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N R L REPORT NO. 3270

FR-3270

SCIENTIFIC PROGRAM OF THE NAVAL RESEARCH LABORATORY

July 1, 1948

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GUIDE/NAVY DECLASS MANUAL 11 DEC 2012

02 SERIES, 05 SERIES, 06 SERIES
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NAVAL RESEARCH LABORATORY

WASHINGTON, D.C.

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SCIENTIFIC PROGRAM OF THE NAVAL RESEARCH LABORATORY

July 1, 1948



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NAVAL RESEARCH LABORATORY

CAPTAIN H. A. SCHADE, USN, DIRECTOR

WASHINGTON, D.C.

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NAVY REPORT NO. 3270



SCIENTIFIC PROGRAM
OF THE NAVAL RESEARCH LABORATORY

July 1, 1948



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NAVAL RESEARCH LABORATORY
CAPTAIN A. R. HARRIS, DIRECTOR
WASHINGTON, D.C.

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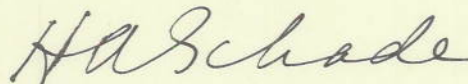
FOREWORD

Program statements appearing on the following pages supersede on 1 July 1948 the "Research and Development Program of the Naval Research Laboratory" dated October 1946.

This document is the Laboratory's primary technical planning medium. It describes in broad terms the work currently under way at the Laboratory and the work which is planned for the future. Essentially it is a revision and modernization of the October 1946 program statement with some minor modifications in the method of presentation and other details.

All scientific activities at the Laboratory are classified into nine fields in accordance with conventional scientific nomenclature. Each of these fields is further subdivided into a number of discrete programs appropriately designated by a letter indicating the field and a number indicating the sequence of the program in that field. A departure from the previous program system will be noted in that current program statements are intended to cover work which may be classified either research, development, or test in accordance with standard Research and Development Board definitions.

These program statements do not represent work units at the Laboratory, and the problem continues as before to be the unit of work for descriptive and accounting purposes. Each problem established at the Laboratory either now or in the future will be categorized under one of these program statements and will further be identified as a research, development, or test type of activity. These classifications will be reflected in the problem numbering system which is described elsewhere.



Captain, USN
Director

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FOREWORD

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All scientific activities at the Laboratory are classified into one of the following categories with conventional scientific nomenclature. Each of these fields is further subdivided into a number of discrete programs, approximately designated by a letter indicating the field and a number indicating the sequence of the program in that field. A departure from the previous program system will be noted in that current program titles must be renumbered to cover work which may be classified under development, or test in accordance with standard Research and Development Board definitions.

These program statements do not represent work units at the Laboratory and the program continues as before to be the unit of work for descriptive and accounting purposes. Each program is assigned to the Laboratory either now or in the future will be categorized under one of these program statements and will further be identified as a research, development, or test type of activity. These classifications will be indicated in the program numbering system which is described elsewhere.

H. B. ...

Chief, USN
Director

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**SCIENTIFIC PROGRAM
OF THE NAVAL RESEARCH LABORATORY**

CHEMISTRY

C01 FUELS

Study synthesis, structure and degradation of compounds. Investigate fuels of naval interest for internal combustion engines. Investigate high energy fuels for naval applications with the accent on those of appreciably higher energy content than hydrocarbons.

C02 LUBRICANTS

Study lubrication phenomena and the reaction of lubricants with bearing materials. Investigate new lubricants and hydraulic and recoil fluids for use over extreme temperature ranges.

C03 PROTECTIVE SURFACES

Study formulation and application of complete organic coatings. This includes the study of pigments for special applications such as corrosion inhibition, antifouling, fungi inhibition. Study chemically formed protective coatings and ceramic coatings for use at high temperatures. Investigate factors affecting adhesion of paint films and develop methods for determining mechanism and adhesion of organic coatings to metal surfaces.

C04 PERSONNEL PROTECTION

Study materials and safety methods in the use of hazardous chemical materials. Investigate methods and materials for protecting personnel from radiation and for elimination of radioactive contaminants from Navy material. Study principles involved and their application in the protection of personnel exposed to lethal atmospheres, including the adsorption and desorption of poisonous gases, formation and poisoning of catalytic surfaces, impregnation of textiles with reactive chemicals, particle size distribution of toxic aerosols, qualitative and quantitative microorganic field methods for detection of toxic gases with emphasis on these problems at ambient temperature extremes.

