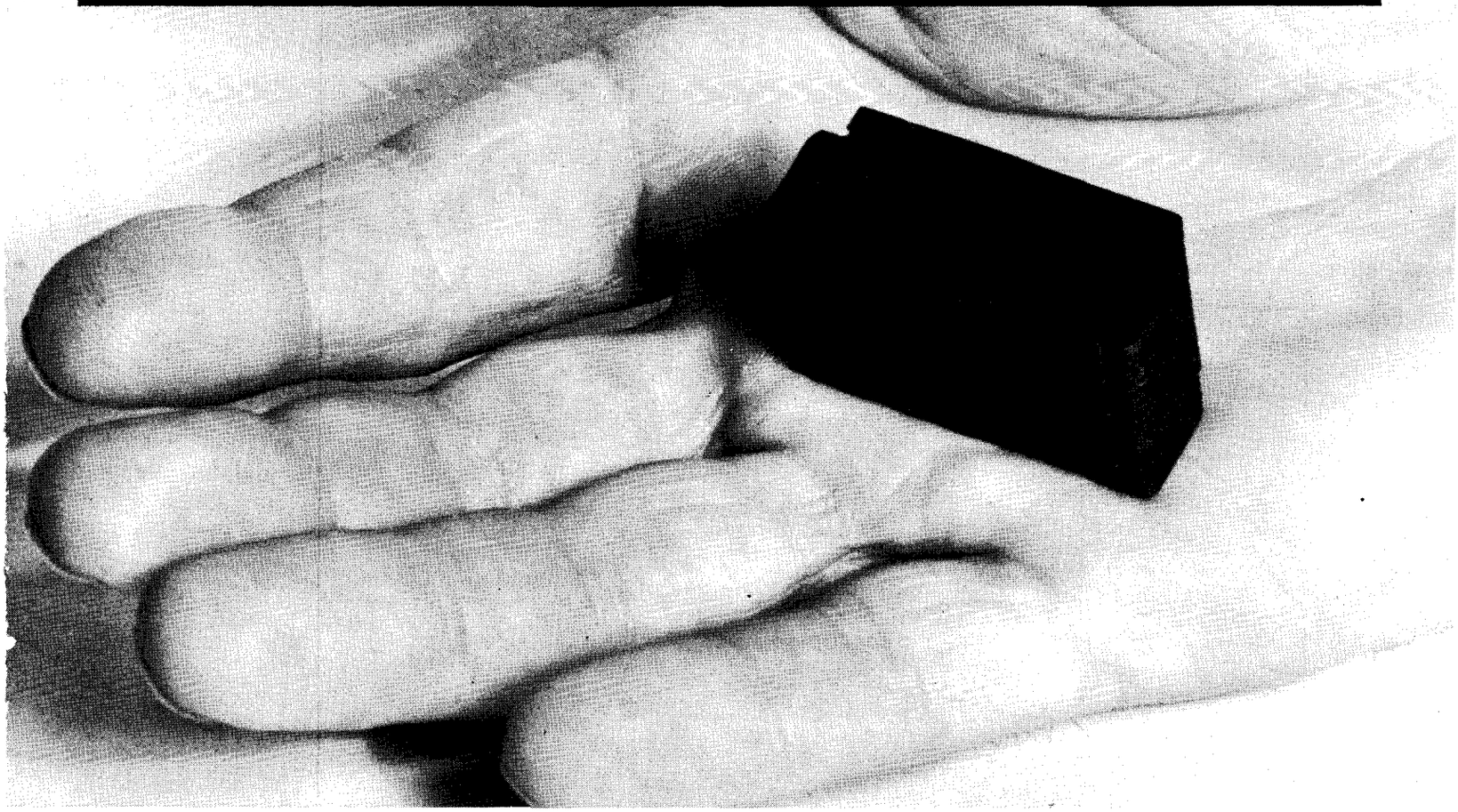
GODDARD NEWS

GODDARD SPACE FLIGHT CENTER / GREENBELT, MARYLAND

VOLUME VII, NUMBER 4 THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION JUNE 29, 1964



With barbers around the nation shaving with a single blade, it may seem noteworthy that Goddard is bonding razors together. However, our experiment with the sharp edges is part of the space effort. We aim to shave light, not beards. See page 8 for further information.

Delta Performance to be Upgraded by Tank Modification

Future Delta launch vehicles, managed and launched under Goddard's direction, will have their performance upgraded sharply by a modification of their second-stage fuel tanks.

The tank diameters will be increased from 32 to 54 inches in eight Deltas that NASA plans to purchase from the Douglas Aircraft Co., according to William Schindler, Goddard's Delta project manager.

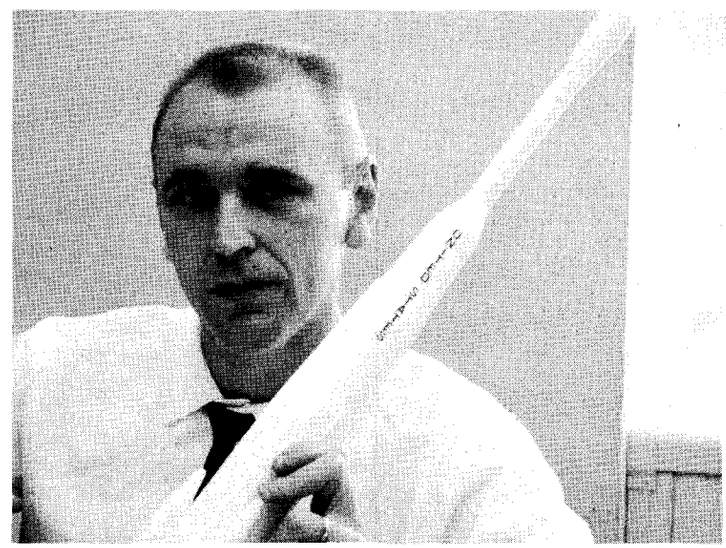
The bigger tanks will improve performance by increasing the burning time from 160 to 400 seconds. The change is expected to cost about $6 million and bring the cost of the eight Deltas to around $15 million. The contract is still to be negotiated.

