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FIELDS OF ACTIVITY AND EXPERIENCE

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SOUTHWEST RESEARCH INSTITUTE
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SOUTHWEST RESEARCH INSTITUTE

Fields of Activity and Experience

LA
The fields of activities of Southwest Research Institute represent present activities, know-how, or past performances in which we feel the Institute has real capabilities. A summary of these facilities are shown in the following two sections.

FIELDS OF EXPERIENCE *and*

SPECIALIZED FACILITIES ,

Southwest Research Institute is a not-for-profit research and development organization, employing in the order of 500 professional, technical, and supporting personnel with a paid research budget of over five million dollars a year.

The Institute is constituted to provide a team approach in attacking research and development problems largely in the physical sciences. Two completely independent sister organizations provide consultation and research facilities in the fields of medical research, animal husbandry and range management. They are Southwest Foundation for Research and Education, and Southwest Agricultural Institute. *1954*

Any inquiries concerning research, development, engineering, or laboratory projects should be addressed to:

Southwest Research Institute
Project Development
8500 Culebra Road
San Antonio 6, Texas

- A -

F I E L D S O F E X P E R I E N C E

This section is a tabulation of the abilities and activities at Southwest Research Institute catalogued according to scientific or engineering titles.

Many subjects in research and engineering involve several disciplines and for this reason a single class of work may be found under more than one heading.

Research and Development Source Information

1. Acoustics

- a. Architectural acoustics
- b. Design of special purpose instrumentation
- c. Electroacoustic analog techniques
- d. Frequency and space selective filters
- e. Hypersensitive subsonic and sonic measurement transducers
- f. Interaction of acoustic and electromagnetic effects
- g. Noise abatement and measurement
- h. Physical acoustics, sound propagation, basic impedance concepts and studies
- i. Physical measurements by acoustic techniques
- j. Physiological and psychological effects of sound
- k. Pulsation suppressors and sound stream absorbers
- l. Special purpose noise and pulsation generating sirens
- m. Ultrasonics
 - Design of transducers and coupling systems
 - Nondestructive testing
 - High power applications

2. Aeronautical Dynamics

- a. Analytical programs in flutter characteristics, airload distribution, fluid flow, space flight, etc.
- b. Experimental programs for design
- c. Instrumentation techniques
- d. Model fabrication and miniaturation techniques
- e. Wind tunnel testing

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3. Aeronautical and Navigational Electronics

- a. Communication
- b. Cooperative radio direction finding
- c. Guidance
- d. Identification
- e. In flight control
- f. Navigation

4. Analog - Dynamic
(See Fluid Flow Laboratory)

- a. Electrical analogs of mechanical systems
- b. Electrical analogs - pneumatic and hydraulic systems including piping, compression equipment, pumps, and motors. Systems of direct interest: compressor facilities, aircraft hydraulic and fuel systems, missile fuel systems, internal combustion engines
- c. Special function generators for general purpose analogs

5. Analytical Chemistry and Instrumental Analysis

- a. Chemical and biological analysis
- b. Electron microscopy
- c. Electron spin resonance
- d. Flame photometry
- e. Gas chromatography
- f. Infrared spectroscopy
- g. Nuclear spin resonance
- h. Radiation effects
- i. Trace analysis

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- j. Ultraviolet
- k. X-ray diffraction

6. Antennas and Transmission Lines

- a. Direction finding antenna arrays and coupling devices
- b. Ferrite antennas and arrays
- c. Field pattern analysis
- d. MF - HF - VHF pattern and impedance measurements
- e. Near field analysis
- f. Radio astronomy antennas
- g. Systems development
- h. Transmission efficiency
- i. Traveling wave antennas
- j. Underground antennas
- k. Unorthodox transmission line networks

7. Applied Mechanics Research

- a. Flow capacity of engines
- b. Fluid flow and flow machinery
- c. Shock tube investigations
- d. Vibrations, vibration isolation and balancing

