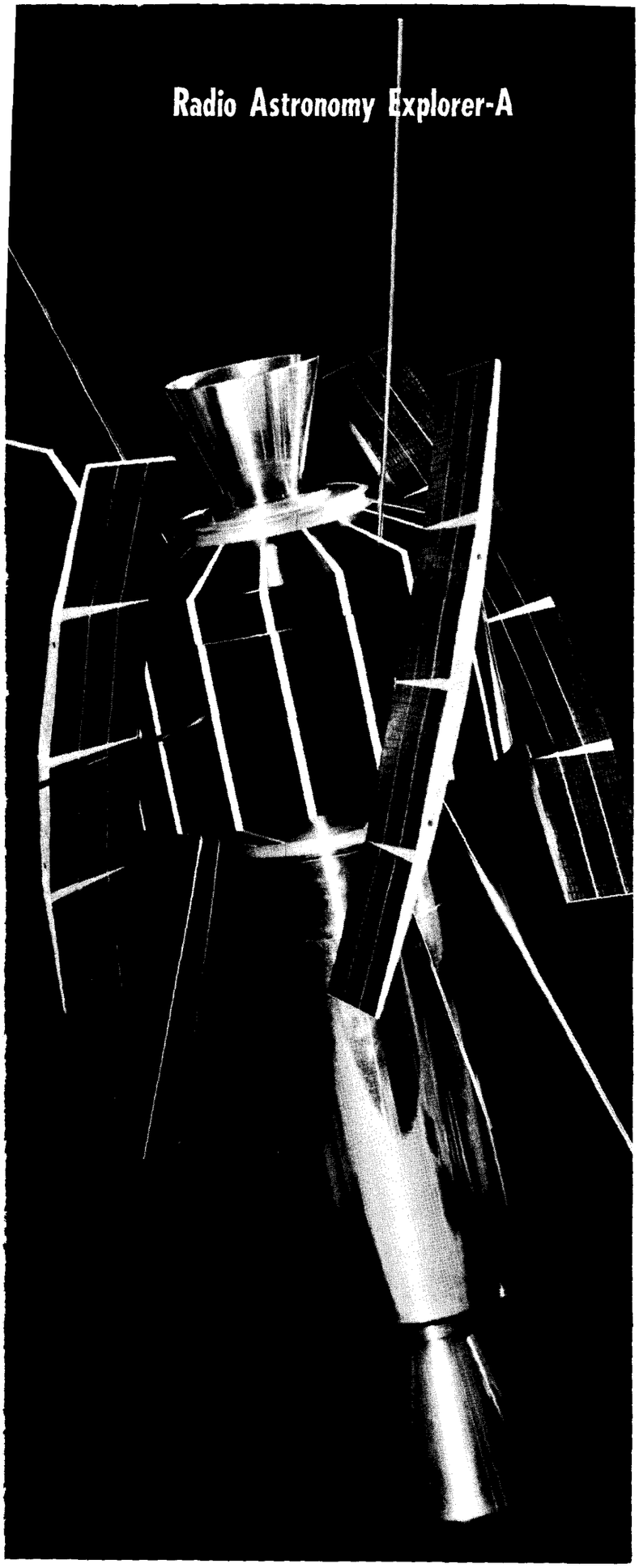


SCALE MODEL of the Radio Astronomy Explorer-A (RAE-A), the world's first satellite devoted to radio astronomy, now under development by Goddard.

GODDARD NEWS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GODDARD SPACE FLIGHT CENTER / GREENBELT, MARYLAND

VOLUME X, NUMBER 2 OCTOBER 18, 1965

World's First Radio Astronomy Satellite Being Developed Here

Now that the design work on the new Radio Astronomy Explorer (RAE) is well underway here at Goddard, astronomers everywhere are eagerly awaiting the 1967 launching of the satellite that will enable them to obtain a radio-signal map of our galaxy at frequencies heretofore unobservable on earth.

The satellite will be tantamount to a 1500-foot antenna system that encircles the earth at a 3800-mile altitude. It will record radio signals that are blocked by the ionosphere. Although many of the subsystems are adapted from previous Goddard projects, two are unique and present unusual design problems: A directive, double V antenna system, plus miniaturized Ryle-Vonberg-type radiometers.

Goddard's principal scientific investigators are Dr. Robert G. Stone and Joseph K. Alexander, Jr., both of the Radio Astronomy Section. Project Manager is John T. Shea, of the Spacecraft Integration and Sounding Rocket Division. Assistant Project Manager is Carl L. Wagner, Jr. of the same division.

Mr. Shea remarked, "RAE will be launched into an elliptical transfer orbit by the Delta DSV–3J rocket from the Western Test Range. A kick motor will be fired at the transfer orbit apogee to circularize the orbit at 3800 miles. A retrograde launch will insure that the satellite remains in full sunlight for the first seven months of its lifetime.

"After the Delta vehicle places the satellite into the transfer orbit, operation of the spacecraft will become the responsibility of RAE project personnel in the Tracking and Data Systems Control Center at GSFC. The complex task of obtaining a circular orbit and deploying the large, fragile antenna system is expected to last about two weeks."

The RAE satellites will have five prime scientific objectives:

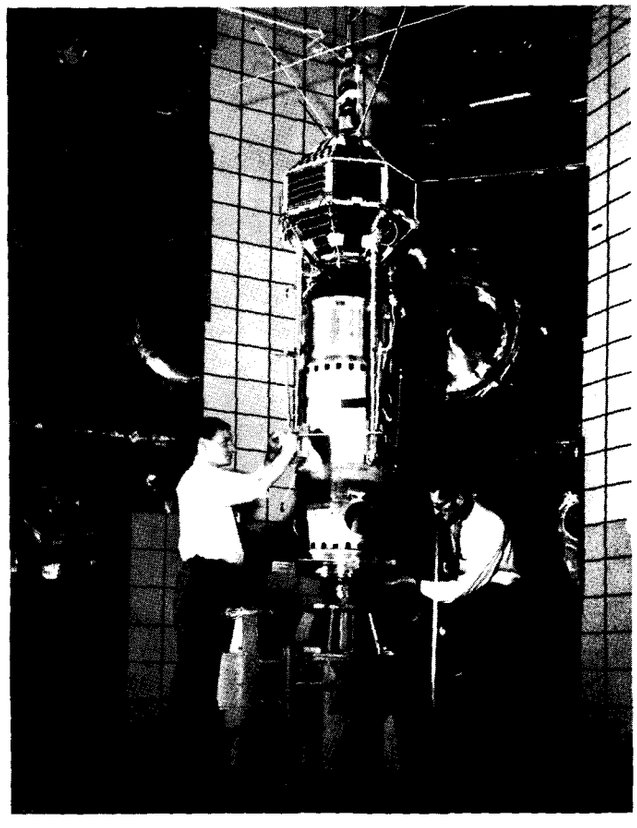
- To observe low-frequency earth radio storms thought to be generated by solar particles interacting with the earth's radiation belts.
- To gather data on low-frequency solar radio bursts which should aid in the study of solar corona electron temperature and density out to distances of 20-30 solar radii.
- To monitor large discrete radio noise sources, such as the southern constellation Centaurus A.
- To obtain an electromagnetic map of the galaxy at frequencies from 10 mc.-400 kc.
- To study Jupiter, the only other planet known to emit low-frequency sporadic noise bursts similar to earth's.