Some of the Deltas to be modified will utilize three solid propellant motors strapped on the Thor first stage for additional thrust augmentation. These Thrust Augmented Deltas (TAD) can place a 1000 pound payload into low Earth orbit compared with 800 pounds for the standard Delta (see Nov. 18, 1963 issue, p. 1).

When large tanks are added to TADs, the vehicle can place 1200 pounds into low Earth orbit or 225 pounds into escape velocity compared to 100 pounds for the standard Delta.

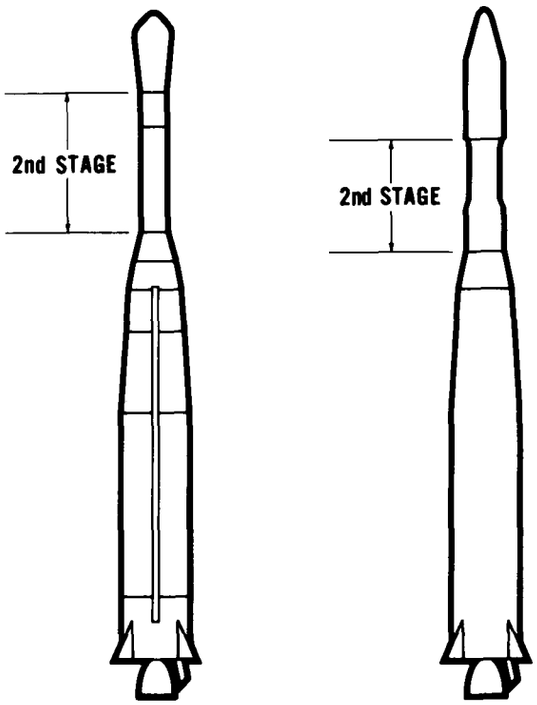
The new large tank Deltas will be used for launching payloads in the Biosatellite, Pio-

(Cont'd. on p. 2)



William Schlindler, Goddard's Delta project manager, is shown with a model of the TAD which will also be modified.

Upgraded Delta (From p. 1)



This drawing shows the difference in configuration between the "standard" Delta (left) and the large tank modified vehicle.

neer and meteorological satellite families. Of the 24 Deltas that have been launched to date, 22 have successfully placed satellites into orbit.

Goddard is responsible for technical direction of the Delta program under the overall supervision of the office of space science and applications, NASA headquarters. Goddard's field projects branch at Cape Kennedy, headed by Bob Gray, has Delta launch responsibilities.

Recent Technical Publications Authored by Goddard Staff

C. Vest, "Adaptation of an MoS_2 'In Situ' Process for Lubricating Spacecraft Mechanical Components" NASA Technical Note D-2288, May 1964.

David Montgomery and Derek A. Tidman, "Secular and Non-Secular Behavior for the Cold Plasma Equations," NASA Technical Note D-2305, June 1964.

A. K. Berndt and J. H. Berbert, "Interpolation and Coordinate Transformation Program Providing Accurate Local Antenna Pointing from Predicted Satellite Positions," NASA Technical Note D-2140, June 1964.

Joseph W. Siry and Joseph V. Natrella, "Attitude Determination for Tiros Satellites," NASA Technical Note D-2143, June 1964.

H. W. Shaffer, W. D. Kahn, W. J. Bodin, Jr., G. C. Kronmiller, P. D. Engels, and E. J. Habib, "The Range and Range Rate System and Data Analysis for Syncom I (1963 4A)," NASA Technical Note D-2139, June 1964.

J. B. Schutt and J. A. Colony and D. R. Lepp, "Thermophototropism in Corticated Alkaline Earth Titanates," NASA Technical Note D-2306, June 1964.

Kazem Omidvar, "Theory of the 2s and 2p Excitation of the Hydrogen Atom Induced by Electron Impact," NASA Technical Note D-2145, June 1964.

Joseph C. Boyle, "Coriolis Effects in Combined Environment Testing," NASA Technical Note D-1914, June 1964.

GODDARD NEWS

"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 a bi-weekly publication of the National Aeronautics and Space Administration's Goddard Space Flight Center, Greenbelt, Md., suburban Washington, D. C. Phone—Ext. 4141 or 4142

Photography by Goddard's photo branch

Bruce Brough, ***Editor*** **Shirley Deremer,** ***Inside Goddard***

Impetus

Editor's Note: This column of thoughts from various quotable sources will run whenever ideas are available which fit this definition—"comments which give impetus to the creative mind; which stretch and exercise the intellect." Publication does not necessarily imply endorsement.

". . . Beyond all doubt, ideas have become a major national resource, as important as a country's land and mineral wealth. Knowledge—the force of intellect—may in the future decide the rise and fall of companies, professions, social classes, regions—even nations. Already, it is creating an entirely new class of leaders.

" 'If the dominant figures of the past 150 years have been the entrepreneur, the businessman, and the executive, the "new" men are the research scientists and the managers of the new computer technology,' observes Professor Daniel Bell of Columbia University.

