J. Watson


**NEWS**

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

TELS. WO 2-4155
WO 3-6925


**FOR RELEASE:** THURSDAY, A.M.
March 25, 1971

RELEASE NO: 71-41

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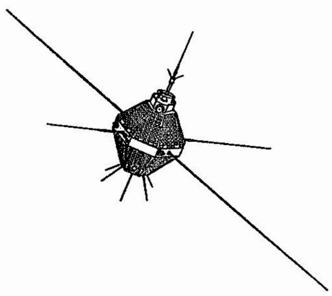

## PROJECT: ISIS-B

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NEWS NASA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (202) 962-4155
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# IONOSPHERE SATELLITE TO BE LAUNCHED

The third satellite in a joint Canadian-United States program to study the ionosphere from space will be launched by the National Aeronautics and Space Administration from the Western Test Range, Lompoc, Calif., no earlier than March 31.

Called ISIS-B (for International Satellite for Ionospheric Studies), the 582-pound, Canadian-built satellite is the largest and most advanced ionospheric spacecraft yet developed. It will continue a comprehensive program to study the ionosphere and the complex mechanisms that affect it.

The spacecraft is an eight-sided spheroid, 48 inches tall and 50 inches in diameter with two sounder antennas, one 240 feet long and the other 61.5 feet long, including the spacecraft.

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ISIS-B, to be called ISIS-2 after orbit is achieved, carries 12 ionosphere investigation experiments--the largest number flown by a single satellite in the program to date. Eight of the on-board instruments were provided by Canadian universities and government agencies and the remaining four were provided by the NASA Goddard Space Flight Center and the University of Texas.

The satellite will be launched into a circular, near-polar orbit by a three-stage thrust-augmented Delta rocket. The orbit planned will be 870 statute miles above the Earth at an inclination of 88.7 degrees, with an orbital period of 114 minutes.

The ionosphere is formed by the Sun's action on the Earth's atmosphere. It is important to scientists from a purely scientific standpoint. Understanding how it works is also important to communications engineers since it reflects certain radio waves used for long distance radio communication, and the selection of the best frequency depends on a detailed knowledge of the ionosphere.

The ionosphere is an electrified gas curtain beginning about 35 miles above the Earth and is divided into four regions or layers--the D, E, $F_1$ and $F_2$ layers. The electron density of each layer varies in altitude and amount of ionization with the time of day, the degree of solar activity, the season of the year and geographical location. These variations are large and not well understood.

The primary scientific objectives of ISIS-B are to continue the program of measuring daily and seasonal fluctuations in the electron density of the upper ionosphere, study radio and cosmic noise emissions and conduct correlative direct measurements of the energetic particles interacting with the ionosphere.

The first launching under the joint agreement occurred on November 29, 1965 when the Canadian-built Alouette 2 and the U.S.-built Explorer 31 (Direct Measurement Explorer) were launched from the Western Test Range. Alouette 2 continues to transmit valuable data.

The launching of ISIS-1, also from the Western Test Range, occurred on Jan. 29, 1969. This 532-pound Canadian-built satellite is still operating successfully.

The primary ISIS program agencies are, for Canada, The Communications Research Centre of the Department of Communications, Ottawa, and for the United States, the NASA Goddard Space Flight Center, Greenbelt, Md. Initially, responsibility for the Canadian portion of the ISIS program was under the Canadian Defense Research Board which became The Communications Research Centre in 1969. NASA's Kennedy Space Center, Western Test Range, Calif., provides pre-launch and launch support services for the program.

The NASA world-wide STADAN tracking network, operated by Goddard, will track the ISIS-B as it has the earlier satellites in the program. This support will be augmented by stations operated by the Canadian Government, France, the United Kingdom, Norway, Japan, India, Australia, and New Zealand.

In addition, scientists from the United Kingdom, France, Japan, Norway, India, Australia, New Zealand and Hong Kong are actively participating with their Canadian and U.S. counterparts in the ISIS Working Group which plans topside ionospheric research activities using satellites in the ISIS program. Data obtained from the satellites are often related to similar ground-based efforts carried on by these and other nations throughout the world.

After evaluation by the principal investigators, the scientific results from ISIS-B--as with the results from earlier satellites in the program--will be deposited in the World Data Center, Boulder, Colo., and in the National Space Science Data Center, Greenbelt, Md., for use by the world scientific community. About two million ionograms are already available. An ionogram is a graphic display of the depth of the ionosphere similar to an echo sounding of water depths.