French Spacecraft Undergoes Test

France's FR–1 spacecraft is shown here being prepared for test in Goddard's Dynamic Test Chamber (DTC).

This test was conducted to verify the mechanical systems design of the spacecraft and to check its operation during the de-spin sequence and separation from the fourth stage rocket motor under a low pressure environment. For this test, the DTC was pumped down to a pressure level of one Torr (one millimeter of mercury).

In this test, the spacecraft was spun up to 180 RPM on the chamber's spin table which is mounted flush with the chamber floor. The spacecraft was then operated through its injection sequence. This included the de-spin and separation events along with erection of the antenna and deployment of an electron density probe from the bottom of the spacecraft.



WILLIAM E. LANG (right) is the Goddard Test Director for the French FR-1 spacecraft. At left is a representative of Centre Nationale d'Etudes Spatiales (CNES), the French National Center for Space Studies. Mr. Lang is in Goddard's Structural Research Technology Section (T&E).

For the test, the prototype model of the FR–1 was used along with a separation unit and a simulated fourth stage Scout rocket. A counter-balanced weight, connected to the spacecraft by means of a suspension cord, supported the unit above the chamber floor after separation.

Support bearing friction was cancelled out with a spinning jet assembly which kept the spacecraft spinning for six minutes after spinup.

The FR–1 is designed to study the propagation of very low frequency (VLF) waves from the ground to the ionosphere as well as irregularities in the distribution of the ionosphere. Instruments aboard the spacecraft will measure the electric and magnetic components of the VLF field and the local electron density.

The spacecraft is scheduled for launch late this year aboard a Scout launch vehicle from the Western Test Range. It will be placed in a circular orbit at an altitude of about 800 kilometers.

DATA TOPICS

(In initiating the Data Topics column, the Goddard News is publishing an article by Curtis M. "Curt" Stout, who came to Goddard in 1958 as a member of NASA's first data processing team. He is a Staff Engineer in the Information Processing Division and a former head of the Data Processing Branch.)

Curtis M. "Curt" Stout

Goddard Faces Data Explosion

Down through the ages, man has been driven to explore new frontiers by this insatiable thirst for knowledge. The last and perhaps most informative quest to discover how life evolved in our universe is in the space frontier. Here man finds an airless, hostile environment which offers him a challenge not only in terms of making new discoveries about the birth of the universe but also in creating a new technology which will provide him the tools he needs to carry out this task in an orderly fashion.

One of the first challenges he faced and conquered was the injection of exploratory probes in the form of earth satellites into the space regions nearest our earth. Almost immediately, the first great discovery in the form of natural radiation belts surrounding the earth was made. In this case from somewhat meager and oftentimes confusing data, Dr. James Van Allen concluded that his detectors had been exposed to intense fields of radiation during certain parts of the satellites' orbit. Since that time many deep space probes and near earth satellites have been used to gather more and more data about the space environment in which our solar system exists.

One might reasonably ask, what has all this to do with data processing? If you will recall, terms such as *knowledge, informative* and *data* were used in the preceding paragraphs. Webster's dictionary defines *knowledge* as "That which is gained and preserved by knowing; enlightenment; learning; also, broadly, the sum of information conserved by civilization." Also *informative* as "Informing; instructive" and finally *data*, "Plural of datum, something given as a fact on which an inference is based." With these definitions in mind, I will attempt to describe how, here at Goddard, a "mountain of data is reduced to a molehill of information" and to point out some of the challenges that face us in this area of the new technology.

To place this discussion in its proper frame of reference, it is important to understand that information and the knowledge that results from its interpretation is transmitted to earth through the medium of data. Why not send the information, directly? Almost without exception, an experimenter does not know what information he will glean from his experiment, for if he knew, he would gain no information. The situation is somewhat analogous to that encountered in taking a course in high school or college. The words in the text book are the data and the understanding we glean from those words are the information. Similarly, experiments in space gather data about the phenomena under study and the experimenter reduces these data to information through the various processes and techniques available to him. A later analysis of this information adds to the store of knowledge about the universe. *(See page 6)*

In Memoriam

Allen M. Ludington

Allen M. Ludington, 38, Deputy Chief of Goddard's Procurement Division, died October 9 of a cerebral hemorrhage.

Mr. Ludington had been responsible for procurement of systems for Goddard's world-wide tracking and data acquisition networks for both manned and unmanned missions. His work, which necessitated a close working relationship with NASA headquarters, also required several visits with the Australian government to whom he was Goddard's prime contract interface.

Mr. Ludington, born in Lebanon, Ohio, entered government service after graduation from Miami University, Oxford, Ohio, in 1950. In 1961, he transferred from Air Force procurement activity at Air Materiel Command, Dayton, Ohio. He received his 15-year government service pin just this past June.

He is survived by his wife, Betty Lee, and three children —Mark, Laurie, and Brent. He is also survived by his mother, Lurene Ludington of Lebanon.

Services were held on Thursday, October 14 at the Oswald Funeral Home in Lebanon, Ohio.

Alouette I Still Going Strong

Alouette I, the Canadian scientific satellite launched September 29, 1962, by NASA, was operating normally as it began its fourth year in orbit.

It was the first international spacecraft to be totally designed and built by a nation other than the United States or the Soviet Union. Three additional international satellites have been launched by NASA since that time in cooperation with Great Britain and Italy. Agreements provide for the launching of 10 additional international scientific satellites by NASA.

When in full sunlight, Alouette has been working about six hours daily gathering information about ionospheric electron density and distribution, using the swept frequency topside sounding technique.

Plans call for launching of four additional satellites in cooperation with Canada, including one to be launched late in 1965.

The Canadian satellite project is a major element in the Topside Sounder Program of NASA's Office of Space Science and Applications (OSSA) with program management assigned to OSSA's Physics and Astronomy division. Project management is exercised by Goddard.

GODDARD NEWS

OCTOBER 18, 1965

"It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."
—Dr. Robert H. Goddard

The Goddard News is published biweekly by the Public Information Office of the Goddard Space Flight Center, National Aeronautics and Space Administration, Greenbelt, Md.

