

Excerpts from REPORT
of the DIRECTOR *of the Applied Physics Laboratory*
July 1, 1960—June 30, 1961

TO THE PRESIDENT OF THE UNIVERSITY:

The year 1961 marks the nineteenth anniversary of the founding of the Applied Physics Laboratory and the seventeenth year of its contract with the Navy. The Laboratory's work for the Navy was originally a broad task of guided-missile research and development, with supporting investigations in various fields of science and engineering. In recent years, as more and more problems related to guided missiles have been solved, the Laboratory's efforts have become diversified and expanded to include other areas, notably the invention, development, and testing of the Transit navigational satellite, development of the Typhon radar and its application in the Typhon program, and participation in the Fleet Ballistic Missile Program.

The success that Transit has had in providing new capabilities for navigation and for collecting new data in geodesy makes it a most interesting program. . . . Perhaps the outstanding event in the Transit program to date was the launching of Transit 4A (1961 Omicron I) on 29 June 1961. Not only did the satellite separate and acquire an excellent orbit that would give it an expected life of several years and lead to many important discoveries about the nature of the earth, but the firing also marked two important "firsts" in satellite history. This launching was the first time that a triple-decker payload had been fired into space and it also was the first time that a nuclear power source had been used in a satellite. . . .

The nuclear power source used, developed especially for this purpose by The Martin Company under the auspices of the Atomic Energy Commission, used the heat generated by the decay of a radioisotope (Plutonium 238) to maintain a temperature difference in a thermopile and so give a supply of electrical energy.

Transit 4A, whose over-all design is quite different from its predecessors, also contains an improved memory system for the purpose of storing information (orbital parameters, time corrections, etc.) received from an injection station at the Howard County site. This information is retransmitted from the satellite to navigating receivers for use in accurate determination of position. . . .

Participation in the Polaris program continued. A number of the Laboratory staff took part in the evaluation trials of all the Fleet ballistic submarines that have been put into commission starting with the USS *George Washington*, the first Polaris submarine.

The development of guided missiles and their auxiliary systems still constitutes more than one-half of the Laboratory's effort. The missile work is primarily concerned with the continuing development and improvement of the Terrier, Tartar, and Talos missiles and the development of the whole Typhon Weapon System. Twelve completed ships now carry Terrier missiles, and APL has participated in tests of the Terrier Weapon System aboard these ships. The first units of a Terrier missile system have been installed on the Italian cruiser *Garibaldi*, marking the first such installation on a NATO ship other than those of the United States. The 80,000-ton aircraft carrier USS *Kitty Hawk*, to be armed with advanced Terrier missiles, was commissioned in April 1961.

The USS *Charles F. Adams*, the first of 24 ships planned to carry Tartar missiles, was commissioned, and APL assisted in the technical evaluation program.

During this year the Laboratory participated in tests of Talos installations aboard the USS *Little Rock*, the USS *Galveston* and the USS *Oklahoma City*.

A large fraction of the Laboratory's work is now directed toward the development of the Typhon missile and associated radars.

The Tactical Analysis and Assessment Group has been engaged in a Laboratory-wide study of the whole anti-air warfare problem of the Navy during which a new and interesting technique of analysis has been developed.

Basic and supporting research occupies about 15% of the Laboratory's effort. Items on which significant progress was made this year include the following: development and operation, according to design, of a direct-current arc that operates on currents of 14,000 amperes and upwards; calculation of the theoretical performance of external burning ramjets; application of hypersonic ramjets for obtaining speeds up to satellite velocities; factors affecting the stability of solid propellant rocket motors; development and evaluation of a new type of high-temperature insulation; measurements of high-temperature gas thermal conductivity by a new line source technique; progress on the preparation of a plasma research generator facility; studies in battle simulation; development of a broadband analog of an adjustable microwave delay line; development of a transistorized active filter circuit applicable to guided missiles; extension of an optimum search theory; development of a high-speed digital line stretcher; fundamental studies of the recombination of HO₂ radicals; interpretations of electron loss mechanisms in plasma afterglows; exploration of magnetic anisotropies in the electron spin resonance spectra of free radicals; studies of optical bore-sight errors in radomes; studies of the rotational and vibrational relaxation in diatomic gases; studies of the fundamental parameters of rare gas discharges; hypersonic shock wave interaction effects in viscous flow;

and development of an infrared spectrometer for rocket gas analysis. . . .

This year has seen the formation of a unified Computing Center to meet the needs of the whole University. Local stations on the Homewood Campus and at the Medical School, each provided with its own staff and necessary equipment, will

be connected by telephone lines to the main equipment nucleus at the Applied Physics Laboratory by July 1962. . . .