C05 ELECTROCHEMISTRY

Study the kinetics, thermodynamics and potential of electrode reactions for application to problems of electrochemical corrosion, plating and storage cells. Investigate instruments in which the primary factor is a chemical determination.

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C06 HIGH POLYMERS

Study the synthesis of polymeric substances, compounding of rubber, synthetic rubber and plastics. Apply these studies to the design and fabrication of items for naval use. Investigate insulating materials from a structural viewpoint and absorbing substances for electromagnetic waves.

C07 CONTROL OF FIRES

Study methods and chemistry of materials for control of damage by fire with emphasis on the extinguishment of fires in hydrocarbons and watermiscible fuels and the halting of the production of toxic smokes and gases from chemical agents.

C08 COLLOIDS

Investigate matter in the colloidal state, including a study of the production, structure, stabilization and new methods of observing colloids, and applications to such items as liquid and gelled fuels, greases, foaming and defoaming, aerosols and smokes.

C09 SURFACE CHEMISTRY

Study the structure, formation and properties of boundary films and their adsorption and reaction at interfaces, including a study of catalytic surfaces, their formation and poisoning.

C10 RADIOCHEMISTRY

Study the chemical reactions brought about by particles of high energy passing through the chemical system acted upon either in the gaseous, liquid or solid state, including the application of radioactive tracer techniques to chemical problems.

C11 PHYSICAL CHEMICAL PROPERTIES

Investigate the chemical and physical properties of new or little-known materials, both organic and inorganic, with a view to special applications, including determination of properties of extremely pure materials.

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ELECTRICITY

E01 ELECTRICAL POWER SYSTEMS

Investigate the limitations to improvement of electrical power systems in missiles, aircraft, surface ships and submarines with emphasis on the design of an optimum electrical power system for carrier-based aircraft and on the design problems caused by raising the voltage of the electrical systems of submarines from 250 to 500 and to 1,000 volts in connection with increased subsurface speeds.

E02 CONVERSION TO ELECTRICAL ENERGY

Investigate the conversion of various forms of energy sources, including ionic, nuclear, electrostatic, thermoelectric, photoelectric and direct conversion fuel cells, into electrical energy. Investigate the conversion of thermal energy through gaseous ion production and separation directly into electrical energy.

E03 ELECTRICAL POWER EQUIPMENT

Investigate the limitations to improvement of performance of major electrical assemblies as generators, regulators, motors, protective and control devices, transformers, switch gear, cables and connectors.

E04 OPERATIONAL EQUIPMENTS

Investigate electrical instruments and equipments for naval craft for special purposes as measurement and computation, protection, alarm, interior communication, electrical heating and de-icing, electromagnetic braking and projection, and electromechanical actuation.

* * *



ELECTRICITY

801 ELECTRICAL POWER SYSTEMS

Investigate the limitations to improvement of electrical power systems in missiles, aircraft, surface ships and submarines with emphasis on the design of an optimum electrical power system for carrier-based aircraft and on the design problems caused by existing the voltage of the electrical systems of submarines from 200 to 300 and to 1,000 volts in connection with increased subsurface speeds.

802 CONVERSION TO ELECTRICAL ENERGY

Investigate the conversion of various forms of energy sources, including kinetic, nuclear, electrostatic, thermoelectric, photoelectric and direct conversion fuel cells, into electrical energy. Investigate the conversion of thermal energy through gaseous ion production and separation directly into electrical energy.

803 ELECTRICAL POWER EQUIPMENT

Investigate the limitations to improvement of performance of major electrical assemblies as generators, regulators, motors, protective and control devices, transformers, switch gear, cables and connectors.

804 OPERATIONAL EQUIPMENTS

Investigate electrical instruments and equipments for naval craft for special purposes as measurement and comparison, protection, alarm, interior communication, electrical heating and de-icing, electromagnetic heating and protection, and electro-mechanical actuators.