"Only 7% of top business managers 65 years ago had a technical background. Now, over 36% are scientists or engineers, and this is rising 1.3 percentage points each year as a new type of business leader takes over.

"The Knowledge Revolution is also changing the economic geography of the nation. The dominante 'growth' institutions of the future will be, not the factories, but the nation's intellectual organizations—the research corporations, industrial laboratories, experimental stations and universities. These, in turn, attract industry. . . .

"The science-based industries sprouting up around university campuses form the nuclei for a new kind of city—the 'ideopolis' or 'city of intellect,' as Clark Kerr calls them.

"Just as in the Industrial Revolution when factories clustered around deposits of coal and iron ore, the industries of the future will congregate around centers of learning in order to tap their principal resource—intellectual talent. . . .

"Since the highly educated never finish their studies, tomorrow's managers are likely to shuttle between practical and academic activity for the rest of their careers. David Rockefeller, president of Chase Manhattan Bank, suggests that high-level executives take every seventh year as a sabbatical leave.

"Although some 2500 executives are sent back to school for several weeks each year, many companies feel they cannot spare top men for a full sabbatical year. Some way must be found to integrate these sabbaticals with the rest of a company's needs, particularly in the fields of information-gathering, management training and long-range planning.

"Perhaps, even while he is catching up on the advanced research being done in his own field, a top-level executive on sabbatical can be exploring 'far-out' areas to see where his company should be active five to ten years hence. Similarly, if he 'sniffs' a promising lead, he might be assigned a task force of younger management men to help dig out information and follow through.

"Such task forces are already widely used by companies as a training ground for new management talent. Under gifted leadership, there is no reason why such a research team might not achieve for business what some of the great research teams have achieved in science.

"The recent entry of a group of Nobel scientists into business management indicates how blurred the boundary between advanced science and advanced business has become.—*News Front, April, 1964, Vol. 8, No. 3.*

Radio Telescope of the Future May Stretch 1000 Feet

A big "X" in space may someday mark the spot for a spaceborne radio telescope. The "X" will result from two 1,000 foot (from tip to tip) antennas extending from a satellite that is under consideration to investigate low frequency radio emissions from galactic regions, distant planets and stars.

The relatively new science of radio astronomy has made numerous far-reaching contributions to knowledge of these phenomena, although observations have been confined to a narrow frequency band.

But what about those regions of the radio spectrum yet unexplored and the technological problems associated with their investigation?

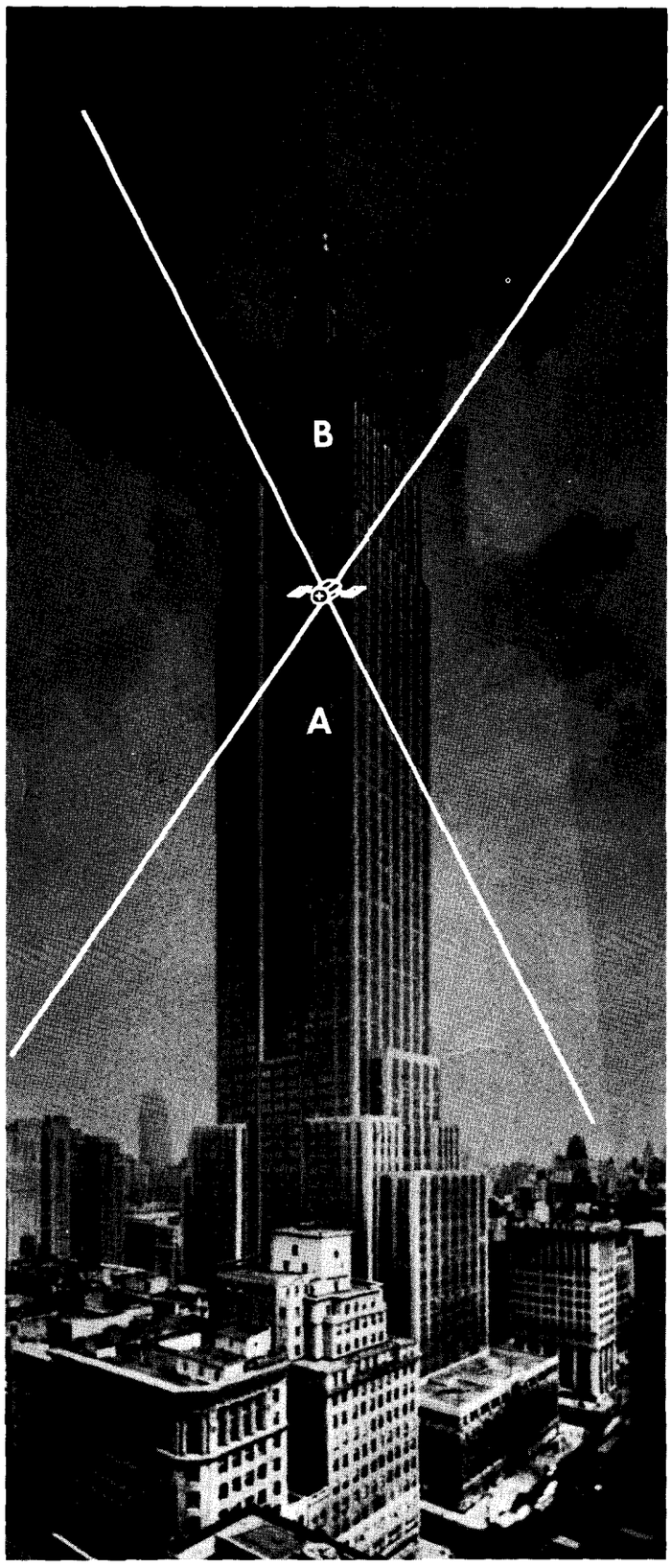
About a year ago Dr. Robert Stone and Joe Alexander, planetary ionospheres branch, went to work on this problem. They knew, at both the millimeter and decameter wavelength extremes of the radio spectrum, that the earth's atmosphere prevents reliable observations from the ground.