Jerry Stark, *Editor* Stephen Jacobs, *Assistant Editor*

Photography by Goddard's photographic branch

* *Press date precedes publication date by approximately seven days.*

Meet Our People

This is another in a series of articles on Goddard personalities

Ernest F. "Ernie" Powers

Ernest F. Powers, Head of Goddard's Operations Support Office (NE&OD), came here in August 1960 as the RCA Manager of the TIROS Technical Control Center. Prior to this time he was Research Associate and Educational Specialist for the U.S. Army Signal School in Fort Monmouth, New Jersey, where he developed courses of study for command and staff officers in electronic warfare system concepts and utilization.

He became Goddard's TIROS Project Coordinator in November 1961, and after 3½ years was made Assistant to the Associate Chief of the Network Engineering and Operations Division. He was appointed to his present position in July of this year.

Asked what his job entails, Mr. Powers said: "We are responsible for near realtime engineering coordination and direction of long-term STADAN station operations, development and application of a unified STADAN documentation system, as well as management and policy direction to the STADAN station directors. The Operations Support Office also provides analyses of present and future needs for Network Operational Support. We represent the Network Engineering and Operations Division to the Project Operations Support Division for operational support, and act as the major contributor to development of division program and budget requirements. We are also responsible for STADAN equipment and facilities configuration control programs and documentation efforts."

Mr. Powers earned his AB degree at Baker University in Baldwin, Kansas, and did graduate work at Rutgers University Graduate School and the University of Maryland.

He was selected as one of the "Outstanding Young Men of America for 1956" by the Junior Chamber of Commerce. While TIROS Project Coordinator, his area won the NASA/TIROS Group Achievement Award. He is also a recipient of the National Methodist Student Scholarship Award.

His magazine article on "TIROS Operations" was circulated nationally in Aeronautics & Astronautics. He is a member of the American Institute of Aeronautics and Astronautics and the American Geophysical Union.

He is a member of the Zeta Chi fraternity, First Methodist Church of Hyattsville, and Methodist Men. Mr. Powers is Superintendent of the Youth of Church School, Chairman of the Church Commission on Christian Social Concerns, and President of Methodist Men. His hobbies are golf, drama and music.

He and his wife, Suzanna, have two children: Patti Sue, 5, and Laurie Beth, 3. They live at 7409 Radcliffe Drive, College Park, Maryland.

(Next issue: Robert J. McCaffery)

APOLLO DISPLAY: 1234567890* Ω/γ:θΦΔω

-χσD+∠.λ↓ STUVWXYZ

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APOLLO DISPLAY: 1234567890*

FIRST APOLLO CONSOLES BEING INSTALLED ABOARD USNS VANGUARD

The first Apollo Console System has just been delivered to the General Dynamics, Quincy, Massachusetts, shipyard for installation aboard the tracking ship, USNS Vanguard. The second system will be delivered to Goddard in the near future for installation in the University Building. There will be a total of nine systems delivered by the Raytheon Company under contract with Goddard.

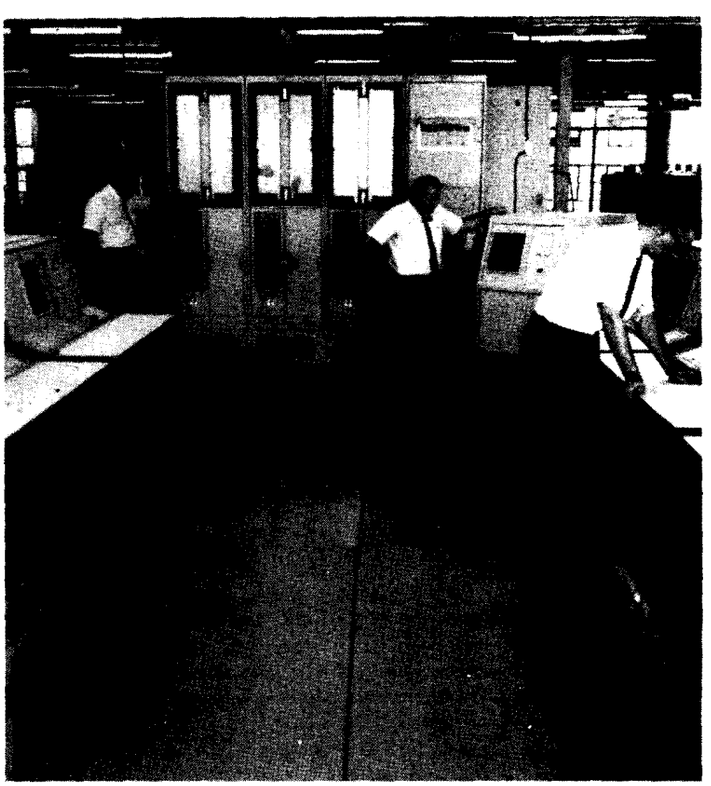
The Apollo Consoles will be used by the Flight Controllers of the Manned Space Flight Network. The first system, shown in the photographs, has been accepted from Raytheon. The system is an advance display system which provides status and dynamic information to the Flight Controllers.

There are seven consoles equipped with either one or two cathode ray tube displays, each capable of displaying lines, letters, numbers or a combination of these symbols.

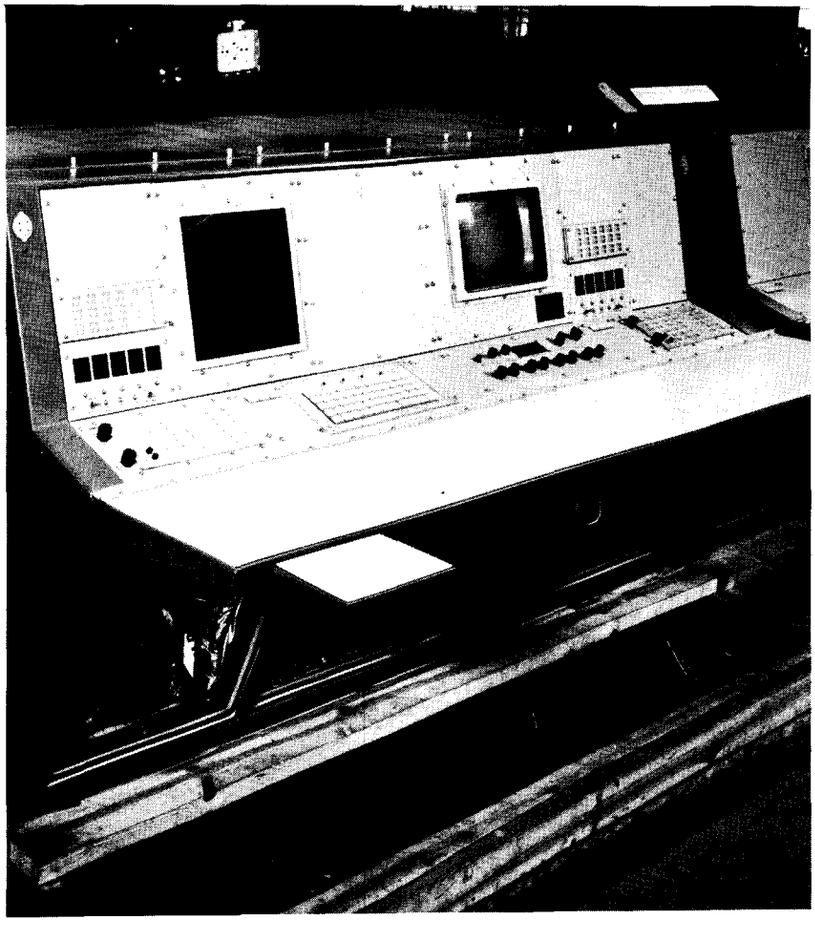
The displays on the consoles are driven by a computer which is controlled by keyboards on the consoles. To provide flight controllers a switch-hitting capability, each console's face value can be instantly changed by placing cleverly designed plexiglass overlays on its operating surface. In this way controllers may relieve each other, or one console may replace the other in case of trouble or need for maintenance. Additionally, the consoles provide a much wider range of information presentation than previously available on Gemini flight control consoles.

