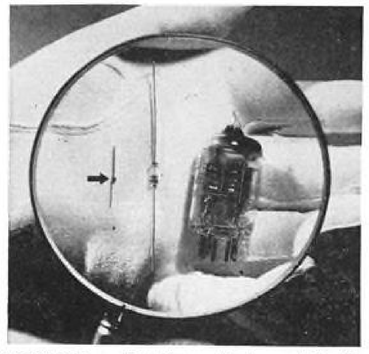
Navigation during interplanetary flight probably will employ combination of existing inertial and stellar guidance techniques, according to Dr. C. S. Draper, Massachusetts Institute of Technology, member of the seven-man panel. Inertial guidance will be used for launch and terminal phases, with celestial body sightings employed during en route portion as a primary reference for determining vehicle position and for establishing reference coordinate indications of inertial system.

To reduce power consumption, Draper suggested that stellar-inertial guidance system might be operated in "slowed down" fashion during most of the en route flight where extreme accuracy is not required. Absence of gravity should improve accuracy of gyroscopes by factor of 10 to 100, Draper said.

Communications will be a restricting, but not limiting factor in space travel, Dr. J. B. Wiesner of M. I. T. told the symposium. Major problem again is available power for vehicle transmitter. Preliminary calculations indicate that an unmanned vehicle landed on Mars could telemeter back data at the rate of one change per second using one-watt transmitter operating at 2,000 mc., providing earth receiving station employed a steerable antenna measuring 300 ft. in diameter and a receiver using extremely low-noise Maser amplifier operated at near absolute zero temperature.

From the Moon, one-watt transmitter would permit transmission of slow-scan TV pictures at rates of several frames per second, Wiesner's calculations indicate.

Ability to measure solar electromagnetic radiation in space, before it has been screened by earth's atmosphere, is a major advantage of satellite-based scientific investigation, Dr. Lloyd Berkner, president of Associated Universities, Inc. told the IRE. He said that the next U.S. satellite, possibly the next Soviet Sputnik, would be equipped to measure X-ray radiation from the sun.



WORLD'S smallest hermetically sealed silicon diode (left), fraction the size of conventional sealed diode (center), is made possible by sealing technique which uses thin layer of glass-like material chemically bonded directly to semiconductor surface, eliminating need to encapsulate whole crystal. Microminiature diode, developed by Pacific Semiconductors Inc., can handle currents as high as 0.3 amp., reportedly has survived nine successive MIL-Standard 202 moisture-resistance tests. New technique should permit major size reductions in airborne digital computers which use thousands of diodes.

An early U.S. satellite also will be equipped to measure cloud cover around the earth, for meteorological purposes, to determine relationship between weather and the position of centers of solar heat absorption and radiation on the earth.

In the field of astronomy, Berkner said that the U.S. hopes to put 40 to 50 in. telescopes up into space in the near future, that astronomers are anxiously awaiting their first look at the heavens from above the earth's atmosphere.

Precision of orbit required to send an unmanned vehicle circling behind the moon and back close to the earth probably will require use of guidance and control within the vehicle, according to paper by Brig. Gen. John A. Barclay of Army Ballistic Missile Agency, delivered by Lt. Col. G. H. Drewry during meeting of IRE's professional group on aeronautical and navigational electronics (PGANE).

To send a vehicle around backside of moon within several thousand miles of its surface and bring it to within 500 mi. of earth to radio back its findings requires nearly impossible precision—if guidance is limited to launching vehicle, as with present satellites, Barclay indicated. Cutoff velocity of launching vehicle would have to be controlled within one part in 500,000, its injection angle into desired orbit would have to be held to within 0.001 deg. and the instant of launching would have to be timed to within 10 sec. unless a trackable launching platform were used.

Aircraft, Rocket Fuel Power May Rise

By Michael Yaffee

Dallas—More power per gallon is the promise of a number of new aviation and rocket fuels now under development.

To the airline operator, these fuels will mean more payload and/or range per dollar. More important, to the missile manufacturer they will mean more powerful engines that will be smaller, weigh less and, in some instances, even cost less than present day powerplants.

On a gallon or pound basis, the higher energy fuels will cost anywhere from 10% to 50 times more than their current counterparts. But on a performance basis, many of them will actually cost less than today's fuels, according to Gulf Oil Corp.'s Robert A. Wells, speaker at the American Society of Mechanical Engineers-American Rocket Society Aviation Conference held here.

As one example of this cost calculation, Wells used the case of Grade 115/145 aviation gasoline containing AK-33X, a methyl cyclopentadienyl manganese tricarbonyl additive under development by Ethyl Corp. and intended for the same application as tetraethyl lead. The use of AK-33X would probably raise the cost of 115/145 aviation gasoline about 10%. Since gasoline constitutes 20% of a piston engine airplane's direct operating cost, this would result in a 2% (10% of 20%) increase in direct operating costs. The use of the additive, however, would reduce fuel consumption 5%, thereby providing the operator with a 3% net saving in direct operating cost. Moreover, longer time between overhauls due to the increased detonation margin resulting from use of the additive will probably add to the 3% net saving.

In the case of turbine-powered commercial aircraft, present aviation grade kerosenes such as turbine fuel and JP-4 do a better job than any new high energy fuel now in sight could do at comparable costs.

It's a different story, however, in the military turbine field where missions often make costs inconsequential. Higher energy turbine fuels could enable present and planned aircraft to fly farther without refueling by packing more Btus in the same tank volume. There is already a well defined need here for fuels with at least 140,000 Btu/gal. and 18,400 Btu/lb. The JP-4 now used by the Air Force averages 119,000 Btu/gal. and 18,700 Btu/lb.

However, as Btu/gal. increases in petroleum-derived hydrocarbon fuels, Btu/lb. and aircraft range decrease. This does not rule out hydrocarbon fuels as such, but only those derived from petroleum. As a result of tests run by oil companies and the Air Force, certain hydrocarbons show promise as high energy turbine fuels and definitely merit further study, according to Wells, particularly the alkylated derivatives of basic polycyclic structures. Alkylation of these materials apparently increases their heating value per unit weight and per unit volume, and lowers their freezing point and viscosity.

Specifically mentioned by Wells were the following polycyclic materials:

- **Decalin**—135,000 Btu/gal. and 18,200 Btu/lb.
- **Mixture of perhydrofluorene** and perhydrophenanthrene—143,170 Btu/gal. and 18,260 Btu/lb.
- **Perhydrofluoranthene**—148,450 Btu/gal. and 18,130 Btu/lb.
- **Isopropylbicyclohexyl**—135,860 Btu/gal. and 18,460 Btu/lb.

Some liquid fuels which ignite spontaneously in air have certain attractions for airbreathing engines, particularly ramjets. For one thing, they do away with the problem of flame-outs; for another, they enable vehicles to fly faster at higher altitudes with leaner fuel mixtures.

In the case of the ramjet, they obviate the need for a flame holder and, compared with hydrocarbon fuels, permit the same amount of thrust to be taken from a much smaller, less complicated and less expensive engine. It is possible, for example, to build a pyrophoric-fueled engine for $600 that will compare with a $5,000-$10,000 petroleum-fueled unit.

The most promising fuels in this group are triethyl aluminum, triethyl borane and trimethyl aluminum. TEA and TEB can be produced in large volumes at reasonable costs. But like all the other promising fuels mentioned by Wells, these too have drawbacks that must be overcome if they are to achieve operational status. In the case of the pyrophoric fuels, they are serious drawbacks—they are extremely destructive to living tissue, ignite spontaneously in air and violently with many other elements, and have poor lubricity.

Better known by such names as Hical, HEF and ZIP fuel, the alkylated boranes are on the brink of large scale production. First major application of this group will probably be in the B-70.

At present, the boranes are still limited by the characteristics of their main combustion product, boric oxide. From 1,000F to 4,000F, boric oxide is a viscous, syrupy liquid that deposits on primary combustor walls, turbine stators and rotors, afterburner walls, injectors, flameholders and variable area nozzles. In a turbine engine burning liquid pentaborane, the liquid oxide flowing along with the exhaust quickly builds up to ⅛ in. thickness which soon stops conventional turbine engines.

Consequently, the boranes will probably be used in afterburners or ramjets where the absence of moving parts eases the problem presented by the viscous oxide combustion product. But even here, borane combustion products cause corrosion and abrasive erosion.

The B-70, Wells surmised, will probably burn hydrocarbon fuel in its six turbojet engines and boron fuel only in the afterburner or ramjet stage.

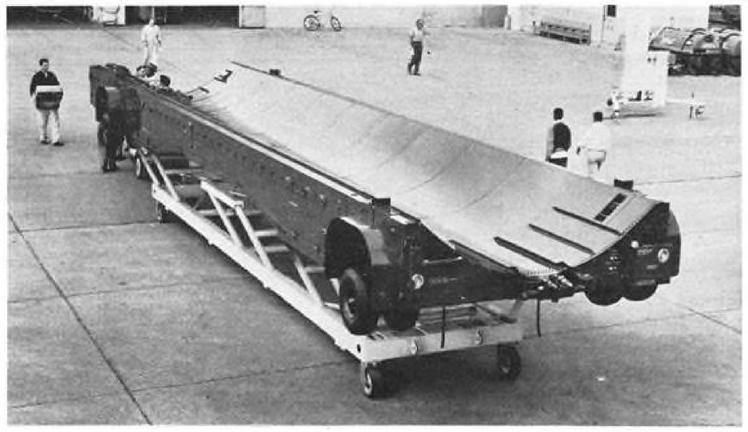
In addition to the viscous and corrosive nature of the combustion products, the boranes are toxic and expensive. Even if the predicted price of $1/lb. is achieved with large scale production, HEF and Hical will still be 50 times more expensive than present hydrocarbon fuels.

Undoubtedly, boron fuels will do a much better job in many instances than present fuels and so merit the added cost. They definitely show enough promise to warrant taking the time and trouble to try to solve the associated problems. It has been variously estimated that the boron fuels can boost performance as much as 40% over present operating levels.

In the field of high energy rocket fuels, hydrogen, of course is theoretically ideal with regard to high specific impulses. But its low boiling point and low density are undesirable.

The value of the liquid boranes as rocket fuels is also questionable, according to Wells. Low density again offsets theoretical increases in specific impulse and results in an overall performance parameter comparable to that of JP-4. Solid boranes show somewhat more promise as high energy rocket fuels and are under development in a joint program of Callery Chemical and Thiokol.

At least in the near future, increased performance in liquid rocket fuels will probably come from further refining of the hydrocarbon fuels. Such materials as RP-1 and JP-6H (narrow cut hydrocarbons) and the alkylated polycyclic hydrocarbon offer somewhat better specific impulses than the wide kerosene cut JP-4, which is taken out of petroleum over a wide boiling point range. Beyond these, Wells sees few bright prospects for high energy rocket fuels.



Titan Transport Vehicles Unveiled

First pictures of Titan ICBM transtainers being made by North American Aviation to transport the Martin missile. Vehicle shown above is for the first stage, below for the second stage. Although no dimensions were given, lengths are approximately 61 ft. and 36 ft. respectively. Points to note—first stage unit: narrowing of underside of center part of transtainer is to prevent it from dragging on sill of cargo plane during loading and unloading. Second stage unit: four heavy metal rollers (one of which can be seen at front left of vehicle) are presumably to allow stage to be rotated while in the transtainer. Tow bar linkage is so arranged that it will steer front wheels when moved right or left.

West Germans Buy U.S. Missiles; Fighter Choice Due in Few Weeks

By David A. Anderton

Geneva—Spinning wheels of West Germany's aerial rearmament program finally appear to be on solid ground.

- **Long-delayed** government purchase decision on Luftwaffe re-equipment now is expected within a few weeks.
- **Orders for 300** Nike-Ajax missiles have been placed by the Defense Ministry.
- **Twenty Martin Matadors** and 12 launchers for the missiles will be bought for training and industrial dissection.

Final choice of the interceptor for the fledgling Luftwaffe has narrowed down to a short list consisting of developments of the Grumman Super Tiger, the Lockheed Starfighter and the French Dassault Mirage 3. Most observers believe the choice will actually be made between the two American types, and that the continued German deference to the French and their design is political in nature.

Requirements have solidified to the state where they demand a two-seater airplane with all-weather capability. Lockheed has a two-seat version, the F-104B; Grumman and Dassault also have designs. None of the airplanes now has all-weather capability.

Current procurement plans favor outright purchase of 150 airplanes from outside Germany, with future production to be done under license by the Flugzeugunionsud. That group now includes Heinkel, Messerschmitt, Bolkoew and Junkers.

One cause for latest delay in the decision has been the scheduled final round of flight tests on the Mirage. It is an open secret in technical circles here that one number of the German test team got pilot-induced oscillations on a highspeed flight of the French design. Reports are that the resulting oscillations loaded the airplane alternately between plus and minus 5G, and the Mirage suffered some damage as a result of the abnormal negative loads.

Reports that German Air Force General Joseph Kammhuber was impressed with the Lockheed Starfighter probably stem from the fact he rode in F-104B at Edwards AFB but was unable to ride in a similar Grumman two seater which has not been built.

Navy has released advanced missile data to USAF which has passed same on to contractors selling here. But Navy will not release same information to its contractors for their sales effort here.

Conflict between Grumman and Lockheed ships boils down to a few performance facts: Lockheed F-104 is faster and has more acceleration; as a flying machine it appeals to pilot psychology, giving him fastest mount in air. Grumman F11F-1F has superior landing and takeoff characteristics and better maneuverability, good speed.

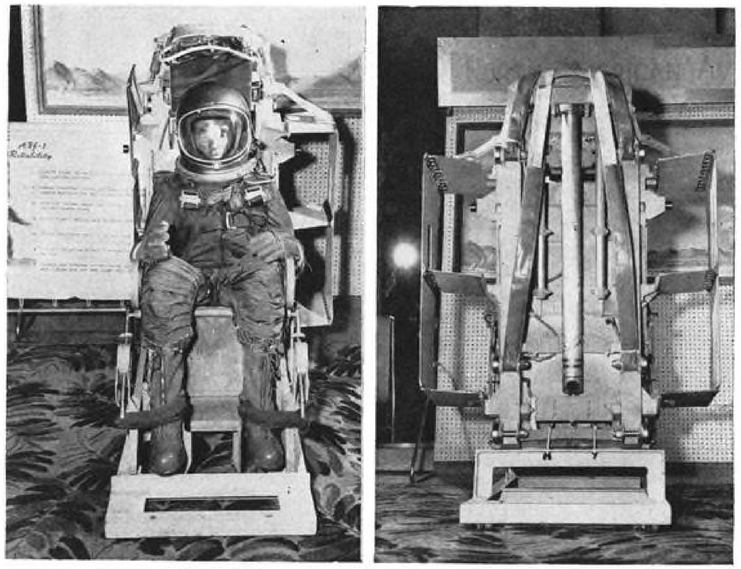
A reliable source told AVIATION WEEK that official USAF flight test figures for the F-104 show landing distance over a 50-ft. obstacle equals 5,400 ft. to stop, of which 3,000 is ground roll after touchdown with drag chute open. Comparable Grumman figures, also official Edwards AFB data, show 3,800 ft. total distance of which 2,490 is ground roll—without drag chute.

Cost of F-104 to USAF is $1,112,000. Cost quoted to Germans is $678,000. Lockheed is building total of 294 under USAF contract and will build subsequent planes with no overhead, no plant costs and no development costs charged to the planes.

Grumman Super Tiger has been to 77,000 ft. and Mach 2.01 as consistent performance. At Mach 2 the yaw damper has been taken off, hard rudder kicked and airplane has damped out. Lockheed airplane is placarded not to be flown without yaw damper below Mach 1.5.

Most of the Nike missiles will be used to defend the Ruhr, industrial heart of Germany.

Matador purchase is already exciting unfavorable press comment. The influential Hamburg paper, Die Welt, blasted the idea as unsound and said that about the only training Germans could do would be to take the Matador apart into seven pieces and put it together again. Anything further, such as replacing defective parts, would violate the Brussels agreement which does not give the Germans permission to work on missiles. Die Welt also had some caustic comments about the expected accuracy of the Matadors, which are the early TM-61C models with nuclear capability and not the late TM-76 Mace.



NORTH AMERICAN Columbus Division A3J ejection seat is similar to McDonnell F4H seat division is building. Stabilizing fin on pilot's right (left) is retracted. Rear view, right.

Space Technology

Development of Food-Waste Cycle Goal of Space Flight Researchers

By J. S. Butz, Jr.

Washington—Completely closed ecological systems, automatically duplicating nature's earthly processes to produce food and water from human waste, are a primary research goal to permit manned interplanetary travel.

These automatic chemical-mechanical systems would represent significant weight savings over carrying food and water stores which amount to about 1.5 tons per year per man. The round-trip to Mars, for example, would require about a year along a high energy trajectory and over three years for a minimum energy space vehicle.

NAVAL full-pressure suit weighs approximately 9 lb. without helmet, replaces 22 lb. suit (AW March 24, p. 37).

General description of such a system was given at the 29th annual meeting of the Aero Medical Assn. here last week by Dr. C. C. Clark, of the Naval Air Development Center, Johnsville, Pa.

Dr. Clark's proposed ecological cycle would provide an answer to the problem of excess water which is produced in the human body's normal metabolic process. This accumulation of excess water, amounting to about 300 cc. per man per day, until recently has been listed among the problems of long space trips by some scientists.

Dr. Clark's theoretical system which returns every atom of human waste to the nutrition cycle is also considered feasible by Air Force physicians.

All of the organic processes necessary for the closed cycle have been synthesized or kept in operation in the laboratory.

Possible cycles are:

• **Excess metabolic water** would be used in forming carbohydrates in the form of glucose water.

• **Solid residue** from urine would be used as food for algae or other biological culture performing the photosynthesis function and producing oxygen for breathing.

Dr. Clark presently envisions the food product from a closed cycle as being glucose water thickened to about the consistency of Pablum by cellulose fiber, a paper thinner than filter paper. The checks on such an automatic system to make certain that poisonous waste material is kept out of the final food product will be made by X-ray diffraction in Dr. Clark's opinion. The ordinary wet chemical methods would not be adequate.

The closed cycle ecological system will not be very efficient energy-wise, even though conservation and reuse of the individual atoms will be 100%. Probably 1,000 times the energy provided to the human body through the final food product will be necessary to operate an automatic cycle. This energy would be available in space in solar form.

Recycling urine was discussed by Capt. W. H. Hawkins of the Air Force School of Aviation Medicine. His studies have convinced him that a weight saving could be realized by a closed cycle urine-pure water system on any space trip lasting longer than one week. The two systems offering this weight advantage over carrying water supplies are: simple separation of poisonous elements by freezing out the pure water or electro-osmosis.

The psychological reaction of space crews depending on such systems for food and water was not discussed formally at the meeting. Several scientists expressed the belief, however, that educating adults to accept such an existence without psychological stress would be one of the most important tasks in preparing man for space flight.

One of the most provocative "thought" lectures made at the meeting was presented by D. E. Beischer of the U. S. Naval School of Aviation Medicine. Dr. Beischer feels that the space traveler should be insured against unpleasant suprises by:

• **Considering the possibility** of a world not centered around carbon and water.

• **Considering the variation** in life shown to be possible by recent advances in nucleoprotein chemistry which have shed so much light on the process of heredity common to all life in the carbon-water world.

Dr. Beischer's ideas were echoed by several of the biologists present who believe that the greatest surprises and adjustments that man faces in the next 50 years will be caused by an increase in biological knowledge rather than space flight.

There is a possibility that man travelling in space or in the upper fringes of the atmosphere might have to pass sticks or circles before his eyes as a reference point in order to see objects at a great distance.

J. W. Miller and Elek Ludvigh, of the U. S. Naval School of Aviation Medicine, said it was found that the eye's efficiency drops sharply in an empty visual field and that hallucinations occur.

Environment Limits

Washington—Experimental investigations to determine the absolute limits of life supporting environment have produced the following data:

- **One cell animals can withstand more than 250,000Gs and equipment to subject them to 1,000,000Gs is being prepared.**
- **Fish will live under 10,000G for half a minute and 7,000G for one min.**
- **Frogs live under one mm. of mercury pressure for half an hour, and bacteria survive for six to eight hours. All liquids in the organisms are boiling under these conditions.**

The experiments were conducted at the U. S. Naval School of Aviation Medicine by D. E. Beischer and his associates.

Final results of the study will help to answer one of the hypotheses mentioned in the "Introduction to Outer Space" report made by the President's Science Advisory Committee last week—that small living particles or animals may be able to survive in space and could drift from our planet.

Sputnik II in Orbit

Sputnik II was photographed with Recording Optical Tracking Instrument camera as it passed within 200 mi. of Air Force Missile Test Center, Patrick AFB, at 6:05 p.m. EST. Lighting was near optimum; it was almost dark at surface while rocket was in full sunlight at about 135 mi. altitude. Sputnik II length is between 74-84 ft., consists of third stage rocket, dog enclosure and instrumentation unit.

Dual Missile Defense Predicted

Salt Lake City—Ballistic missile defense system now under development is almost certain to become obsolescent before it becomes operational as result of technological advances in both ballistic missile design and detection techniques already on the horizon.

Warning comes from Dr. Richard C. Raymond, manager of General Electric's Technical Military Planning Operation (Tempo), speaking here at the third annual Air Power Symposium.

Dr. Raymond predicted that presently planned ballistic missile defense system may have to be expanded to provide two distinctly different types of active defense missile systems.

• **Point-defense,** short-range missile to protect Strategic Air Command bomber and missile bases. This corresponds to Army's Nike-Zeus, programmed for ICBM defense (AW Feb. 24, p. 66).

• **Area defense** longer-range missile to protect population-industry centers and give increased coverage to strategic striking force.

Dual-type missile defense system suggested by Dr. Raymond is comparable to objectives of Air Force Wizard program, recently halted by Secretary of Defense McElroy.

Fifteen minute warning to be provided by ballistic missile early warning system now under development is "barely sufficient" to launch strategic counterblows, Dr. Raymond said, and the figure will be "even less for some future (ballistic missile) trajectories."

This will require greatly increased political-decision speed, if full advantage is to be gained from the costly surveillance system, he said.

Although SAC ballistic missile defense site can be "hardened to a certain extent," Dr. Raymond said, there is no point to designing it to withstand a direct hit which would knock out the nearby SAC base it is intended to defend—particularly if the missile site's rate-of-fire and effectiveness must be sacrificed to protect it from fallout.

Present point-defense concept of making relatively low-altitude attacks on enemy ICBMs, using the atmosphere to screen out light-weight decoys from war head-carrying nose cones, is "probably all right," Dr. Raymond said. If the attack is very heavy, the point-defense missile site can concentrate on those weapons dangerous to the target being defended and to ignore near misses.