Ionospheric effects, man-made radio interference, and radio noise from the artificial radiation belt combine to hinder ground observations at long wavelengths (frequencies below 20 megacycles) while tropospheric absorption and refraction hamper short wavelength (frequencies above 300,000 megacycles) observations severely.

Below ten megacycles the radio emissions from the galaxies, Jupiter or the Sun are mostly cut off. Therefore, the lower in frequency you go, the more certain it is to be filtered out by the earth's ionosphere.

Since 1932, radio engineers, astronomers and physicists have come a long way in the state-of-the-art. Drawing on the results of these accomplishments Stone and Alexander among others, suggested that the unexplored areas of the radio spectrum could be examined by performing experiments in space —beyond the atmospheric blanket. Consequently, they proposed to establish a radio astronomy program as an integral part of NASA's space science program combining space flight and ground based observations.

Specifically, the purpose of the program would be to study the development and the effects of sporadic radio noise bursts from the Sun; and the sporadic decameter radio emission from the planet Jupiter; determine the low frequency spectra of galactic and extra-galactic radio sources; and map the spatial distribution of galactic and extra-galactic radio sources at low frequencies.



This is how an orbiting radio telescope with 1,000-foot antenna would compare in size with the Empire State Building in New York. The building is 102 stories tall.

The problem is that with a low frequency (for example 1 megacycle) you are dealing with a wavelength of 300 meters or approximately 1000 feet. This means that you must have a satellite using an antenna with a length approaching 1000 feet. This gains directivity so a scientist can discriminate against certain portions of the sky.

There are, at present, a series of first generation experiments with satellites and rockets which make essentially non-directive measurements. Dr. Stone said, "We are now looking into the feasibility of a satellite antenna which can be used as a directive array.

"Therefore," he continued, "we must deploy an antenna made of 1000 feet of tubing or wire. With just a single 1000 foot boom, however, the pattern obtained would be unsuitable. It has an equal reception in the forward directions as it does in the back which means that if it is oriented along the earth-satellite vector, we can pick up all the radiation that may break through from the ground.

"The effects of the artificial radiation belt would be reflected off the ionosphere." "However," explained Dr. Stone, "it turns out that by combining two such linear elements each 1000 feet long into what is known as a "V" antenna we are able, by a few tricks, to obtain a front-to-back ratio so that we can tell what noise or galactic features we are receiving directly."

A "V" beam antenna system provides reasonable gain, functions over a wide frequency range and is mechanically simple to deploy from a satellite. By having two antennas, each 1000 feet, extending from a stabilized satellite there are four possible "V" antennas. One "V" beam can always be earth oriented, while the other is space oriented.

Radio astronomy is just beginning to mature as a scientific discipline. Soon it may be possible to extend the range of observations beyond the limits of the atmospheric "window". Thus, information about the parts of the radio spectrum that can only be observed effectively from an orbiting radio telescope can be made available.

From Gemini Launch Pad to Landing . . .

"As soon as the Gemini and Apollo space vehicles leave the launch pad at Cape Kennedy, these men will have the command, communications and operations responsibilities for the manned space flight missions," George Karras, station director at Goddard's manned space flight network engineering and training center, Wallops Island, Va., said.

He referred to a casually dressed group of students standing in the former naval air station hangar that has been converted into a "school for space."

The group, made up of highly trained electronics engineers and technicians—specialists in the fields of space tracking, data processing, and communications—was taking a 10-minute coffee break between classes.

They are being trained to maintain and operate manned space flight network stations that will support Gemini and Apollo projects to land men on the Moon.

"Our graduates have the life and death responsibility for all manned space flight mission technical information," Karras said. "We have no room for mistakes in our business."

The Wallops facility, in addition to being the NASA engineering and training center, is one of many tracking stations operated around the world by Goddard for NASA (see Nov. 18, 1963 issue, p. 6).

Many of the school's students are "old hands" who were "on station" during the Project Mercury flights that ended last year.