PART OF A CRT DISPLAY is shown with characters and numbers.

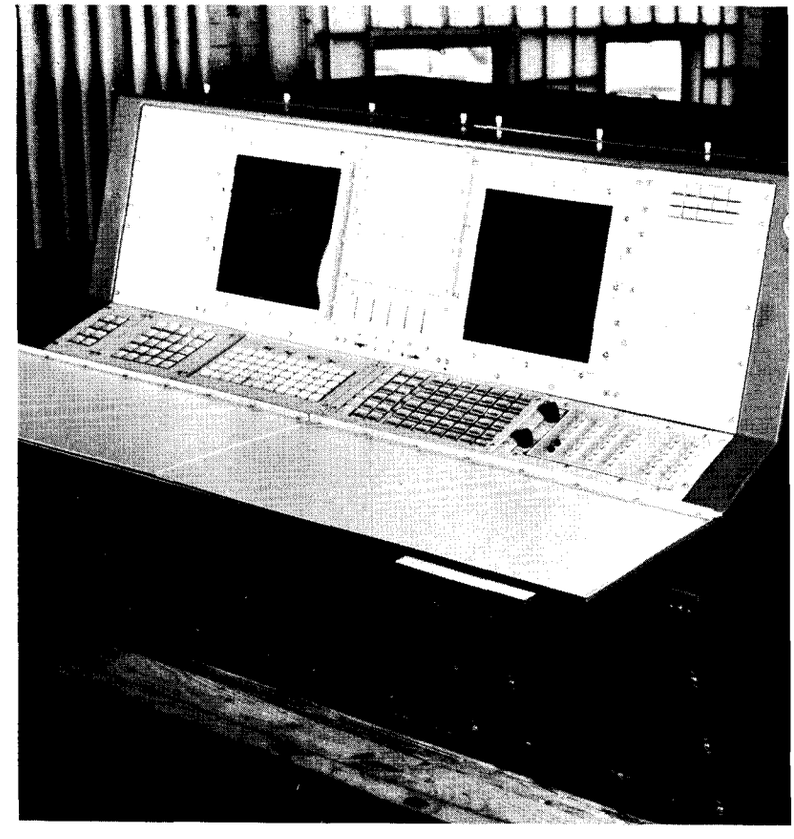
***THREE GODDARD ENGINEERS** are shown at work on the system. From left to right; Keith D. Fellerman, Technical Officer; Carl O. Roberts, Jr., Head, Systems Section (MFEB); and Paul Pashby, Data Operations Branch.*



***PRODUCTION LINE LOOK** trol consoles. Shown are t' LSM/SIVB.*

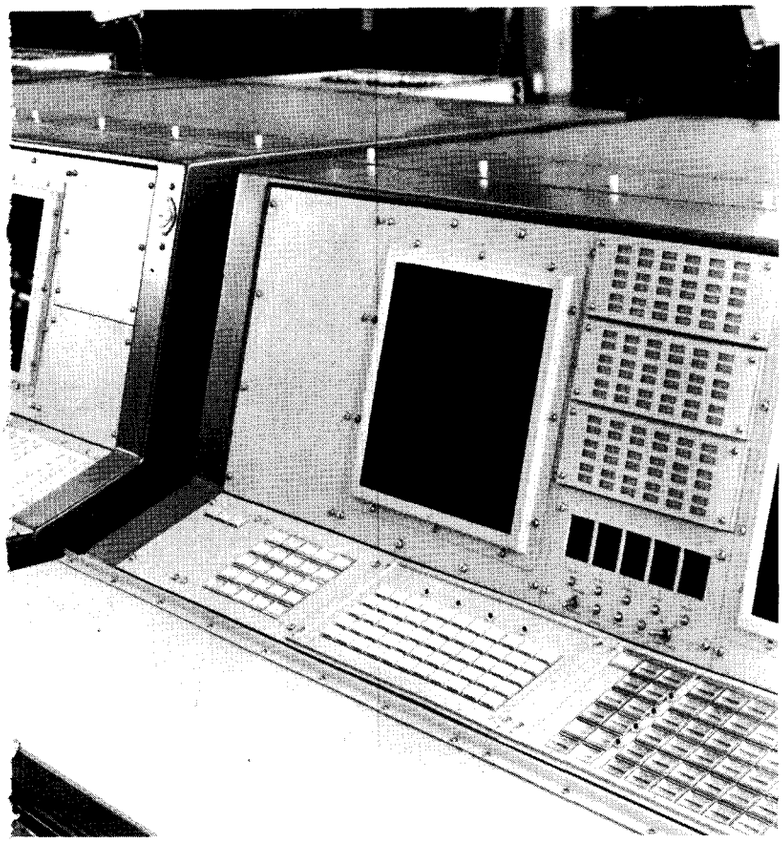


↑ *AEROMEDICAL CONSOLE is the position for two Flight Surgeons who monitor astronaut physical conditions.*

