NASA FACTS

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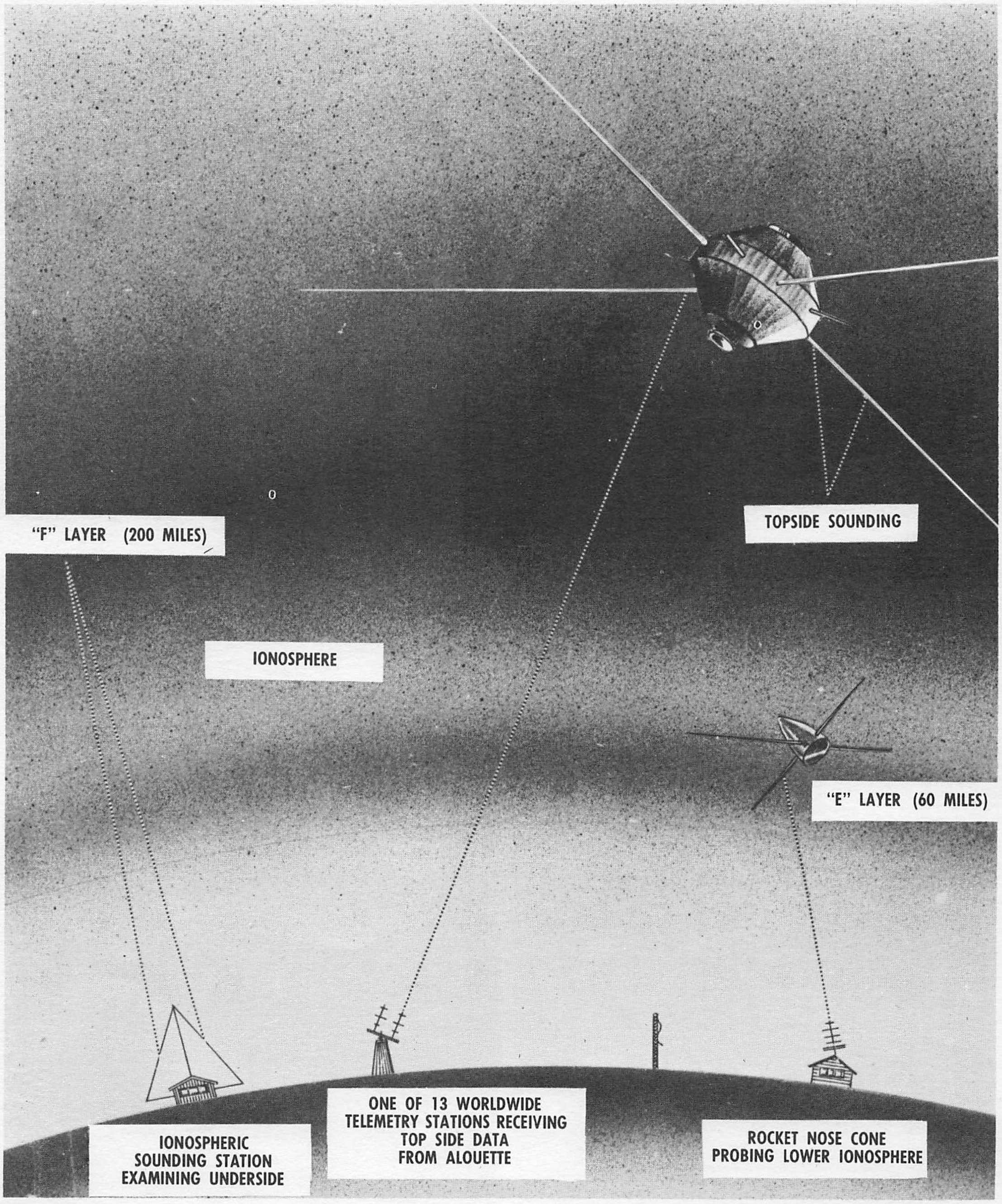
ALOUETTE—CANADA'S FIRST SATELLITE