The prime contractor for ISIS-B is the RCA Ltd., Montreal, Canada, which built the satellite under supervision of the Communications Research Centre. The Delta rocket is built for NASA by the McDonnell-Douglas Corp., Huntington Beach, Calif.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS)

THE IONOSPHERE

The Earth's ionized atmosphere extends upwards from approximately 35 miles above the Earth, and is created largely by solar ultraviolet radiation which strikes the neutral air molecules, causing them to split into electrically charged ions and electrons. These charged particles form an electrical conductor capable of reflecting radio waves, making possible radio transmission over long distances on the Earth's surface. Canada, in particular, depends on ionospheric reflection for communication in its northern regions.

Since charged particles interact with magnetic fields, the Earth's magnetic field plays a strong role in the behavior of the ionosphere. Activity on the Sun creates a moving plasma of charged particles which extends beyond the Earth, carrying with it an associated magnetic field. Enhancements of the solar plasma and its associated field interact with the Earth's magnetic field, causing ionospheric disturbances, thereby linking ionospheric behavior with solar activity. The Earth's polar and near-polar regions are most affected since the magnetic field lines that originate near the poles and extend a very great distance from Earth are accessible to solar and particle fields.

When the ionosphere becomes disturbed following solar storms or other phenomena associated with the Sun, its reflecting properties are affected. Consequently, radio communications are disrupted, sometimes for lengthy periods. A variety of disturbed conditions may occur at high latitudes.

Perhaps the worst ionospheric condition, from the standpoint of high latitude communications, is the polar blackout. During such occurrences, radio reflections from the ionosphere do not occur at normal frequencies. Rocket flights and other experiments have shown that these polar blackouts stem from an abnormal ionization increase in the lower ionosphere (D-region) which is caused by precipitating solar particles. The resultant greater number of collisions between ionized and neutral particles in this region causes radio waves to be absorbed before they can be reflected. During such conditions radio communications at high frequencies may cease for periods of several days.

The ionospheric storm is another type of disturbance which is most prevalent at higher latitudes. It is characterized by a general instability of ionospheric conditions, a decrease in the maximum density of ionization and an increase in radio wave absorption. The maximum useable frequencies are much lower than normal during these periods and within the restricted communication spectrum the radio signals are subject to rapid fluctuations in signal intensity. An ionospheric storm is usually accompanied by a period of unusual fluctuation in terrestrial magnetic activity and is related to solar activity through the passage of solar plasma past the Earth. Such conditions may persist for days.

Sudden ionospheric disturbances also cause loss of communications, producing an abrupt and simultaneous radio fadeout throughout the sunlit hemisphere of the Earth, which may last from 10 minutes to an hour. This phenomenon is caused by solar X-ray bursts which cause enhanced ionization in the D-region of the ionosphere.

It is clear that, in addition to its scientific value, increased knowledge about the ionosphere can be applied directly to communications and tracking operations. Predictions of ionospheric storms and disturbances are often unsatisfactory because they are based on inadequate information. By gaining an improved knowledge of the ionosphere and the mechanisms affecting it, more precise predictions can be made, and better methods developed to deal with communicating via the ionosphere. Canada, with its northern communications problem, has a special interest in such knowledge.

The ionosphere is studied from the ground by transmitting strong radio signals and listening for the reflected echoes. The resultant time delays and received signal strengths are used to obtain information on the ionization at various heights in the ionosphere, up to the layer of maximum electron density.

Above this layer, the ionosphere must be sounded from above to provide such information. A satellite sounder is ideal for this as it also provides information on the topside ionosphere over the entire globe. By means of the topside sounding technique developed in Canada, world-wide electron-density profiles can be obtained above the height of maximum electron density of the ionosphere. To interpret these in terms of the physical processes which take place, additional information is needed. Some of this is supplied by the direct measurement instrumentation carried in addition to the topside sounder.

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## ISIS-B SCIENTIFIC EXPERIMENTS

The following experiments carried by ISIS-B were chosen by a joint committee of Canadian and US scientists:

Swept and Fixed Frequency Ionospheric Sounder (G.K. Lockwood and L.E. Petrie, Communications Research Centre of Ottawa.)

To map the electron density profile of the ionosphere below the spacecraft using both swept and fixed frequency transmission over the range 100 khz to 20 mhz. Swept frequency profiles will be available every 144 km along the satellite path, and fixed frequency profiles every 0.27 km.