METALLURGY

NOV PHYSICAL METALLURGY

Study effects of chemical composition, crystal structure, microstructure, processing variations and atomic characteristics on physical, chemical, mechanical, electrical and magnetic properties of metals and alloys. Determine influence of stress-state, strain rate, and environment on flow and fracture. Carry out studies on both ferrous and non-ferrous materials with the objective of developing alloys that will be suitable substitutes for critical materials or that will have improved properties.

NOV MELTING AND CASTING

Study the physical chemistry of reactions occurring between molten metals and oxides, phosphates, slags, crucibles, and molds; the solidification characteristics of metals and alloys including nucleation, crystal growth, segregation, and nonmetallic inclusions; casting and the effect of composition, particle size and distribution, and molding variables on properties of mold materials.

NOV WELDING

Study the effect of variation in welding conditions, and of composition and methods of manufacture of base metal and electrodes on the properties and microstructures of welded areas. Investigate the correlation between microstructures and modes of failure of welds. Study causes of porosity and cracking, and effects of residual stress, rate and temperature on performance of welds.

NOV ANALYTICAL METHODS

Develop improved methods for analysis, testing or identifying metals, including chemical, mechanical, radiographic, electrical, spectrographic and x-ray diffraction methods.

NUCLEONICS

H01 PROPERTIES OF NUCLEAR PARTICLES

Conduct studies of the nuclear reactions and reaction products including those induced by positive ions, neutrons, gamma rays and beta rays. Devise experiments and theories to determine properties of elementary nuclear particles including their interactions with each other and with various fields (electromagnetic, neutrino, meson, etc.).

H02 POSITIVE ION INDUCED REACTIONS

Study the resonances in the reactions induced by proton and deuteron bombardment of the light elements and examine the energies of the reaction products using a 2 MEV electrostatic accelerator to provide the excitation energy.

H03 BETATRON STUDIES

Examine very short life activities induced by high energy gamma rays from a 20 MEV betatron. Compare gamma-ray and beta-ray efficiencies in inducing nuclear reactions. Likewise, compare the scattering of gamma and beta rays by nuclei and by electrons.

H04 COSMIC RADIATION

Study the nature and properties of cosmic ray constituents at very high altitudes by the use of aircraft, balloons, and rockets.

H05 SYNCHROTRON DEVELOPMENT

Determine the feasibility of a large orbit air core synchrotron by constructing such a machine for use at low energies.

H06 NUCLEAR MOTIVE POWER

Study problems of pile design in the light of naval requirements including pile product recovery, heat transfer and shielding.

H07 ISOTOPE SEPARATION

Continue the evaluation of methods for the separation of isotopes, including thermal diffusion and electrolytic processes.

H08 RADIOLOGY OF NUCLEAR PROCESSES

Set up adequate safety practices in connection with high energy radiation sources at the Laboratory. Study problems involved in shielding from, detection and concealment of, radioactive processes.

* * *



NUCLEONICS

H01 PROPERTIES OF NUCLEAR PARTICLES

Conduct studies of the nuclear reactions and reaction products including those induced by positive ions, neutrons, gamma rays and beta rays. Develop experiments and theories to determine properties of elementary nuclear particles including their interactions with each other and with various fields (electromagnetic, neutron, meson, etc.).

H02 POSITIVE ION INDUCED REACTIONS

Study the reactions in the reactions induced by proton and deuteron bombardment of the light elements and examine the energies of the reaction products using a 3 MEV electrostatic accelerator to provide the excitation energy.

H03 BETA-RAY STUDIES

Examine very short life activities induced by high energy gamma rays from a 30 MEV betatron. Compare gamma-ray and beta-ray efficiencies in inducing nuclear reactions. Likewise, compare the statistics of gamma and beta rays by neutron and by electron.

H04 COSMIC RADIATION

Study the nature and properties of cosmic ray constituents at very high altitudes by the use of aircraft, balloons, and rockets.

H05 SYNCHROTRON DEVELOPMENT

Determine the feasibility of a large orbit x-ray synchrotron by constructing such a machine for use at low energies.

H06 NUCLEAR MOTIVE POWER

Study problems of pile design in the light of naval requirements including pile protection, heat transfer and shielding.

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H08 RADIOLOGY OF NUCLEAR PROCESSES

Set up adequate safety practices in connection with high energy radiation sources at the laboratory. Study problems involved in shielding from, detection and concealment of radioactive processes.