But the requirements for an active missile defense for population-industry targets are quite different, Dr. Raymond pointed out, because this target cannot fly away or evacuate fast enough and because penetration by a few missiles does not eliminate need for continued defense. Area-type missile sites must therefore be designed to operate for extended period, despite blast, thermal damage and radioactivity in the area, he said. Furthermore, the communication lines which link individual missile sites in an area-defense system must also be hardened against damage, and principal facilities must be located away from likely targets, unlike the point-defense sites.

Area defensive missile must strike while enemy vehicle still is in space, which requires use of techniques for discriminating between decoys and actual warheads, Dr. Raymond said. However, a compensating advantage is the fact that it may only be necessary to damage nose cone sufficiently to prevent it from successfully re-entering the atmosphere, without actually destroying it prior to re-entry.

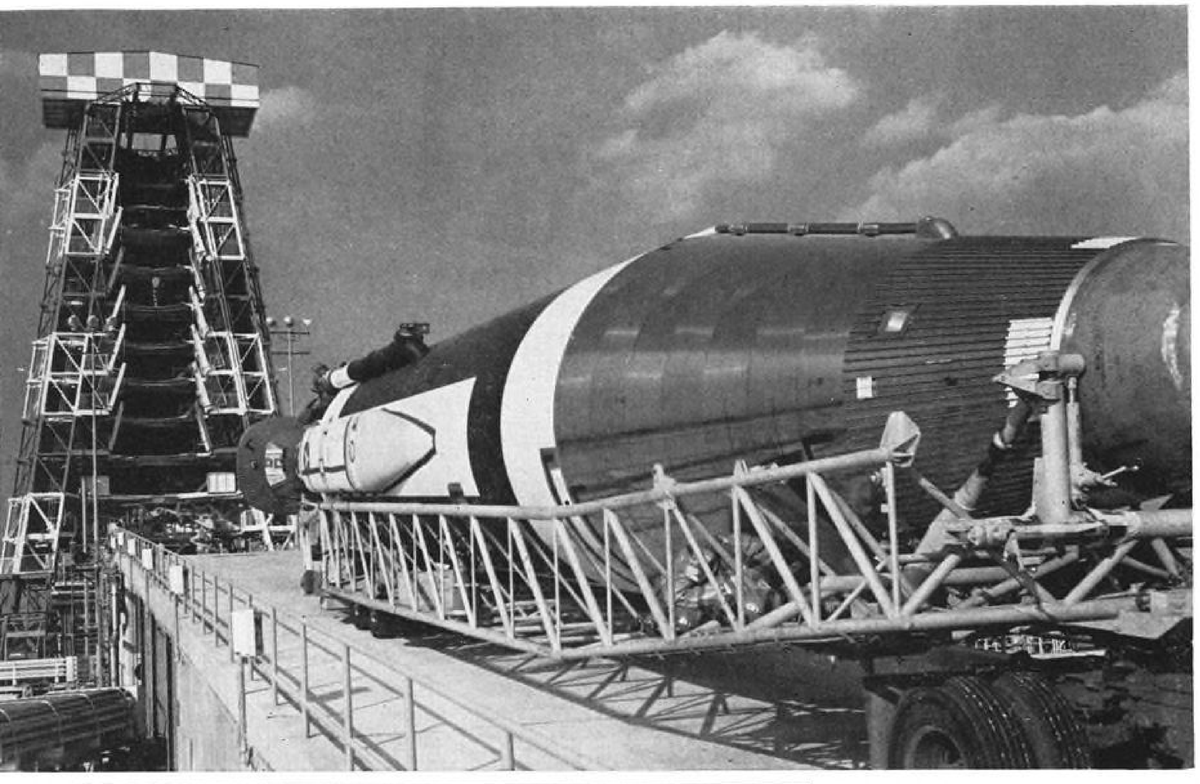
Explorer III Orbit

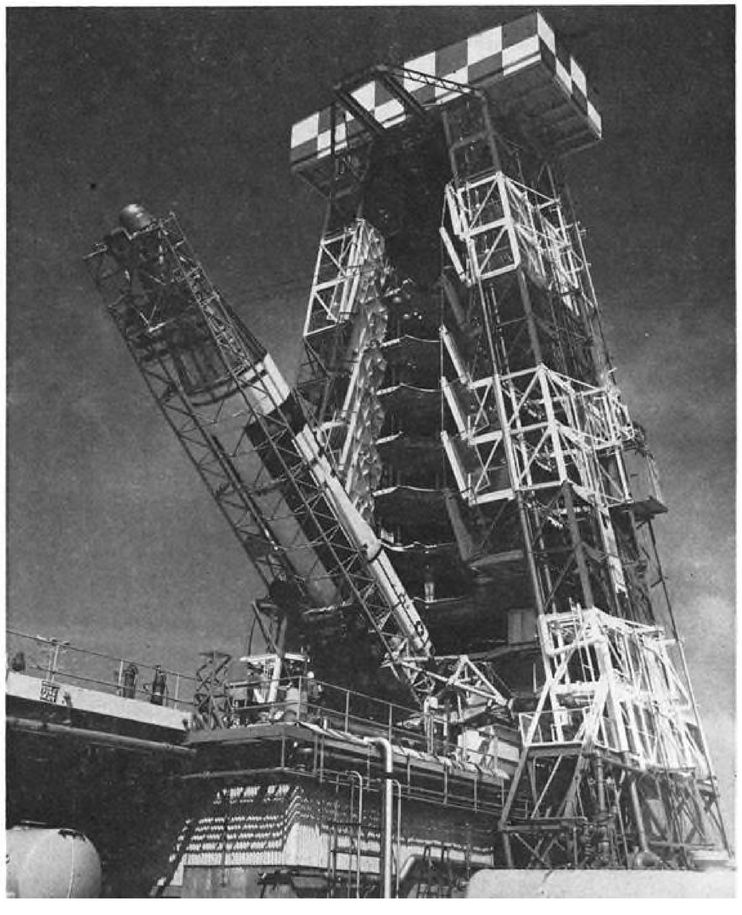
Washington—Explorer III was launched by Army last week from USAF Missile Test Center, Cape Canaveral, Fla., into what apparently will be a short-lived orbit. A slight guidance system error created an apogee of about 1,735 mi. instead of 1,217 mi. as planned and brought the perigee within 125 mi. of the earth, according to Naval Research Laboratory, which also estimated the satellite's life will be 4-6 months.

Instrumentation in Explorer III is an improvement over Explorer I and will provide more information as long as it is aloft. The new satellite records total omidirectional cosmic ray incidence and intensity on a small tape recorder during its orbit. This information is sent to the ground in five seconds by high power transmitter as the Explorer passes over a minitrack station.

A low power transmitter continuously sends external and internal temperature readings which can only be received by special equipment. The internal temperature is expected to stay between 43F and 104F as the same aluminum oxide striping pattern used on Explorer I is incorporated on the new vehicle. The low power transmitter also sends micrometeorite information and a cosmic ray count.

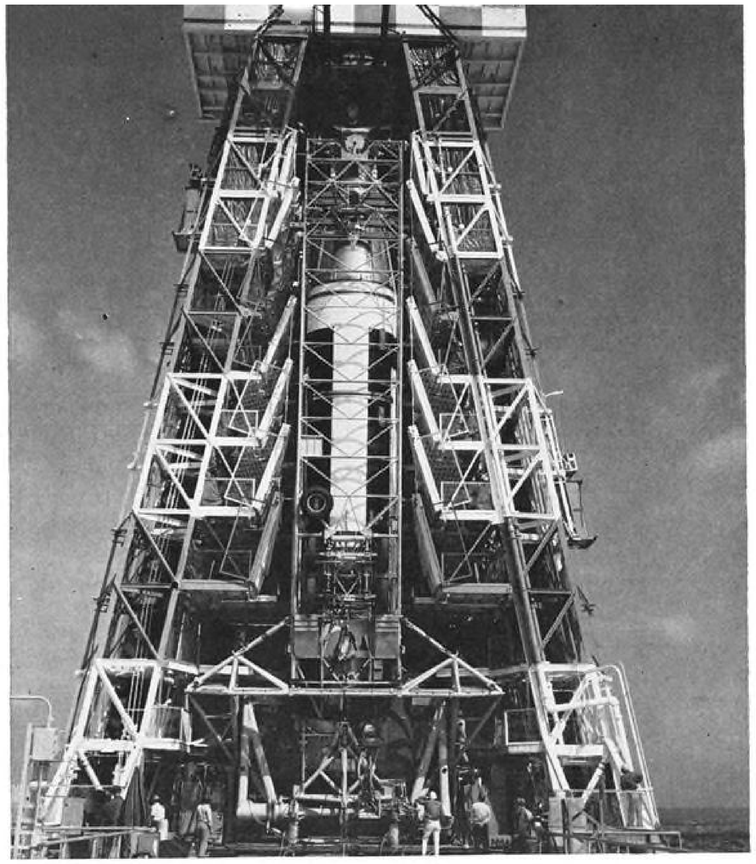
The launching vehicle was a Jupiter C rocket essentially unchanged from the ones previously fired. Present period of the satellite is about 115 min.

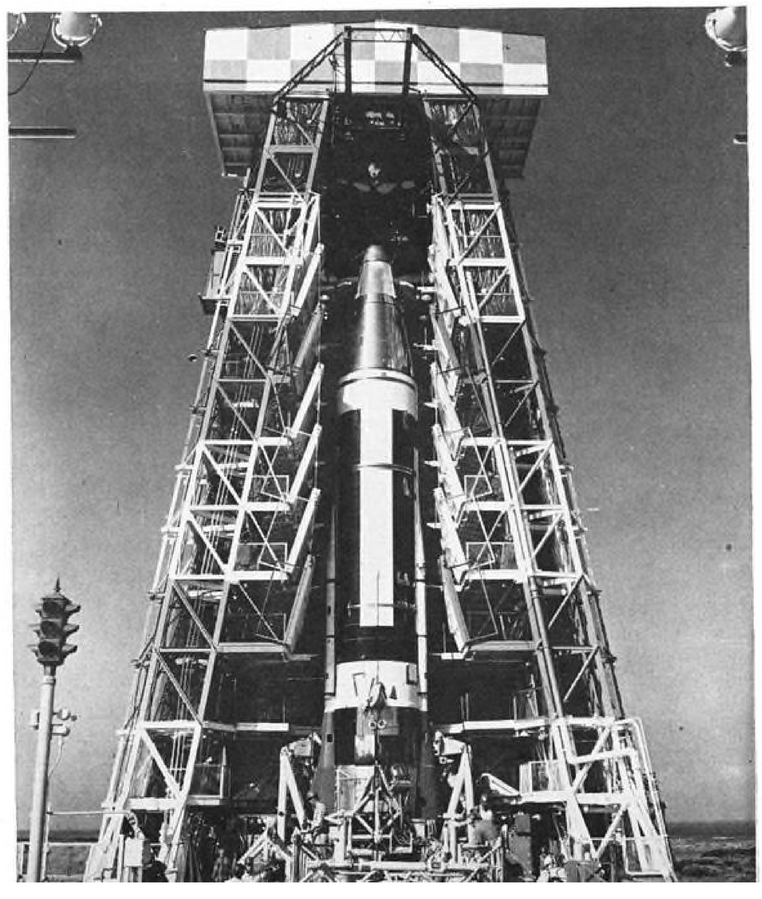




Atlas Transporter Positions Missile In Service Tower

Atlas ICBM 12-story servicing tower has gantry cranes, work platforms, electrical and pneumatic air systems for machine and automatic tools. Demineralized water system is used to wash missile. Sliding waterproof weather curtains are also used for security. Tower has two-way communications to blockhouse, two fire protection systems, emergency escape cable for workmen on upper stations, and complete lighting system. Missile is backed up ramp on cross-country trailer. Base of missile is then secured to launching device. Crane hoists missile, trailer to vertical position. After missile is fixed on launcher, trailer is lowered and seven retractable work platforms are positioned. Two 16-man elevators hoist men, equipment. Tower, on transfer table on railroad tracks, is rolled back 500 ft. for firings. Tower is built to withstand 120 mph. winds, can be moved safely in 60 mph. winds.





Overtime Policy Eased

Washington—Overtime policy on procurement contracts has been changed by Defense Department to ease administrative burdens of contractors and contracting agencies under revised Armed Services Procurement Regulation 12-102.

Extensive overtime still is subject to high-level review within a service. Overtime regulations on ballistic missile programs remain unchanged. The ASPR is to be "given a liberal interpretation in favor of getting on with the job" in any case of doubt on a high-priority program, Deputy Secretary Donald A. Quarles said. Revision cancels the overtime directive (4105.48) of last Oct. 1 and Quarles' memorandum of last Jan. 16.

News Digest

Swiss order for P.16 home design fighter was deferred following crash of the third prototype into Lake Constance. Order for 100 aircraft (AW March 24, p. 65) will not be reinstated until investigation reveals details. Pilot ejected safely when nose grew increasingly heavy in landing approach and he was unable to correct it. It was second P.16 to crash into Lake Constance.

Republic Aviation Corp. stretchouts and cutbacks reduced company's 1956 sales of $346,214,310 to last year's $269,017,856. Net earnings were down from $7,367,435 to $6,102,631, or $4.15 a common share. Republic said Defense Department economies will continue to be felt through first three quarters of this year, but adds volume production of F-105 Thunderchief is expected to begin in last quarter to run through 1960.

Northrop Aircraft Inc., revealed that familiar pattern of higher sales and lower earnings was reversed in six months ended in January. Sales of $125,524,168 were lower than same period last year, when $135,323,974 was reported, but earnings rose from $2,236,157 to $2,864,369, or $1.82 a share. Backlog, primarily because of increased orders for Snark missile, rose to $275 million from $196 million three months earlier.

Lockheed Aircraft Corp.'s sales and earnings increased in 1957; sales to a record high of $868,315,000. Earnings of $16,309,000 or $5.52 a share were 8% higher than 1956. Lockheed predicted its missile business in 1958 would increase approximately 150%, to $180 million.

CAB Fare Probe to Continue Into 1959

Board to resist pleas to cut short investigation in its search to determine passenger fare level standards.

By L. L. Doty

Washington—Most optimistic estimates by Civil Aeronautics Board staff members now place date of decision in the General Passenger Fare Investigation at January, 1959, with a strong possibility of a second interim fare increase before then.

Despite a recent bid by American Airlines to rush the investigation through to a finish by June (AW Jan. 27, p. 38), both the Board and its staff members will resist any short cuts and allow the case to run its normal course.

The Board is determined to put an end to general criticism that it has regulated airline rates for 20 years without the benefit of fare level standards for guidance.

Meanwhile, the mounting critical financial condition of the airline industry is forcing the Board to keep a watchful eye on current earnings. Staff members say the current recession prompted the Board's action in granting an average 6.6% fare increase in January as an interim relief measure.

In mid-January, the Board took an unprecedented step when it asked the trunkline carriers to file year-end results by January 31.

The move indicated the urgency with which the Board is now viewing the financial problems of the airlines since statutory reporting periods set April 1 as the normal deadline for year-end reports.

Analysis of the reports undertaken by the Board staff was conducted as an emergency measure without regard to tariffs filed by the airlines or to findings at that time in the General Passenger Fare Investigation. If the financial depression of the industry continues to deepen, the Board will again call upon its staff for further studies as a basis for another fare increase.

In its decision on the American petition to expedite the fare case, the Board reaffirmed this stand by stating that any "necessary interim relief will continue to be available outside the framework" of the General Passenger Fare Investigation.

Such action, however, will draw dissension within the Board. In concurring with Board majority denying the American Airlines motion, Member G. Joseph Minetti expressed concern that any future interim fare increases granted prior to the final resolutions of the general fare case will "prejudge many of the issues."

Minetti admitted to the need for watching the financial requirements of the airlines during the investigation but warned of the possibility of strong resistance to higher fares by potential travelers during the present recession. The degree to which fares can be hiked without pricing the airlines out of their market also has been a source of concern to Board Chairman James R. Durfee.

Vice Chairman Chan Gurney has consistently recognized the seriousness behind the airlines critical financial situation. New member, Louis J. Hector, saw the need for help in the form of a fare increase but last year said that data presented by the airlines in the suspended passenger fare investigation was not sufficient to prove that need.

Hector, however, is rigidly opposed to taking any short cuts in the General Passenger Fare Investigation and charges that the Board opinion on American's move to expedite the case did "not sufficiently stress the impropriety of the suggestion that the Board take steps to terminate the hearing within one month."

He added that any attempts to cut short the cross-examination by the Board's Bureau of Air Operations would "possibly be illegal and . . . would jeopardize the independent status of our staff which the Board must always jealously guard."

Purpose of the General Passenger Fare Investigation is not to determine finally whether fares should go up or down. The CAB is seeking to set "standards" on which a future fare level can be based for long-term operations. It has been a lack of such standards that has evoked congressional criticism of past practices in rate setting.

And it has been the standards issue that has prolonged the hearings in the investigation thus far. The CAB has charged its staff with setting these standards as the only means by which a logical fare level can be reached. The airlines, however, fear that a wrong interpretation or application of the proposed standards can further tighten regulatory restrictions on their operation.

As a result, both the Bureau of Air Operations and the 12 trunklines have taken almost inflexible positions on the proposed standards so that testimony gathered to date in the hearings cover a detailed compilation of widely varying opinions of the parties involved.

Key issues involved in the determination of standards are:

- **Load factors** and their relationship to rates of return.
- **Income tax allowances.**
- **Depreciation and residual** value of aircraft.
- **Rate of return.**

To illustrate the complexities involved in setting standards on these issues, staff members are attempting to determine, for example, whether rate of return should be based on all airline earnings collectively or on the results of each individual airline. Such measures as striking an average on all carriers except those with extremely high rates of return and those with very low rates of return have been considered as a method of establishing a criterion for the industry.

A completely revised fare structure legally cannot be included in the present General Passenger Fare Investigation. A move to change the present fare structure would require another formal proceeding which, according to the estimates of one staff member, might last as long as five years. Another possible method would be through a series of informal conferences with the airline.

The staff could recommend a tapering fare in the present investigation which would, in effect, create a major adjustment in the fare structure. For example, in the most recent fare adjustment, $1.00 was added to the rate between all points. This had the effect of increasing rates on hauls of 200 miles by one-half of one cent per mile and by one tenth of one cent on trips of 1,000 mi., slightly tapering the fare base.

But most observers feel that a straight across-the-board revision of fares will result from the present investigation. Other possibilities include an adjustment of fares according to geographic areas, elimination of the roundtrip discount or a widening of the spread between first-class and coach fares as a means of increasing rates without discouraging traffic growth.

Petition Reaction Divided

Washington—American Airlines petition to the Civil Aeronautics Board to accelerate the General Passenger Fare Investigation as a means of bringing the case to a finish by June failed to win the undivided support of the airline industry.

Of the 12 domestic trunklines involved in the investigation, only Continental, Eastern and Western filed supporting letters. Five carriers remained silent on the issue while United, TWA and Braniff opposed the American motion.

American proposed in its motion the elimination of an examiner's initial decision in the case and suggested that the record be certified directly to the Board for final decision.

On this point, Braniff said that "in a case as complex as this, an initial decision should be rendered by one person, i.e. the examiner, who has heard all the evidence and who has the greatest familiarity with the record."

United agreed with American that the case should be given priority treatment but added that expedition of the case should not "be accomplished by emasculation of the hearing procedures through waiver of the examiner's initial decision."

American Replies to Load Factor Charge

By Robert H. Cook

Washington—American Airlines has termed as "totally unrealistic" Civil Aeronautics Board charges that the airline can restore its 1953-56 average system load factor by control over flight schedules.

Testifying for American in the General Pasesnger Fare Investigation, Melvin Brenner, assistant director of schedule planning and forecasting, said the airline's present load factor is lower than the earlier average primarily because its load factor during the 1953-56 period was "abnormally" high due to a lack of equipment and a lower level of competition.

The Bureau of Air Operations has filed an exhibit indicating that American has experienced an increasing traffic density that should make it possible to control load factors and hold them at previously experienced levels.

Questioning the bureau's interpretation of "traffic density," Brenner countered that ratios that were offered as a yardstick of airline load factor progress are both inaccurate and "statistically over-simplified."

Past Analysis

Brenner said an analysis of past figures shows that many of American's individual schedules that were formerly considered excellent from a sales and load factor standpoint of 1953-56 have now dropped to the "very good" or "good" category. While such a change does not warrant a schedule cut, he said, it does fail to offset losses on many of the airline's less favorable schedules. Even the less productive schedules pose a substantial problem since any move to curtail or eliminate them often poses a threat to public service.

Pointing out that American is not totally unable to influence load factors through scheduling action, Brenner said the airline continuously adjusts schedules in an effort to improve load factors, but, at the same time, must guard against any sacrifices in public service or competitive effectiveness.

Brenner cited several cases where American's load factors on major route segments suffered between March, 1956 and March, 1957. The period was chosen because it maintained a load factor close to the airline's average for 1956 and the 1953-56 period used by bureau counsel.

In this period, American's load factor declined from a high of 68.1% to a low of 63.1% as a result of "general slippage" from high to moderate load factor ranges and moderate to low ranges.

Capital Competition

As a case in point, Brenner cited Capital Airlines' competition with Viscount service which was inaugurated between these same months on these routes with the indicated load factor reductions: New York-Chicago, down from 67.1% to 53.7%; New York-Detroit, down from 70.6% to 52.6%; Buffalo-Detroit, down from 63.6% to 54.8%; Rochester-Detroit, down from 67.2% to 61.9%.

Brenner told the bureau that American attempted to sustain its load factors by curtailing service but was unsuccessful. In the New York-Detroit market, American dropped two roundtrips in the face of eight and a half roundtrips by Capital. Rather than strengthening American's load factor, he said it had a reverse effect, with the loss of 84 one-way passengers and a weakening of load factors on all of the remaining flights.

Capital's influence in the Washington-Chicago market had an even more telling effect, he said, with American cutting its service from five roundtrips in July, 1955, to only two by April, 1957. The previous month, the airlines had a pattern of two and a half daily roundtrips on this segment with a load factor of 40%. Yet, despite a normal market growth over a two year period plus a cut in schedules, American's load factor for the remaining two flights, during the months of July and August, 1957, was only 41%.

"There could scarcely be a more graphic demonstration of my point," Brenner said. "Where a rounded pattern of competitive service is available, a carrier cannot normally improve its load factor by curtailing its own pattern, since that merely drives its former passengers to the competitor's flights."

Traffic Density

Brenner also criticized the bureau's use of "traffic density" as a means of controlling load factors.

He said the four ratios used by the bureau—passenger-miles per route, revenue ton-miles per route-mile, passenger-miles per station and revenue ton-miles per station—are largely "duplicative." In particular, he took issue with the bureau's reliance upon certificated route mileage as a measure of a carrier's system.