Very Low Frequency Receiver and Stimulator (R.E. Barrington, Communications Research Centre, Ottawa.)

To observe VLF radio signals of natural origin within the ionosphere from 50 hz to 30 khz; to observe VLF signals propagated from ground transmitters; to stimulate and observe VLF resonances produced by a swept frequency oscillator within the spacecraft; to observe the effects of the surrounding ionosphere plasma on the short sounder antenna.

Energetic Particle Detector (I. B. McDiarmid and J.R. Burrows, National Research Council, Ottawa.)

Direct measurement of electron and proton particle fluxes relative to spacecraft orientation and location. Geiger counters, solid state detectors and scintillators are used to detect electrons between 20 and 200 kev, solid state detectors for protons between 250 kev and 30 mev. To provide overlap with the soft particle experiment, a detector capable of measuring the total energy flux of electrons between 0.6 and 10 kev in energy is included.

Soft Particle Spectrometer (W.J. Heikkila, University of Texas at Dallas.)

Direct measurement of the distribution in energy and direction of both negative and positive particles in the energy range 10 ev to 10 kev, especially over the auroral zones.

Ion Mass Spectrometer (J.H. Hoffmann, University of Texas at Dallas.)

Direct measurement of the relative abundance of positive ions of mass numbers in the range 1 to 64 AMU.

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Cylindrical Electrostatic Probe (L.H. Brace and J.A. Findlay, Goddard Space Flight Center.)

Direct measurement of electron density and electron temperature using two Langmuir probes at opposite ends of the spacecraft.

Ion Temperature Probe (J.L. Donley and E.J.R. Maier, Goddard Space Flight Center.)

Direct measurement of electron temperature, ion temperature, ionic composition, and charged particle density by means of a retarding potential analyzer.

Very High Frequency Beacon (P.A. Forsyth, University of Western Ontario.)

Simultaneous transmission of two stable frequency unmodulated 100 milliwatt signals at 136.410 mhz and 137.950 mhz from a common omnidirectional antenna system with linear polarization. Irregularities in the ionosphere will affect the relative polarization and amplitude of signals received on the ground.

Background Noise (T.R.Hartz, Communications Research Centre, Ottawa.)

To monitor the background noise levels due to galactic, solar and ionospheric sources for correlation with other phenomena.

6300 Å Auroral Photometer (G.C. Shepherd, York University, Toronto).

Direct measurement and mapping of intensity of oxygen red-line emission from the aurora and from night, twilight and day airglow sources. The instrument is a photometer with two optical channels, one broadband for white light, the other narrow band (red light), pointed in opposite directions, perpendicular to the satellite spin axis.

3914Å/5577Å Auroral Scanning Photometers (C.D. Anger, University of Calgary, Alberta).

Direct measurement and mapping of aurora emissions at two wavelengths of light over the entire auroral zone. An image-dissector type of photometer will provide high resolution two-color aurora pictures for comparison with other observations of auroral activity. The photometer is to be pointed perpendicular to the spin axis of the satellite.

## DELTA LAUNCH ROCKET

ISIS-B will be launched by Delta 84 from the SLC-2 East Launch pad at the Western Test Range. Launch time for a March 31 mission will be 6:40 PM PST. In order that the ISIS-B orbit will be in the desired relative position to its sister satellite (ISIS 1), Delta 84 can be launched only during a one-hour period

If Delta 84 is successful, it will mark the 78th time in 84 attempts that the workhorse booster had done its job.

The ISIS-B spacecraft will be launched by a three-stage Delta launch vehicle technically named Delta E. The rocket configuration will mark the last of the short Thors which is the first stage rocket for Delta. The third stage will be the FW-4D solid propellant rocket.