OPTICS

N01 OPTICAL PROPERTIES OF MATERIALS

Conduct basic studies of absorption, scattering, reflection, refraction, and radiation of light by optical glass, films, plastics and crystals. Study radiation from various light sources including high intensity. This program includes the optical spectrum from the extreme ultraviolet through the infrared.

N02 GEOMETRICAL OPTICAL DEVICES

Devise overall designs of optical systems for laboratory and naval use including studies of devices of large light-gathering power and wide-angle coverage; applications of plastics and new materials to optical instruments, narrow band-pass optical filters; selective reflecting surfaces.

N03 OPTICS OF THE ATMOSPHERE AND OF THE SEA

Investigate the attenuation and scattering of radiations throughout the optical spectrum by clear air, haze and fog. Measure the brightness and polarization of, and radiations from, the daylight sky at various altitudes above sea level. Measure the brightness of and the radiations from the night sky in various areas, and of the aurorae. Carry out high altitude research on the optical features of the atmosphere and of the sun. Investigate the optical properties of the sea and of water in various areas.

N04 SPECTROSCOPY

Conduct basic spectroscopic work throughout the radiation spectrum on atomic and molecular structures with emphasis on the spectral distribution in arcs and gaseous discharge, photoelectric effects in the extreme ultraviolet, infrared spectral properties of metallic films, emission and absorption spectra of rocket flames and gas flames. Apply optical and mass spectroscopy to problems of analysis, structure and rates and mechanisms of chemical reactions.

N05 PHYSIOLOGICAL OPTICS

Study performance of the eye under various conditions of adaptation and illumination; study aberrations of the eye; determine the visibility of objects and the legibility of characters. Extend visual camouflage to regions not now covered.

N06 RADIOMETRY AND PHOTOMETRY

Develop and maintain special photometers for brightness and color standards and measurements. Evaluate luminous materials for brightness, color and duration. Study applications of special photoelectric cells. Investigate phosphorescence and fluorescence.

Interest is in photoelectric and flicker methods of measuring low brightness, spectra and quantum efficiencies of fluorescent materials, fluorescence sensitizers, grid controlled photomultiplier, and fast bolometers.

N07 ULTRAVIOLET AND INFRARED SYSTEMS

Apply ultraviolet and infrared radiations to detection, signalling and control systems. The program deals with the development of ultraviolet and near infrared communication systems and their components, thermal detection and control systems and their components, and with countermeasures to thermal detectors.

PHYSICS

P01 ELECTRICAL AND MAGNETIC PROPERTIES

Conduct theoretical and experimental research in phenomena of the solid state with emphasis on electrical and magnetic properties. The program includes the electrical properties at the boundary surfaces of semiconducting and conducting materials; the variations of properties with temperature and intense magnetic fields; ferromagnetic properties at high frequency; the conductivity phenomena induced in dielectrics by cathode ray bombardment; and the relations between the properties of elementary particles and the microscopic properties of matter. Investigate the superconducting state. Study conductors and semiconductors at low temperatures and at microwave frequencies.

P02 ENGINEERING PHYSICS OF MATERIALS

Investigate materials used in operational equipment, as contact, semiconductor and rectifier materials, dielectrics. Determine the characteristics of materials operating under extreme ambient conditions of temperature.

P03 ATMOSPHERIC ELECTRICITY

Study atmospheric electrical phenomena in relation to the effects upon the operation of naval craft with emphasis on studies of the origin and separation of electrical charge in precipitation areas, electrical charging of missiles and aircraft operating in an atmosphere of snow, fog, rain or dust, methods for reduction of the electrical charging of missiles and aircraft or elimination of the undesirable effects of the charging, and reduction of lightning hazards.

P04 HEAT POWER

Investigate heat power devices with emphasis on pulse jet engine experiments to improve fuel economy, thrust-drag ratio, service life and instrumentation; combustion and flow.

P05 METEOROLOGY

Conduct research leading to special meteorological instruments which will be more accurate and more rapid in their response to atmospheric temperature, pressure and humidity.