Explaining that seat-mile capacity of any carrier is determined by many factors, Brenner said that changes in a carrier's operational system frequently have little or no bearing upon route mileage statistics computed by adding the point-to-point route segments. As examples, he recalled the removal of restrictions in the consolidation of Eastern's New York-Washington and Washington-St. Louis routes that permitted several new nonstop services, including New York-St. Louis.

The addition of only 185 mi. to the National Airlines system, between New York and Boston, made possible nonstop operation on the 1,261 mi. Boston-Miami segment.

Backup Traffic

Brenner said that a route award, involving relatively limited mileage, may make a much more extensive new service for which authority previously existed economically feasible by providing "backup" traffic support or better equipment routing.

Capital benefited this way, Brenner said, when its Atlanta-Birmingham extension was granted, thus allowing a competitively effective routing for operation of its previously existing New

York-Atlanta and New York-New Orleans authority.

Further attacking the "density" interpretation, Brenner cited American's 78% load factor on a one daily nonstop round trip schedule in March 1956 between Cleveland and St. Louis. The following year, he said a second round trip was added, resulting in a load factor of only 60% for the two trips. Passenger-miles offered on the segment had increased by 60%, which could be interpreted by the bureau as an increase in density and ability to sustain higher load factors. Brenner asserted, however, that the "so called density" resulted only from an increase in traffic due to additional capacity on the segment. The attendant drop in load factor was not an isolated case, he said, but is typical of what befell all of the airline's segments that formerly had a load factor of better than 75% in March, 1956. These segments accounted for 95 million passenger-miles and 117 seat-miles with an average load factor of 81%.

By March, 1957, with seat-miles on these segments up 30% and passenger miles up 20%, Brenner said the average load factor for this group had declined to 74%.

"Thus we come to the sheer, inescapable lack of validity involved in this approach to load factor analysis," he said. "We end up with the obviously absurd result that, if a carrier deliberately set out to over schedule its routes for competitive advantage, the resulting increase in its system traffic would show up, by the bureau's methods, as an increase in traffic density and therefore an ability to obtain higher load factors."

Braniff, Continental Report 1957 Revenues

Washington—Both Braniff Airways and Continental Airlines reported last week that operating revenues hit an all-time high in 1957.

Braniff set a new record with $62,887,000, reflecting heavy gains in all traffic categories. The airline carried 2,038,656 passengers and operated 956,964,000 revenue passenger-miles during the year. Net operating income, before non-operating charges and income taxes, increased 6.7% over 1956 to $4,447,489.

Net earnings were $1,727,097, a drop of 8.4% below that of 1956. Total operating expenses increased more than 20% in 1957 with a figure of $58,439,982 as compared to $48,267,485 for the previous year.

Continental reported a 25% increase in operating revenues with $23,272,520 as compared with $18,548,127 for 1956. Passenger revenue increased 31% to $21,373,973 as compared with the 1956 level of $16,279,033.

Operating expenses for the year reached a new record of $22,567,223, a gain of 30% over the 1956 level of $17,325,233.

Net operating income for the airline was $696,297 as compared with $1,222,894 for 1956. The figure reflects the cost of integrating four new DC-7Bs into the Continental fleet.

Greater interest expenses and lesser profit on the retirement of property and equipment reduced the airline's final net income to $96,073.

Riddle Asks Subsidy; Needed for 'Survival'

Miami—Riddle Airlines Inc., last week asked Civil Aeronautics Board for an increase in mail pay to subsidize its "strenuous efforts to ride out the present storm." The all-cargo carrier said its request was "a question of survival."

Riddle is the first cargo airline to apply for subsidy.

Riddle's application said that after 11 years of service without financial aid from the government, the airline had reached a point where it must bring its problems before CAB. It asked exemption from a certificate limitation to a service (non-subsidy) mail rate for a temporary period "until present depressed economic conditions" have improved.

The application referred to "the harsh facts of Riddle's situation."

• **Traffic for December,** January and February was down 18.6% from the same period of 1956-57. Southbound traffic, the carrier's highest-yield business, was off 24.1% and the largest single market, New York-Miami, showed a 40.1% drop this winter over last.

• **Decline was out** of Riddle's control, being due primarily to the economic recession and aggravated by a poor Florida season (AW March 24, p. 31).

• **Riddle lacks** funds "to survive a national crisis." Preliminary figures show an operating loss of $285,000 in January, $235,000 in February. Losses in the past have been met by acquisition of new capital, but no new sources are available. Arthur Vining Davis, "a principal source of funds in the past," has decided he will put no additional capital into the company. During the last fiscal year he advanced more than $2 million. (Davis is majority stockholder in the airline.)

• **Air Force** will institute a completely new Logair setup when present contracts expire in June. Riddle's contract with the military cargo airlift accounted for 553,200 mi. of operation in February, whereas common carriage mileage amounted to only 396,595.

• **In view** of the uncertain situation, no meaningful estimate of the coming year's operations can be made. The carrier recently got $1.5 million as a second mortgage on its property and has sold a DC-4 for $240,000.

Without government help, the application avers, Riddle cannot continue to operate.

Airport Aid Program Gets Record Outlay

Washington—Commerce Department has earmarked a record $63.5 million for construction and improvement projects at 358 airports under the Fiscal 1959 Federal Aid Airport Program.

Total expenditures, largest annual allocation in the four-year federal aid program which began in 1955, will be matched on a 50-50 basis by local project sponsors.

The program, administered by the Civil Aeronautics Administration, is the final phase of the program of contract authority approved by Congress in 1955. Of the total amount, $60.5 million will be spent on 341 airports within the U.S. with the balance going for airports in U.S. territories.

Airports receiving more than $1 million in aid are: Los Angeles International, Oakland International, San Francisco International, Miami International, Atlanta Municipal, Chicago O'Hare, New Orleans Moisant International, Detroit-Metropolitan Wayne County, New York International, New York LaGuardia, Philadelphia International, Greater Pittsburgh, and Houston International.

Four Routes Awarded In Great Lakes Case

Washington—Civil Aeronautics Board last week announced the award of four new routes from the Great Lakes region to Florida in the Great Lakes Southeast Service Case. The Board named the following airlines to serve the routes involved in the case:

• **Northwest Airlines** to operate a route from Chicago to Florida in addition to the service now provided by Eastern and Delta.

• **Delta Air Lines** to operate a Detroit-Florida route through an extension of its Florida-Cincinnati route northward. Eastern also serves this route.

• **Trans-World Airlines** to operate a route from St. Louis to Florida in addition to the service now provided by Eastern. Vice Chairman Chan Gurney dissented in the TWA award.

• **Capital Airlines** to operate a route from Buffalo, Cleveland and Pittsburgh to Florida. No carrier serves this route at present. Gurney also dissented on this decision.

First Details of McDonnell Utility Jet

Washington—First detailed performance specifications on McDonnell Aircraft's new UCX 10-passenger four-jet executive utility transport, powered by either General Electric J85 or Fairchild J83 engines, point to a 45,000 ft. maximum cruise altitude, range (with reserve) in excess of 2,000 mi., and a top speed of Mach .79, which would put airplane in 500 mph.-plus category.

Prototype UCX, which would feature pressurization and all-weather capability, is yet to fly. Airplane is in running for USAF contract for a high-priority passenger and cargo hauling aircraft. It will probably be made available to civilian executive transport market.

Both J85 and J83 turbojets are rated at 2,000 lb. thrust at sea level. Performance estimates show J83 configuration generating highest speeds, less fuel weight for both normal and extended range missions.

Airplane incorporates low, swept-wing design, with four separate underwing nacelles in forward position. Wing span is 57 ft., length 66 ft., height 24 ft.

For ease of handling, airplane utilizes boost control. Lateral control is provided through small outboard ailerons, used in conjunction with upper surface spoilers from a point near aileron root to the inner nacelle. Spoilers are located in region of rear spar. No leading edge slats are included.

Lift components for UCX embrace Fowler flaps outboard and split flaps inboard. Spoiler lateral control with small tip aileron permits use of more of wing span for flaps. Airplane apparently uses spoilers as drag brakes in landing.

Normal fuel capacity is 1,880 gal., for range of 1,500 nautical mi. For additional range, fuel capacity can be increased to 2,500 gal. by addition of 620 gal. in wing center section.

Maximum fuel capacity is 3,098 gal. This with additional 598 gal. external belly tank under wing at centerline for J83 model. Larger tank—about 1,100 gal.—is required for J85 model. Refueling is over-the-wing from two points, one per side.

For navigation, McDonnell jet specifies large-dish antenna—presumably one for AN/APN-59 radar unit.

Normal cabin volume in the UCX is 685 cu. ft. Cargo capability is 9,000 lb. Airplane's cabin baggage compartment runs 30 by 52 in. Additional baggage can be stowed under electronic racks forward of main cabin. Wardrobe space measures 30 by 41 in. Galley space is 30 by 52 in.; lavatory, 30 by 36.

Cost per nautical mile, computed by McDonnell rules for 1,500 nautical-mi. range and 200 hr./yr. utilization for J85 engine, would run about $1.01.

McDonnell UCX Dimensions

Wing area (sq. ft.)	550
Aspect ratio	6.0
Taper ratio	.365
Thickness	.115 ave.
Sweep c/4	35
Span	57' 0"
Length	66' 0"
Height	24' 0"
Horizontal tail area (sq. ft.)	124
Horizontal tail span	23' 4"
It/MAC	2.95
Vertical tail area (sq. ft.)	86
Total wetted area (sq. ft.)	2,922
Total wetted area ratio	109%
Fuselage diameter outside	92"
Head room, aisle-ceiling	74"
Cockpit length	86"
Cabin length	228"
Seat spacing	40"
Crew passengers	2/10
Max. density seating	17
Max. litter capacity/attendants	12/2
Max. cargo (lb.)	9,000
Normal fuel, internal wing	1,880
Intermediate fuel	*2,500
Max. fuel	†3,098

* 620 gal. in wing center section, under fuselage.

† With additional 598 gal. external belly tank under wing at centerline for J83 model. Larger tank (about 1,100 gal.) required for J85 model.

Normal Mission

	GENERAL ELECTRIC J85	FAIRCHILD J83
Takeoff gross wt.	33,750 lb.	32,500 lb.
Passengers	10	.....
Fuel wt.	12,900 lb.	11,700 lb.
Range	1,500 n. m.	1,500 n. m.
Range, max. cruise	1,306 n. m.	.....
Max. cruise alt.	45,000 ft.	45,000 ft.
Service ceiling (TOGW)	37,900 ft.	.....
Service ceiling, 1 eng.	30,200 ft.	.....
Cruise Mach	.74	.79
Max. cruise Mach	.79	.....
Mil. critical field length	3,470 ft.	.....
Landing speed	88 kt.	.....
Landing ground roll (½ fuel)	1,760 ft.	1,740 ft.
Landing distance (½ fuel)	2,460 ft.	2,430 ft.

Extended Range Mission

	GENERAL ELECTRIC J85	FAIRCHILD J83
Takeoff gross wt.	44,950 lb.	41,400 lb.
Fuel wt.	23,700 lb.	20,150 lb.
Range*	2,200 n. m.	2,245 n. m.
Max. cruise alt.	45,000 ft.	45,000 ft.
Service ceiling (TOGW)	34,400 ft.	.....
Service ceiling, 1 Eng.	22,400 ft.	.....
Cruise Mach	.73	.78
Mil. critical field length	6,400 ft.	.....
Landing speed (mil. spec. res.)	88 kt.	.....
Landing ground roll (½ fuel)	2,090 ft.	2,000 ft.
Landing distance (½ fuel)	2,850 ft.	2,730 ft.

* With 70 kt. headwind, plus 30 min. endurance at sea level in lieu of Mil 5011A

AIRLINE OBSERVER

► Watch for Air Line Pilots Assn. to reaffirm its stand to American Airlines that no jet transports will be flown by ALPA pilots unless three pilot crew members are assigned to each aircraft with or without flight engineers. ALPA will restate its position as a result of a five-year contract signed by American Airlines last week with Flight Engineers' International covering turbine aircraft. The engineers' contract also could result in a pilot strike date against American. American pilots have been anxious to set a strike date but have deferred action because of ALPA opposition to an American strike at this time. The American agreement with the engineers could easily change ALPA's position. However, chances of an early strike are slim since a Presidential fact-finding board would likely intervene to forestall a stoppage of flight activities.

► Aeroflot's route expansion program (AW March 24, p. 24) was set back once more when the airline lost a bid to operate Tu-104 jet transports between Prague and Damascus. The Soviet-owned airline was refused transit rights through Greece by the Greek government.

► Rate of increase of domestic trunkline revenue passenger-miles continued its steady leveling-off in February to reach an 11.9% increase for the month as compared to February, 1957, when a 12.9% increase was recorded. In February, 1956, the increase of revenue passenger-miles for the month was 16.8%. Despite the dismal traffic picture, airline stock prices on the New York Stock Exchange remained steady and held close to 1958's highs.

► Incompatibility between an anti-hydraulic-fluid paint and a degreasing agent is suspected to have been the cause of blistering and corrosion discovered on the underside of Comet Mark IIs in service with the Royal Air Force. There is no evidence of corrosion on Comet aircraft which have not been painted.

► Golden Triangle operations calling for IFR regulations on all airline flights over 9,500-ft. on routes between Chicago-Washington-New York will be expanded to cover the triangle routes between Boston-Key West-Chicago and on all routes along the West Coast. Air Line Pilots Assn. is now polling its board of directors to determine the feasibility of expanding controlled airways. Most pilots feel the proposals will receive unanimous support in favor of more IFR operations.

► Russian designer O. K. Antonov has developed a larger version of his four-engine An-10 turboprop transport aircraft. The new An-10A model, which is scheduled to fly this year, seats 100 passengers instead of 84 on the standard An-10. Additional cabin space was obtained by lengthening the An-10's fuselage 6.56 ft. and by placing the seats closer together. Mockup of the An-10A's fuselage, together with models of all new Antonov planes, are being sent to the World's Fair which opens in Brussels in mid-April.

► Passenger manifest requirements, which cost international airlines approximately $1 million annually, are gradually being eliminated. This year, 13 European countries have dropped manifest requirements on flights within Europe. Spain and Austria have eliminated the manifest entirely and Ireland no longer requires it for flights to and from the United Kingdom. In North America, neither the U.S. nor Canada calls for manifests on any flights, and several Caribbean area governments are now considering abolition of manifest.

► Civil Aeronautics Board is proposing amendments to civil air regulations that will require all aircraft engaged in IFR flight to be equipped with electronic radio communication and navigational equipment that has been approved by the Civil Aeronautics Administration, meets uniform standards of performance and is in proper operating order. Purpose of the proposed amendments is to establish minimum standards of performance, maintenance and repair of electronic equipment on small aircraft in accordance with standards now applying to large aircraft. Board suggests some reduction in operating temperature requirements for equipment used by small aircraft would be made under the revised ruling.

SHORTLINES

► **Air Line Pilots Assn.** has taken exception to Civil Aeronautics Board findings as to the probable cause of the crash of a Northeast Airlines Douglas DC-3s at New Bedford, Mass., which killed 12 persons last September. Members of ALPA's Accident Investigation Committee reported that "erroneous altitude information" to the pilots of the plane was the "primary" cause of the crash. CAB said "probable cause of the accident was . . . pilot attempted to make visual approach by descending prematurely in the approach area without adherence to the prescribed instrument landing system procedure dictated by existing weather conditions."

► **Canadian Pacific Airlines** will ask the Canadian Air Transport Board for daily service rights between the east and west coasts of Canada as part of its proposed transcontinental service. Airline will ask for routes between Toronto and Edmonton, stopping at Regina; Montreal and Vancouver, stopping at Toronto and Winnipeg; Montreal and Vancouver, stopping at Ottawa, Saskatoon and Calgary; Montreal and Winnipeg, stopping at Ottawa; Montreal and Vancouver, stopping at Edmonton. The airline will use Douglas DC-6B aircraft on the new routes.

► **International Air Transport Assn.** will split its Traffic Conference into two separate sessions this year. The first meeting will take place in the Caribbean beginning May 13 to deal with interline traffic handling agreements, restricted articles and traffic documents. The second meeting, to be held in the south of France, will consider all fares and rates and questions of major policy.

► **Lufthansa Airlines** is scheduled to begin nonstop twice weekly Lockheed 1049-G Constellation service between New York and Brussels on April 2nd, in time for the Brussels World's Fair. In addition to these flights, Lufthansa will begin daily Convair 440 service to Brussels from Frankfurt, Dusseldorf and London on April 1. Total frequency of Lufthansa services in and out of Brussels will be 32 weekly. The German airline also will add a new route from Hamburg and Frankfurt to Rome effective April 2.

► **Mohawk Airlines** carried 26,649 passengers in February, a 1.5% decline from February, 1957. The airline says severe winter weather in the first two months of 1958 cost the local carrier approximately $200,000 in passenger revenue.

Air-Ground Telephone

Northwest Orient Airlines, pleased with results of its trial air-ground telephone installation, put the service in on a fleetwide basis. The airline installed its first unit in a Boeing Stratocruiser several months ago.

The public telephone is mounted on the stewardess panel in the rear of the Stratocruiser's main cabin. Passengers pay about $1.50, plus regular surface rates, for a call and use credit cards or reverse charges. Calls can be made to any point in the U.S. as long as the plane is within 175 miles of ground radio facilities at Chicago and Detroit.

Wing Assembly Set For 880 Jetliner

San Diego—Target date for major assembly of the Convair 880 jet transport has been set for April 10.

Additional aircraft assemblies will be started at three week intervals during the initial build-up with production eventually to be programmed at six airplanes per month.

Construction of the 880 will begin with the wing and proceed without the conventional "major-mating" of wing to fuselage. Wings are assembled in six large fixtures—sufficient for building three sets simultaneously.

After assembly, the wings of airplane No. 1 will be cured—two halves at a time—on June 19 in a Scotchweld oven to create leak-proof, integral fuel tanks.

The two wing halves will then be brought together by means of a center tie box, and an over-wing barrel and under-wing canoe will be attached. Successive sections of the fuselage will be mated as the wing moves down the assembly line. First flight of the 880 is now scheduled for early 1959.

Airport TV Circuit Posts Flight Data

Kansas City, Mo.—Closed-circuit television system to distribute schedule information through the passenger terminal here has been installed by Trans World Airlines.

Fourteen RCA Victor television receivers, from 14 to 24 in. in screen size, are linked to TWA's operations office and located at various points on the airport premises. Master board with flight data is picked up by the camera. The receivers are spotted at information booth, reservations room, ticket counters, flight dispatch office, maintenance foreman's office, commissary, executive office, and ramp office.

System cost $11,000 to install.

DESIGN . . . . *for Jets and Missiles*

PART: Exhaust casing.

CUSTOMER: General Electric (T 58 turboshaft engine)

MATERIAL: A-286, with stainless steel components.

TOLERANCES: .010 maximum gap on mating sheet metal parts prior to welding.

ADHERE TO: MIL 5923

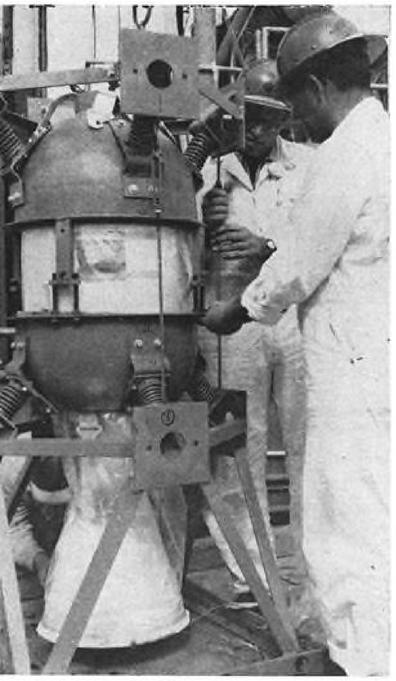
MADE BY: THE BUDD COMPANY, Defense Division

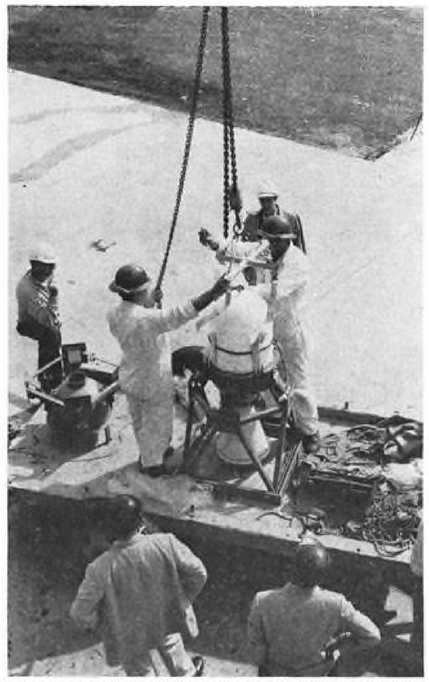
Here is an example of an intricately welded and closely toleranced sheet metal assembly reflecting The Budd Company's engineering and manufacturing facilities. These facilities, used by jet engine and aircraft manufacturers since 1942, now stand ready to assist the minds and the men who are making today's missiles.

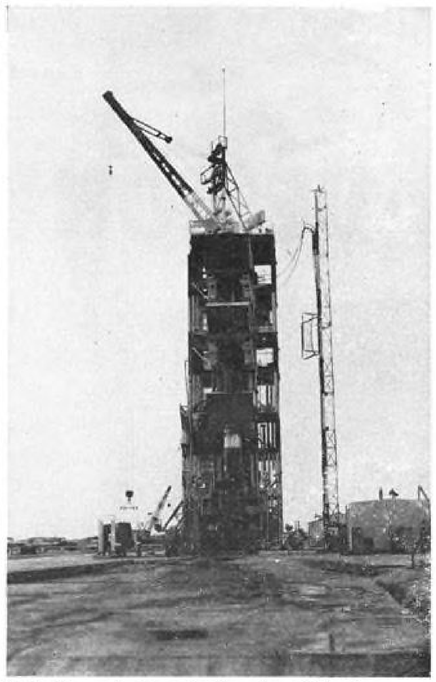
THE BUDD COMPANY

Philadelphia 15, Pa.