Technical illustration by the Canadian Defence Research Telecommunications Establishment depicts ground, sounding rocket, and topside-sounder satellite studies of the ionosphere. The E and F layers designate regions of different electron density. The F layer contains the greatest concentration of electrons

SOUNDING IONOSPHERE FROM ABOVE

Canada's Alouette satellite, launched September 28, 1962, is sending data that is not only advancing scientific knowledge of the ionosphere but also may contribute to improvement of radio communication on earth. The satellite is furnishing this important information by carrying out from above investigations that for years have been conducted by ionosondes from the ground.

Ionosondes are instruments used to study the ionosphere by radio-echo sounding. In radio-echo sounding, radio signals are beamed to the ionosphere, and the ionosphere's ability to reflect them is determined and analyzed.

Radio waves are reflected only if the electrons in the ionosphere are sufficiently concentrated to act as a mirror for the radio frequency employed. As frequencies rise, increasing electron density is required to turn signals back.

Generally, electron density increases with altitude up to about 200 miles and then tapers off. Earth-originated signals that can pass through the ionospheric region of maximum electron density cannot for the most part be reflected back to earth by the less dense region above.* As a result, ground-based sounding usually cannot provide information about the upper ionosphere; that is, the ionosphere above the zone of maximum electron density. Moreover, even today's global network of about 150 ground ionosondes is unable to cover the ionosphere over many areas of earth, especially of the polar and equatorial regions.

Alouette has opened new vistas in ionospheric research by extending radio-echo sounding techniques to a platform in space. Covering most of earth, Alouette is sending radio signals downward and reporting results.

DEFINITIONS

Electron—a negatively-charged constituent of the atom.

Ion—a molecule or atom which has lost or gained an electron, thereby acquiring an electrical charge.

Ionosonde—an instrument employing radar principles that is used for study of the ionosphere by radio-echo sounding.

Ionosphere—an electrified region of the atmosphere beginning about 40 miles above earth. It reflects certain radio signals, making possible world radio communication. Its upper limit is as yet undetermined.

Radio-Echo Sounding—a method of studying the ionosphere by bouncing radio signals from it. A particular radio frequency will be reflected when it hits a given electron density. Thus, the reflected frequency discloses the existence of a given electron density and the return time indicates the distance at which electron density was encountered.

Topside Sounding—radio-echo sounding from an altitude above the region of maximum electron density. Contrasted with bottomside sounding from ground stations.

EXPERIMENT DESCRIPTIONS

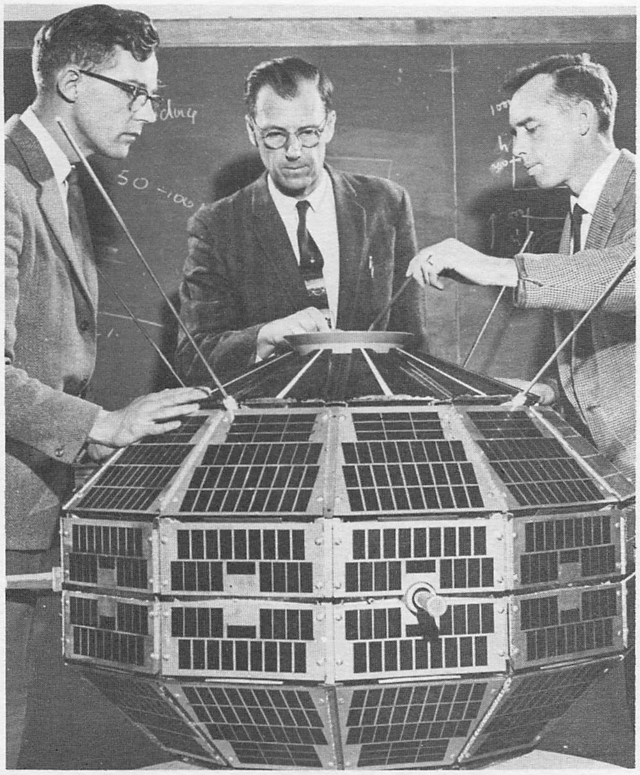
Alouette is designed principally to measure, by latitude, daily and seasonal fluctuations in electron density of the upper ionosphere. Canadian scientists are particularly interested in data on the Arctic ionosphere that could throw new light upon the severe and prolonged disturbances that plague radio communication in their nation's northern areas.