P06 UPPER ATMOSPHERE

Conduct research by the use of upper atmosphere vehicles on the properties and characteristics of the upper atmosphere together with other phenomena which can be studied advantageously at high altitudes. Develop rockets, equipment and instrumentation

in support of this work. This investigation includes cosmic rays; the ionosphere; temperature, pressure and composition of the upper atmosphere; ionization of jets; voltage gradients; and spectroscopy.

P07 PHOTON AND PARTICLE COUNTERS

Accomplish research, development and application of Geiger, crystal, proportional and ion chamber counters with interest in the counting characteristics of gaseous mixtures, temperature insensitive counters, low voltage counters, high efficiency and directional gamma ray counters, proportional alpha particle counters and scintillation counters.

P08 ELECTRON MICROSCOPY, X-RAY AND ELECTRON DIFFRACTION

Devise new applications of these techniques to the study of pigments, catalysts, metals, colloids, impregnating materials, smokes, thin films, crystal structure of alloys at high temperature, corrosion and surfaces.

P09 CRYSTALS

Devise new and improved ways of growing and processing synthetic crystals and associated non-metallic solids. Study their structure and its relation to physical properties. The studies may be expected to lead to development of materials having improved properties for sound generators, semiconductors, optical purposes (including infrared and ultraviolet transparency, cathode ray screens, luminous dials, paints, and markers), and throw light on the phenomena of surface adsorption and absorption that may lead to improved adherence of protective surface coatings.

P10 APPLIED MATHEMATICS

Study and develop mathematical methods applicable to the fields of strength of solids, dynamics of fluids, dynamics of complex structures, thermodynamics, and electrodynamics. Conduct basic studies on the design of experiments in order to provide data adequate for subsequent analysis, synthesis, and statistical treatment thus yielding broader generalizations. Guide and perform computations by rapid and versatile machine methods.

* * *

RADIO

R01 COMMUNICATION

Analyze the requirements for a comprehensive communication program of the Navy. Investigate such factors as choice of frequency, spectrum utilization, means for decreasing vulnerability and merits of various types of modulation. Investigate systems to provide short- and long-range communication between subsurface, surface and supersurface units for all areas including the polar region. Study systems utilizing audio, graphic, visual, and electromechanical means to improve such factors as traffic handling capacity, security, accuracy, and reliability. Study relay systems for the transfer of information or intelligence, such as for the extension of communication ranges within a task force.

R02 DETECTION

Investigate detection systems for all applications considering such factors as target handling capacity, spacial coverage, position accuracy, perception of target, decreased vulnerability and moving target indication. Conduct fundamental studies of radar for detection of small and high-speed targets up to extreme ranges and high altitudes including the provision for altitude determination; detection of all classes of targets providing high target capacity; three dimensional information, high position accuracy and rapid target interpretation and designation; detection and recognition of all classes of targets from submarines; long-range detection from aircraft of all classes of targets beyond the normal horizon of ships and shore.

R03 IDENTIFICATION

Analyze operational requirements for electronic recognition and identification, evolve techniques and special components applicable to such systems; develop experimental models. Study techniques for artificial azimuth sharpening, elimination of unsynchronized signals, coding and decoding, cryptographic security devices, and electronic sorting.

R04 NAVIGATION

Investigate navigation systems with a view to the long-range program requirements of the Navy. Conduct studies leading to the development of specific navigational aids and systems with emphasis on carrier-all-weather flying systems enabling aircraft to perform all functions necessary for military missions; short-range navigation systems for small surface or subsurface units providing position or guidance information; long-range systems with provision for security and other military requirements for subsurface, surface or supersurface units.

R05 CONTROL

Investigate factors affecting precision control. Investigate systems for the automatic control of gunfire, the guidance of missiles, and the remote control of aircraft from

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unstabilized control bases. This program involves the application of servo theory to over-all systems, including tracking, electromechanical stabilization and computation, launcher control, and ballistic and aerodynamic control and the development of tracking, telemetering, beacon, recording and computing equipment for proving ground instrumentation and data reduction useful in the development and evaluation of missile guidance systems.

R06 COUNTERMEASURES

Evolve techniques for exploration of the complete radio spectrum with primary emphasis on such fields as interception, direction finding, signal analysis and vulnerability with indicated work on jamming and deception which can be applied against all radio and radar systems. Study vulnerability of U. S. and, where possible, foreign radio and radar equipments for developing countermeasures. Devise jamming methods, techniques, and experimental systems for use in fleet maneuvers against U. S. radar and radio systems. Evolve experimental devices and systems suitable for use in fleet maneuvers for providing confusing and misleading radio and radar information.