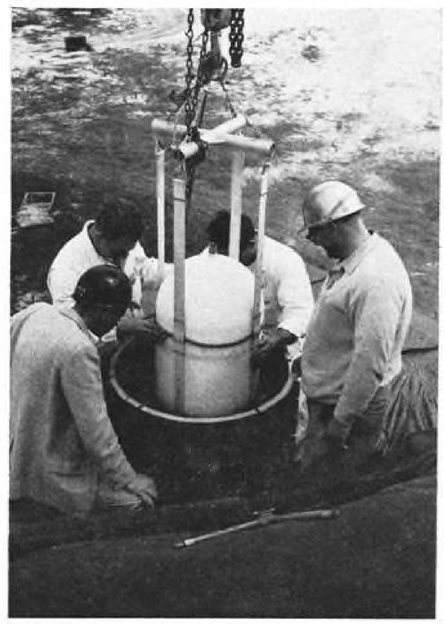
Budd







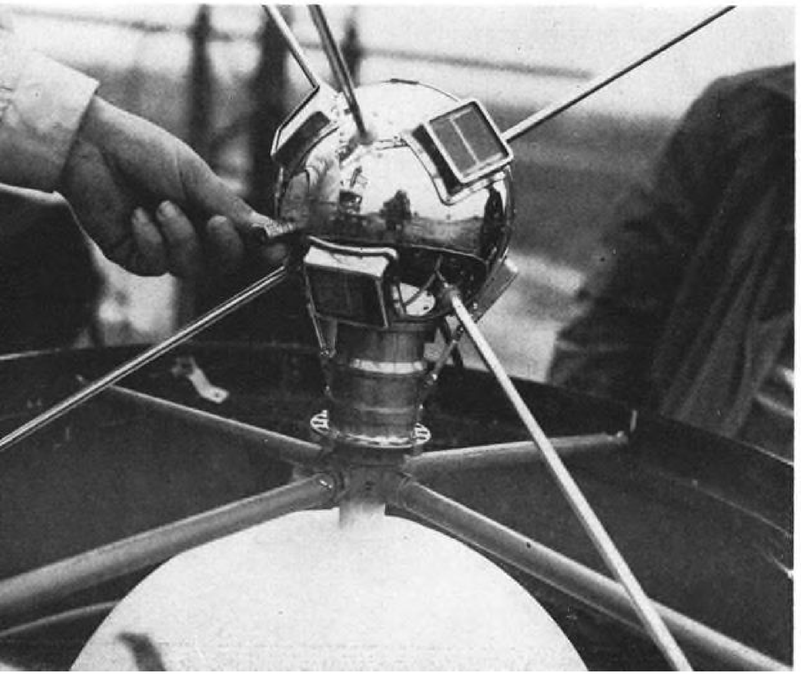
Third stage rocket of TV-4 Vanguard vehicle arrives at Cape Canaveral launching pad (left). Plastic film protects rocket from humidity. In center, propulsion unit is stripped of its protective packaging and is readied for hoisting. Vanguard is shown at right in shield.

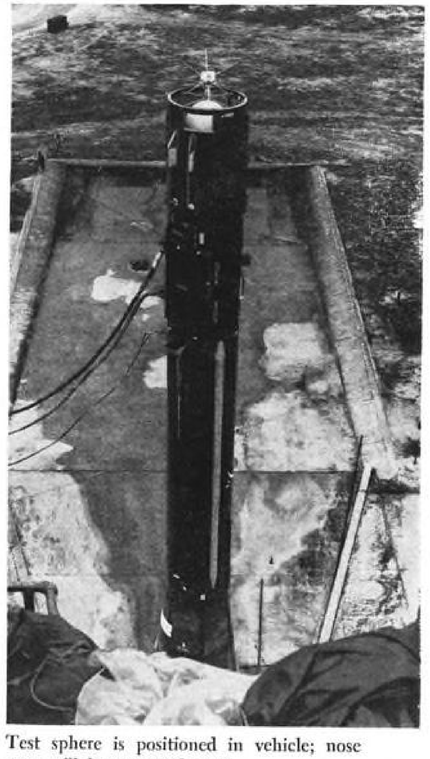


Third stage rocket is lowered into place, supported by sling (left and center). At right, engineers install spider guide on top of the third stage rocket. Spider guide is designed to steady the rocket unit so that separation from vehicle is straight and accurate.

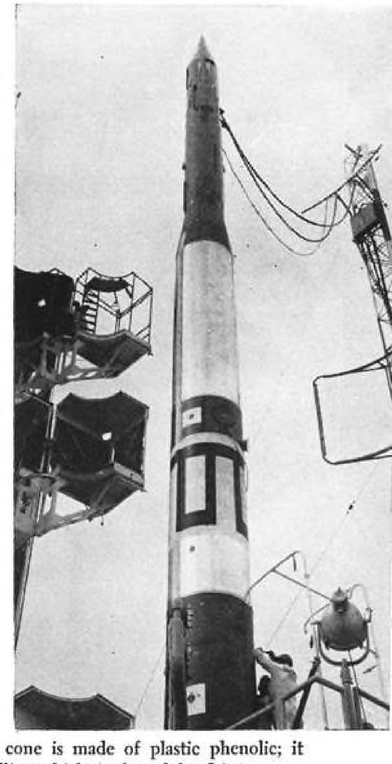
Technicians Ready Vanguard To Place Satellite in Orbit

Switch on side of Vanguard test satellite is turned to "on" position (below). The satellite's radio transmitter is now ready to broadcast its signal during orbit.





Test sphere is positioned in vehicle; nose cone will be mounted next.



Vanguard nose cone is lowered into position (left), and inspected (center) by technicians. Nose cone is made of plastic phenolic; it streamlines vehicle and insulates sphere from heat. At right the gantry crane moves back and the satellite vehicle is cleared for firing.

TITANIUM tank, designed for Atlas missile, is rinsed prior to heat treatment. Tank will hold helium which is used to pressurize the missile's propellant fuel.

Atlas Range Boosted, Weight Cut By Use of Titanium Alloy Sphere

Use of titanium alloy in the fabrication of spherical helium storage bottles for Atlas intercontinental ballistic missile is saving Convair engineers more than 700 lb. in structural weight and adds similar number of miles to missile's range.

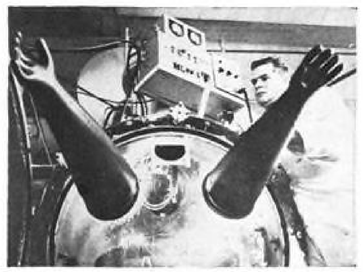
The alloy (90% titanium, 6% aluminum, 4% vanadium) is produced by Titanium Metals Corp. of America and is fabricated into spherical tanks by Titanium Fabricators, Inc. Ranging from 16 to 24 in. dia., the tanks hold the helium used to pressurize the propellants. Number of tanks used in each missile was not disclosed.

Engineers said that in long-range missiles it is estimated that each pound of weight saved can add one mile to overall range.

Original studies showed that a satisfactory titanium tank could be made at a weight of 50 lb. The same unit in aluminum weighed 80 lb.; in steel, 125 lb.

Titanium alloy advantages which influenced its selection by Convair include its ability to retain its properties at low temperatures and under high pressure, since the helium is stored in the missile at temperatures to −300F and pressures up to 3,200 psig. Corrosion resistance of the alloy also was cited, presumably because of intended use with fluids other than helium, which is chemically inert.

Convair's interest in titanium for missile applications goes beyond pressure vessels for the Atlas. In addition to tanks, titanium may be used for missile skins and hydraulic tubing, according to L. W. Standley, senior engineer in charge of mechanical design at Convair Astronautics Division.



GAUNTLETS are inflated by argon-helium mixture used to form inert atmosphere which protects metal during production. Workmen use gloves to gain access.

Satellite Comparison

	VANGUARD	EXPLORER I	SPUTNIK I	SPUTNIK II
Weight in orbit, including final stage rocket case	50 lb. plus	30.8 lb.	184 lb.*	1,120 lb.*
Initial orbit time	135 min.	114 min.	96.2 min.	103 min.
Initial apogee	2,513 mi.	1,600 mi.	560 mi.	1,056 mi.
Initial perigee	407 mi.	220 mi.	145 mi.	150 mi.
Estimated lifetime	Five to 10 years	Several years	Remained in orbit 2 months	6 months

* Final stage rocket case may not be included.

ICBM Effectiveness Depends on Support

Los Angeles—USAF's ballistic missiles are more dependent upon logistic support than any weapons ever developed, Maj. Gen. Ben I. Funk, chief of Air Materiel Command Ballistic Missiles Office, told San Fernando Valley Chambers of Commerce.

Gen. Funk attributed this dependence to the reduced warning time inherent in missile warfare and extreme reliability demanded by loss of human control at the moment of firing. Immobility of the big missiles calls for new concepts of supply and servicing. Third determinant of missile logistics is the greatly increased ratio of ground support equipment to actual missiles. He said that about 80% of total maintenance effort will be expended in ground support equipment. Ten Atlas ICBMs at a launching site will account for less than 20% of the total site cost and spare parts will be less than 10%.

Electronic data processing equipment and teletype and transceiver communication nets are vital to control the vast logistics enterprise. Major unit of the entire system is a big computer operated by the Ballistic Missiles Group and located at San Bernardino, Calif., which will be linked by the logistics communication network to missile squadrons, weapon storage sites and contractors. All transactions will flow through this system. Computer is expected to be operating this fall.

Gen. Funk emphasized the role of small business and subcontracting in missile development and production. He pointed out that of more than $1 billion paid to ballistic missile prime contractors, $267 million or almost 21% was passed on to small business subcontractors. The overall national figure for small business subcontracting participation is 22%. The ballistic missile business figure is expected to rise as progress from development into production continues. Almost 50% of money spent on Atlas and 40% on Titan has gone to subcontractors.

Rocketdyne reports that $40 million or nearly 18% of the amount of the prime contracts for Atlas and Thor engines went to first tier subcontractors. Of this, $13 million was passed on to second, third and fourth tier concerns. Businesses employing less than 50 people received 39% of the total, 22% went to companies employing 50-100 people and 5% went to those employing 200-500 people. Rocketdyne has a total of 4,084 small business subcontractors.

Douglas Aircraft reports that over 23% of the amount of the Thor contract went to small subcontractors.

Funk also announced establishment of a small business office to guide small firms in their dealings with prime contractors.

ENGINE runup starts on second Lockheed project Electra at Burbank, Calif., flight line. Each engine develops 3,750 eshp.

Electra's Goal Is Short-Medium Market

By Irving Stone

Burbank—Lockheed Aircraft Corp. is relying on its Electra transport's combination of turbojet engine and propeller to better the economics of the U. S. air travel segments which carry about 75% of airline traffic—the short to medium range runs.

To meet this key role in airline transportation the Electra propjet, now test-flying and scheduled for initial delivery to Eastern Air Lines in September, is designed particularly for:

- **Workhorse service** in a many-flights-per-day routine, backed by an over-400-mph.-cruise capability.
- **Low initial and operating** costs.
- **Fast servicing and maintenance,** prime factors in keeping plane flying and in slicing turnaround time.
- **Superior close-to-ground** flight characteristics and ramp maneuverability.
- **Basic simplicity** coupled with high reliability.

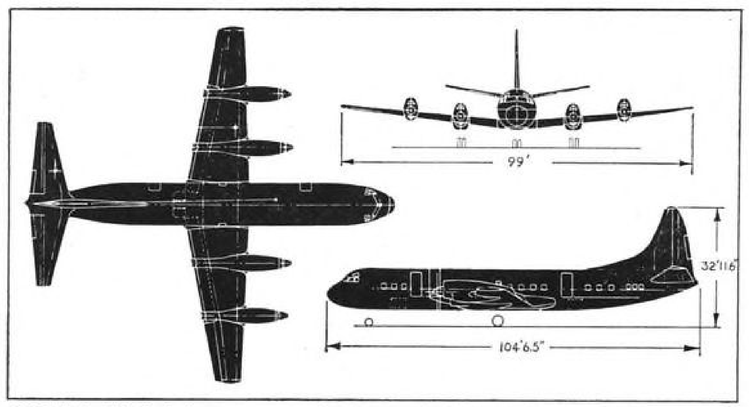
Setting its design sights to hit bull's-eye values in all these and supporting categories, Lockheed engineers have chalked up more painstaking detail analysis and test in the evolution of the Electra than with any other Lockheed transport.

Traffic Analysis

When the up-coming jet transport era began to take shape, extensive analysis by Lockheed showed that 75% of the air-traveling public was "commuter" types in the short to medium range category. This was a big segment of the market and Lockheed designed for it. General concepts began to jell in late 1954. Firming of design was prompted in large measure by American Airlines' design competition for a short to medium range plane. American made it clear in mission description that the plane would have to go "into the bushes"—to small towns with relatively short-runway airports. Another consideration was that the vehicle would have to operate with a low load factor—40% to 50%—and make money or at least break even. Combined with this was the attainment of block-to-block speeds in the general area that the public had been led to believe would be available in this next round of commercial transports.

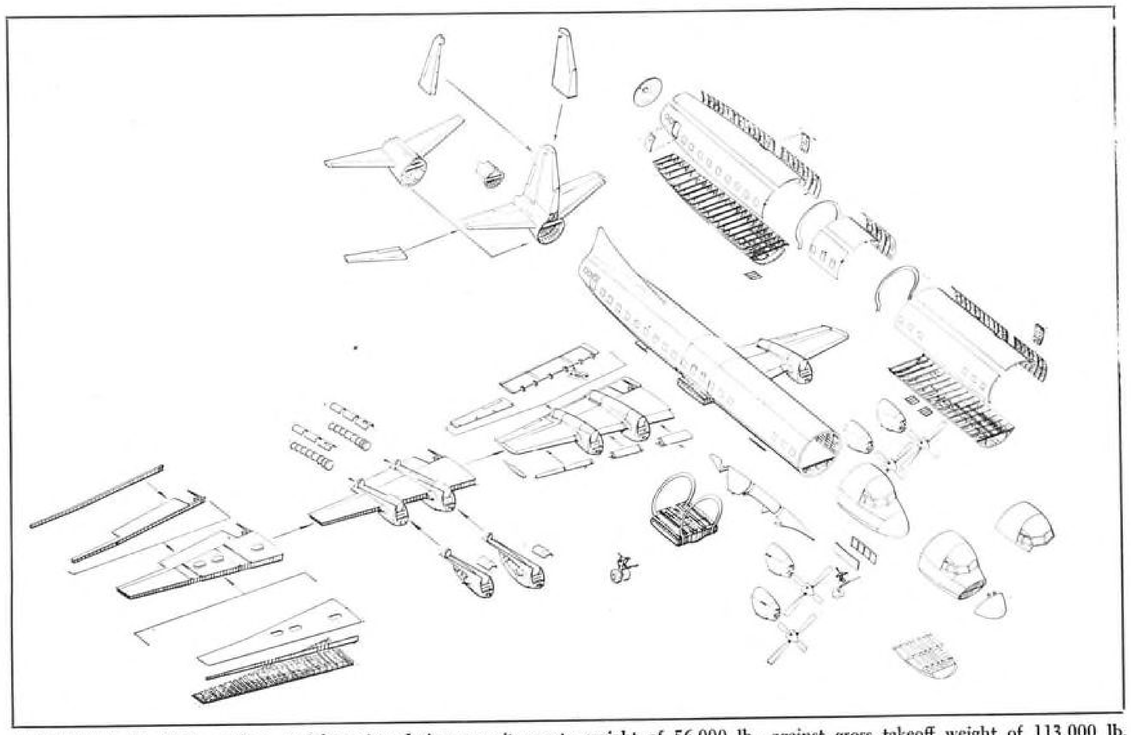
For its broad target, Lockheed picked an over-400-mph. cruise speed. Supplementing this, it was clear that the plane would require rapid acceleration and deceleration, good low-speed maneuverability, short takeoff and landing runs, minimum stopover and turnaround time.

Analysis of these requirements, in conjunction with a study encompassing the entire family of jet-type engines and large and small aircraft, prompted selection of the propjet powerplant. Lockheed believed that this engine possessed favorable operating characteristics on the ground and near the ground, together with a more-than-reasonable cruise speed, considering that the plane would spend a relatively small portion of its operating life at cruise. Propjet also was pinpointed because of its high takeoff thrust, high approach and landing drag, and relatively low specific fuel consumption. In the short-to-medium haul, Lockheed engineers determined that flight would frequently be between 5,000 and 15,000 ft. and in this regime the propjet demonstrates

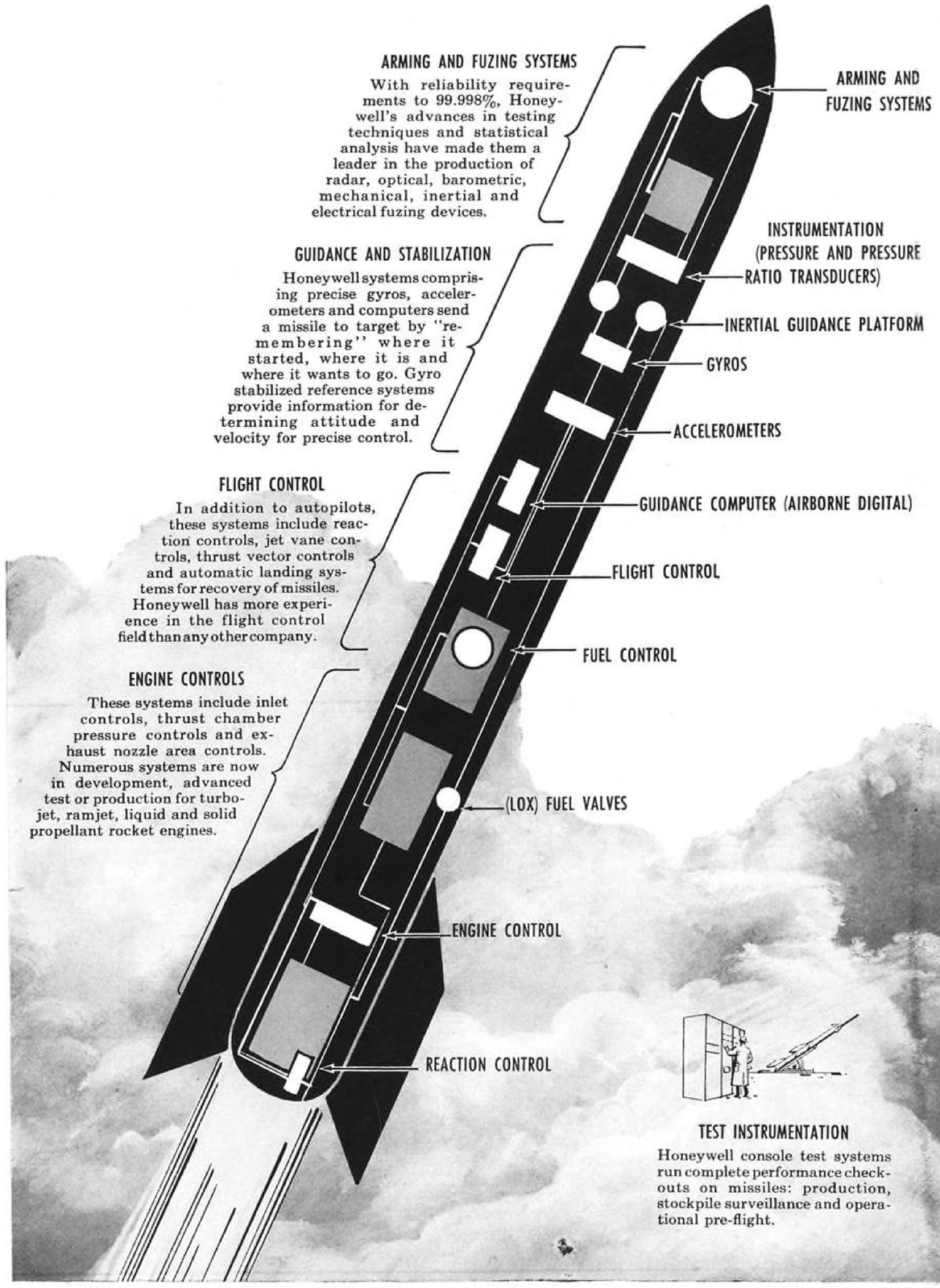


ELECTRA cabin body has constant inside diameter of 128 in. for four or five-abreast seating.

LEAD Electra on final assembly line is expected to begin proving program in April. Second, fourth aircraft on line are for Eastern Air Lines.



MINIMUM bulk, light engines, weight-saving design permit empty weight of 56,000 lb., against gross takeoff weight of 113,000 lb.



TEST INSTRUMENTATION

Honeywell console test systems run complete performance check-outs on missiles: production, stockpile surveillance and operational pre-flight.

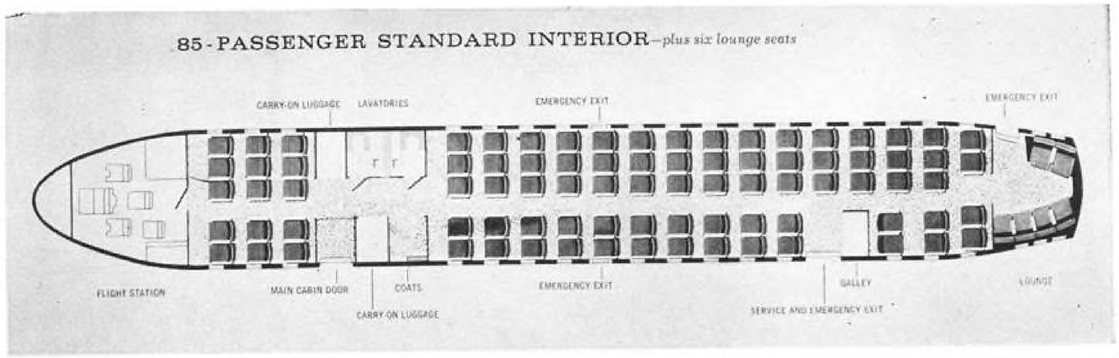
How many brains make a missile?

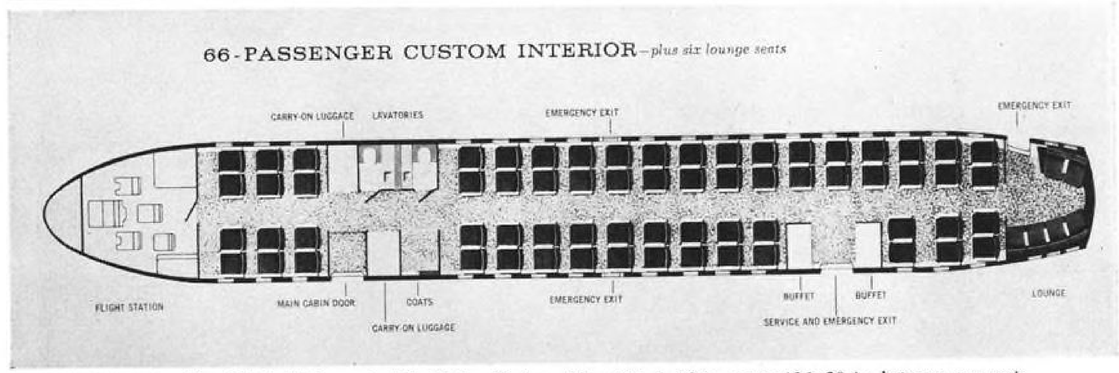
Control systems are the brains that guide, control and explode missiles. Honeywell can build any of these integrated control systems or sub-systems.