8. Atmospheres (Synthetic and Controlled)

- a. Biological
- b. Study of life in closed space
- c. Toxicological and pollution studies
- d. Trace contaminants

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9. Automation

- a. Computation devices for control systems
- b. High speed sorting
- c. Material handling systems
- d. Missile simulators
- e. Special purpose radio frequency spectroscopy devices for quality and process control
- f. Training devices

10. Bearing Research

- a. Bearing wear and fatigue
- b. Gear materials, lubricants, and lubrication
- c. Gear scuffing and fatigue
- d. Hydrodynamic and hydrostatic bearings
- e. Rolling-element bearing materials, lubricants, and lubrication
- f. Sliding-element bearing materials, lubricants, and lubrication

11. Biological Facilities and Experience

- a. Antigen and fungicide development
- b. Fungal and mycotic diseases of man
- c. Growth promoters for plants and animal life
- d. Insecticides
- e. Pesticide residues
- f. Pollen studies
- g. Screening of biocides
- h. Toxicity studies

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12. Bio-Medical Electronics

- a. Instrumentation
- b. Special control and analysis systems

13. Biophysics
(See #19 - Chemical Physics)

14. Building Technology

- a. Atomic shelter development
- b. Prefabricated building studies and designs
- c. Structure installation and application manuals
- d. Missile shelter development
- e. School design for maximum utility, economy, standardization
- f. Standardization of prefabricated building materials

15. Business and Industrial Development in Mexico

- a. Appraising and utilizing Mexican scientific and engineering research and development
- b. Defining and interpreting the business effect of government regulations and Mexican business practices
- c. Exploring and utilizing the raw materials and resources of Mexico
- d. Finding and appraising opportunities for export and import and the establishment of facilities in Mexico
- e. Marketing and market research

16. Business Management

- a. Applying and utilizing business research techniques in individual companies
- b. Effecting cost reduction through materials and design engineering and evaluating manufacturing processes and product engineering

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- c. Defining and establishing long and short range company objectives.
- d. Forecasting the impact of new technological developments and trends on technology in individual companies and industries
- e. Interpreting and relating economic data and business indicators to individual company planning and performance
- f. Organizing and administering company planning for growth and evaluating and monitoring company planning programs
- g. Organizing and managing research and engineering as effective company functions and evaluating specific scientific research and engineering development projects

17. Forming

- a. Design of compositions for glasses, glazes, enamels, body materials, whitewares, and ceramics
- b. Design and development of processes, techniques and equipment applicable to the ceramic and related industries
- c. Literature studies for preparation of bibliography on specific areas of ceramics
- d. Production, processing and uses of ceramic materials
- e. Selection of ceramic bodies and their related constituents for specific applications
- f. Synthesis of ceramic materials, their production, uses and properties
- g. Special studies of physical and chemical properties of ceramic materials under varying conditions of temperature and atmosphere
- h. Technical marketing studies in nearly all areas of ceramics

18. Chemical Engineering

- a. Corrosion
- b. Diffusion
- c. Heat transfer - studies using acoustic vibration

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- d. High temperature reduction process
- e. Process design
- f. Process development
- g. Process economic studies
- h. Process improvement

34. Chemical Physics and Instrumental Methods of Structural Studies

- a. Application of infrared, Raman, and X-ray fluorescence techniques to study of solid and liquid chemical systems for quality control and for special applications
- b. Study of nuclear magnetic resonance
- c. Study of nuclear and electron spin resonance
- d. Effects of ionizing and microwave radiation on materials and chemical compounds
- e. Study of chemical reactions and decay, reaction mechanisms, species identification, effects of chemical additives and environmental factors on radical reactions
- f. Measurements of physical and chemical bonding between atoms and solid substrates
- g. Methods of structure determinations in organic and biological compounds by high resolution nuclear spin resonance
- h. The chemical and radiochemical reaction mechanisms in organic and biological systems and compounds
- i. Solid state reaction kinetics
- j. Spectral applications of X-ray diffraction, X-ray fluorescence, electron diffraction and electron microscopy
- k. Stability of chemical compounds under various environmental conditions
- l. Studies of chemical and physical properties of organo-metallics, chelates, high polymers, by nuclear and electron spin resonance techniques

20.