R07 SYSTEMS INTEGRATION

Study factors and develop techniques to increase effectiveness of combined electronic systems, particularly those leading to the rapid and accurate exercise of combat command. Study techniques for the collection, evaluation, presentation, and distribution of information provided by electronic and associated systems for command plotting, fighter direction and target indication. Study techniques and develop instrumentation required for the determination, suppression, and avoidance of interference.

R06 ELECTRON TUBES

Conduct research in the field of electron tubes with emphasis on forms of electron storage tubes suitable for improved presentation of radar information and for applications in electronic computers and in communication systems; generation of power at millimeter wavelengths with emphasis on low-power tunable oscillators; study of power limitations of magnetrons; study of thermionic and secondary electron emission of thorium cathodes; study of interaction between electron beams.

R09 ANTENNAS

Conduct research to support a long-range program in the field of antennas. Evolve design techniques for new antenna types, including antennas submerged in sea water, artificial refracting media, focussing objectives, dielectric antennas, helical antennas, rapid scanning antennas, and beam-shaping antennas. Develop techniques and equipment for antenna measurements, such as the automatic computing and recording of radiation patterns and impedance. Investigate antennas for new radio systems and adapt existing systems to new installations and new tactics. Investigate operational and installation problems, such as fairing-in and multiplexing.

R10 CIRCUITS, COMPONENTS AND INSTRUMENTATION

Investigate lumped-constant and distributed-constant circuits with emphasis on such factors as frequency stabilization, synchronization, spectrum utilization, compactness,

flexibility and reliability. Investigate components with emphasis on such factors as power handling capability, compactness and stability under conditions of extreme temperature, humidity or acceleration. Conduct research in electronic instrumentation, investigating instruments and techniques needed for support of the Laboratory program and to fill specific needs of the Navy where available instruments and techniques will not suffice.

R11 PROPAGATION

Study the propagation of electromagnetic waves, including extraterrestrial, ionospheric, tropospheric, ground wave, and sea water propagation, and attenuation and reflection by jet gases. Study reflections from natural and man-made objects, and back scattering from and absorption by clouds, rain storms and the sea surface with emphasis on quantitative results and the physical characteristics of the reflected waves. Devise methods of target shaping to minimize reflection with emphasis on the radar detection of small targets in the presence of sea return. Conduct research on the absorption of radio waves. Study available materials and devise new materials having high permeabilities at high frequencies, for use as components in absorbing films.

R12 PRECISION LOCATION

Analyze the operational requirements for various precision location systems. Investigate radar systems and components for the acquisition and precision tracking of targets and missiles, and for obtaining extreme target resolution, including development of sequential and simultaneous lobing systems; radio frequency electronic switching devices at high power levels; and high resolution radar techniques.

R13 APPLIED PSYCHOLOGY

Conduct research on human response, skills and proficiency and apply to the design of electromechanical systems to make the controls and consoles fit human capacities and to obtain better intelligence from the displays with emphasis on fire control and guidance systems and missile control devices.

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flexibility and reliability. Investigate components with emphasis on such factors as power handling capability, component and stability under conditions of extreme temperature, humidity or acceleration. Conduct research in electronic instrumentation, investigating instruments and techniques needed for support of the Laboratory program and to fill specific needs of the Navy where available instruments and techniques will not suffice.

III PROPAGATION

Study the propagation of electromagnetic waves, including extraterrestrial, ionospheric, tropospheric, ground wave, and sea water propagation, and attenuation and reflection by jet gases. Study reflections from natural and man-made objects, and back scattering from and absorption by clouds, rain storms and the sea surface with emphasis on quantitative results and the physical characteristics of the reflected waves. Develop methods of target mapping to minimize reflection with emphasis on the radar detection of small targets in the presence of sea return. Conduct research on the absorption of radio waves. Study available materials and devices now available having high permittivities at high frequencies, for use as components in absorbing lines.