Honeywell is now developing and producing systems, sub-systems and components for the following missiles: Sidewinder, Honest John, Asroc, Corporal, Thor, Redstone, Wagtail, LaCrosse, Sergeant, Little John, Titan, Falcon, Vanguard and many *classified* applications. This broad experience in missiles, as well as a solid background in rockets and aircraft systems, makes Honeywell the logical company to aid you in your airborne control problems. Contact Minneapolis-Honeywell, Military Products Group, 2753 Fourth Ave., South, Minneapolis 8, Minnesota.

Honeywell

Military Products Group





STANDARD interior aisle width is 17 in., seat width 18 in. Custom aisle width is 26 in., seat width 20 in. between arm rests.

very economical fuel consumption. Also, the propjet would give a higher percentage of scheduled completions by reason of its economic holding ability, in comparison with a pure jet. Lockheed planners reasoned that there is no angrier passenger than one who is put down at an alternate airport 200 to 400 mi. away from his destination.

Powerplant chosen was Allison 501-D. Question of difficulty with reduction gearing in any propjet engine has been raised frequently in the industry. Lockheed considers these doubts completely unfounded. Essentially, this gearing is an extension of reduction gear experience piled up in 20 years of operation with piston engines on the airlines. Only unique feature of propjet reduction gearing is its greater step-down, but this poses no problems, Lockheed engineers say.

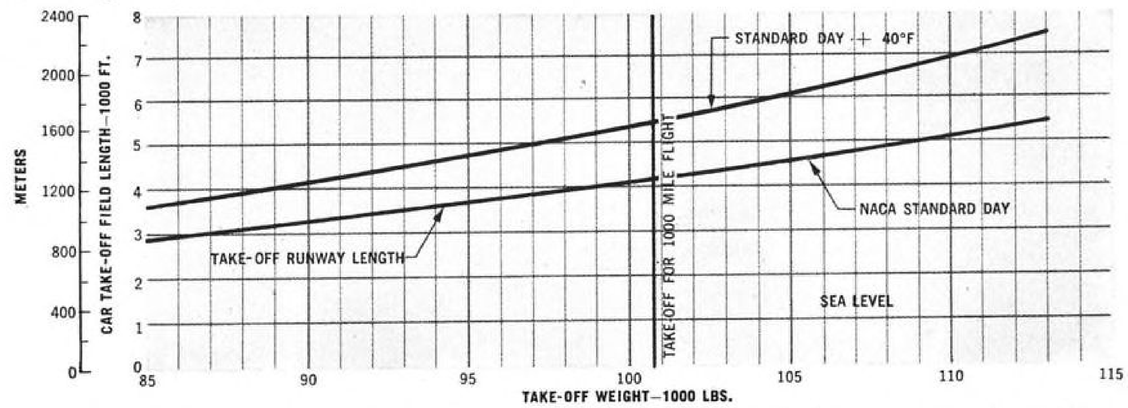
Economy Goal

Lockheed's target was to achieve lowest cost per seat-mile in the short-to-medium haul category, roughly approximating 150 to 500 mi. General approach was to keep size and weight of plane as low as possible.

After considerable discussion with airlines on requirements to meet demands of the short to medium haul, Lockheed established a 66-passenger custom (first class) configuration, and an 85-90 passenger (standard) layout. Relatively short (104.6 ft.) fuselage length accommodates 18 rows of seats by location of pressure bulkhead further aft and carrying full width of cabin farther forward.

Long experience showed Lockheed that the mid-diameter of its Constellation transport was optimum for comfortable four or five abreast accommodation. Four abreast would be considered luxury accommodations; five abreast seat dimensions would have to be roughly equivalent to those in present short-haul twin-engine transports.

Electra cabin body was thus de-



TAKEOFF field length for standard day (CAR compliance) is 4,190 ft. for 100,700 lb. takeoff weight, necessary for 1,000 mi. flight.

VISIBILITY is good in Electra cockpit, which has three-abreast seating. Flight station has separate air conditioning system, also has 11 cu. ft. portable oxygen cylinder for crew use.

signed with a constant inside diameter of 128 in. to meet these two categories of travel. Lockheed planners also have found that the Electra fuselage diameter will fit "thrift class" seating of six abreast, although this category was not contemplated when the fuselage diameter was fixed. Thrift class service on the Electra probably would get its initial impetus in Europe. Passengers arriving at European gateways on turbojets via the North Atlantic run would board the Lockheed propjet for thrift class transportation to other European points. Lockheed believes that the Electra cabin can be exploited to accommodate 99 to 120 passengers, depending on internal arrangements preferred by the customer.

Small Wing

For minimization of bulk to match the medium-to-short range mission, Lockheed has come up with a small wing specifically tailored for minimum drag. This low aspect ratio configuration with its wide chord results in a good spar depth and lightweight structure.

Use of the propjet engines also contributes to low weight. Allison 501-D13 weighs about 1,750 lb. compared with more than 3,500 lb. for the turbo-compound used in Lockheed's Super Constellations and Douglas DC-7s. Also, the Allison propjet gives about 4 hp./psi. of frontal area while current piston types run about 1½ hp./psi. of frontal area.

With minimum bulk, light engines and overall refinements for weight saving, Electra has emerged with an empty weight of 56,000 lb. against a gross takeoff weight of 113,000 lb. This results in a 2:1 ratio, considered a major achievement.

Electra is designed with a high structurally limited landing gross weight—95,650 lb. This is considerably more than the normal operating landing weight, which will usually be about 85,000 lb., and will make it possible to carry into most airports a large quantity of extra fuel in excess of reserve fuel. This would eliminate necessity for frequent refueling, additional ground time, excessive equipment use and more ground personnel.

Factor that Lockheed stressed for operating economy is provision for high forward speed during descent. This necessitated stronger wing section but paid off in reduction of flight time in route segments. This reduced time is directly translated into lower costs associated with hours in the air.

Lockheed engineers realize that the Electra will spend much of its time in operations relatively close to the ground, such as circling before landing or following takeoff, because of the large number of hops it will make in an average day in the short-to-medium pattern. Electra is expected to minimize this operational phase by being small and maneuverable.

Many takeoffs and landings involve much taxiing. However, taxiing time is shorter for the Electra because landing run is shorter as a result of large propeller disk area, coupled with stopping force stemming from props in ground idle position. Reverse thrust is not used except for emergency, icy or wet run-

Low operating costs

On short-sector, high-frequency flights the new Local Service Viscount will provide the lowest operating costs of any postwar aircraft in this category. Design refinements make possible exceptionally low break-even load factors on local service operations. Vickers engineers will gladly make a complete cost analysis of *your* routes.

Proved popularity . . . big capacity

Since its introduction to American service in 1955, the Viscount has firmly established itself as the most *preferred* of all modern airliners. Because of its famed smoothness, silence and speed, the jet-prop Viscount has boosted load factors an average of 35% for 27 airlines worldwide. The new Local Service Viscount will comfortably accommodate from 54 to 65 passengers. In either configuration there is ample space for passenger baggage and mail.

Dependable, economical Rolls-Royce power

The Local Service Viscount is powered by four performance-proved Rolls-Royce Dart 506 jet-props. These engines have demonstrated their outstanding ruggedness and reliability under operating conditions similar to those of local service operations. The Dart 506 engines are unsurpassed for economy, ease of maintenance and hours between overhauls. (TCA reports approval for 1800 hours—with current test engines being run to 2000 hours.) They give the Viscount exceptional take-off and climb performance and a cruising speed of 300 mph at 10,000 feet.

FROM THE WORLD LEADER IN JET-

Fast intermediate servicing and terminal turn-around

The Local Service Viscount can be operated on routes of up to five 100-mile sectors—without refueling and with a minimum of ground handling. Provisions are made for fast under-wing pressure refueling at terminal points (overwing fueling points are also provided).

Less ground equipment is needed and valuable time is saved by the Viscount's integral, hydraulically operated stairs. Further savings are assured as the engines rarely require water-methanol at intermediate stops.

The #4 engine can be kept running during intermediate stop-overs—thus assuring ample power for restarting the engines. If longer stop-overs are required, internal restarting is still possible because of increased battery capacity. Brakes on number 1, 2 and 3 engines prevent windmilling of props, permit safe, quick on-and-off loading of passengers on the left side, freight on the right.

Local Service Viscount means Jet Age growth for you and the communities you service!

By cutting flying time almost in half—and by introducing Jet Age service comparable to the best offered by the "trunk" lines—the Viscount will open doors to important *new* business traffic that means accelerated growth. This growth will benefit not only local carriers, but the areas they serve—areas that deserve the opportunities that come with the best and most modern airline service.

Because the Local Service Viscount is tailored for highly economical operations—and because its payload capacity is sufficient to absorb future growth—it is the ideal airliner for local service carriers today *and tomorrow!*

For information, contact: Christopher Clarkson, U.S. representative, 10 Rockefeller Plaza, New York 20, N.Y.

PROP AIRCRAFT...

VICKERS LOCAL SERVICE VISCOUNT

POWERED BY FOUR ROLLS-ROYCE DART ENGINES

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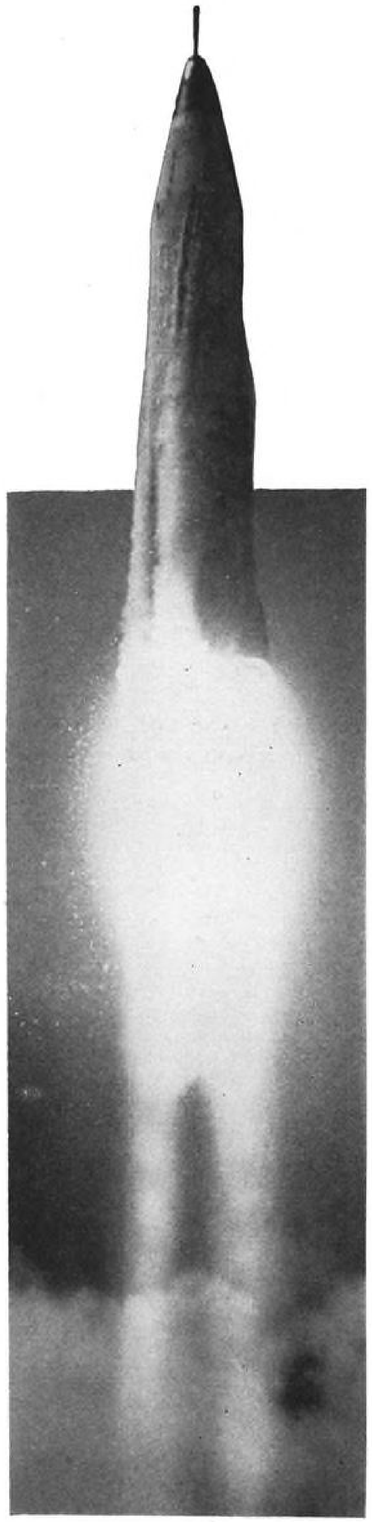

First test firing of the ATLAS ICBM at Cape Canaveral, Florida, June 11, 1957.

Honeywell Rate Gyro
Type JRT
Shown ½ size

Flight Control for the ultimate weapon

Three Honeywell Rate Gyros, Type JRT, provide missiles with precise three-axis directional stability and are currently being supplied to the ATLAS missile program.

The Type JRT is a highly accurate precision instrument for measurement of absolute rates of rotation in inertial space. Viscous damping is electro-mechanically controlled to maintain a constant damping ratio over the entire operating temperature range of −65°F. to +175°F.

This new Honeywell Rate Gyro is designed expressly for flight control of missiles and flight instrumentation in missiles and aircraft where severe ambient conditions prevail . . . and at the same time where low threshold, minimum hysteresis, excellent linearity, high natural frequency and ruggedness are essential.

Honeywell inertial components and engineering experience are available to assist in the solution of your Gyro system problems. Write for Bulletin JRT . . . Minneapolis-Honeywell, Boston Division, Dept. 11, 1400 Soldiers Field Road, Boston 35, Mass.

Honeywell

Military Products Group

DESCRIPTIVE DATA

- EXCELLENT LINEARITY: 0.25% of full scale.
- LOW HYSTERESIS: Less than 0.1% of full scale.
- LOW THRESHOLD: Less than 0.01 degree/second.
- MICROSYN PICKOFF: Variable reluctance type providing infinite resolution and high signal-to-noise ratio.
- FULL SCALE RATE: Up to 1000 degree/second.
- FULL SCALE OUTPUT: Up to 12 volts.
- RUGGED: Withstands 100 G shock.
- VIBRATION: Withstands 15 G to 2000 cps.
- SIZE: 2 7/64" diameter 4 5/16" long.
- WEIGHT: 2 lbs.

way conditions. Less taxiing and parking time also results from improved maneuverability inherent in fast response of engine-propeller combination in both acceleration and deceleration.

Saving in taxi time may amount to only one or two minutes for takeoff and landing situations, but multiplied by as many as 10 or 12 hops per day, it adds up to a sizable economy, considering related factors such as reduced engine time, less flight crew time, fuel savings and reduced maintenance cost.

Electra can be operated at various altitudes dictated by weather or traffic control conditions with small effect on flight schedules or operating costs, Lockheed says. At 200-mi. flight distance, if flight plan altitude is changed from 10,000 ft. to 5,000 ft., there is an improvement in block time of 1% and the increase in operating costs will be about 1%. If it is necessary to fly at 20,000 ft. instead of 10,000 ft. for a 200-mi. trip, then block time is reduced by 1.8% but operating cost is improved by 0.3%.

For 250-mi. flight distance, if flight plan is changed from 10,000 ft. to 5,000 ft. cruise, block time is improved by .4% but operating cost is increased by 1.6%. If the change for the same trip is from 10,000 ft. to 20,000 ft. altitude, block time deteriorates by 1.3% while operating cost is lowered by 1.2%.

Average Flight Distance

Estimate of flight distance average for Electra U.S. route service will be in the neighborhood of 200-250 mi. Initially, Electra will be used for some of the "blue ribbon" flights, involving relatively long distances, so that average flight lengths will be high in the early years of Electra service. Eventually this distance will be reduced toward the 200-250 mi. flight length as the pure jet transports are put into service for medium-long range service.

Direct operating costs calculated by Lockheed for standard 85-passenger Electra, assuming zero wind conditions, 14½ cents per gallon fuel cost, 15-min. maneuver time and using 1955 Air Transport Assn. cost method, are 2.5 cents per seat-mile for 100 mi. flight distance, 1.93 cents for 200 mi., 1.72 cents for 300 mi., 1.57 cents for 400 mi., 1.5 cents for 500 mi., 1.32 cents for 1,000-mi. flight distance.

Takeoff field length for standard day, based on Civil Air Regulations requirements, assuming an engine failure at the most critical point in takeoff run and propeller automatically feathering, is 4,190 ft. for takeoff weight of 100,700 lb., necessary for 1,000-mi. flight. For standard +40F hot day, this distance is 5,420 ft. At maximum takeoff weight of 113,000 lb., standard day and hot day field lengths required

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are 5,470 ft. and 7,550 ft., respectively.

Climb to 20,000 ft. requires but 23 min. at maximum gross takeoff, while 15,000 ft. is reached in 13 min.

Landing distance at sea level and standard temperature, based on CAR requirements, including the .6 factor and excluding benefits of reversed props, is 4,920 ft. at an average landing weight of 85,000 lb. At maximum landing weight of 96,650 lb., this distance is increased to 5,400 ft.

Cost Control Factor

Cost control, starting right in engineering, has been much more an important factor in Electra design than in any other Lockheed project. Price of plane is under $2 million generally, depending upon extent of customer options and quantity ordered. This price is considered relatively low in today's market and also because of Electra's earning capacity.

Electra has been planned and tooled for 10½ per month production rate. This tooling approach means that fewer manhours and less rework time will be used to produce the aircraft.

Production rate is premised on sale of 400 aircraft; to date 144 have been sold to 11 airlines. Like any other transport aircraft enterprise, the 400 figure is a target fixed at the beginning of the program and is the basis for all planning, tooling and production line facilities. In essence, it is a risk assumed by the manufacturer, but it lowers the unit cost per plane.

Tight Scheduling

Unusually careful detail scheduling has been funneled into engineering, purchasing and manufacturing to ensure meeting technical and delivery commitments.

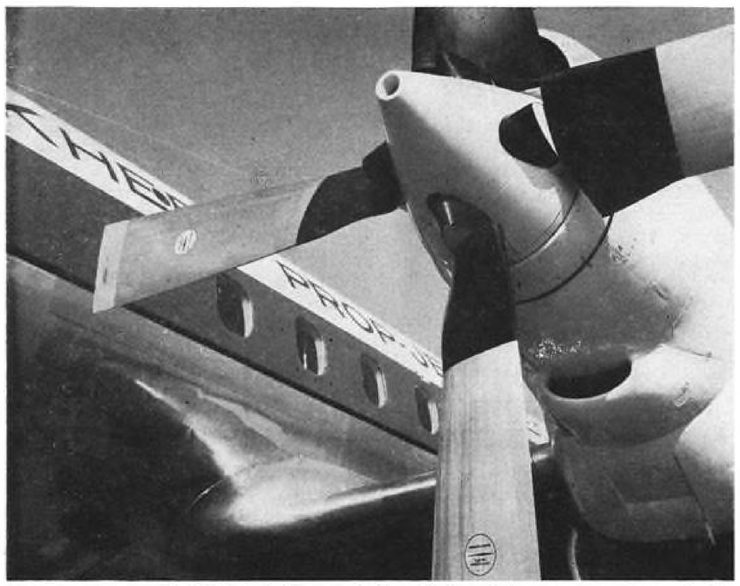
On-time delivery is vital because receipt of these planes by airlines has been timed for phasing into the jet transport era to facilitate crew indoctrination and training, and to allow airlines which are also getting the big turbojets (such as American Airlines, Eastern Air Lines, National Airlines, KLM Royal Dutch Airlines) to avoid conflicting introduction problems and permit them to rack up prior experience with the propjet. First flight of first Electra was approximately 55 days ahead of schedule.

For additional insurance that there will be no delay in deliveries, Lockheed is conducting an extensive operational "wringout" program. It will have more test planes in the Electra program than in any of its previous transport developments. This will include five Electras plus the Elation, a bailed Navy Super Constellation with Electra's Allison propjet propulsion system (AW Oct. 14, p. 93), as well as a 1961S Constellation with Allison propjet engine installed in No. 4 position.

Lockheed has contributed an all-out effort to build the highest degree of serviceability and maintainability into the Electra, proceeding on the premise that these factors are among the most critical for airline operators.

Lockheed's philosophy was that serviceability and maintainability would have to be designed into the Electra from the start. Company's maintenance and equipment design staff includes former airline engineers who, from the beginning of preliminary design, virtually looked over the shoulders of Lockheed transport designers. Coupled with this approach, the maintenance group canvassed a substantial cross-section of airlines using a wide range of equipment to find out what their current problems were. This gave a detailed picture of what was to be avoided and what was to be stressed in the Electra design for serviceability and maintainability.

For another check, before systems design was under way, Lockheed's maintenance design group established target times for installation and removal of equipment. These figures were circulated and served as ground rules for maintenance. As installation drawings progressed, they were checked by the maintenance design group to



TURBOPROP propeller blade is hollow steel. Four-blade unit incorporates spinner, feathering and reversing actions. Spinner also contains electrical anti-icing system.

estimate if target times would be met. This check was further evaluated on functional mockups.

In addition, component and system installations for representative and critical units are being checked on the first production Electra. Changes will be successively made and checked out on four more Electras, after which specific target times should be resolved.

Service, Maintenance Criteria

Factors established as prime requisites for maintainability and serviceability were simplicity, reliability, interchangeability, safety and accessibility. Degree of accessibility for all components is based on a system of priority related to the degree of servicing anticipated and component service life.

One of the key observations was that too much maintenance on today's aircraft had to be performed from inside the airplane. To overcome this, design for external maintenance was stressed using "service center concept," which provides for concentrated equipment grouping easily reached from external locations. This allows specialized maintenance personnel to work in concentrated areas on equipment requiring their particular skills.

Trouble-shooting procedures are simplified and access is afforded without removal of paneling or cargo. Electra service centers include:

• **Hydraulic center**, located just aft of rear wing-beam, accessible through large door in fuselage belly. It contains such items as electrically-driven pumps, filters, reservoirs, selector valves and aileron power booster. Use of electrically-driven pumps minimizes line lengths normally involved when pumps are engine-mounted and permits checkout of hydraulic system with engines inoperative. Manifolds located directly in the hydraulic service center are used to plug in components normally line-mounted. This minimizes leak potential. Manifold connections are designed so that hookups cannot be made incorrectly. Manifolding has saved considerable weight in comparison with line mounting and has eliminated 19 external connections in one hydraulic installation.

• **Electrical service center** is located forward of front wing-beam, in fuselage belly. It concentrates in a single area such items as the main power distribution, generator control equipment, engine-propeller control equipment. This arrangement minimizes lead lengths to and from powerplants. Location of electrical and hydraulic service centers on opposite sides of the center section wing box puts a maximum distance between electrical leads and hydraulic fluids with their flammable potential.

• **Air conditioning** service center, located just forward of electrical center, also has separate access door and contains freon system components, air-cycle cooling units, recirculator fan, main system filters, cabin duct electric heater and electrical control package.

Other details of Lockheed's emphasis on easy maintainability and serviceability include these provisions:

• **Radome, retained by four** quick-disconnect latches, is hinged at top for access to weather radar and associated components. With radome open, four doors give complete access to cockpit controls and back of instrument panel.

• **Package plug-in-type system** components have been used wherever possible. In some instances, this approach will save as much as three hours of maintenance time, Lockheed estimates. Example is in fuel system, where functional components such as pumps, valves, quantity probes and drip sticks are removable from outside of tank without necessity of draining fuel.

• **Main and nose landing gear** incorporate mechanical linkage which physically blocks actuation of the retract strut to eliminate possibility of inadvertent retraction while plane is resting on gear. In addition to serving as a safety feature, this arrangement saves mechanic's time involved in installing safety pins after each landing. Considering that Electra on normal schedules may make one landing per hour average, this saving will cut at least one half hour per day in mechanic's time, possibly will cut down on number of ground crew required.

• **Landing gear axle** has been designed with internal threads for mating with wheel retaining nut. This eliminates possibility of damage to thread as in former practice when wheel bearing race was scraped across external threads in wheel removal. Damage to these external threads meant dressing at least, and possibly replacement of complete axle and piston assembly.