Circuitry

- a. Future circuits including impedance matching
- b. Network analysis
- c. Network development
- d. Radio frequency circuits for specified applications and their characteristics
- e. Special applications of semiconductor devices
- f. Transmission line networks

21.

Combustion Research

- a. Chemical kinetics of combustion
- b. Combustion, detonation, and preignition in spark ignition engines
- c. Combustion and detonation in diesel engines
- d. High-energy fuels and combustion
- e. Jet fuels combustion

22.

Communications

- a. Properties of the radio wave
- b. Propagation studies
- c. Special purpose adaptations of television and radio
- d. Special purpose data transmission equipment
- e. Telegraphy
- f. Telemetry
- g. VLF

23.

Components

- a. Development of special components, such as printed circuit transformers and rotating electrical couplers
- b. Reliability studies

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24.

Computers

a. Computations Laboratory

1. Application of digital computer techniques to scientific and engineering problems

2. Development of small size digital computers

3. Development of special purpose digital computers

4. Development of data storage systems

25.

Materials (Minerals)

1. Development of new materials to determine their commercial potential

2. Development of new methods

3. Process and plant design

26.

Construction

1. Assistance in setting up engines, fuels, and lubricants test laboratories or facilities

2. Development of test methods in the fields of engines, fuels, and lubricants

27.

Corrosion

1. High temperature gas metal reactions, slag metal reactions

2. Low temperature aqueous corrosion, stress corrosion cracking

28.

Compassing

1. Airframe design

2. Development of jamming systems

3. Direction finding

4. Infrared direction finding

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- e. Passive direction finding on atmospheric disturbances
- f. Special recognition and discrimination for early design

29. Direction Finding

- a. Analogs of Direction Finders
- b. Antennas for radio direction finding
- c. Aperiodic arrays and devices for wide band direction finding
- d. Electronic scanning with phase and gain matched dual channel receivers
- e. Instantaneous direction finding for noncooperative targets
- f. Interfering fields application of direction finders
- g. Miniature direction finding antennas
- h. Multiloop arrays
- i. Propagation theory and measurements
- j. Ship and aircraft direction finding systems • MF • HF • VHF
- k. Statistical measurements of direction finder performance
- l. Theory of radio direction finding

30. Diversification and Product Planning
(See #89 - Process Development)

- a. Analyzing and appraising specific products and development projects
- b. Analyzing and appraising market and financial aspects of new or improved products
- c. Analyzing and appraising diversification by acquisition or merger
- d. Analyzing and appraising patents and inventions and negotiating patent license and know-how arrangements
- e. Determining applications and needs for new or improved products

- f. Finding and appraising new industrial products, technical processes, engineering materials and technical services
- g. Planning and administering new product programs and market strategy
- h. Locating and developing sources of new product ideas

Resources and Industrial Development

- a. Exploring and evaluating naturally occurring and other economic resources of geographical regions and trading areas
- b. Finding and appraising opportunities for starting or expanding businesses
- c. Finding and evaluating plant site locations
- d. Measuring and forecasting the economic future of trading areas and geographical regions
- e. Utilizing and allocating economic resources in organizing and planning for industrial development

32. Electrical Measurements

- a. Conduction mechanisms
- b. Electrical properties of the earth at radio frequencies
- c. Hall effect
- d. Properties of materials
- e. Semiconductor properties
- f. Tunnel effect

33. Electrochemistry

- a. Battery and cell studies
- b. Development of special analyzing and plating techniques

34. Electromagnetic Wave Propagation

- a. Antennas for measurements
- b. Direction of arrival measurements
- c. Electromagnetic wave propagation
- d. Multipath measurements including direction finding
- e. Near fields
- f. Phase measurements at MF-HF
- g. Polarization measurements
- h. Propagation theory for MF-HF-VHF
 - i. Surface wave theory and measurements
 - j. Underground or underwater propagation
 - k. Wave tilt measurements