III PRECISION LOCATION

Analyze the operational requirements for various precision location systems. Investigate radar systems and components for the acquisition and precision tracking of targets and missiles, and for obtaining extreme target resolution, including development of sequential and simultaneous lobing systems; radio frequency electronic switching devices at high power levels; and high resolution radar techniques.

III APPLIED PSYCHOLOGY

Conduct research on human response, skills and proficiency and apply to the design of electromechanical systems to make the controls and consoles fit human capabilities and to obtain better intelligence from the displays with emphasis on fire control and guidance systems and missile control devices.

SOUND

S01 TRANSDUCERS

Conduct theoretical and experimental investigations directed toward improving means for converting electrical and other forms of energy into sound or vibration, and vice versa.

S02 PROPAGATION

Investigate the behavior of elastic waves within a medium and at its boundaries as determined by the physical properties of the medium leading to a better understanding of the physical characteristics of conducting media through a study of their effects on transmitting waves and contributing to knowledge of the physics of liquid and solid states and of the requisites for sound transparency and nonreflectivity.

S03 HARBOR, FLEET BASE, COASTLINE DEFENSE

Study and devise means for the application of sonar techniques to the protection of stationary installations. Investigate means of giving early and positive warning of the approach of high speed submarines, sneak craft and underwater missiles, especially through the use of bottom-mounted remotely controlled sonar and sonobuoys.

S04 LOCATION OF SMALL OBJECTS

Determine the possibilities of intense underwater ultrasonic pulse signals for locating mines and other types of small objects and, in particular, for improving the resolving power of sonar equipment. Study ways and means of displaying or recording the received echoes to best advantage.

S05 RECORDING AND REPRODUCTION

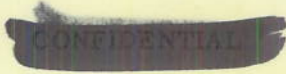
Study recording and reproducing of sound or vibration with a view to improving the present fidelity, speed, power and frequency limits.

S06 SONAR ELECTRONICS

Study theoretically and experimentally the effects of complex electrical waves in linear and nonlinear electrical networks, particularly in the ultrasonic frequency region, including a study and classification of noise and discrimination against specific types and directed toward clarification and extension of the basic principles that determine the behavior and limitations of various elements of sonar systems.

S07 SONAR SYSTEMS

Investigate sonar systems, long-range listening equipment, echo detection equipment for use on surface vessels, submarines and aircraft for the purpose of navigation, search, holding contact and attack.



S08 BIO-ACOUSTICS

Study the effect of elastic waves of different amplitudes and of different single frequencies and frequency bands on living matter including tissues and organs of the body.

S09 COUNTERMEASURES

Devise methods of jamming the sound receiving equipment of other ships or of homing missiles and of luring homing torpedoes or missiles away from their target.

Investigate the behavior of elastic waves within a medium and at its boundaries as determined by the physical properties of the medium leading to a better understanding of the physical characteristics of existing media through a study of their effects on trans-
mission waves and contributing to knowledge of the physics of liquid and solid states and of
the properties for sound transparency and acousticality.

S03 NARROW BAND COASTLINE DEFENSE

Study and devise means for the application of sound techniques to the protection of
coastline installations. Investigate means of early early and positive warning of the
approach of high speed submarines, aerial craft and underwater missiles, especially
through the use of bottom-mounted vertically controlled sonar and sonobuoys.

S04 LOCATION OF SMALL OBJECTS

Determine the possibilities of locating underwater ultrasonic pulse signals for locating
mines and other types of small objects and, in particular, for improving the resolving
power of sound equipment. Study ways and means of displaying or recording the received
signals to best advantage.

S05 RECORDING AND REPRODUCTION

Study recording and reproduction of sound or vibration with a view to improving the
present ability, speed, power and frequency limits.

S06 SONAR ELECTRONICS

Study theoretically and experimentally the effects of complex electronic waves in
linear and nonlinear electrical devices, particularly in the ultrasonic frequency region,
including a study and classification of noise and distortion against specific types and
direction toward classification and extension of the basic principles that determine the be-
havior and limitations of various elements of sound systems.

S07 SONAR SYSTEMS

Study systems, long-range listening equipment, echo detection equipment
for use in surface vessels, submarines and aircraft for the purpose of navigation, search,
depth control and attack.

PRNC-5876-5-25-48-800