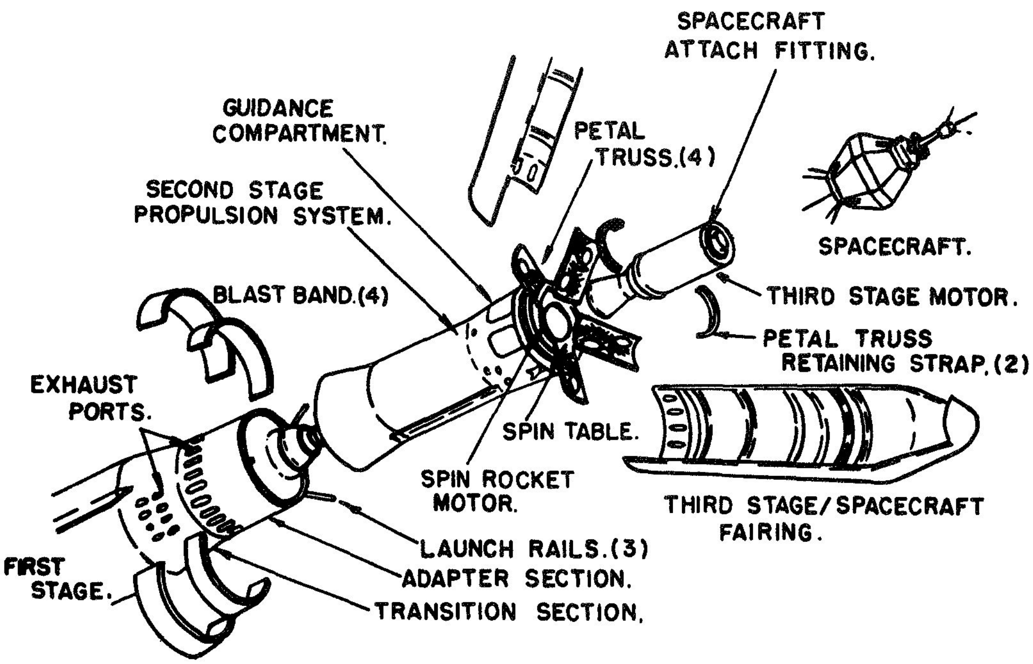
Nominal flight plan calls for Delta 84 to inject ISIS-B into a circular 870 mile orbit, inclined 89 degrees to the Equator with an orbital period of 114 minutes.

Delta is managed for NASA's Office of Space Science and Applications by the Goddard Space Flight Center, Greenbelt, Md. Launch operations are the responsibility of NASA's Kennedy Space Center's Unmanned Launch Operations. The McDonnell Douglas Corporation, Huntington Beach, Calif., is Delta prime contractor.

General characteristics for the three stage Delta-E are:

| | |
|---|---|
| Total Height: | 106 Feet |
| Total Weight: | 225,000 pounds |
| Maximum Diameter: | 8 feet |

| | |
|---|---|
| First stage thrust (average): | 325,000 pounds (includes solids) |
| Second stage thrust | 7,800 pounds |
| Third stage thrust | 10,000 pounds |




ISIS-Delta Rocket Separation

## DELTA 84 NOMINAL FLIGHT EVENTS

| EVENT | TIME (seconds) | ALTITUDE (statute miles) | SURFACE RANGE (statute miles) | VELOCITY (miles-per-hour) |
|---|---|---|---|---|
| Solid Motor Burnout | 38.6 | 6 | 2 | 1,481 |
| Solid Motor Separation | 70 | 17 | 10 | 2,096 |
| Main Engine Cutoff (MECO) | 151.5 | 82 | 89 | 8,417 |
| Shroud Separation | 160.5 | 94 | 105 | 8,373 |
| Second Engine Cutoff (SECO) | 533.7 | 501 | 983 | 13,693 |
| Third Stage Ignition | 1168.5 | 870 | 2,825 | 12,034 |
| Third Stage Burnout | 1199.3 | 870 | 2,921 | 16,013 |
| ISIS-B Separation | 1313.5 | 871 | 3,337 | 16,012 |

## ISIS-B FACT SHEET

Launch: Complex SLC-2, Vandenberg AFB, Calif., Western Test Range.

Launch Rocket: Three-stage Delta E (Improved Delta) with three solid-stage augmentation rockets attached to the first stage and the F-W 4 third stage motor.

Orbit: Circular 870 miles (1400 km) 88.7 degrees prograde inclination.

Period: 114 minutes

Weight: 582 pounds

Power: 11,000 n on p solar cells. Three nickel cadmium batteries of 17 cells each.

Command execution: 216 possible commands can be received and executed by the spacecraft. An on-board programmer allows five commands to be stored for later execution, together with their times of execution.

Data storage: Tape recorder: 64 minutes recording time, record/playback speed ratio of 1:4.

Transmission: 136 MHz real-time data transmission system.
400 MHz recorded data/playback transmission system.
136 MHz beacon transmitter system.