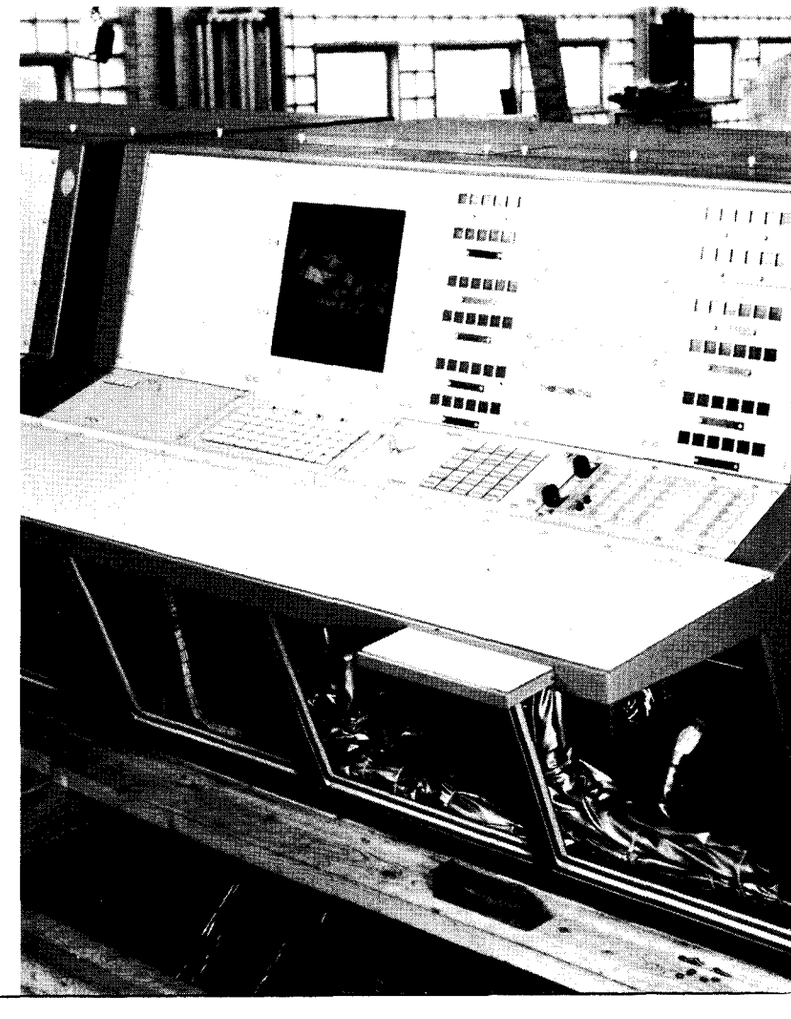


↑ *COMMAND COMMUNICATOR CONSOLE is the position of the Chief Flight Controller.*

↓ *FLIGHT DYNAMICS OFFICER'S CONSOLE is used on the three tracking ships only and is used for orbital insertion control.*



masks versatility of Apollo con-
two CSMs, the LEM and the



Two Goddard Men Win NASA's Highest Award

NASA Administrator James Webb presents awards to Dr. Meredith (center) and Dr. Nordberg.

The NASA Exceptional Scientific Achievement Award was presented to Dr. Leslie H. Meredith, Chief, Laboratory for Space Sciences, and Dr. William Nordberg, Assistant Chief, Laboratory for Atmospheric and Biological Sciences.

Dr. Meredith was honored for his work on the Explorer and observatory-type spacecraft. Dr. Nordberg was presented the award for his contributions to the meteorological satellite program. Other recipients of NASA's highest civilian award were H. Julian Allen, Ames Research Center; Dan Schneiderman, Jet Propulsion Laboratory; and Eberhardt Rechtin, also of JPL.

The awards were presented October 5 by NASA Administrator James E. Webb, Associate Administrator Dr. Robert C. Seamans, Jr., and Earl D. Hilburn, deputy associate administrator. The ceremony was held at the Dept. of Health, Education and Welfare Auditorium (2:30 p.m. EDT, Tuesday, Oct. 5).

Principal speaker was Dr. T. Keith Glennan, president of Associated Universities, Inc. Dr. Glennan was the first NASA administrator and is immediate past president of Case Institute of Technology, Cleveland. A musical program was presented by the U.S. Navy Band orchestra under the direction of Lt. Cdr. Anthony A. Mitchell.

Award categories included outstanding leadership, exceptional scientific achievement, group achievement, exceptional service and length of service.

The awards: Outstanding Leadership—presented by Administrator Webb—Smith J. DeFrance, who retires Oct. 15 after 45 years' service, Ames; and Bruce T. Lundin, Lewis Research Center, Cleveland.

Exceptional Service—presented by Seamans—John R. Cassani, JPL; Seymour C. Himmel, Lewis; and William Lilly, NASA Headquarters, Washington.

Group Achievement—presented by Seamans—Agena Project, Lewis, accepted by Dr. Seymour C. Himmel; Florida Operations Team, Kennedy Space Center, Fla. (formerly of Manned Spacecraft Center, Houston), accepted by G. Merritt Preston and Walter Parsons; Launch Support Equipment Engineering Division, Kennedy Space Center, accepted by Theodor A. Poppel; and Scout Project Office, Langley Research Center, Hampton, Va., accepted by Eugene D. Schult.

Thirty-year service awards, presented by Hilburn, went to Joseph L. Bailey, Luther E. Bennett, Addison S. Bomberger, Thomas C. Crabe, Mary G. Creegan; Roy L. Daisey, C. J. George, Alfred S. Hodgson, Felix H. Kane, Gladden R. Leonard, James G. Lewis, William D. Patrick, Brooks C. Preacher, William M. Thompson, Mateel A. Ward, Valdean Barco Wham, and Clarence M. Young, all of NASA Headquarters.

DATA TOPICS *(from page 2)*

I have alluded to the transmission of data from satellites and probes to the earth. This function is carried out by encoding the data in the spacecraft and telemetering the resulting signals on a radio frequency link. On the ground, at remote receiving sites located around the world, the telemetry signals are recorded on magnetic tape and shipped to Goddard where the data processing task begins. Each day, more than a hundred reels of tape are received by the Data Processing Branch and logged in at our Analog Tape Library. Punched cards are created which contain identification data needed in the further processing of the tapes. Owing to the desire on the part of the experimenters to receive their data in chronological order, the tapes may be stored in the library up to a month, at which time they are scheduled for the next major step, i.e., conversion from an analog signal to digital data suitable for computer processing. In the jargon of data processing this is termed analog to digital conversion or simply A/D. In this process, depending on the telemetry code, the signal is extracted from the noise by a signal conditioner or a comb filter, synchronization or the orderly sequencing of the data is carried out and finally ground Universal Time (GMT) is decoded and intermixed with the data to produce a formatted computer-compatable tape. The Data Processing Branch now has a number of these A/D lines (called STARS lines) now in operation, sometimes around the clock, on the ground floor of Building 14.

The next step of the operation is carried out in a general purpose digital computer. In this phase, data is extracted for the purpose of determining the data quality, Universal Time is checked, and if necessary, corrected since it is through this medium that the orbital position of the spacecraft is correlated with the data, and finally, the data is decommutated or separated into the various experimenter tapes. A Univac 1107 computer is used for the purpose of sorting this data into the various experimenter tapes. This process goes on intermittantly since fairly large batches of data can be processed in a relatively short time period. In the intervening time periods, the reduction and calculations required as a part of the experimenters data analysis is carried out for several of the Goddard experimenters as well as processing of data for other satellites.