The ionosphere is formed by a break-up of neutral atmospheric molecules into negatively charged electrons and positively charged ions. This results largely from absorption by the atmosphere of X-rays and ultra-violet light from the sun and by impact of solar energetic particles (chiefly protons) on atmospheric molecules.

In effect, the ionosphere is an electrically charged gas curtain in the sky. One property of this curtain is that it reflects certain radio waves, making possible world radio communication. Solar eruptions, however, affect the ionosphere, leading at times to disruption or complete blackout of radio communication.

Alouette sounds the ionosphere by "sweeping" radio frequencies across it. "Sweeping" frequencies is analogous to running up and down a musical scale. By bouncing approximately

**A minute fraction of radio signals, amounting to as little as 1/10,000,000,000th of transmission strength, is reflected back to earth by collisions with individual electrons. Only a few huge radio telescope complexes, such as at Arecibo, Puerto Rico, and Lima, Peru, possess the power and sensitivity to pick up such faint reflections.*



Full-scale Alouette model is checked by Canadian scientists. Protruding from mid-section are ends of Alouette's long sounding antennas, retracted as during launch.

700 different frequencies between 1.6 and 11.5 megacycles from the ionosphere, Alouette measures precisely and in detail electron densities at various altitudes over almost the entire globe.

To supplement data from its sounding experiment, Alouette picks up cosmic noise and natural radio signals originating within the ionosphere. Cosmic noise is a term for natural radio signals orignating in outer space. The frequency at which Alouette stops receiving cosmic noise indicates electron density in the satellite's vicinity. Radio signals within the ionosphere are produced by its fast-moving electrons. Their volume (loudness) varies with electron density.

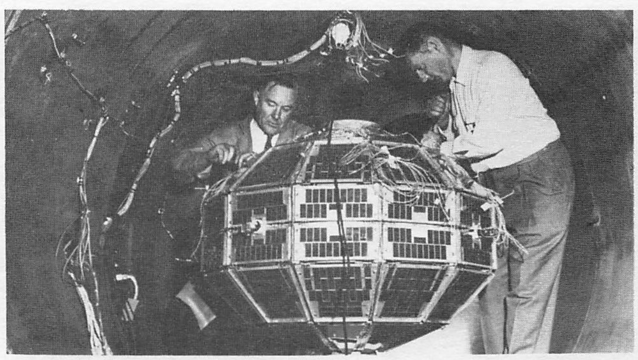
In another experiment, Alouette gauges the intensities of high-energy radiation in space, including naturally-produced cosmic rays and the artificial radiation created by the United States nuclear experiment of July 9, 1962. (On that date, a hydrogen bomb detonated about 250 miles above Johnston Island in the Pacific Ocean emitted a flux of high-energy electrons that became trapped in the earth's magnetic field. Alouette's orbit is within the resulting radiation zone.) Experimenters will attempt to determine more precisely the relationships between changes in the ionosphere and changes in the intensity of high-energy radiation in space.

SPACECRAFT DESCRIPTION

The 320-pound, nearly oval Alouette is 42 inches in diameter and 34 inches high. It is encrusted with about 6500 solar cells that convert sunlight to electricity for running satellite instruments. Rechargeable nickel cadmium batteries power Alouette when the satellite is on the earth's night side. They also furnished electricity from launch until Alouette was in orbit and its solar cells were functioning. The batteries are recharged by electricity that is not used by other satellite instrumentation.