Antennas: Sounder: Crossed dipoles 240 and 62 ft. long
Telemetry: (136 MHz): turnstile whips
Telemetry: (400 MHz): turnstile whips
Beacons: ring antenna

Main modes of operation: The spacecraft can be turned on by a single command, into any one of ten principal modes of operation, using various combinations of experiments and telemetry. The command can either be received directly from the ground or from the stored command capability of the on-board programmer. Other modes of operation may also be selected upon command.

Automatic ionogram transmission: An automatic ionogram transmission mode is provided, using the swept frequency sounder and the 136 MHz direct transmission telemetry. One ionogram can be transmitted every three minutes in this system.

Attitude sensing: three-axis flux gate magnetometer solar aspect sensor.

Attitude control: spin maintenance and spin axis control by magnetic torquing.

ISIS-B EXPERIMENTS AND PRINCIPAL INVESTIGATORS

| | |
|---|---|
| Swept-Frequency Sounder | * G. Lockwood and L. Petrie, Communications Research Centre, Ottawa, Ontario. |
| Fixed-Frequency Sounder | * G. Lockwood and L. Petrie, Communications Research Centre. |
| Cosmic Noise Experiment | * T. Hartz, Communications Research Centre. |
| VLF Receiver and Stimulator | * R. E. Barrington, Communications Research Centre. |
| Retarding Potential Analyzer | * E. Maier, B. Troy, J. Donley, NASA Goddard Space Flight Center, Greenbelt, Md. |
| Ion-Mass Spectrometer | * John H. Hoffman, University of Texas, Dallas. |
| Soft-Particle Spectrometer | * W. J. Heikkila, University of Texas. |
| Energetic Particle Detector | * R. Burrows, National Research Council, Ottawa. |
| Radio Beacon Transmitter | * P. A. Forsyth and C. Lyon, University of Western Ontario, London, Ontario. |
| Atomic Oxygen Red-Line Photometer | * G. Sheppard, York University, Toronto, Ontario. |
| Cylindrical Electrostatic Probe | * Larry H. Brace and J. A. Findlay, Goddard Space Flight Center. |
| Auroral Scanner | * C. D. Anger, University of Calgary, Calgary, Alberta. |

# ISIS-B PROJECT OFFICIALS AND CONTRACTORS

## CANADA

### Communications Research Centre, Department of Communications

| | |
|---|---|
| Dr. R. C. Langille | Director General, CRC |
| Dr. I. Paghis | Program Coordinator |
| Dr. Colin A. Franklin | Program Manager/Chief Engineer |
| Harold R. Raine | Deputy Program Manager |

## UNITED STATES

### NASA Headquarters

| | |
|---|---|
| Frank Gaetano | Program Manager |
| Dr. E.R. Schmerling | Program Scientist |
| I. T. Gillam IV | Delta Program Manager |
| James T. Bavely | Network Operations, OTDA |

### NASA Goddard Space Flight Center

| | |
|---|---|
| E. Dale Nelsen | Project Manager |
| John E. Jackson | Project Scientist |
| William R. Schindler | Delta Project Manager |

### NASA Kennedy Space Center, Unmanned Launch Operations

| | |
|---|---|
| John Neilon | Director, Unmanned Launch Operations |
| Henry R. Van Goey | Manager, Western Test Range Operations Division |
| Damon C. Latham | Spacecraft Coordinator |

## CONTRACTORS

| | |
|---|---|
| Radio Corporation of America, Ltd; Montreal | Spacecraft Prime Contractor |
| McDonnell-Douglas Astronautics Co., Huntington Beach, Calif. | Delta Launch Rocket |

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Tracking and Data Acquisition Network: Stations of the world-wide Space Tracking and Data Acquisition Network operated by the Goddard Space Flight Center: Fairbanks, Alaska; Fort Myers, Fla.; Kavai, Hawaii; Rosman, N.C.; Johannesburg, South Africa; Winfield, England; Orroral Valley, Australia; Quito, Ecuador; Santiago, Chile; and Tananarive, Madagascar.

Other ISIS tracking stations include:

Tromso, Norway
Bretigny, France
Ouagadogou, Republic of Upper Volta (France)
Terre Adelie, Antartica (France)
Singapore (U.K.)
Falkland Islands, South Atlantic (U.K.)
Resolute Bay, NWT, Canada
Ottawa, Ontario, Canada
Kashima, Japan
Ahmedabad, India
Boulder, Colorado

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