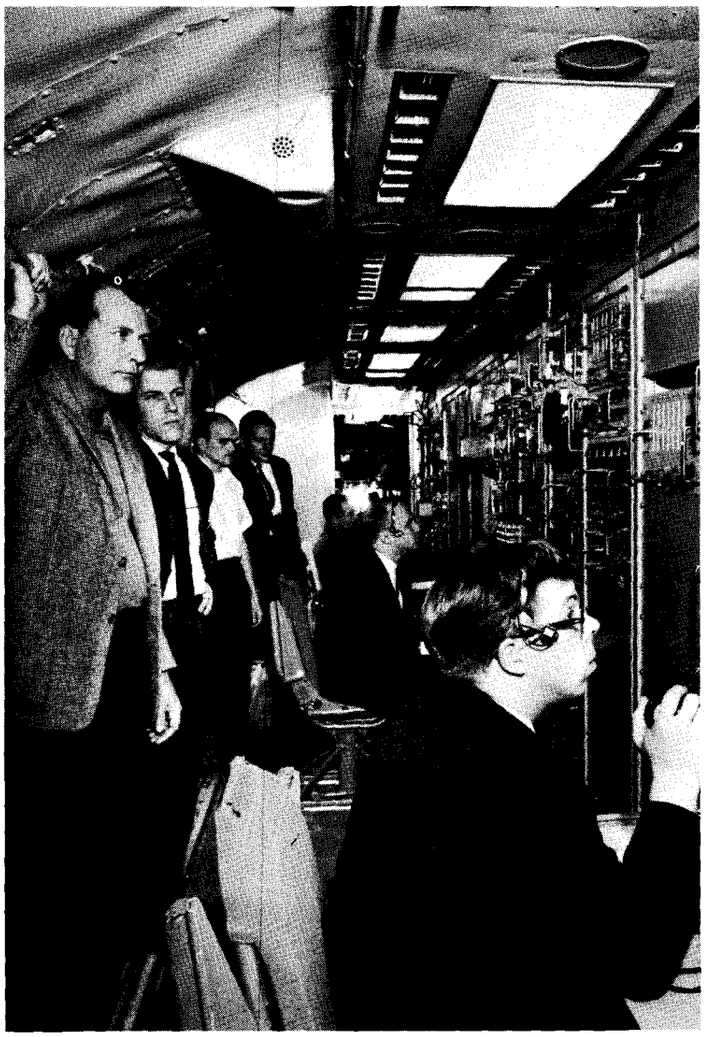
When one of these veterans completes his training he could be assigned to his former station, or to a new post.

If he is a new man, he is assigned to one of the stations being equipped to handle the

George Karras, Wallops Island station director.

A student at the space-age school (right) is receiving instruction on a new tracking and receiving antenna from an instructor at the Wallops Island facility. The students will take their places at stations around the world as Project Gemini goes into high gear.

Training the Trackers



Wallops Island students are learning how this electronics-laden Constellation aircraft can simulate a satellite pass over ground stations for training purposes.

Gemini tracking and communications—Carnarvon, Australia; Kauai, Hawaii; Grand Canary Island; Guaymas, Mexico; Corpus Christi, Texas; Bermuda; Cape Kennedy; or the two tracking ships.

School Opened In 1961

The school, opened in July 1961 to train replacement personnel for the Project Mercury network, is operated for Goddard by the Bendix Field Engineering Corporation. Director George Karras is a Goddard man: The instructors and the majority of the students are Bendix contract personnel.

Gemini is "an entirely different type of mission than Mercury," Karras said. "It will be of longer duration, up to 14 days, and two spacecraft will be involved in experiments for a space rendezvous and docking."

In order to accomplish the rendezvous of the manned Gemini capsule with the previously launched unmanned Agena vehicle the network will have to provide data on new orbital paths. Also, it will have to provide tracking, data acquisition, and command control of the Agena and Gemini spacecrafts.

The objectives of the school, Karras said, are twofold: (1) to make available and provide various levels of training to all supervisory, maintenance, and operating personnel associated with the manned space flight network, and (2) to provide engineering assistance to the manned flight operations division at Goddard, concerning testing, modifications, and procedures required for the necessary skill drills and "warm-up" periods.

Goddard Speech and Paper Presentations

(Technical presentations approved as of June 19, 1964 for period through July 12. Requests for copies of speeches and papers should be made directly to the author.)

SPEECHES

Kenneth W. Stark, IEEE (European Region), London, England, July 6, ***"Survey of Continuous Loop Recorders Developed for and Flown on Meteorological Satellites."***

S. Ishtiaq Rasool, International Congress of Vacuum Techniques in Space Research, Paris, France, July 2, ***"Physics and Chemistry of the Upper Atmosphere."***

Patrick Thaddeus, Governor's School of North Carolina, Winston-Salem, N. C., July 10, ***"Science and Space."***

PAPERS

W. N. Hess, American Institute of Aeronautics and Astronautics, Washington, D. C., June 29—July 2, ***"Space Environment."***

Alfred B. Riley & W. G. Stroud, Symposium on Concentrated Vortex Motions in Fluids (I.U.T.A.M.), Ann Arbor, Mich., July 6-11, ***"Vortices in the Atmosphere."***

Computer Search System Aids Library Users

A computer-based literature search system is now in operation at Goddard's library. The newly-implemented system is based on magnetic tapes of journal literature indexed in *International Aerospace Abstracts* and report literature indexed in *Scientific and Technical Aerospace Reports (STAR).*

The search system is operated for the library by the business data branch.

Service is being offered on a weekly basis. Inquirers should submit their questions to the staff of the library's documents section.

Questions will be processed on Monday of each week and lists of references will be available to the requester by Thursday of the same week.

From left, Dr. Richard Lehnert, systems analysis office; John M. Weaver, Goddard's chief librarian; and Marion Craig, documents librarian, examine a computer print-out. Dr. Lehnert is the "satisfied customer."

Electrical Engineering Added to ¾-Credit Graduate Study Program

Goddard and the nearby University of Maryland have agreed to conduct a ¾-credit graduate study program in electrical engineering beginning with the fall semester, 1964. The program will be patterned after the one this Center currently has in operation with Catholic University in the fields of physics, mechanical engineering, aerospace engineering, and space science and applied physics.

For your information, the Thursday "noontime" movies in building 8 have been cancelled for the summer months. Watch the Goddard News to find out the date they will resume in the Fall.