Each of the functions described above is carried out for the satellite projects for which Goddard has the major responsibility. Also, in some cases where the experimenters require it, analog strip charts are produced from the data and digitized in a semi-automatic fashion.

In the support of this data processing operation we have an Instrumentation Development Branch which is responsible for the design and development of the hardware used in data processing. Also, we have a section of analysts and programmers whose function is the production of programs for use in our computers.

As a result of the latest reorganization, our new Division, the Information Processing Division, has brought together most of the elements needed for the design, implementation and operation of the entire information system. In the near future our new home will be building 23 which we hope will be completed by fall of 1966.

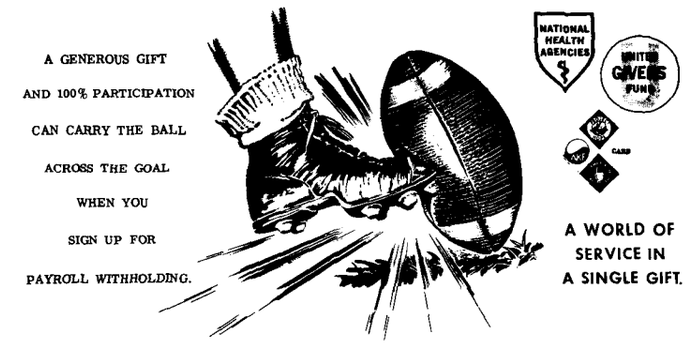
As I mentioned briefly in the beginning, we believe that there are many challenges facing us in the field of data processing. One that is immediately obvious is the problem resulting from the data explosion created by using spacecraft as an experimenters work bench in space. If it were possible to conceive of a reliable scheme whereby only the information contained in the data now being sent from satellites could be transmitted, a large savings in time and money might be realized. Certainly one of our goals is to provide experimenters with advice in information systems in order to maximize the information content and minimize the data volume to be generated by his experiment. Another challenge which we feel needs a great deal of effort lies in the area of information display which will allow the experimenter to view his results in the most compact and yet informative manner possible.

Data processing at Goddard has grown by leaps and bounds over the past six years and our facility for this task is probably the largest of its kind in the country. We take great pride in our progress and accomplishments; anticipate even greater challenges in the future.

INSIDE GODDARD

GODDARD SPACE FLIGHT CENTER / GREENBELT MARYLAND

October 18, 1965



GSFC KICK-OFF!

Dr. Clark Launches Goddard's 1966 Combined Federal Campaign

"The 1966 Combined Federal Campaign is being conducted this month through October 29, 1965.

"This great humanitarian appeal combines the needs of 155 local, national and international health, welfare and social service agencies in the Greater Washington Area. Through our participation, we, as citizens, will be able to express our deep concern for the welfare of the less fortunate by helping to provide for the essential services needed to assure a healthy and better community.

"It is my pleasure to serve as Chairman for the GSFC Combined Federal Campaign this year; Dr. John W. Townsend, Deputy Director, serves as Vice Chairman; and Gerald E. Griffin, Head, Policies & Procedures Office, is Campaign Manager. Assistant Directors have assigned CFC Coordinators within their Directorates who have designated CFC Division Chairmen.

"The combined drive provides contributors with the option of authorizing payroll deductions, making cash contributions, or paying pledges by installments directly to the Combined Federal Campaign. Contact your CFC Division Chairman for details. I urge each of you to consider making your contribution in the form of an annual pledge through the payroll deduction plan. The biweekly deduction from your paycheck would be a nominal amount and would eliminate:

1. The personal sacrifice of making one fair share donation, or
2. Constant reminders throughout the year of a "bill due."

"We in Goddard can be justifiably proud of the NASA programs in which we participate. We can also be proud of the fact that we have recognized our obligations to our own community as evidenced by our successful efforts in previous years. This year we have a greater challenge. Our quota for the Combined Federal Campaign is $93,636.00.

"I feel confident that you will give this year's campaign your generous support and that we will proudly achieve our goal."

John F. Clark

John F. Clark, Acting Director

Our Girl Friday

This is another in a series of articles on Goddard secretaries

Kitty Lou Dolan

Kitty Dolan remarked that she might be a little prejudiced but she doesn't think there is a more interesting or fulfilling job than hers. She is secretary to Eleanor C. Pressly, Head of the Vehicles Section of Goddard's Sounding Rocket Branch.

She came to Miss Pressly on June 11, 1963, immediately after graduating from High Point High School, Beltsville, Maryland. In fact, she graduated one day and started work the next. Her prior work experience was in the school office.

As secretary for the Vehicle Section, Kitty handles travel orders, procurement request, work orders, shipping requests, technical notes, X-documents, Wallop Island schedules, outgoing letters, and memos. She maintains files, calls in first-look reports of sounding rocket launchings, and performs any other duties that may arise.

In discussing Kitty's efficiency, Miss Pressly said: "We are extremely happy with Kitty. She has a difficult job to do and does it exceptionally well. Her depth of interest and attitude of helpfulness are priceless commodities that are hard to find these days."

Kitty said: "There is always something going on with so many types of sounding rockets that I'm always kept busy and very interested. Perhaps the most important part of my job is the people with whom I work. There could be no nicer, more considerate or easier boss to get along with than mine. As for the men, they are very helpful and go out of their way to make my work easier. To sum it up, I don't think anyone could be happier or more content with a job than I am."

Kitty will be 21 in January. She made the National Honor Society in high school, and was a majorette for the Beltsville Volunteer Fire Department during seven of her school years. Her hobbies are bowling and sewing.

She lives at 4812 Odell Road, Beltsville, Maryland, with her mother, Mrs. Betty J. Dolan, sister, Shirley, 13, and brothers, Danny, 7, and Russell, 3.

(Next issue: Lucille L. "Lucy" Loche)

FORTHCOMING GODDARD SCIENTIFIC COLLOQUIA

October 22, 1965 October 29, 1965

Bldg. 3 Auditorium, 4:00 p.m.

Professor James W. Warwick

University of Colorado

"Nonthermal Radio Emission From Jupiter"

Jupiter is the source of a strong magnetic field; embedded in the field, there is a substantial trapped particle population. In these respects, it is similar to the earth with its magnetosphere. The evidence, however, follows from radio emission of kinds not yet detected from the earth. Furthermore, Jupiter's innermost large satellite produces important modifications to Jupiter's magnetosphere. These changes, without parallel in our magnetosphere, produce sharp changes in particles towards smaller L-shells.

Dr. William W. Kellogg

Laboratory of Atmospheric Sciences

National Center for Atmospheric Research
Boulder, Colorado

"Physics, Chemistry and Dynamics of the Atmosphere"

Recent investigations of the dynamics of the atmosphere, cloud physics, and the chemistry of trace gases and aerosols will be reviewed. Special attention will be given to work performed at the National Center for Atmospheric Research.