• **Nose landing gear scissor** is constructed to give free swiveling action as soon as towbar is attached. This eliminates danger, in former practice, of damage to nose wheel if mechanic would forget to disconnect scissors. Disconnection of towbar automatically puts nose gear back in locked position for steering.

• **Quick trouble-shooting** arrangement in anti-icing bleed air system uses a single push-to-test check point to determine if system leakage is within limits. This check can be performed quickly at pre-flight and, in combination with system valving, indicates general location of excessive leak.

• **Rigging adjustments,** except in aileron control system, are limited to system terminating points. This eliminates intermediate adjustments with attendant possibility of incorrect rigging. Rigging pins are used at terminal points to speed adjustment and eliminate special rigging templates. Similar rigging provisions also apply to engine controls.

• **Safety wire and cotter pins** have been eliminated wherever possible in favor of self-locking nuts and self-locking threaded inserts in airframe, equipment, engines and propeller. This is intended to save considerable disassembly time in maintenance and overhaul operations—estimate is that in

overhaul of one engine and propeller about 20 manhours will be saved.

• **Unusually large number** of access doors (188) generally are equipped with quick-acting fasteners to speed line and periodic inspection, eliminate need for pulling one piece of equipment to gain access to another. Although wing leading edge is hinged, faster access at specific areas is provided with doors averaging 6 x 8 in.

• **Complete interior consists** of pretrimmed panels which can be quickly snapped into place on rubber shock mounts. This facilitates complete change of interior color or trim scheme, allows quick individual panel replacement when damaged, permits individual panel removal for access to structure for inspection. Panel scheme also allows access to electrical radiant heating elements for cabin, which operate at low watt density for maximum element life. Cabin wall has protective film adjacent to fuselage skin, followed by 1½-in.-thick Fiberglas blanket adjacent to an aluminum alloy core honeycomb panel which contains the heater elements. This is followed by a Fiberglas sheet covered with trim material for cabin interior. Radiant heating panels in cabin floor seat area are heavier and stronger than those in walls to compensate for abuse factor. Electrical heating panels are also installed under cargo compartment flooring. Here, heating elements are held to a single metal sheet by phenolic-impregnated glass cloth.

• **Relocation of anti-collision** rotating beacon is another example of seemingly unimportant maintenance refinement, but move is expected to save considerable manhours if bulb replacement is required. Normally this beacon is mounted on vertical tail, where it must be reached by long ladder or frame. On Electra, beacons are on top and bottom of fuselage in area of rear service door, so that top bulb can be replaced easily from inside cabin and bottom bulb from ground.

• **To minimize ground-support** equipment, in turn minimizing ramp congestion, Electra's freon cooling system, hydraulic system, folding stairway and and cabin heating system all use electrical power which can be supplied from a single electrical ground power cart or ramp connection. Plane is designed to use existing servicing and ground maintenance equipment including wing and axle jacks (used for Constellations and DC-7s) and water and toilet servicing equipment.

• **Allison modified its 501-D13** propjet engine for improved maintainability in airline service, in accordance with Lockheed specifications. Major refinement is ability to remove turbine and burner can assemblies with engine installed in the aircraft. In addition to facilitating maintenance or replacement, this will be a considerable aid during periodic inspection to determine if overhaul periods may be extended.

• **Engine nose reduction gear** box also can be removed with engine installed.

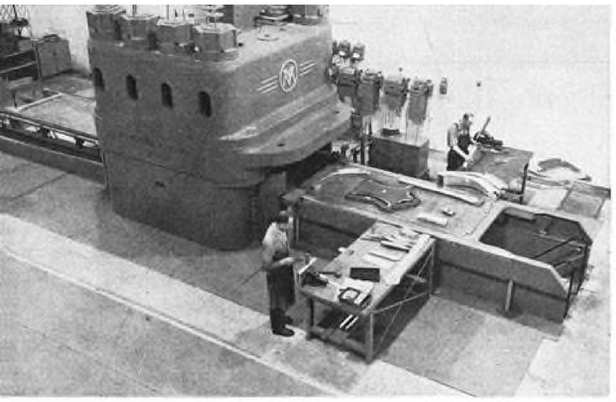
• **Complete propjet power egg** can be removed and installed in approximately two hours. Lift bar attaching to top of power egg is fitted with a Lockheed-designed sling incorporating an infinitely variable center of gravity positioner to eliminate time-consuming handling adjustments. In addition to handling power egg, lift bar and sling also will fit bare engine.

• **Numerous propeller functions** may be checked directly from cockpit. This includes blade angle follow-up, feathering, reversing, negative torque system operation and leakage rate of propeller hydraulic system (with engine operative or static).

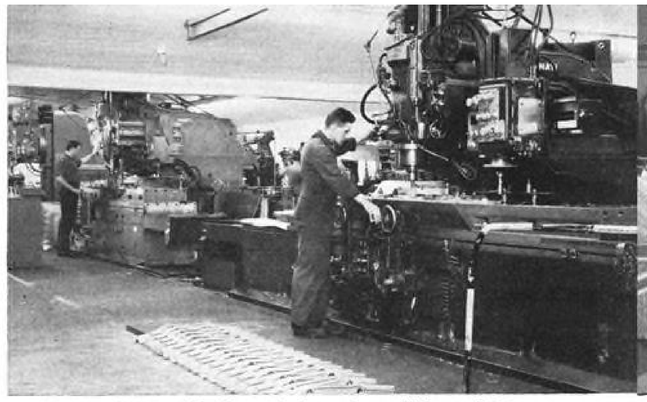
(This is the first of two articles on the Lockheed Electra. The second will appear in next week's issue.)

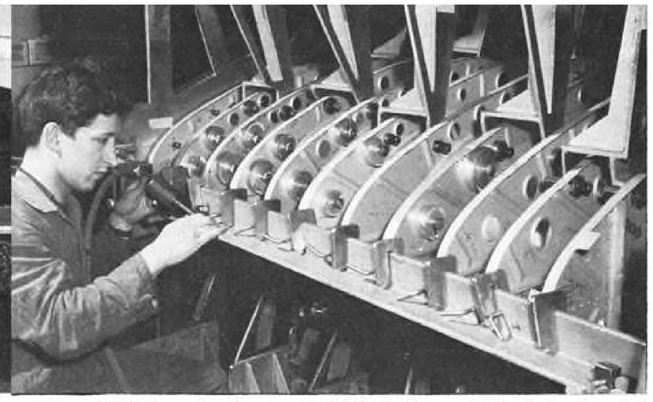
Electra Basic Data

DIMENSIONS, AREAS	
Wing area	1,300 sq. ft.
Wing span	99 ft.
Fuselage length	104 ft. 6.5 in.
Fuselage inside diameter	128 in.
Height over tail	32 ft. 1 in.
STRUCTURAL DATA	
Takeoff structural design gross weight	113,000 lb.
Landing structural design gross weight	95,650 lb.
Maximum zero fuel weight (In Electras for which additional orders are placed, this figure will be raised to 86,000 lb., providing payload increase of 5,040 lb., with manufacturer's weight empty increase of 50 lb.)	80,910 lb.
Limit maneuver load factors	Positive 2.50 Negative 1.00
Maximum limit gust load criteria	50 fps. up to 324 kt. EAS
Design limit diving speed	405 kt. EAS below 8,000 ft.; Mach .711 above.
Design limit level flight speed	324 kt. EAS below 12,000 ft.; Mach .615 above.
WEIGHT SUMMARY (85 PASSENGER STANDARD)	
Weight empty	56,125 lb.
Operating equipment (total)	3,213 lb.
crew and crew baggage	895 lb.
passenger and service equipment	1,530 lb.
ship's equipment	269 lb.
system fuel and oil	324 lb.
consumable oil	195 lb.
Operating weight	59,338 lb.
Payload (total)—(space limit)	21,195 lb.
passengers (85)	14,025 lb.
baggage	3,400 lb.
cargo	3,770 lb.
Reserve fuel (2½ hr.)	8,200 lb.
Landing weight (with above reserve)	88,733 lb.
Design gross	113,000 lb.
ENGINE DATA	
Length	145 in.
Width	27 in.
Height	36 in.
Weight	1,750 lb.
Fuel	Kerosene or JP-4
Takeoff	3,750 eshp. S. L. fuel .543 lb./hr./eshp.
Maximum continuous	3,375 eshp. S. L. fuel .555 lb./hr./eshp.
Climb 94% max. rated temp.	3,105 eshp. S. L. fuel .568 lb./hr./eshp.
Cruise 90% max. rated temp.	2,700 eshp. S. L. fuel .592 lb./hr./eshp.

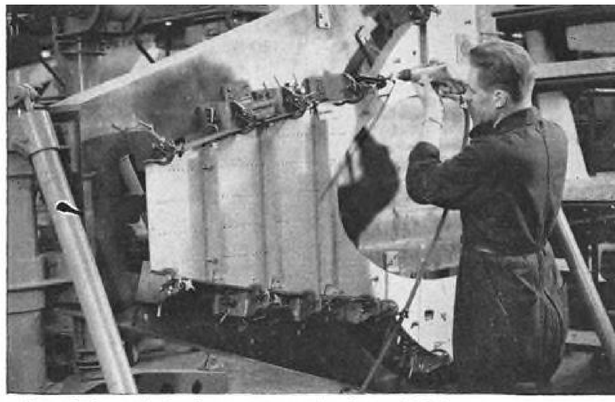


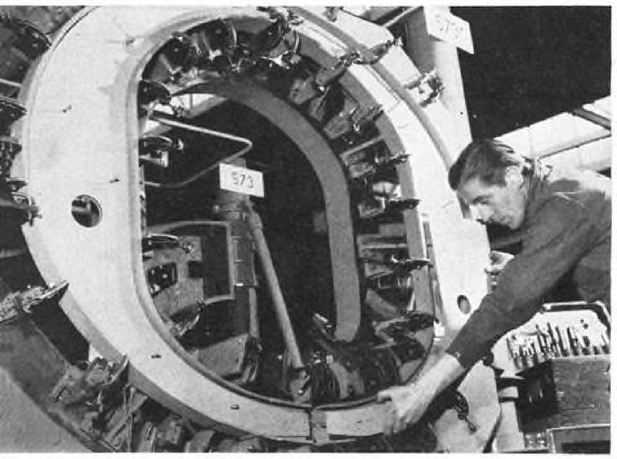
RUBBER press with 8,000 lb. pressure (left) is of Swedish design, manufacture. Cincinnati-built vertical copying mill is at right.



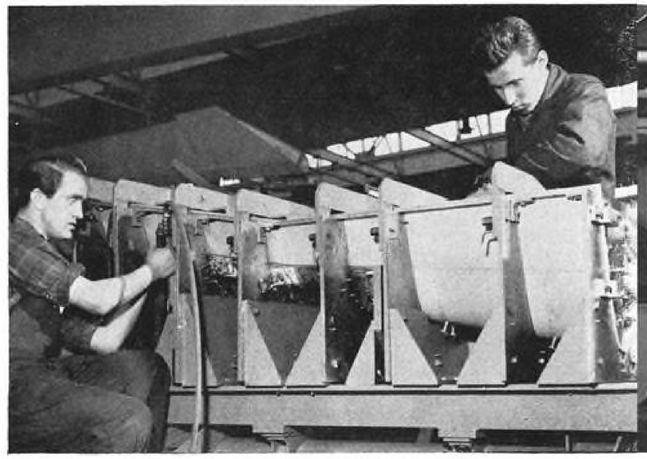


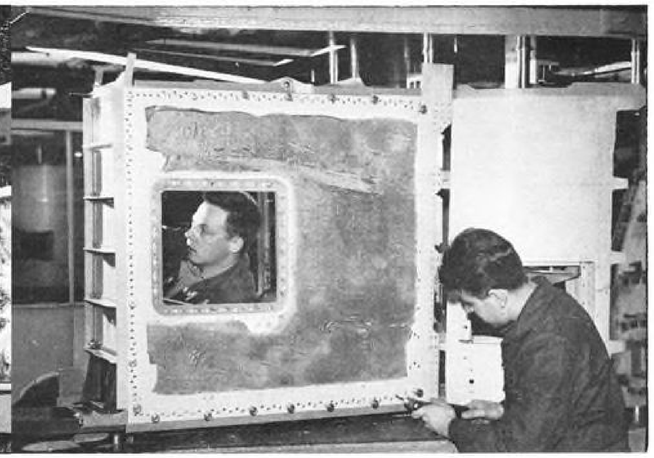
CENTER section frames are drilled in fixture at left. Integral tank is formed partly by main fuselage center-section frame (right).



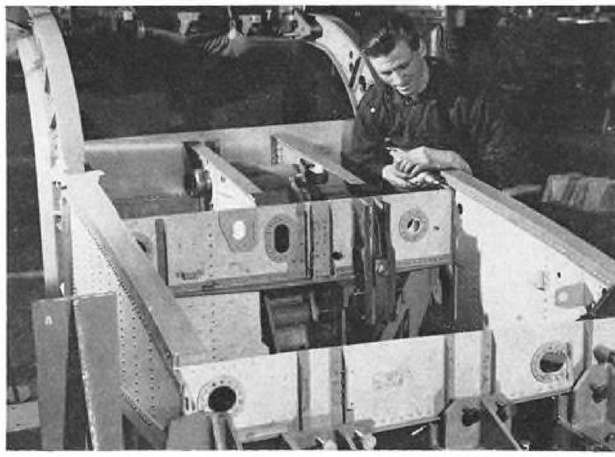


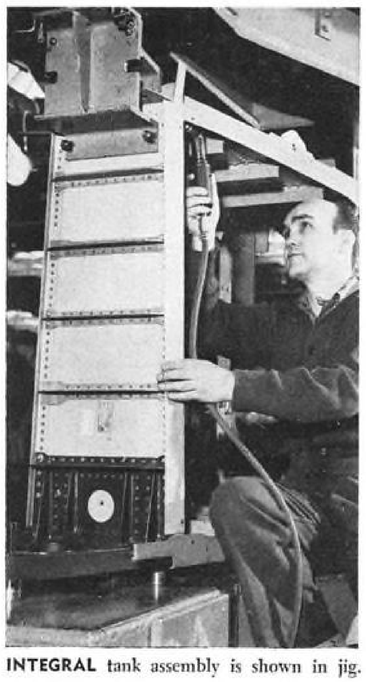
MAIN fuselage frame in powerplant section is assembled in jig at left. Wing leading edge is assembled in bench jig at right.





INTEGRAL tank section final assembly (left) shows skin plating being positioned, drilled. Landing gear bay components are milled (right).





INTEGRAL tank assembly is shown in jig.

Saab Producing J35 Draken

By David A. Anderton

Linkoping, Sweden—Tooling for the Saab J35 Draken was a paramount design consideration from the start, once it became known that the Swedish air force wanted the all-weather fighter plane in quantity. Before the prototype flew, the company was authorized to start ordering long lead-time material for an initial production order.

Production tool design started in March, 1956, and tool manufacturing began a few months later. Production order came through that August and in September the lines began to move.

Production Tooling

About 25,000 tools will be used in J35 production, of which about one-fifth are machine tools.

There will be about 300 assembly jigs of the fixed type and about 3,500 sub-assembly jigs of more or less mobile types.

Saab's jig borers, which had previously been reserved mainly for the manufacture of tools, were increased in numbers for component fabrication. Detail production could start without waiting for all tools to be made; tools and fixtures could be eased into the program when finished rather than delaying the whole program run while they were being made.

Bonded honeycomb structure is used in the J35 wing panels. This is the company's first full-scale production run with this structure and it has expanded what was an experimental bonding area into a production shop with presses and an autoclave.

The structural frames in the rear fuselage are rugged members; they carry the engine and wing loads. Geometrically they have variable flange angles and cross-sections, a tough machining job.

Saab tool engineers designed a special miller to make the rings, and the unit is now in full production.

Practically all J35 structural components, and most of its machined parts, start life 100 ft. underground in an enormous factory built to withstand the rigors of modern air attack. Here in caverns blasted out of the solid rock Saab plant engineers supervised design and construction of an underground shop, complete to the last detail of a "weather clock" that tells workers the temperature, wind velocity and weather on the surface.

Raw materials come in by truck down a long spiral ramp that curves into a receiving area for stock. Material is routed through the shop from there on, in routine fashion. An observer below the surface loses any feeling of strangeness within a few minutes after arriving at the lower level. Air conditioning, sound suppression, excellent lighting and the well-planned shop layout give him no sensation of claustrophobia. Ceilings are normal height, and none of the rough rock covering is noticeable anywhere.

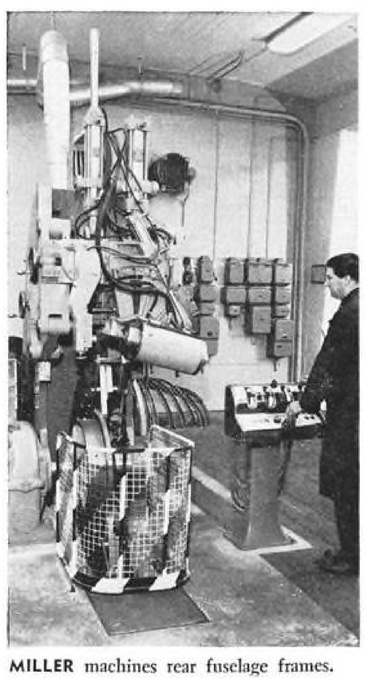
Components go on to the surface factory where they will enter a modified production line now being slowly brought into shape. Like the Lansen before it, the Draken was planned for production using a scaled model of the complete factory area, detailed down to the bench work on components. Final assembly floor flow will be in two parallel lines while major sub-assemblies are fed in from their areas at right angles to the main line.

First airplanes off the line will probably not be to production standards as far as tooling goes. The J35 specifications require that from the 21st airplane on, there shall be complete interchangeability of parts. Saab tool engineers like to emphasize: "Interchangeability, not replaceability."

Tooling Differences

"We have a basic difference from American techniques in our tooling," said chief tool engineer Roland Johnson, "and it is because the Saab approach is entirely with mathematical coordinates." That means that the master template is made in the tool shop with the aid of a coordinatograph which plots the aircraft lines accord-

Sub-assemblies Underground



MILLER machines rear fuselage frames.

ing to mathematical tables of offsets. This master never leaves the tool shop, and is the only one made.

"We use Masonite and densified wood forms a lot because of the traditional high quality of Swedish woodworking," he added. "For jigs, we use a Meccano-set type—like the ones developed by the Germans during the war and used later to some extent by Republic—with clamping fixtures and cut tubing. Your tool engineers prefer solid construction and say that these Meccano jigs settle and you only find it out later on inspection."

"We're a little more conservative on simplification of design—don't carry it as far as you do. And we're not using titanium because steel comes in too soon on high-performance airplanes anyway. It isn't worth the bother to make two switches in material when we can make one."

"We have one major aim, and that is to reduce the number of people standing around hammering on metal."

Probably the biggest contributor to this goal is the Saab rubber-press process, which was developed to avoid hand work after forming and heat-treating. Most of the Saab components are formed on the rubber press, in a two-operation technique.

Press Technique

First pressing is made in the soft annealed state with a die that is a little undersize. Sliding blocks are used to increase the moment of inertia in a compression flange to get a wrinkle-free first pressing. This first operation produces a piece in which the flange angles are about correct and the bend line is deliberately moved to a predetermined location.

This step, like any conventional pressing of a double-flanged ring former, for example, puts the outer flange in compression and the inner flange in tension.

After trimming of the flanges to "correct" height and solution heat-treating, the part is placed in a female die and repressed. This step stretches the outer flange and compresses the inner one, so that the stresses caused in the first forming are counteracted by the equal and opposite stresses of the second pressing.

The part comes out of the press with no distortion; bulkheads will lie almost exactly flat on a surface plate.

Another time-saver, says Johnson, is the British Wharton system of tool sets used to build up drilling and milling fixtures. Saab bought five sets and now considers them as indispensable tooling aids. Each set includes 250 standard elements from slotted bed plates to precision angles, all ground to an eight-mu finish. These temporary jigs and tools are built up without drawings, and after being used and before disassembly, are photographed and parts-listed for future reference.

Saab is thinking in terms of numerical control of some of its machines using binary data. Under such a set-up it figures one man could handle three precision machines at the same time. But most machines don't require the complexity of complete numerical control and could be made automatic with a simple linear programmer. This is the line of current development work at Saab; one vertical miller now operates this way.

Other highlights of the Saab production tooling:

• **Mild steel routing** in the tool room, using a British Wadkin highspeed woodworking machine with carbide cutters.

• **"Air cushions" are used** to float the heavy backplates and other flat jig components so that they can be easily moved for alignment before final fixing in place. Air is bled in at high pressure between matching plates.

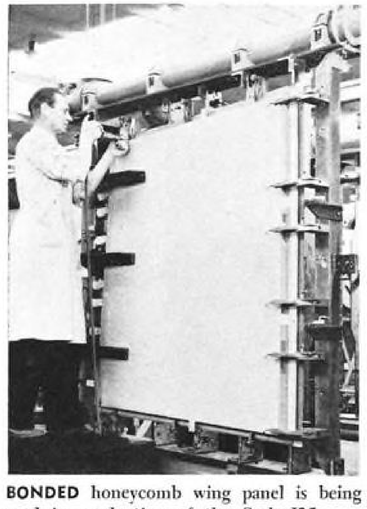
• **Jig tubing is used** as an air reservoir for riveting guns and drills in the assembly areas.

• **Workers' hand tools** are bought by the company, unlike the practice in the U.S. Tools are periodically inspected, repaired or replaced more frequently than by an individual owner.

Johnson and other Saab tool engineers have had numerous contacts with their counterparts in the U.S. through visits and information exchanges. Most impressive to Saab engineers was the short time interval between airplane design and the appearance of the first production aircraft in the U.S.

Out of this exchange has come much technical help in both directions, said the Saab engineers.

Compared to current airframe production in the U.S., Saab says its output per man-hour is about 22% higher than the best American figure known to the firm. One of the reasons may be the incentive wage system adopted by the company after agreement between the union and management. The basic unit prices are established on learning curves.



BONDED honeycomb wing panel is being used in production of the Saab J35.

Ground Testing

Functional system tests and strength checks are the major items done by Saab engineers in ground testing of their airplanes. On the J35, a complete control system has been built with prototypical lengths of boost system tubing, dynamically correct responses and other aerodynamic and physical parameters simulated. It is in effect a hydraulic system test rig, because it also incorporates the complete landing gear with its retraction, extension and brake systems as well as the elevons and rudder. This type of control simulator has been in use for more than five years, starting with the J32 Lansen.