The ¾-credit program is the result of mutual concern on the part of Goddard and the participating universities regarding the academic development of engineers and scientists. It provides a practical program through which the graduate education of promising employees can be accelerated.

Consequently, in the fall of 1962, Goddard and Catholic University conceived the program at both the masters and doctoral levels. Participants carry an academic load of approximately nine credit hours per semester, which is about ¾'s of a full graduate study load.

Thus, this new approach serves as a compromise between full-time graduate study and part-time study which usually involves three to six credit hours per semester. Participants work at Goddard on Monday, Wednesday and Friday and attend school on Tuesday, Thursday and in some cases on Saturday morning.

The participating university departments schedule their graduate courses with the program in mind, and provide each student with a desk for his campus study. In contrast to the part-time study program, students in this program are brought into closer contact with their professors and are provided with the opportunity to do a greater amount of course work.

Participants currently enrolled in the Catholic University program are: Tom Flatley, spacecraft technology; Albert Fleig, spacecraft systems and projects division; Donald Kniffen, Leo Blumle, James Halow, and James Williams, space sciences division; Kenneth Rosette, Sterling Smith, George Honeycutt, and Earle Young, test and evaluation division and Thomas Carson, manned flight operations division.

With the addition of the University of Maryland to the plan and with the success of the Catholic University program it is expected that Goddard will continue to be rewarded with an increased technical competence on the part of its participants.

Dr. Howard Tompkins (seated, center), head of the electrical engineering department of the University of Maryland's College of Engineering is discussing the ¾-credit graduate study agreement with James Reese (left), chief of Goddard's employee development branch and Jack Peake, chairman of the Center's training committee and head of the space electronics branch.

A THEORETICAL SOLUTION:

What is the Origin of Energetic Particles?

Dr. Paul Nakada of Goddard's theoretical division explained a plausible solution to a prime question — "where do radiation belt energetic particles originate?"—in a speech to American Geophysical Union this spring. He presented evidence that the Sun is the source.

About two years ago, experiments by Leo R. Davis, energetic particles branch, indicated that radiation belt protons nearest the Earth are much more energetic (active) than those further away.

The charged particles which Davis studied were located from about two to five Earth radii from the center of the planet.

Davis also noted that the flux of protons (a measure intensity) is not only large—but also very constant.

Dr. Paul Nakada

After the discovery of this phenomena, and subsequent studies which proved its constancy—Nakada and others in the theoretical division began to study the "why."

Referring to his work on the subject with Dr. Wilmot N. Hess, theoretical division chief, and Prof. T. W. Dungey, a Goddard consultant associated with Imperial College in London, Dr. Nakada said, "We first tried to explain why the protons nearer the Earth are more energetic.

"In addition, our studies gave evidence that the center of our solar system is also the source of these charged protons.

(Cont'd. on p. 7)

Energetic Particles (From p. 6)

"Up to now, many scientists have postulated and theorized that these particles come from the Sun. Now, we feel reasonably sure that this is true."

This is—in simplified "shorthand" understandable to the non-mathematician — the way the discovery was made:

First, Nakada and his colleagues started with the mathematical descriptions of three *usual* methods of movements of trapped energetic particles. These are:

- Spiral movement around lines of force;
- Bounce from northern hemisphere to southern hemisphere and back; and
- Drift motion around the world (at a fixed distance from same).

Ordinarily these three periodic motions tend not to change.

It is extremely difficult if not impossible to cause changes in the first two methods of movement. However, the third — drift motion around the world — has been found to be easily changed, relatively speaking, by known natural phenomena.

Thus, if this third "invariable" is changed, it follows that the particle can change its position relative to distance from the Earth.

Mathematical analysis, using set formulas for the first two methods of movement and a slightly different formula for the third based on actually observed natural phenomena, indicates the following solutions:

- The accelerating mechanism for the particles is one when the third "invariant" is changed;
- Diffusion of the particles is rapid compared to loss processes; and
- The *sources* of the protons is near the edge of the magnetosphere.

This latter point is pertinent when the origin of the particles is concerned. The magnetosphere is made up of particles trapped by the Earth's magnetic field. It is well known that protons from the Sun can easily reach the outer edge of the magnetosphere.

Therefore, since these studies by Nakada, Hess and Dungey point to the *edge* of the magnetosphere as source, the solar origin theory is given strong support.

TIROS VII and VIII Rest - - Wait for Hurricanes

Even TIROS satellites need a vacation now and then.

The work day for TIROS VII and VIII has been cut in half giving both satellites a long needed rest. They need it, because beginning in August (when hurricane watch intensifies) the two weather-eyes-in-space will start working overtime.

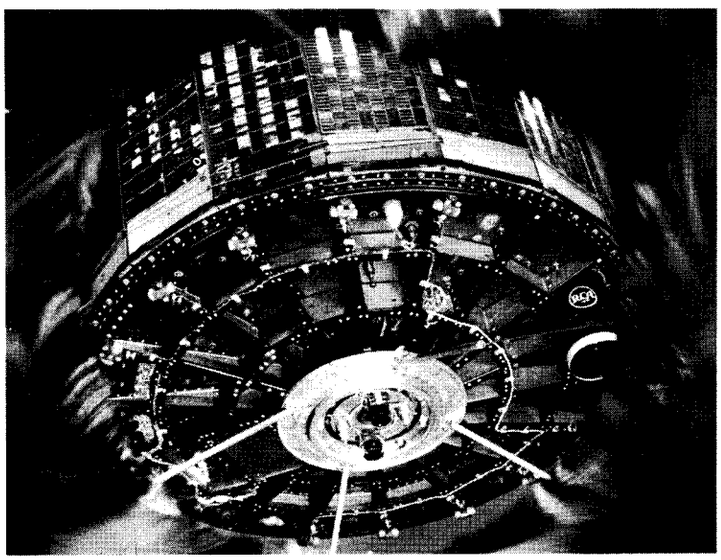
NASA hopes this short vacation will stretch the life of delicate weather-measuring instruments in the two satellites. Both Goddard-managed spacecraft have already outlived their expected lifetime of four months. TIROS VII was launched in June of 1963 and TIROS VIII followed in December of 1963.