Dr. James A. Van Allen Lecture Scheduled

In conjunction with the Metropolitan Washington Board of Trade, Science Industry Committee, the University of Maryland is sponsoring a lecture at 8 p.m. on Thursday, October 21, 1965, at Ritchie Coliseum on the University of Maryland campus. The speaker will be Dr. James A. Van Allen, Professor of Physics and Head of the Department of Physics and Astronomy, State University of Iowa. He will speak on the subject of "Space Science: Past, Present and Future".

The lecture by Dr. Van Allen will be the first of a series of lectures sponsored by the Metropolitan Washington Board of Trade and the local universities in the Washington area. Mr. C. Frank Riley, Jr., of Booz, Allen Applied Research Inc. is the Chairman of the Lecture Series.

Astronaut McDivitt Speaks at Goddard Scientific Colloquium

Astronaut James A. McDivitt visited here October 8 and was a featured speaker, along with Goddard's Dr. Paul D. Lowman, Jr., at two sessions of the Goddard Scientific Colloquium, held at 1:30 p.m. and 4:00 p.m.

***DIRECTOR'S OFFICE.** Dr. John F. Clark, Acting Director (from left); Astronaut McDivitt, and Associate Director Eugene W. Wasielewski pause for a photo before having lunch in the Building 8 cafeteria, October 8.*

DR. PAUL D. LOWMAN, Jr. (from left), Astronaut McDivitt and William R. Witt, Chairman of the 1:30 p.m. session, during the question-and-answer segment of the Goddard Scientific Colloquium.

***AFTERNOON SESSION.** Sitting in the audience (while Dr. Lowman is speaking) are Astronaut McDivitt (from left), Dr. George F. Pieper, Chairman of the 4 p.m. session, and Associate Director Eugene W. Wasielewski.*

IRRADIATED SOLAR CELLS RECOVERED AT HIGH TEMPERATURES

A Goddard researcher has discovered that silicon solar cells damaged by electron radiation can be completely recovered any number of times when subjected to high temperatures for a period of time.

"The discovery might pave the way for future solar cell arrays which are immune to space radiation," according to Dr. P. H. Fang who made the discovery. Dr. Fang, a physicist in the Thermal Systems Branch of Goddard's Spacecraft Technology Division, will present a paper on this subject at the *Photovoltaic Specialists Conference* being held here at Goddard October 18-20.

As a typical example of his laboratory results, Dr. Fang cites the case of an N-on-P (negative-on-positive) silicon solar cell which exhibits about 11 percent efficiency in converting sunlight directly into useful electrical voltage. The efficiency of this cell was reduced to about eight percent when it was bombarded by electrons of a two millivolt energy level.

Dr. Fang was able to recover the full efficiency of this cell by heating it to a temperature of 390 degrees Centigrade for about 15 minutes. This same cell was recovered similarly after several successive exposures to electron radiation.

The N-on-P silicon solar cell is a slice of silicon crystal about 15 mils (thousandths of an inch) thick which has phosphor impurities diffused into the top surface and boron impurities diffused into the bottom surface. This gives the crystal a negative region at the top and a positive region at the bottom. Electrons are made to flow between these two regions when the cell is exposed to sunlight.

Radiation causes damage to this cell by deteriorating the regular lattice structure of the silicon crystal. Essentially, a whole atom is knocked loose from its position in the lattice by an impinging electron or other high energy particle in space. This produces "traps" in the crystal where the moving electrons are caught, thus reducing the possibility of their being collected for circuit use. Annealing, however, restores the atoms to their positions in the crystal lattice and thereby recovers the efficiency of the cell.

In making practical use of Dr. Fang's discovery, solar cell arrays or paddles would have to be designed to withstand temperatures up to 400 degrees Centigrade. The recently developed solar cells with evaporated contacts can withstand these high temperatures.

During his investigations of other heating techniques for annealing solar cells onboard orbiting spacecraft, Dr. Fang studied one described as the "greenhouse effect." This is simply a window system in which the solar cells are enclosed. The system is designed to collect and retain heat from the sun to warm up the solar cells just as a greenhouse does in providing heat for plant growth.

In his tests, Dr. Fang was able to obtain the required annealing temperature with a greenhouse system which was subjected to one solar constant of energy in a vacuum environment.

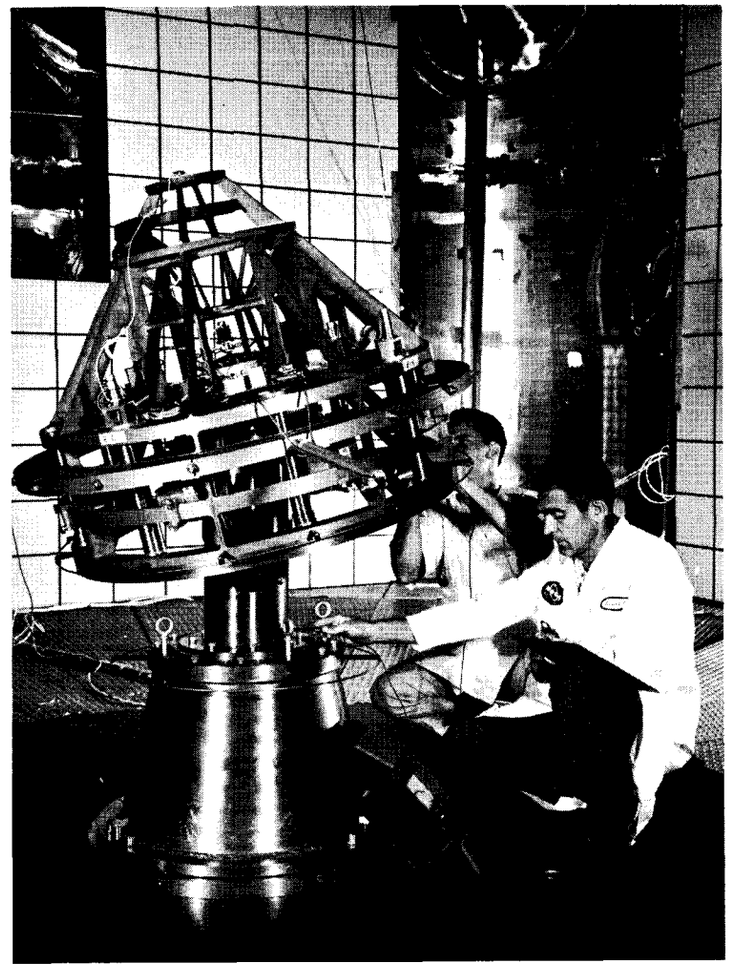
Photovoltaic Conference

Solar cell specialists from across the country are meeting at Goddard this week to exchange information on the latest developments in the field.