During the past year three new buildings have been completed or are nearing completion at the Howard County site. The Computing Center building was occupied in February

1961, and the Experimental Radar Building, begun in June 1960, was occupied in May 1961. Work is progressing well on the new Propulsion Research Laboratory and it is expected to be ready for occupancy by the end of September. . . .

R. E. GIBSON
Director

JOURNAL PUBLICATIONS

A compilation of recently published books and technical articles written by APL staff members.

- A. A. Westenberg and N. de Haas, "High Temperature Gas Thermal Conductivity Measurement with the Line Source Technique," in "Progress in International Research on Thermodynamic and Transport Properties," Academic Press, N. Y., 1961, 412-417.
- E. L. Cochran and F. J. Adrian, "Electron Spin Resonance Identifies Radio Chemical Species," *Nucleonics* **19**, 12, Dec. 1961, 47-50.
- W. Liben and L. A. Twigg, Jr., "A Variable Ultrasonic Electro-Optical Delay Line and a New Ultrasonic Optical Effect in Fused Quartz" (Letter), *J. Appl. Phys.* **33**, 1, Jan. 1962, 249.
- R. R. Newton, "Ellipticity of the Equator Deduced from the Motion of Transit 4A," *J. Geophys. Research*, **67**, 1, Jan. 1962, 415-416.
- W. R. Wendt, "Nuclear Ship Traffic in World Seaports," U. S. Naval Institute *Proceedings*, No. 707, 88, 1, Jan. 1962, 42-53.
- S. M. Blinder, M. L. Peller, N. W. Lord, L. C. Aamodt, and N. S. Ivanchukov, "Electron Spin Resonance of Tetraphenylpyranyl Radical," *J. Chem. Phys.*, **36**, 2, Jan. 15, 1962, 540-544.
- I. F. Wagner, "The Design of Experiments in War Gaming" pp. 55-66A-G;
- and
- A. Pennington, "History of War Gaming," pp. 2-5, Washington Operations Research Council *First War Gaming Symposium Proceedings*, Feb. 1962.
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ADDRESSES

Principal recent addresses made by APL staff members to groups and organizations outside the Laboratory.

- H. W. Woolard, "Theoretical Analysis of the Flow and Drag of Surface Irregularities Immersed in a Wall-Layer Stream in a Supersonic Main Stream,"
- and
- H. H. Hart, "High Angle of Attack Phenomena Associated with the Supersonic Planar Configurations," *Fifth U. S. Navy Symposium on Aeroballistics*, U. S. Naval Ordnance Laboratory, White Oak, Md., Oct. 16-18, 1961.
- G. F. Pieper, "Research Aspects of the Transit Program," *American Nuclear Society*, Iowa State University, Dec. 5, 1961.
- W. Liben, "Microelectronics," *U. S. Naval Academy Advanced Science and Mathematics Seminar*, Dec. 15, 1961.
- W. H. Guier, "Some Special Problems in Statistical Inference Associated with Satellite Tracking," *American Statistical Society*, N. Y., Dec. 27-30, 1961.
- G. L. Seielstad, "Communications Between Scientists" (Panel), *American Association for the Advancement of Science*, Denver, Colo., Dec. 26-30, 1961.
- A. Pennington, "Computer War Gaming Techniques," *Navy War College Command and Staff Course*, Newport, R. I., Jan. 3, 1962.
- D. W. Juergens, "APL Satellites," *American Institute of Electrical Engineers—IRE Student Branch*, University of Colorado, Jan. 9, 1962.
- J. O. Artman, "Electric Field Effects on Ruby ESR," *Magnetic Resonance Seminar*, Washington, D.C., Jan. 18, 1962.
- A. A. Westenberg and N. de Haas, "High Temperature Gas Thermal Conductivity Measurement with the Line Source Technique," *Thermophysical Properties Symposium*, Princeton, N. J., Jan. 25, 1962.
- J. O. Artman and J. C. Murphy, "Splitting of the Ground State Levels of Ruby by an External Electric Field,"
- and
- E. P. Gray, "Numerical Trajectory Analysis of Charged Particle Confinement in Superposed Steady and Rotary Magnetic Fields,"
- and
- G. F. Pieper, C. O. Bostrom, and A. J. Zmuda, and B. J. O'Brien (State University of Iowa), "Detection of Solar and Van Allen Belt Protons by Injun Satellite," *American Physical Society*, N. Y., Jan. 26, 1962.
- A. A. Westenberg, "Complex Reaction Kinetics in Nozzle Flow," *Institute for Defense Analysis*, Washington, D. C., Jan. 29, 1962.
- R. M. Fristrom, "The Experimental Determination of Radical Concentrations in High Temperature Systems," *New York University Department of Chemistry Colloquium*, Feb. 2, 1962.
- W. Liben, "Microelectronics," *Naval Medical Research Institute*, Bethesda, Md., Feb. 20, 1962.