Static strength tests are made in the usual way, except that the applied loads are carried into the structure on fittings attached to the frame. This gives concentrated point loads rather than area-distributed loads such as would be obtained with tension-patch techniques. Loads are applied with the hydraulic jack and whiffletree system, and strain gages are used for readout.

Automatic typewriters and punch cards are used. The test is carried to destruction of the airframe.

The J35 is a 12G ultimate load airplane, and according to test engineers, still has substantial margins.

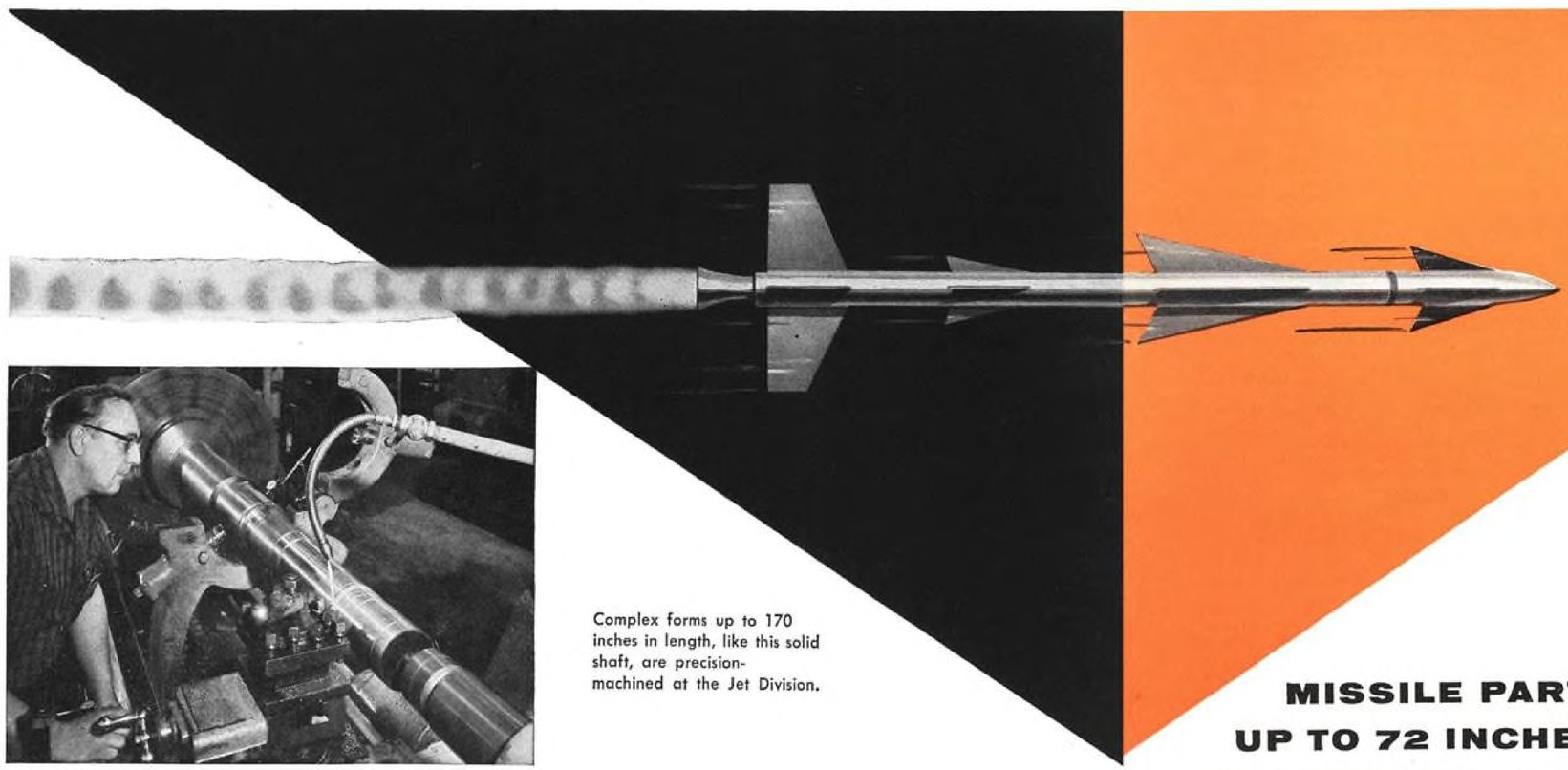
Windshields are checked for strength against bird impacts by a cannon which shoots carcasses against the glass.

One of the more ornate system rigs is a gigantic "Ferriswheel" device which mounts a production-type J35 fuel system. Fuel tanks on the J35 are placed fore and aft of the center of gravity in the wing root, and there was some concern on their effects on stability and controllability in pitch. With this wheel, the entire automatic fuel system can be operated and fuel can be transferred for balance while the wheel is rotating or pitching.

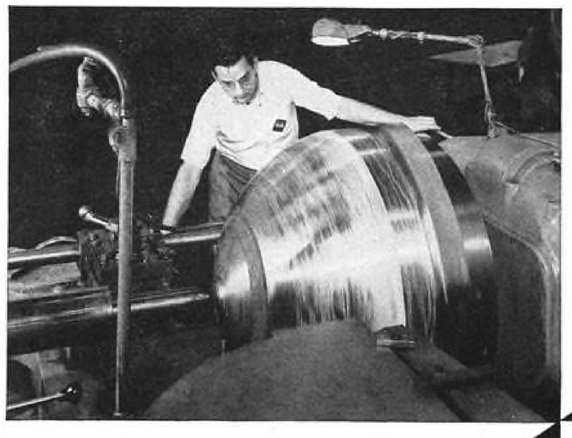
Test facilities also include a climate chamber big enough to take a complete forward fuselage—"but not big enough for everything we want to do," said one engineer—and capable of producing temperatures from −94F to 212F. The chamber can be evacuated to a simulated altitude of about 115,000 ft.

There is a small kinetic heating test rig and the usual kinds of vibration and structure test equipment seen in modern plants.

(This is the second of two articles on the Saab J35. The first appeared in last week's issue.)



Complex forms up to 170 inches in length, like this solid shaft, are precision-machined at the Jet Division.



Contour-machining the inner and outer surfaces of forging used in liquid-propellant fuel tank for missiles.

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Altitude Data Aids Weapon Design Study

By James A. Fusca

Natural and induced environments that will be encountered by future Air Force weapon systems operating at altitudes above 75,000 ft. are being studied for USAF by Radio Corp. of America to develop ideas for design of simulation facilities for these vehicles.

Much moderately accurate information is available on the natural environments at these altitudes. Data have been gathered by instruments sent aloft in balloons and rockets, by radar tracking of meteors, by inference from measurements made at lower altitudes and similar means.

More accurate and complete data are expected from well instrumented, relatively long duration satellites which overcome the disadvantages of comparatively short observation times of other methods.

Categories of vehicles included in the study are sustained. Flight vehicles such as manned aircraft, boost glide vehicles powered only for the first few seconds of flight, ballistic vehicles such as conventional missiles, and satellites.

Natural Environments

Natural environments analyzed in the study in terms of their effects on these vehicle types are:

- **Atmospheric composition.**
- **Extremely high vacuum.**
- **Solar radiation.**
- **Ozone.**
- **Dissociated gases.**
- **Aurorae.**
- **Ionized gases.**
- **Solid particles.**
- **Magnetic field.**

By collecting available data on each of these environmental conditions and analyzing their possible effects on each type of vehicle, the study predicts problems that can be anticipated and simulated on the ground during weapon development.

Below 300,000 ft. the atmosphere can be considered to be made up of the same percentage of constituent gases as at sea level because of the mixing effect caused by winds. Above approximately 300,000 ft., the atmosphere is considered to consist of dissociated gases.

Principal constituents of air are nitrogen (78.09%), oxygen (20.95%), argon (0.93%) and carbon dioxide (0.03%). The total of these figures when carried to more decimal places is actually between 99.99 and 100%. Other constituents always present in minute quantities are hydrogen, helium, neon, krypton and xenon.

According to the theory of partial pressures, a mixture of gases such as air should settle out in a "diffusive equilibrium." In practice, however, the turbulence caused by winds apparently prevents formation of diffusive equilibrium to very high altitudes.

One theoretical study indicates that the periods necessary for diffusion are long when compared to the sun's daily heating cycle and the tidal motion of the atmosphere. Conclusion reached is that the atmospheric constituents

REGION	HEIGHT OF MAX IONIZATION (FEET)	N_e = AVG. MAX. ELECTRON NO. DENSITY $S = \frac{N_e, \text{SUNSPOT MAX}}{N_e, \text{SUNSPOT MIN}}$	$\frac{1}{2}$ THICKNESS (FEET)	RATE OF ION PROD (I) & COEFF OF RECOMBINATION (α)	NO. DENSITY OF NEUTRAL PARTICLES	THEORIES ABOUT THE ORIGIN
D	200,000 for ions, no max for electrons	$N_e = 1.5 \times 10^4/cm^3$ Absent at night $S = 1.00$			$8 \times 10^{15}/cm^3$	1) 0_2 1st ionization pot. (12.2 eV). 2) Ionization of metals, Na in particular. 3) Ionization of NO.
E	330,000	$N_e = 1.5.10^5/cm^3$	70,000	$I = 6 \times 10^8/cm^2$ column $\alpha = 1 \times 10^8 cm^3/sec$	$6 \times 10^{12}/cm^3$	1) 0_2 first ionization pot. (12.2 eV). 2) 0_2 second ionization pot. (16.1 eV). 3) $O(^1S) + O(^1S) \rightarrow O_2^+ + e$. 4) Preionization of 0_2 due to strong absorption bands in energy range 12.2 to 13.55 eV. 5) High energy photon theory.
Es	Slightly higher than E and overlapping	higher than E-ionization	Patches or thin strata of ionization within normal E		Same as E	Impact by meteoric particles. In high latitude, bombardment by fast solar corpuscles as produce aurorae.
F_1	650,000	$N_e = 2.5 \times 10^5/cm^3$ (midday; absent at night) $S = 1.56$	200,000	$I = 1.8 \times 10^9/cm^2$ $\alpha = 4 \times 10^9\ cm^3/sec$	$1 \times 10^{11}/cm^3$	1) N_2 second ionization pot. 2) Ionization of O at its first ion. pot. (13.5 eV) gives the F_1 layer at the ht. of max ion prod. and the F_2 layer higher up due to ht.-dependent recombination coeff and/or tidal effect.
F_2	1,000,000	$N_e = 1.5 \times 10^6/cm^3$ midday $N_e = 2.5 \times 10^5/cm^3$ midnight $S = 4.00$	450,000	$I = 1.5 \times 10^9/cm^2$ column $\alpha = 8 \times 10^{11}\ cm^3/sec$, day $\alpha = 3 \times 10^{10}\ cm^3/sec$, night	$2 \times 10^{10}/cm^3$	1) N_2 first ionization pot. (15.5 eV). 2) O first ionization pot. (13.5 eV). 3) See 2) under F_1. 4) N_2 first ion pot. and O second and third ion pot.

ASPECTS of the ionosphere and hypotheses as to origin of discrete layers are shown in tabular form (S. K. Mitra, 1952).

have no time to settle by diffusive separation even up to heights of 150 mi.

Composition of the atmosphere is not considered to present problems for the vehicles under consideration, except for ozone. On rare occasions, clouds or ice particles may occur at altitudes of 80,000 to 250,000 ft. that could cause damage by impact and erosion.

Pressure is a natural condition, with its lowest static values at the highest altitudes. Static pressures, however, do not indicate the vehicle environment because of the effects of vehicle velocity. Dynamic pressure is a function of vehicle velocity and altitude.

Variation of density or mean free path of air molecules in the atmosphere presents three types of media through which the vehicle must move. Region where the molecules of air ahead of the vehicle are affected before striking the vehicle is known as the continuum flow region. This is encountered in the altitude region below 300,000 ft. The other extreme occurs for altitudes above approximately 500,000 ft. where the air molecules ahead of the vehicle are not affected by the vehicle until they strike the skin of the vehicle directly. This is a region where the mean free path of molecules is in the order of over 100 ft.

Region in between these two extremes where the mean free path of molecules is in the order of 0.1 to 100 ft. is known as the slip flow region.

Detrimental effects of a high vacuum on all of the four types of vehicles would be the same:

- **Leakage of fluid** through seals.
- **Absence of air damping** in vibration.
- **Reduction of heat-convection** effects.
- **Corona discharge** or arc-over.
- **Possibility of explosive** decompression of pressurized vehicles.

Solar Radiation

Only about two-thirds of the energy radiated by the sun reach the surface of the earth; the remainder is reflected, scattered or absorbed in the atmosphere. Value of the energy absorbed by the earth's surface at noon on a summer day with the sun directly overhead is about 1,000 watts-square meter. At any other time of year or hour of day, the energy received will be less in proportion to the cosine of the angle of the sun's elevation.

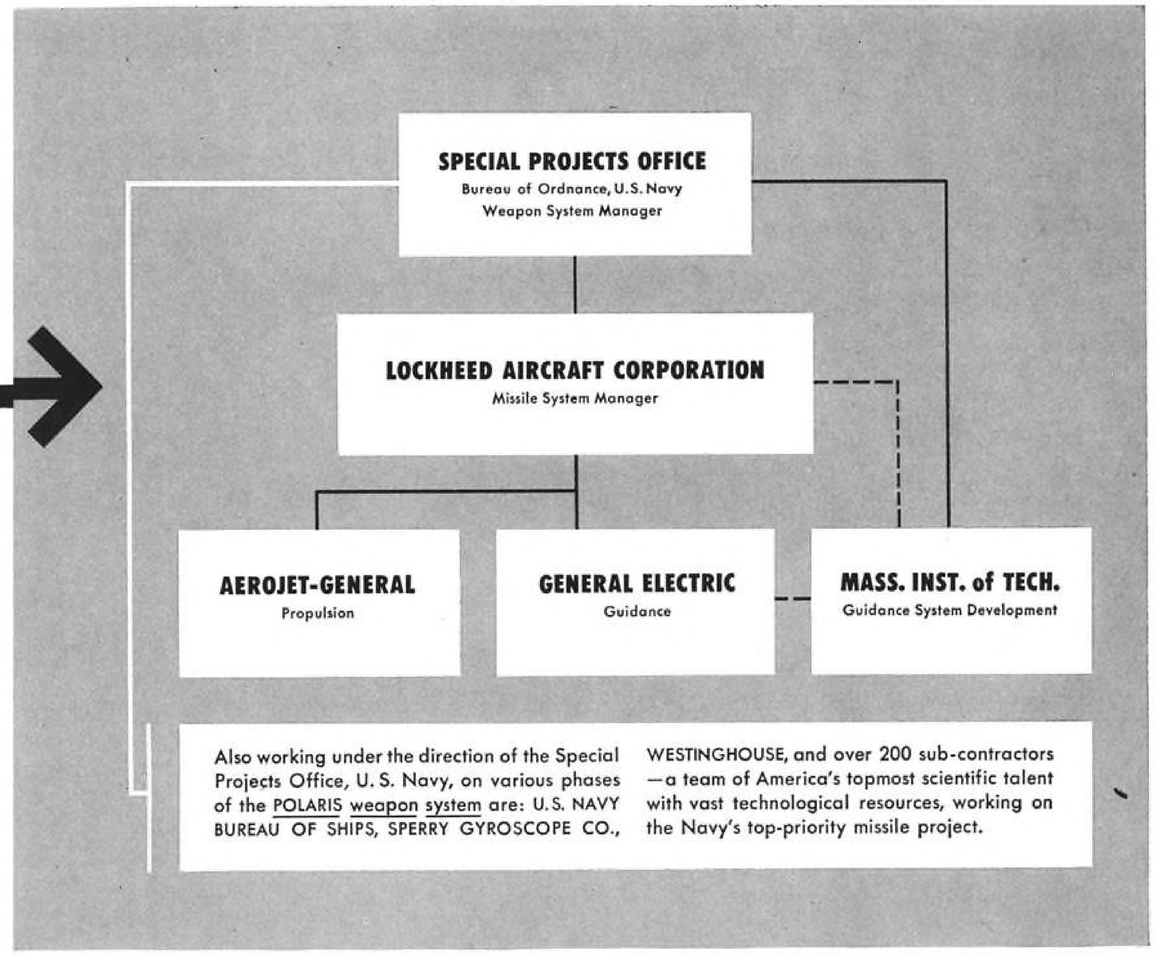
Solar radiation travels within an almost complete void until it encounters the earth's atmosphere where some wavelengths are selectively absorbed by the air's different constituents. Therefore, as solar radiation penetrates the atmosphere, its energy vs. wavelength distribution is continuously changing as more energy is absorbed.

All wavelengths shorter than 2,800 angstroms are completely absorbed, and more than 50% of the ultraviolet be-

This is the task force developing the

POLARIS

—new Fleet Ballistic Missile for the U.S. Navy



Fourteen months ago Lockheed was appointed missile system manager of the POLARIS. The objective: to develop a solid-propellant missile with a thermonuclear warhead, which could be launched underwater from nuclear submarines to hit targets 1,500 miles away. The technological problems involved were admittedly the most complex yet encountered in the history of ballistic missile development.

Progress to date on the POLARIS has exceeded all expectations of the U.S. Navy. Lockheed is proud to be associated with its fellow task force members and the sub-contractors developing the complete POLARIS weapon system. The brilliant contributions and splendid teamwork of these more than 200 POLARIS subcontractors, and their dedication to our mutual goal—greater security for our nation—speeds the progress of the POLARIS missile system, prime responsibility for which is Lockheed's.

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tween 2,800 and 3,800 angstroms. Except for solar heating, only the ultraviolet part of the spectrum is important for other environments such as ozone, dissociated gases and ionized gases.

In order for a photon of solar radiation to form ozone or to ionize a gas, it must have a certain minimum energy. This energy is proportional to the frequency of the light or inversely proportional to the wavelength. Thus, in each reaction of the environment there is a maximum wavelength of light which will be effective.

Longer wavelengths, no matter what their intensity, will not cause the reaction, although they will heat the reactants and the higher temperature might cause an increase in the reaction rate.

A sustained flight vehicle or boost glide vehicle would be flying between 100,000 and 300,000 ft. and would be exposed primarily to 2,000 to 3,000 angstrom solar radiation and to some X-rays. A ballistic vehicle because of its short time of travel would not be damaged by solar radiation.

A satellite, at greater than 1,000,000 ft. altitude, would be subjected to all the sun's radiation. Except for some isolated portions, there is a large part of the ultraviolet spectrum for which there is no practical knowledge concerning effects on materials other than metals, which will absorb them.

Ozone Concentration

As an environment, the important characteristics of ozone are its concentration, location and chemical reactivity. Peak concentration of ozone in the atmosphere usually is through the 65,000 to 80,000 ft. altitudes, where the maximum concentration is about 11 parts per million of air.

Maximum concentration does not change much with greater total values of ozone but instead the ozone layer becomes thicker and the same high concentration is likely to occur for a greater range of altitudes.

Energy required for the formation of ozone in the atmosphere comes from ultraviolet radiation. Damaging effects of ozone are due almost entirely to its chemical reactivity; for example, with organic materials such as rubber under stress. Ozone reacts readily with unsaturated organic compounds, adding all three oxygen atoms at a double or triple bond.

Resulting compounds are "ozonides." Decomposition of ozonides results in rupture at the position of the double bond and, subsequently, in the formation of acids, aldehydes and keytones.

Ozone is also harmful to humans. In sensitive persons, two parts per million will cause severe lung irritation in less than an hour. At eight parts per million, breathing capacity is cut 50% in one hour, and the lungs begin to fill with fluid.

Both sustained flight vehicles and boost glide vehicles will be subjected to the effects of ozone, while ballistic vehicles and satellites will not. One possibility for manned vehicles is that ozone can be made to decompose entirely by subjecting it to high temperatures (above 100C) before the air containing it is brought into the vehicle.

Dissociated Gases

Between 280,000 and 330,000 ft. a transition occurs in the composition of the atmosphere with oxygen supposedly being 100% molecular (O_2) at 280,000 ft. and nearly 100% atomic (0) at 330,000 ft. Heights and relative concentrations have been developed theoretically.

Theory on the formation of atomic nitrogen is based on aurorae spectra. Atomic nitrogen is believed to be produced at heights of 425,000 to 900,000 ft., with the maximum rate of production at 525,000.

Only vehicle that will be affected by these dissociated gases is the satellite. Metals which form an adherent oxide film may only form a thicker film and at a faster rate as would, for example, aluminum. Atomic oxygen will react with such metals as iron, copper and silver, and with many organic materials, especially those with double bonds. Atomic nitrogen does not react easily with metals except under very high temperatures.

Aurorae occur most frequently at geomagnetic latitudes of 70 deg., ordinarily stretching from about 300,000 to 600,000 ft. altitude. The lower edge can be sharply defined and its mode is 350,000 ft. but it ranges from 250,000 to 450,000 ft.

All forms of aurorae such as quiet arcs, glows, coronas, rays and flames are of short duration, lasting from seconds up to half an hour. More than 100 wavelengths of emission spectra of the aurorae are known, with different forms of the aurorae varying in intensities of certain spectral lines.

It is commonly accepted that the primary cause of both aurorae and magnetic storms is corpuscular radiation emitted by the sun. These electrically charged corpuscles are diverted toward the geomagnetic poles by the earth's magnetic field.

Only the satellite vehicle would be subjected to the dense part of the aurora; going through the usual auroral thickness of 300 mi. would require about 60 sec. A satellite passing over both poles would be in the dense auroral region for less than 5% of the time.

Effect of passing through the aurorae would be that the satellite would be subjected to weak X-rays that would not penetrate metal skins of moderate thickness.

Assumptions as to both height and density of ionized gas layers are based on radio signal reflections and instrumented rockets. If a spectrum of radio signals from one to 10 megacycles is reflected, the signals will be reflected at different times (corresponding to different heights) which vary with the frequency where time increases directly with frequency.

There are numerous theories regarding the causes of ionized gas layers. Some of the possibilities have been formulated from information obtained from both the reflection and instrumented rocket techniques.

Electrons and ions making up these layers would have only thermal energies; their velocity would be too low to cause sputtering. Their primary effect would be electrical; interfering with or reflecting radio signals being sent to or from the vehicle.

Solid Particles

Meteors and meteorites are only part of the solid particle environment. In addition, it is important to consider meteoric debris whose relative velocity in the atmosphere is zero.

All of these particles are believed to be in orbit about the sun, although one view holds that the orbits are hyperbolic rather than elliptical. Zodiacal dust, originating from micrometeorites, is considered to be distributed uniformly throughout space in the earth's orbit.

Number of solid particles that would strike a vehicle, causing damage by penetration or erosion, is considered to be one of the major environmental questions.