While the satellites rest, the tempo is picking up for NASA engineers at Goddard. They are checking and rechecking all tracking and receiving equipment at TIROS ground stations at Wallops Island, Va., Point Mugu, Calif., and Fairbanks, Alaska.

They want to be sure that the large electronic ears (telemetry antennas) which listen for TIROS' heartbeat are in top working order.

Getting special attention is the equipment which picks up video (visual) signals from the satellite. To the naked eye this signal looks like any other on a kinescope. But the sensitive eye of a 35 mm camera at the station takes a closer look. It photographs the video signal as it flashes across the television-type screen, and a photograph is produced.

Weather Bureau officials at these stations are always anxious to receive TIROS pictures, but especially during hurricane season from August to October. Suspense builds up each time a picture comes in because it could show one of the most destructive forces in nature in fetal stages. If it does, teletype machines chatter away sending out storm warnings to people in the path of the storm.



TIROS in space probably looks something like this retouched photograph.

Each year, hurricane damage runs into the millions of dollars and hundreds of people are killed and injured. Much of this can be prevented by advanced storm warnings.

This is where TIROS satellites have starred on many occasions. In numerous instances, TIROS satellites have spotted hurricanes in advance of all other weather observation means. TIROS III spotted Hurricane Carla in September of 1961 and provided advanced warning so more than 350,000 people could flee from the path of the storm. A relatively small number of deaths were attributable to Carla as she swept across the country.

President Johnson, when he was Chairman of the National Aeronautics and Space Council, cited some estimates of cost savings based on the accurate prediction of weather only five days in advance. These include:

- $2.5 billion dollars a year to agriculture;
- $45 million to the lumber industry;
- $100 million to surface transportation;
- $75 million to retail marketing; and
- $4 billion in water resources management.

Both TIROS VII and VIII are now in ideal orbits some 400 miles above the Earth for their hurricane watch this season. Their precise orbits will allow them to get especially good views of the Earth just north and south of the equator which is the breeding area for most hurricanes and tropical storms.

TIROS VII has more experience in hurricane hunting than the younger TIROS VIII. TIROS VII orbited the Earth during the 1963 hurricane season spotting 16 hurricanes and typhoons. This satellite has taken more than 66,000 pictures with 90 percent being useable by meteorologists. More than 156 storm bulletins have been issued as a result of the data collected by TIROS VII.

Although TIROS VIII doesn't have as much hurricane experience as the rest of the family, it has the distinction of being the first TIROS to carry a special camera called APT for automatic picture transmission. A relatively simple system, APT transmits pictures on the slow-scan principle similar to that used to send radio photographs.

Overall management of TIROS is the responsibility of the office of space science and applications at NASA headquarters. Technical direction is exercised by Goddard.

The Radio Corporation of America, under the direction of Goddard, builds the spacecraft. Operational use of the meteorological data from the satellite rests with the Department of Commerce's Weather Bureau.

Fabrication Shaves Costs by Bonding Razor Blades

Maurice Levinsohn's fabrication specialists enjoy the enviable reputation of being able to design and make almost anything. This capability has been put to the test many times: Most recently by Jack Triolo of the spacecraft technology division, who ordered a new type reference disc as part of his optical experiment which may be orbited aboard Goddard's upcoming Advanced Technological Satellite (ATS).

Specifications called for the disc to be constructed from 13° single edge razor blades bonded together so their sharp edges formed a light trapping surface.

Anthony Walch, metal modelmaker lead forman and James Munford, engineering office, poured over blueprints, rolled up their sleeves, and began an obviously difficult task. They first tried soldering the blades together, but this didn't work, since tiny amounts of solder leaked into the crevices between the sharp edges. The shiny metal caused light reflection and was not acceptable for the experiment. Attempts to weld the blades met with the same problem.

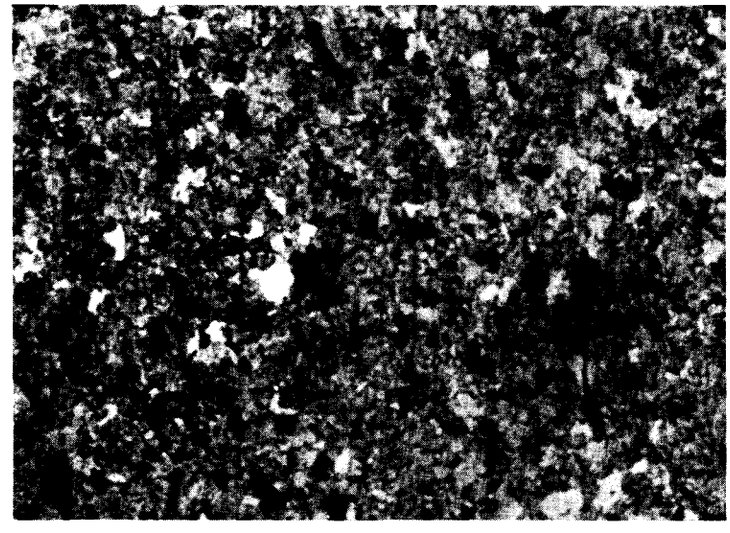
Bonding Came Next

Next, the two craftsmen tried a technique known as diffusion bonding. "We first cleaned each blade throughly to remove all traces of oil," explained Munford. "Then we stacked and clamped them tightly to assure intimate contact. Next the blades were placed in a stainless steel can which was filled with helium and connected to a vacuum pump which evacuated the gas to about 10^{-7} millimeters of Mercury. The vacuum was used to prevent dulling of the blades by oxidation. A spot weld sealed the vacuum, and the can was placed in a furnace for a 1600°F, five-day bake."