Alouette's sounding equipment includes two long antennas—one 150 feet in length and the other 75 feet. The 150-foot antenna is believed the longest ever employed on a spacecraft. The antennas are extended in the shape of a cross. They are fashioned from thin strips of spring steel that were coiled like measuring tapes at launch and unwound by a motor-driven spool shortly after the satellite was in orbit.

Other major equipment includes radiation particle detectors; radio receivers, amplifiers, transmitters, and other antennas for experiments and telemetry; and associated electronic apparatus.

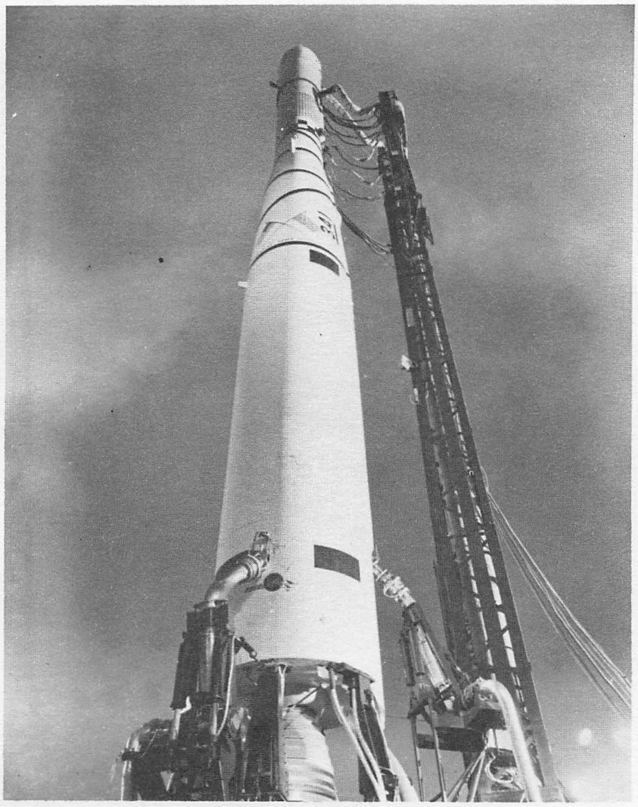


Canadian technicians prepare a prototype Alouette for thermal tests. Powerful arc lights in this vacuum chamber simulated on the prototype exposure to the sun's heat anticipated on the satellite in space.

The Alouette project developed from a proposal by United States representatives at the March 1959 meeting of COSPAR, the Committee on Space Research of the International Council of Scientific Unions. At that meeting, the United States offered to launch experiments or complete satellites prepared by foreign scientists.

LAUNCH AND ORBITAL DATA

A NASA Thor-Agena B vehicle launched Canada's Alouette satellite from Point Arguello, Calif., at 11:05 p.m. PDT, September 28, 1962. The satellite's perigee, or closest approach to earth, is about 620 miles; its apogee, or farthest distance from earth, approximately 640 miles. Alouette completes a circuit of earth every 105.4 minutes. Its orbit is inclined 80.48 degrees to the equator, enabling Alouette to pass and acquire ionospheric data over most of earth.



NASA Thor-Agena B with Alouette payload is poised on pad at Point Arguello, Calif.

COOPERATIVE SPACE PROGRAMS

Project Alouette is one of many cooperative space programs embarked upon by the United States and other countries. Among the projects and cooperating countries are the following:

SATELLITES

Canada, France, Italy, United Kingdom, the Soviet Union and European Space Research Organization (ESRO).

SOUNDING ROCKETS

Argentina, Australia, Canada, Denmark, France, Federal Republic of Germany, India, Italy, Japan, New Zealand, Norway, Pakistan, Sweden, and U.K.