35. Electronic Countermeasures
(See #28 - Countermeasures)

36. Electronics
(See #37 - Electromechanical Devices)

- a. Antennas and wave propagation including direction finding
- b. Data handling, analysis, and conversion systems
- c. FM, AM, and PM telemetering circuits and systems
- d. Instrumentation circuitry
- e. Nondestructive testing devices and circuits
 - (1) Automatic magnetic inspection circuitry
 - (2) Automatic ultrasonic inspection circuitry
 - (3) Filmless X-ray, gamma, and neutron radiography
 - (4) Special combinational inspection circuitry
- f. Radio frequency and microwave spectroscopy
- g. Servo systems

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- Signal correlation systems
- Signal noise detection systems
- Special purpose digital and analog computers
- Special recognition and discrimination (signature) circuitry
- 1. Transistor and vacuum tube circuits

27. Electromechanical Devices
(See #36 - Electronics)

- a. Analog simulation techniques
 - (1) Electrical analogs of pneumatic and hydraulic systems including piping, valves, compression equipment, pumps, motors. Systems of direct interest: compressor facilities, aircraft hydraulic and fuel systems, missile fuel systems, internal combustion engines
 - (2) Electrical analogs of mechanical systems
 - (3) Special function generators for general purpose analogs
- b. Data handling and conversion systems
- c. High sensitivity pressure and seismic transducers
- d. High speed scanning circuitry for automatic inspection
- e. Plant automation
- f. Self-referencing and zeroing mechanisms
- g. Servomechanisms for special applications
- h. Special purpose recorders and display units
- i. Transducer design and development
- j. Transducers for physical measurements
- k. Transistorized FM, AM, and PM, telemetering equipment designed for minimum power drain

38.

Electron Physics • Basic Physics
(See Basic Physics Laboratory)

- a. Dielectric absorption measurements
- b. Energy conversion
- c. Gaseous discharge phenomena
- d. High power arcs and plasma physics
- e. Microwave spectroscopy
- f. Photoelectricity, luminescence
- g. Physics of static charges
- h. Thermal emission; hot cathode materials

39.

Engine Evaluation

- a. Automotive and aviation engines components and accessories
- b. Performance of automotive, industrial, and marine engines
- c. Performance of gas turbines
- d. Test development

40.

Engine Research

- a. Basic research, design and development
- b. Combustion chambers
- c. Development of evaluation techniques
- d. Engine component research and design
- e. Engine performance analysis
- f. Muffler and manifolds
- g. Multifuel engines
- h. Piston and piston rings

Redesign of existing engines (including gas turbine) for different fuels

Specialized ignition systems

Valve, valve gear, and cam design and development

41. Environmental Research

a. Characteristics and effects of world environments

b. Dust and small particle research, mechanically generated dust clouds

c. Equipment performance (including gas turbine engines) under extreme temperatures

d. Laboratory evaluation and development of products to operate under high and low temperatures, humidity, explosive vapor, salt spray, rain, sand and dust, and high altitude environments

e. Military equipment specifications and requirements

42. Environmental Studies

a. Dwelling environment

b. Ordnance engineering research

43. Fire Technology

a. Analysis of combustion gases

b. Combustion inhibitors

c. Evaluation of flame spread characteristics

d. Fire detection, suppression and extinguishment

e. Magnesium fires

f. Specialized fire protection problems

g. Studies of fire hazards and methods of control

h. Toxicity of combustion gases

44. Fluid Dynamics

- a. Analytical and experimental studies
- b. Dimensional analysis and model studies
- c. Dynamics of compressible and incompressible flow
- d. Experimental determination of flutter characteristics, aerodynamic influence coefficients, aeroelastic characteristics
- e. Fluid amplifiers
- f. Fluid instrumentation and measurement
- g. Liquid motions in fuel tanks
- h. Pulsating flow mechanisms, measurement and suppression
- i. Turbulence and noise generating mechanisms and suppressions