According to William R. Cherry, Head of Goddard's Space Power Technology Branch, "we will discuss the most recent accomplishments in solar cells and related areas such as deployable solar cell arrays, light weight substrates on which solar cells are mounted, radiation effect damage on solar cells, and thin film solar cells."

Mr. Cherry is responsible for coordinating the conference here at Goddard. It is expected to attract about 150 specialists.

The conference, to be held in the auditorium of Building 3, is being sponsored jointly by the IEEE, AIAA, the Air Force, and NASA. A total of five sessions will take place between Monday, October 18 and Wednesday, October 20.



GODDARD TECHNICIANS test a subliming solid thruster in T&E's Dynamic Test Chamber.

AIR FORCE FLIES GODDARD EXPERIMENT

The first experimental subliming solid control rocket to be flown in space is a Goddard experiment carried aboard the Air Force's OV2–1 satellite launched by a Titan 3C from Cape Kennedy. The function of the control rocket is to keep the spacecraft spinning at the proper spin rate.

"The subliming solid control rocket has a thrust of only 1/100 of a pound and represents a new concept of thrust generation for control of spacecraft," said Dr. Joe Fedor, Goddard's technical director of the experimental project.

The new control unit is based on a new kind of solid propellant which does not require the usual rocket ignition or combustion processes or storage of high pressure gas. When the outlet valve is opened, the solid propellant changes to a gas which expands through a nozzle and produces thrust. The control rocket offers advantages of low weight, pressure and temperature as well as simplicity and high reliability.

The subliming solid control rocket was developed and manufactured by Rocket Research Corporation of Seattle, Washington, under the sponsorship and management of Goddard's Mechanical Systems Branch. Fran Federline is Goddard's technical representative for the project.

NASA Consolidates Unmanned Launch Activities Under Kennedy Center

NASA has consolidated its unmanned launch activities at both the Eastern and Western Test Ranges under the John F. Kennedy Space Center, NASA, effective October 1.

At Cape Kennedy, Fla., the Launch Operations Division of Goddard became an integral element of the Kennedy Center which is directed by Dr. Kurt H. Debus. Robert Gray became Assistant KSC Director for Unmanned Launch Operations.

At the Western Test Range, Lompoc, Calif., the part of the Goddard team permanently assigned to that range and the NASA Pacific Launch Operations Office which logistically supported it also was placed under KSC and supervised by Gray.

KSC supervises checkout and launch of all NASA launch vehicles except the solid propellant Scout rockets which are developed and launched by the Langley Research Center, Hampton, Va., at Wallops Station, Va., and the Western Test Range.

"We are proud to welcome this distinguished launch organization to the KSC," Dr. Debus commented. "Under the skillful management of Robert Gray, the Goddard team and its associated industrial contractors has compiled an outstanding record in support of NASA's unmanned investigations of space. The addition of their exceptional competence in both launch vehicle and spacecraft preparation broadens the Kennedy Space Center's responsibilities to include all of NASA's major launch vehicles."

Kennedy Space Center Throws "Welcome Aboard Party"

DR. KURT H. DEBUS, Kennedy Space Center Director, cuts cake commemorating the addition of Goddard Launch Operations (GLO) to the Kennedy Space Center. GLO Manager Robert Gray looks on.

With the consolidation, KSC began carrying out the following unmanned missions: lunar and planetary missions for the Jet Propulsion Laboratory; scientific, meteorological and communications satellite missions for Goddard; Atlas-Centaur and Atlas- and Thor-Agena flights for the Lewis Research Center; lunar missions for Langley; and interplanetary and scientific satellite missions for the Ames Research Center. These missions will be launched by the new unmanned launch directorate.

The new KSC unit includes three divisions: Medium Launch Vehicles, Space Vehicle Technical Support, and Western Test Range Operations. The Delta, Agena and Centaur vehicles involved are managed by Launch Vehicle and Propulsion Programs of NASA's Office of Space Science and Applications.

Gray's organization continues to function as an integral unit but within the overall Kennedy Space Center launch organization which has as co-equal elements launch vehicle operations, instrumentation, and manned spacecraft.

This move is another step in NASA's planned consolidation of large groups operating at one geographical location under a single field center. Earlier this year, the manned spacecraft organization, previously established by the Manned Spacecraft Center at Cape Kennedy, became part of KSC. Its chief, G. Merritt Preston, became Deputy Director for Launch Operations.

The Oct. 1 transfer of staff and functions included 107 Civil Service personnel of the Goddard launch operations team and 22 more members of the team from the Pacific Launch Operations Office moving under KSC. These 129 Civil Service personnel are responsible for a combined government-industry operation involving more than 1600 industrial contractor personnel at the Eastern and Western Test Ranges.

Goddard Launch Operations has compiled an impressive record of 47 successes out of 55 launches assigned to it.

Originally a 20-man unit called the Vanguard Operations Group, the team was transferred from the Naval Research Laboratory to NASA when it was founded in October, 1958. Its first launch for NASA satellites. Rangers, Mariners, TIROSes, Echos, Ex- study cloud cover.

The Goddard Team has launched more than half of all NASA satellites. Rangers, Mariners, TIROSes, Echos, Explorers, Nimbus, Relays and Syncoms are among the payloads launched by this group. Also launched by Goddard were the world's first privately owned satellite, the American Telephone and Telegraph Co.'s Telstar, and the world's first commercial satellite, the Communication Satellite Corp.'s Early Bird.

Launch vehicles fired by the Goddard team include the Delta which has achieved successes in 30 out of 33 lift-offs. The three-stage Delta had 22 straight orbital successes and in 1963 Goddard's Delta launch team received NASA's Group Achievement Award.

Atlas-Agena launches have made possible the longest flights in space history. Mariner IV photographed Mars in July after a 312-million-mile flight. Mariner II flew near Venus in 1962 and three Ranger spacecraft made close-up photographs of the Moon.

Centaur was the first known rocket launched using high energy liquid hydrogen fuel in its upper stage.

In addition, the Goddard team launched two Thor Agenas, two Atlases for reentry tests and two Thor ballistic flights carrying Echo communications satellites—all successfully.

SR SCOREBOARD

All Goddard-Managed —

FIVE SOUNDING ROCKETS LAUNCHED IN TWO WEEKS

Rocket Type	Experiment	Proj. Scientist	Site	No. Launched
Aerobee 150	Stellar X-ray	Dr. Fisher	White Sands	1
Javelin	Mother-Daughter Propagation	Dr. Nisbet	Wallops Island	2
Nike Apache	TMA and DC Probe	Dr. Smith	Ft. Churchill	2

Goddard launchings this year. (Jan. 1-Oct. 12): 156; Launched Sept. 29-Oct. 12; total 5.