A meteor weighing one microgram will penetrate aluminum skins of satellite or space ships up to one millimeter thick. Smaller and less energetic micrometeroites will not penetrate but instead gouge out small pieces of skin in a manner similar to sandblasting.

In addition to the physical damage resulting from such collisions, their effect will also be to change the emissivity of the skin which will be important in maintaining temperature equilibrium in the vehicle.

Effects on sustained flight or boost glide vehicles will be simple abrasive wear of the skin. Ballistic vehicles will be exposed for such a short time that the effect is insignificant.

Satellites will operate at altitudes where they will collide only with high velocity particles. There will be continuous abrasion due to sputtering but present knowledge is insufficient as to the numbers of particles heavy enough to penetrate the skin.

Maximum value of the constant horizontal component of the earth's magnetic field is at the magnetic equator. It is 0.3 gauss. Ninety-four per cent of the field strength is considered to be caused by the earth's internal structure.

The source for the remaining 6% is assumed to be a group of three ring currents existing in the atmosphere around the earth. These ring currents are supposed to consist of ionized molecules moving with a constant velocity of about 55 kt. at the height of the lower ionosphere.

One Firm Value

The only firm value of the environment is the proportionality of the strength of the earth's magnetic field to the cube of the distance from the center of the earth. This value holds to 300,000 ft. The supposed presence of ring currents between 350,000 and 500,000 ft. would cause a jump in the magnetic field value at these altitudes, so that the existence of a constant-value magnetic field at altitudes above 300,000 ft. is unlikely.

The only deleterious effect of the earth's magnetic field might be due to 2.5 mev. protons arriving from the sun and being directed toward the geomagnetic poles by the magnetic field. Only the satellite vehicle would be subjected to this type of bombardment—not the other vehicle types.

Protons with an energy of 2.5 mev. are absorbed by about four inches of air at normal temperature and pressure. Because the stopping power of aluminum is only about 1.26 times that of air, these particles would penetrate satellites above 300,000 ft.

(This is the second of two articles describing hyper environments: those natural and induced environmental conditions found at altitudes varying from the present operational ceiling of about 75,000 ft. to interplanetry space. Induced environments, those created by the operations of aircraft or missiles or by their interaction with the natural environments, were the subject of the first article.)

FILTER CENTER

► **Fully Compensated Gyro**—Lear will develop new vertical gyro for Navy Bureau of Aeronautics incorporating full acceleration compensation about both pitch and roll axes, using modification of technique employed in Norden-Ketay turn-compensated gyro (AW Feb. 10, p. 89). To provide full turn compensation at all aircraft speeds, gyro motor will be powered from a variable frequency source whose frequency is varied as a direct function of indicated airspeed or ground speed, obtained from a Doppler auto-navigator.

► **Hoffman Powers Vanguard**—Silicon solar cells used to power one of Vanguard's two radio transmitters were manufactured by Hoffman Electronics Corp. Vanguard's solar cells have efficiency of about 12%, company says.

Firestreaks Travel With Mk. 7 Javelin

Mk. 7 Gloster Javelin, latest modification of current British all-weather fighter, carries two de Havilland Firestreak infrared homing missiles, two pods, each carrying 37 unguided air-to-air rockets, and two 30 mm. Aden cannon. Mk. 7s will go into service with RAF Fighter Command later this year, will gradually become command's main strength. Plane is powered by two Armstrong-Siddeley Sapphires rated at 11,000 lb. thrust each. Afterburners are being developed for later installations on this model and the Javelin Mk. 8. Fairings at intersection of underwing pylon and wing leading edge smooth out airflow at high speeds.

Republic Aims Alouette at Civil Market

By Erwin J. Bulban

New York—Foundation for a long-range program of rotary wing aircraft design, sales and service aimed primarily at serving commercial requirements is being built by Republic Aviation Corp.'s newly formed Helicopter Division.

"We are not forgetting the military, but this thing has to grow on the basis of cooperation with commercial helicopter operators," Herbert Munsey, manager of the division emphasized to AVIATION WEEK.

Policy, which has complete support of Republic top management, will be to steer clear of projects tailored primarily to military requirements; instead make proposals on the basis of off-the-shelf availability, with the military paying for any extras that it requires. Management's feeling is that a large portion of the present high cost of commercial helicopters can be directly traced to high overhead required to support military requirements in facilities, research and development and meeting contractual agreements. On-again, off-again contract-letting and cutbacks are also cited as cost builders.

CARGO SLING operation is performed by one of Republic's two Alouette II demonstrators. Demonstrators have 360-hp. Artouste turbines; deliveries are made with 400-hp. engines.

ASSEMBLY LINE in Republic's Helicopter Division facility shows half-dozen Alouette IIs. Ship nearest camera is serial No. 1086. Basic price in U. S. is $88,665.

Management Team

In setting up its new division, Republic gathered a management nucleus having considerable rotary wing background. Lineup includes:

- **General Manager** Herbert Munsey, former assistant vice president of Bell Helicopter Corp. and with that company some 18 years.
- **Sales Manager** and assistant to the division manager Gerald R. Rouillard, former regional sales manager for Continental Aviation's Turbine Division, which has manufacturing rights in U.S. for Turbomeca engines.
- **Director of Commercial Sales** Frank H. Kelley, former executive vice president of Hawk Helicopters, Ft. Worth, and supervisor of commercial sales for Bell.
- **Director of Engineering** William E. Cobey, formerly president of Transcendental Aircraft Corp.
- **Chief Pilot** Tom Mason, former Petroleum Helicopters pilot.
- **Field Service Manager** Joseph Girard, formerly with Vertol Aircraft Co.

Initially, design and production of its own helicopters does not loom large in the division's current planning—philosophy is to maintain low overhead, with primary emphasis on sales and service and then work up to production when demand is justified.

Where will the products come from?

Tipoff to the type of operation envisaged by the division is its recent acquisition of sole distribution rights in North and Central America of French Sud Aviation Alouette II (Lark) turbine-powered five seater. Over a year ago, Republic Aviation set up the initial parameters for a sales and eventual production licensing agreement with Sud, then sponsored a nationwide 13,400-mi. tour of two of the helicopters (AW May 6, 1957, p. 50).

Favorable comment arising from these demonstrations led the company to renegotiate its agreement and settle on terms late last year.

Currently it is airfreighting disassembled Sud-built Alouettes to the United States, has brought in a dozen

UPPER and lower Alouette instrument panels swing out for access.

thus far including two demonstrators. Under its agreement with Sud it will have 120 units available for distribution here in 1958, if needed.

Considering the short time the division has been operating, its initial success appears to be impressive in addition to emphasizing management's planning to aim for the civil slice of the helicopter sales "pie"—first half-dozen Alouettes are being delivered within the next few weeks, all to commercial operators. First machine has been handed over to a customer; Aetna Helicopters, Inc., Etna, Calif., specializing in U.S. Forest Service operations (AW Mar. 17, p. 21).

Spares Service

Parallel with sales effort is buildup of spares inventory to ensure that its customers will be able to keep their helicopters operating with shortest possible lead time in spare parts. Program covers stocking 600-hr. requirement in spares for each helicopter that leaves Republic's Farmingdale, N. Y., facility.

The improved Turbomeca Artouste II-BI, which delivers 400-hp. in the CAA-certificated version, an increase over previous 360-hp., is now a 250-hr. engine. Republic says that it will be a 500-hr. engine by the end of this year.

Main all-metal rotor blades now are 1,200 hr. items. In the 600-hr. category are tail rotor shaft, main shaft drive, oblique shaft, main gear box and main gear case.

Company points out that during tour of its two demonstrators, ships experienced only 53.5 min. of maintenance per flight hour including all preflight, periodic inspection and corrective maintenance during the total of 590 hr. flown.

Ships can use kerosene, JP-1, JP-4 or 80 octane fuel; company is currently investigating use of dieseline.

During the demonstrations in Denver

Piper Research, Test Center

New 10,000-sq.-ft. engineering building is first unit of Piper Aircraft Corp.'s 40-acre development center at Vero Beach, Fla. Center will concentrate on new business and utility aircraft designs. Flight tests will also be handled here. Center will permit atmosphere free of day-to-day factory problems, which admittedly handicapped previous development programs of Lock Haven, Pa., manufacturer. Under direction of Fred E. Weick, facility's initial program is development of a new low-cost agricultural airplane. Piper factory also will maintain engineering program.

area, helicopter operated at 16,500 ft. pressure altitude (18,300-ft. density altitude) carrying a pilot, passenger, radio equipment, oxygen. One ship landed on 14,260-ft. Mt. Evans, Colo., carrying a passenger, while another Alouette hovered above it carrying three people and camera equipment to record the event. Republic outlines a typical oil off-shore mission for the Alouette, carrying four people and pilot 75 mi. and return with 30-min. fuel reserve.

Company is studying installation of a jump seat between the two front seats, which would provide six-place capacity on short missions.

To maintain close relations with the French manufacturer, Republic maintains a liaison representative in Sud Aviation plant, as Sud does at the U.S. manufacturer's facility. In addition the division is able to call on Republic International's Paris office.

Availability of parts from France is very good, Munsey told AVIATION WEEK, citing, as an example, how the division had telegraphed Sud Aviation for an oil pressure transmitter (a non-Sud-manufactured item) on a Friday and received the requested material on the following Tuesday.

Company is now working on a powerplant exchange program to ease overhaul problem and expects to have this ready in a few weeks.

With sales program underway, next step being phased in includes gradual component manufacture here toward

Monte-Copter Makes Tethered Flight

Prototype pressure-jet Monte-Copter is shown during recent first tethered flight at Boeing Field, Seattle, Wash. (AW Mar. 10, p. 83). Helicopter now has two Continental engines delivering 140 air horsepower each, later version is planned for a single 200-air-hp. engine. Finished craft will also have wings to provide additional lift and unload rotors during high speed forward flight and will also incorporate a Fiberglas-reinforced plastic fuselage to permit amphibious operation, Maurice L. Ramme, president-founder (right) reports.

goal of building the entire aircraft in the U. S.

Among early-stage components will be the Alouette's skid-type landing gear, instrumentation (some instruments in early deliveries are French), and rotor blades. Company has been talking to possible suppliers of latter item, has yet to make a selection.

Helicopter Division is organized so that it will be able to tap the parent company's resources when needed, paying for such services. As Munsey explained it, if the division needs a tractor, it will be able to get one through Republic; same goes for consultation with the corporation's engineers, use of its research facilities and even assignment of production or assembly line personnel.

In this way, the division, operating under its own budget, will be able to make most economical use of available services, requiring a minimum of its own equipment and personnel—with buildup commensurate with increase in business. This utilization of temporarily idle personnel and equipment also benefits the parent corporation in reducing cost of these overhead items.

But this relationship does not make the division wholly dependent upon the parent corporation for services. For example, as it gets into manufacturing phases, it plans to allocate jobs on a bid basis, with the parent corporation being considered as a vendor which will have to supply quotations on sub-assemblies in competition with others.

Product Improvement

Helicopter Division also is planning a product improvement program on the Alouette, which will be based on keeping the craft suitable to operator's requirements based on continued surveys and discussions with the industry. Division is building a nucleus of engineers to work on this development program.

Alouette apparently will not be a one-shot project at Farmingdale; thinking is to handle a line of civil helicopters. Engineering staff will be primarily responsible for working out design parameters based on sales organization's contacts with the industry, then will work with an established manufacturer in adapting his product to one that Republic can add to its line. Philosophy will be not simply to sell a foreign product here, but instead to market a foreign-designed product developed to needs in this hemisphere.

High utility of the turbine-powered Alouette compared with comparable-size available equipment was cited as reason Aetna Helicopters decided on getting into this new equipment. Aetna Manager Robert E. Trimble noted that he will be able to carry twice the payload he now carries in one of the firm's three Bells (two 47Gs and one 47G-2)

at a much higher speed—90 mph. compared to about 60 mph.

Bulk of Aetna's operations in Northern California and Oregon is working with the U.S. Forest Service on fire fighting, timber cruising, road surveys, getting men and equipment into primitive areas (where mechanized equipment is not permitted to enter) and carrying administrative personnel.

Trimble estimated that the operation puts in some 600 hr. annually on its Bells, operating at altitudes ranging from about 3,000 ft. to 7,000 ft.

On fire fighting missions, Aetna's job is primarily to get men and materiel into position for combating outbreaks—firm has carried over 100 men and their equipment in one day into some areas. During serious blazes, utilization goes away up: company has flown 139 hr. in 17 days, once Trimble put in 13¼ hr. in a single 24-hr. period on such missions.

Helicopters at least double the utilization of Forest Service fire fighters; men would lose at least a day in walking out of some of the areas and the helicopters get them to the scene in 15 min. to 45 min.

An important point in this type of operation is keeping size of the vehicle to a minimum. Heavy brush areas provide narrow choice of landing locations. Trimble noted that the Alouette is smaller than the Bell 47; its rotor diameter measures 35 ft. compared with 33 ft. 6 in. for the Alouette. Sometimes a difference of just a couple of feet would dictate landing people another mile or two away from their selected drop, requiring a hike through heavy brush with a pack.

Aetna estimates that for the Alouette it will have to charge just a little more than double the rate for its Bells, which is approximately $100 an hour, at the start until it develops cost experience. Even at this figure, the higher utilization of the new ship is expected to make it a profitable venture.

PRIVATE LINES

Luscombe Silvaire Special, in production at Ft. Collins, Colo., will sell for $5,995 flyaway factory. Optional equipment offered includes: wing flaps, $465; wheel pants, $125; navigation lights, $32.50; landing lights, $59.50; jump seat, $37.50 and Narco Superhomer with omni, $630.

Requirement for flares as mandatory equipment for aircraft carrying passengers for hire at night has been revised by Civil Aeronautics Administration in Amendment 43-8 which makes this item optional. Requirement for their inclusion on long overwater flights still holds.

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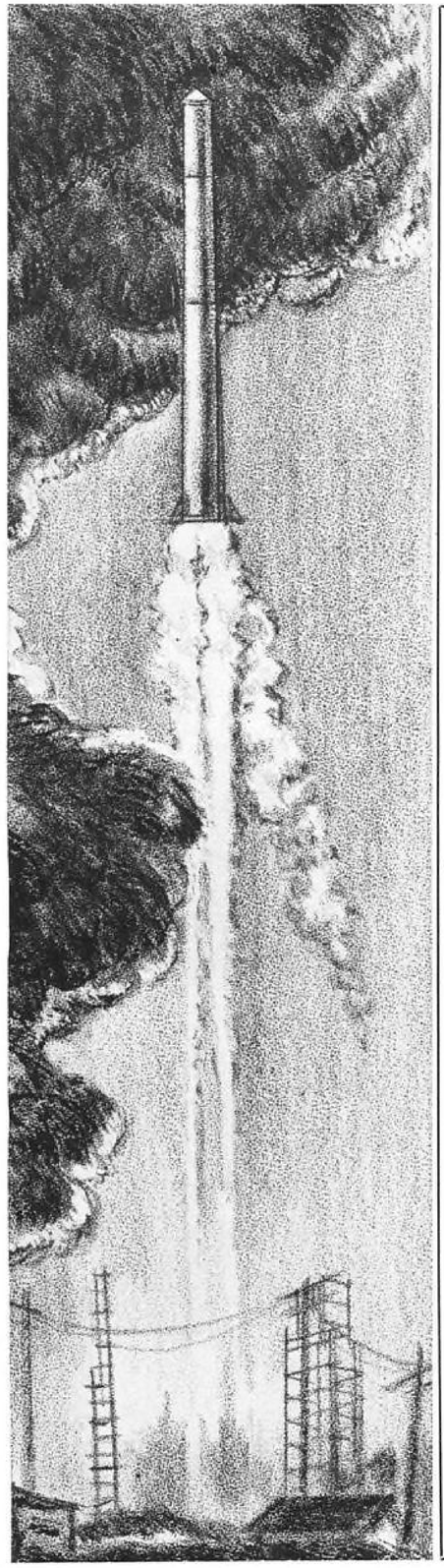

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LETTERS

Eye Response

Your article entitled "Human Factors Geared to Space Flight" in the March 3 issue of AVIATION WEEK (p. 167) is an extremely interesting and useful review of the thinking and work that space flight imposes on man.

Some of the assertions of man's capabilities, however, makes one wonder! For example: man's eye is claimed to be able to detect an object which subtends a visual angle of as little as one half second of arc. This is interpreted to mean that man can resolve two small objects just touching each other (tangent to each other at some point). However, if this object size is calculated at 12 in. distance, then it turns out to be approximately 7,500 Angstroms (10^{-8}cm). Furthermore, McDowall states: "If two points are so close together that they subtend a visual angle less than 50 sec., usually taken as 1 min., both images will fall on one cone, and the two points will therefore appear as one."

Also, in the wavelength region of 4,000-7,000 Angstroms an assertion is made that the rods and cones may react to less than five quanta. If the highest energy quanta (4,000A°) are considered, then their energy content is approximately 2.5×10^{-11} ergs. McDowall asserts that this sensitivity is of the order of 10^{-8} ergs, a considerable difference!

The range of intensity for the eye is asserted to be 100 million in the article. Sears[2], however, asserts it to be 100,000!

The minimum detectable power audible is given by such vague terms that no comparison is possible. However, it is fairly well known that the threshold of pain is 130 db. above the minimum audible signal. This agrees with the article.

One can't help wondering where or how the figures were obtained for the eye response.

[1] McDowall, R. J. S., Physiology and Biochemistry, Copyright 1946, 39 Ed. The Blakiston Co.
[2] Sears, F. W., Optics, p. 134, Copyright 1949, Addison-Wesley Press.

PAUL A. SILBERG
Sr. Research Analyst
Scientific Analysis Office
Melpar, Inc.
Falls Church, Va.

Telemetry Bands

Your recent article in the Feb. 17 issue of AVIATION WEEK (p. 27) is an excellent summary of problems presently being experienced with use of telemetry in missile and aircraft flight testing. These problems were anticipated by the Aeronautical Flight Test Radio Coordinating Council and other aircraft industry organizations including the Aircraft Industries Assn. As a result, our Council has been actively working toward solutions of the problem for some time.

One of the major aspects of this problem is a shortage of radio frequency allocations for telemetry operations. We have been pressing for additional allocations in hearings before the Federal Communications Commission. In this activity, we have also

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

been closely coordinating with government and civil organizations concerned with such matters.

Among these have been the Air Force, Navy, Army, CAA, NACA and working groups of the military Inter-Range Instrumentation Group. Details of our presentation to the FCC with complete statistical exhibits, were forwarded to you with our letter of June 11, 1957.

Our appearance before the FCC, with witnesses including Mr. George S. Trimble, vice president-engineering for the Martin Co. and representatives from Boeing, Lockheed and Douglas, was well received. At present, the outlook for early frequency allocation action is excellent. Also, a number of telemetry equipment manufacturers are actively interested in producing appropriate "hardware" for operation in the new frequency bands which we expect to be allocated. To further this effort, specifications for appropriate telemetry equipment are presently being prepared by the Aircraft Industries Assn. W-99 Project on Telemetry Equipment Specifications. Definite results should be forthcoming from this Project shortly. . . .

R. E. WINSLOW, Chairman
Aeronautical Flight Test
Radio Coordinating Council
Boeing Airplane Co.
Seattle, Wash.

Suggested Method

It seems that your excellent magazine has opened the page of Letters to a discussion among nuclear physicists.

We are assured by J. M. Mesnard (AW Jan. 20, p. 110) that there is no danger from a satellite, such as the Sputnik, since the logical source of γs might be Co^{60} or La^{140}.

J. Hyams, et al., (AW Jan. 20, p. 110) agree in principle with the observation of Machado (AW Nov. 25, p. 126). They also speak of proton/neutron ratio in isotopes, such as $_{92}U^{235}$ and other isotopes.

First, we suggest the nuclear physicists adopt a method of designating their elements so as to suggest the structure of the atom. How are they made up, how can one visualize the macroscopic nature of the nucleus?

A hydrogen atom consisting of a proton and an orbital electron may become a neutron. The electron falls out of the orbit and is absorbed by the proton. This is known as beta-decay.

The neutron is not affected by an electric field; it can be absorbed by the proton if it comes within a distance of $.4 \times 10^{-12}$ of an inch.

Then the hydrogen atom becomes rich with a neutron, known as deuterium—D.

If another neutron falls into the nucleus of a deuterium it becomes a tritium, according to:

H + n yields D
D + n yields T

A nucleus of any element is made up of Ds and Ts. The presence of tritium in a nucleus characterizes the isotopicity of it.

Mesnard's Co^{60} should be written as $D_{21}T_6$ and La^{140} as $D_{31}T_{26}$; it shows that one nucleus consists of 21 deuterium and 6 tritiums, and the other of 31 Ds and 26 Ts. The nuclei with an abundance of Ts are more easily subjected to beta-decay, according to:

$T_2 - \beta^-$ yields D_3
$D_3 + \beta^-$ yields T_2

U^{235} should be written $D_{41}T_{51}$, here Z, the atomic number = 41 + 51 = 92

A, the atomic weight 2x41 + 3x51 = 235

41 neutrons are attached to 41 deuterons and 2x51 = 102 neutrons are attached to 51 tritiums. The extra neutron in each tritium is capable of undergoing beta-decay.

$D_{41}T_{51} + \beta^- \longrightarrow (D_{41} - D_3) \quad (T_{51} + T_2) \longrightarrow D_{84}T_{53}$

The atomic number has been diminished by one — 38 + 53 = 91

One of the deuterium due to photodisintegration was converted into two neutrons. Each neutron attached itself to two other deuteriums, thus becoming two tritiums.

$\gamma + D$ yields $n + n$

How would one designate $_{91}Pu^{239}$?

Assume that the nucleus consists only of Ds, then the mass $A = 2 \times 94 = 188$ and $239 - 188 = 51$ additional neutrons that go to make up 51 tritiums.

$D_{94}T_{51}$ is the correct method of designating the macroscopic nature of plutonium. This method shows how the neutrons are distributed in the nucleus.

We hope that the physicists from Livermore, Calif., and Montreal, Canada, will adopt this language very shortly.

YASHA YAVITCH
Columbus, Ohio

Anti-Gravity

Your enthusiastic anti-gravity reader, Ronald Monroe (AW Jan. 6, p. 118), should be referred to the work of the Gravity Research Foundation at New Boston, N. H. The Foundation was founded by Roger Babson, the eminent stock market analyst and one of the outstanding pseudo-scientists of our time.

To date the Foundation has not been successful in repealing either the first or the second laws of thermodynamics but their work is continuing.

An interesting account of Babson and other modern pseudo-scientists is presented in the book "Fads and Fallacies in the Name of Science" by Martin Gardner (Dover Publications, Inc., New York, 1957). The book is comprehensive and entertaining.

WILLIAM P. RODDEN
Los Angeles, California

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