45. Friction and Wear Research

- a. Cryogenic lubrication, friction and wear research
- b. Dry-film lubrication
- c. Dust erosion of gas turbine components
- d. Friction and wear
- e. Gear lubrication
- f. High temperature lubrication, friction and wear research
- g. Hydrodynamic and hydrostatic lubrication
- h. Lubrication, friction and wear at high speeds
- i. Rolling-element bearing lubrication
- j. Seals
- k. Sliding-element bearing lubrication
- l. Vacuum lubrication, friction and wear research

46.

Fuels

(See #6 : Lubricants)

- a. Crude oil evaluation
- b. Electrostatic effects in fuel flow
- c. High density fuels
- d. Mechanism of crankcase deposit dispersion
- e. Separation methods for petroleum
- f. Storage stability of fuels
- g. Thermal stability of jet fuels

47.

Fuels Evaluation

- a. Aviation fuels
- b. Diesel fuels
- c. Motor fuels

48.

Fuels Research

- a. Aircraft engine fuels
- b. Automotive engine fuels
- c. Carburetor detergency
- d. Carburetor icing
- e. Corrosion and compatibility
- f. Development of evaluation techniques
- g. Electrostatic effects of fuel flow
- h. Filtration and water separation
- i. Fuel additives
- j. High-energy fuels
- k. High thermal stability fuels

1. engine fuels

2. Low temperature flow and pumpability

3. Performance characteristics

4. Physical properties

5. Storage stability

49. Gear Research
(See #10 - Bearing Research)

50. Geologic, Geographic (terrain) and Environmental Studies of Areas

51. Geophysics

- a. Aerial reconnaissance and prospecting methods
- b. Arctic geophysical instrumentation
- c. Detection of shallow buried objects
- d. Gravity instrumentation and gravitation research
- e. Lunar and planetary geophysical studies
- f. Magnetic, thermal and acoustic studies of soils
- g. Metallic and nonmetallic mineral prospecting methods
- h. Oceanographic instrumentation and research
- i. Petroleum prospecting methods
- j. Polar-region geophysical studies
- k. Seismic and electrical measurements of ice thickness
- l. Three-dimensional electrical and electrostatic systems

52. Heat Transfer Research

- a. Heat conduction
- b. Heat engines, compressors and blowers
- c. Heat transfer and mass transfer
- d. Liquid metals research, with special emphasis on thermodynamic, heat transfer and compatibility properties
- e. Theoretical heat transfer analysis
- f. Theoretical thermodynamic analysis of unconventional engine cycle and propulsion systems
- g. Thermal shock
- h. Thermodynamic properties

53. High Temperature Chemistry (to 10,000 °F)

- a. Fast quenching of high temperature mixtures
- b. Production of low entropy compounds from high entropy mixtures
- c. Thermodynamic computations

54. High Temperature Physics

- a. Ablation phenomena at high heating rates
- b. • Design of high thermal flux testing equipment
- c. High temperature reaction mechanisms and kinetics
- d. Materials evaluation at high heating rates (up to approximately $600 \text{ cal/cm}^2/\text{Sec}$ ($2300 \text{ BTU/ft}^2/\text{Sec}$))
- e. Measurement of thermophysical properties of materials at high heating rates and temperatures
- f. Physical and chemical behavior of very hot surfaces
- g. Sublimed refractory films
- h. Thermal diffusivities at very high thermal gradients

- i. Thermal flux generation and measurements
- j. Thermally-induced stress waves

55. Hydraulic Fluids Research

- a. Development of evaluation techniques
- b. Liquid metals and nonmetals
- c. Lubrication characteristics
- d. Organic fluids
- e. Physical properties

56. Information Theory

- a. Communication techniques
- b. Correlation techniques
- c. Data handling techniques
- d. Filter design

57. Infrared

- a. Analysis of radiation from missile and rocket power units
- b. Image converters
- c. Scanners
- d. Systems