GROUND-BASED METEOROLOGY

Argentina, Australia, Austria, Belgium, Brazil, Burma, Canada, Chad, China, Colombia, Costa Rica, Czechoslovakia, Denmark, El Salvador, France, Federal Republic of Germany, Hong Kong, Hungary, Iceland, India, Indonesia, Iraq, Ireland, Jamaica, Japan, Kenya, Mauritius, Mozambique, Netherlands, New Zealand, Norway, Poland, Portugal, Rhodesia/Nyasaland, Senegal, South Africa, Sudan, Switzerland, Thailand, United Arab Republic, United Kingdom.

COMMUNICATIONS

Brazil, Canada, Denmark, France, Federal Republic of Germany, Italy, Japan, Norway, Spain, Sweden, United Kingdom.

TRACKING AND ACQUIRING DATA FROM SPACECRAFT

Argentina, Australia, Bermuda, Canada, Canton Island, Chile, Ecuador, India, Iran, Japan, Malagasy, Mexico, Netherlands, Nigeria, Peru, South Africa, Spain, United Kingdom.

INTERNATIONAL COOPERATION

Designed and developed by Canadian scientists, Alouette is the first satellite built by a nation other than the United States and the Soviet Union. It is named for the high-flying Canadian songbird of the lark family.

The satellite was built by the Defence Research Telecommunications Establishment (DRTE) of Canada. It is a precursor of a somewhat similar NASA spacecraft to be launched early in 1963. Their chief difference is that the NASA satellite will transmit radio signals downward at about a half dozen specific or "fixed" frequencies instead of "sweeping" over a wide range of frequencies. Data from both satellites will be incorporated into the overall topside sounder program and be made available to the world scientific community. Alouette's ionosphere ex-

Canadian engineers at DRTE's Ottawa reduction center check equipment used to process Alouette data.

periments are being conducted by DRTE; the radiation experiment by Canada's National Research Council.

Scientific direction of the Alouette project is provided by A. H. Zimmerman, Chairman, Canadian Defence Research Board, and Homer E. Newell, Director of NASA Office of Space Sciences. Project managers are John H. Chapman of DRTE and John E. Jackson of NASA's Goddard Space Flight Center.

Thirteen stations in a half dozen countries are gathering information from Alouette. Site locations and their directing organizations are as follows:

(1) St. Johns, Newfoundland; College, Alaska; East Grand Forks, Minn.; Fort Myers, Fla.; Quito, Ecuador; Antofagasta, Chile; Winkfield, England, and Woomera, Australia—Minitrack stations of NASA.

(2) Resolute Bay, Northwest Territories; Prince Albert, Saskatchewan; and Ottawa, Ontario—Stations operaed by the DRTE.

(3) Singapore and South Atlantic Ocean stations operated by the British Department of Scientific and Industrial Research.

Data from the world-wide network of stations are funneled to Goddard Space Flight Center, Greenbelt, Md., where they are processed and forwarded for study to the DRTE, near Ottawa, Ontario, Canada.

STATEMENT OF THE PRIME MINISTER OF CANADA

"On behalf of the Government of Canada and the Canadian people, I express our pride in this great scientific achievement of developing a Canadian satellite.

"To all the scientists of the Defence Research Board and the workers who designed and built the Alouette, I express the congratulations of the Canadian public. This is a tribute to Canadian scientific standing, placing us as it does, among the first nations to seek knowledge of outer space by the medium of a satellite.

"The knowledge gained, which will be used for peaceful purposes, should greatly improve the problem of communication.

"The launching of the Alouette with United States supplying the rocket power is a practical illustration of the cooperation for peaceful purposes which exists between the United States and Canada.

"I congratulate the Canadian designers for selecting such a distinctive Canadian name as Alouette."

JOHN GEORGE DIEFENBAKER
Prime Minister of Canada
September 29, 1962

Canadian scientists examine shrouded nose cone of Javelin sounding rocket at NASA's Wallops Station, Va. The rocket, launched June 14, 1961, was one of two that tested operation of Alouette instruments in space.

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