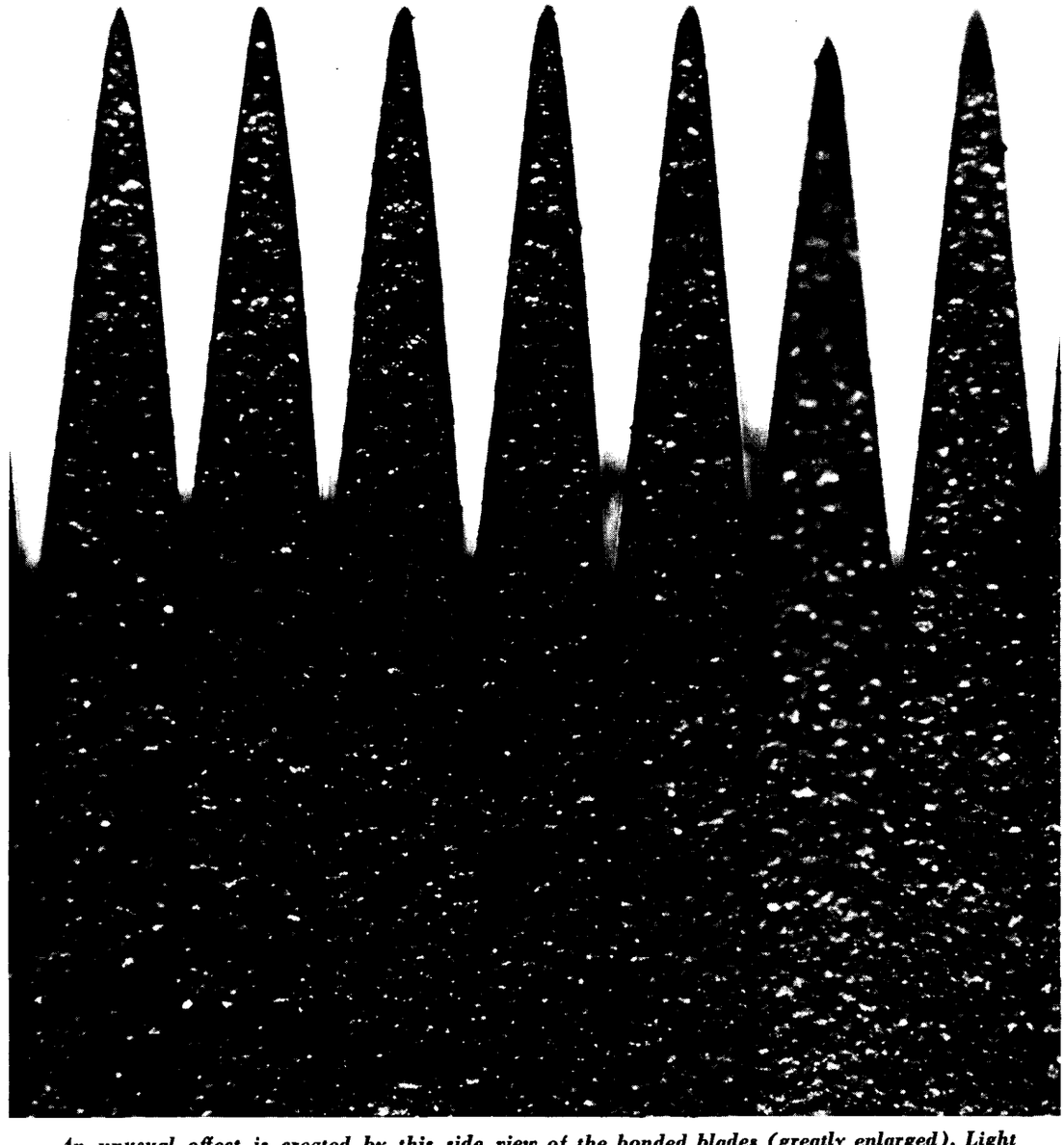
After cooling slowly, the blades were removed from the closed container. They were found to be bonded permanently together, and the angles between the edges were extremely sharp which permitted the efficient capture of light regardless of the type of coating used on the surface.

Mr. Levinsohn's men are now engaged in shaping the fused blades into a circular pattern. Within a fraction of the time required by an outside contractor, the completed reference disc will be delivered to Jack Triolo, who can then proceed with the development of his space experiment.

Triolo is just one of many of Goddard's space scientists who regularly utilize the skill and ingenuity of the fabrication division. Here they have found ready answers to the most perplexing fabrication problems at substantial savings in both time and money.



This photomicrograph shows how the metal surfaces of the blades have been bonded permanently by diffusion.



An unusual effect is created by this side view of the bonded blades (greatly enlarged). Light striking the razor blade edges is "trapped" as it bounces down into the crevices.