58. Instrumentation,

(See #5 - Analytical Chemistry & Instrumentation Analysis)

- a. Acoustical transducer development
- b. Audio sonics instrumentation
- c. Arctic geophysical instrumentation
- d. Electrical and electronic medical instrumentation

- e. Electromagnetic wave measurements instrumentation
- f. Geological instrumentation
- g. Radio frequency resonance absorption spectroscopy
(MMA, EPR, NQR, and NMR) specialized equipment
- h. Seismic transducer development

59. Interference Reduction

Analysis and elimination of electromagnetic radiation from electrical and electronic equipment

60. Lasers

- a. Continuous and pulsed lasers
- b. Use of arc imaging furnace for continuous existation of ruby lasers

61. Liquid Metals Research

- a. Compatibility characteristics of liquid metals
- b. Lubrication with liquid metals
- c. Thermophysical properties of liquid metals

62. Literature Surveys

- a. Critical appraisal of literature source materials
- b. Literature reference studies to develop background information
as to the existence and extent of previous work in the
fields of engines, fuels, lubricants and materials

63. Lubricants
(See #46 - Fuels)

- a. Corrosion characteristics of synthetic lubricants
- b. Crude oil evaluation
- c. Development of thixotropic fluids and lubricants
- d. High temperature lubricants

- e. High temperature stability of synthetic lubricants
- f. Low temperature flow characteristics of synthetic lubricants
- g. Lubricating oil additives
- h. Mechanism of crankcase deposit dispersion
- i. Separation methods for petroleum

64. Lubricant Evaluations
(See #45 - Friction and Wear) (See #47 - Fuels Evaluation)

- a. Aircraft
- b. Diesel engine lubricants
- c. Gasoline engine lubricants
- d. Industrial lubricants
- e. Marine engine lubricants

65. Lubricant Research

- a. Aircraft engine lubricants
- b. Automotive lubricants
- c. Corrosion and compatibility
- d. Development of evaluation techniques
- e. Greases
- f. High thermal stability lubricants
- g. Impact sensitivity of lubricants in contact with missile fuels and oxidizers
- h. Jet engine lubricants
- i. Low-temperature flow and pumpability
- j. Lubricant additives

- k. Lubrication characteristics
- l. Missile engine lubricants
- m. Organic and inorganic liquid lubricants
- n. Physical properties
- o. Radiation resistant lubricants
- p. Solid lubricants

66. Magnetics

- a. Generation of extremely uniform fields
- b. Instrumentation

67. Marketing and Market Research

- a. Analyzing and forecasting factors affecting industrial product distribution and market penetration
- b. Analyzing and forecasting market position of individual companies in relation to competition
- c. Analyzing and forecasting market and profit potentials
- d. Analyzing and forecasting supply and demand for industrial products, technical processes, engineering materials and technical services
- e. Analyzing and forecasting trends in product acceptance
- f. Determining and forecasting effect on product acceptance of engineering and technical design features
- g. Determining and forecasting trends in industrial product pricing
- h. Determining product uses and product needs
- i. Identifying companies, industries and persons who control or influence industrial product purchase and use

- j. Identifying technological factors influencing the purchase and use of industrial products, technical processes, engineering materials and technical services
 - k. Organizing company sales and distribution functions for maximum market penetration
68. Masers
(See #60 - Lasers)
69. Materials Development Experience
- a. Forming
 - b. Melting in various types of furnaces
 - c. Metal fabrication techniques
 - d. Rolling
70. Materials Engineering
- a. Alloying behavior of refractory metals
 - b. Crystallography of precipitation
 - c. Lattice defects, imperfections in crystals
 - d. Light metals and special purpose alloys
 - e. Metal fiber reinforced materials
 - f. Phase equilibria and transformations
 - g. Plastic deformation, fatigue, fracture, brittleness, textures
 - h. Transport phenomena, diffusion, sintering, heat treatment
 - i. Special metal joining problems
71. Mechanics and Mechanical Development
- a. Abrasive machining
 - b. Automatic apparatus

- c. Correlation of vibrational characteristics to dynamic stress
- d. Design and development of special equipment and techniques
- e. Drilling equipment and techniques
- f. Dynamic pressure and fluid flow - measurement, control, damping
- g. Mathematical analysis of vibration, application of impedance concepts and model studies
- h. Mechanical instrumentation development
- i. Shock and acceleration - transducer development, special purpose recorders.
- j. Test apparatus
- k. Vibration measurement and suppression

72. Metallography

- a. Evaluation of service failures
- b. Phase identification and distribution
- c. Structure examination

73. Mexico
(See #15 - Business and Industrial Development in Mexico)

74. Mineralographic (Microscopic Studies)

- a. Determination of proportions of various minerals present in granular material
- b. Identification of metallic minerals and texture of metallic ores

75. Naval Dynamics

- a. Hydroelasticity and slamming
- b. Hydrofoils
- c. Ship motions and stability

76.

Navigational Electronics

(See #3 - Aeronautical and Navigational Electronics)

77.

Nondestructive Testing and Inspection

- a. Automatic electronic systems
- b. Defect recognition and discrimination systems
- c. Magnetic, eddy current, and ultrasonic testing techniques for testing metals and nonmetallic materials
- d. Magnetoabsorption techniques for testing ferromagnetic materials
- e. Mechanical
- f. Radiofrequency resonance absorption spectroscopy specialized equipment and technique development for testing metals and nonmetallic materials
- g. Radiography (X-ray) (See Gamma Radiation Laboratory)
- h. Thermal techniques for testing metals and nonmetallic materials
- i. Ultrasonics

78.

Nonmetallic Mineral Processing and Plant Design

79.

Nuclear Physics

- a. Neutron and positive ion activation analysis
- b. Special purpose detectors with associated telemetering
- c. Use of tracers in process controls

80.

Optics

- a. Electron microscopy
- b. Emission and absorption spectroscopy
- c. High-intensity light generation and applications
- d. Optical absorption and emissivity measurements

- e. Optical density or brightness measurements with high speed scanning and display
- f. Optical masers
- g. Schlieren systems
- h. Special purpose optical system design with associated electronic and/or electromechanical controls, displays, etc.

81. Organic Chemistry Experience and Abilities

- a. Catalysis - metallics, nonmetallics, compounds, catalyst systems
- b. Cellulose chemistry
- c. Coatings technology
- d. Condensed aromatic ring high density fuels
- e. Development of antioxidants and antidegradants
- f. Elastomer evaluation
- g. Finishing materials, preservatives
- h. Food chemistry
- i. Insecticides
- j. Organometallics
- k. Petrochemicals
- l. Plant chemistry and plant biochemistry
- m. Polymers, applications, synthesis, modification
- n. Synthesis of new compounds by hydrogenation, chlorination, and other reactions of various functional groups

82. Petrographi (Microscopic) Studies

- a. Cement and other manufactured inorganic materials
- b. Chemical microscopy • chemical determination of microscopic quantities of inorganic matter from any source •

- c. Minerals and rocks - identification of complex mixtures of minerals
- d. Soils or dust for mineral content, physical and chemical characteristics and abrasiveness

83. Physical and Inorganic Chemistry

- a. Bench-scale process studies
- b. Catalyst evaluation
- c. Chemistry and processing of sulfur
- d. Colloid chemistry of drilling mud additives, clays and gels
- e. High pressure adsorption
- f. High pressure compressibilities of gases and liquids
- g. Hydraulic fluids
- h. Kinetics of chemical reactions
- i. Measurements of physical properties of solutions
- j. Phase rule studies and applications
- k. Solubility equilibria at high pressure
- l. Studies of non-Newtonian fluid systems
- m. Survey of chlorates and perchlorates
- n. Thermal decomposition of liquids

84. Physical Measurements

- a. Measurement of high-intensity thermal radiation
- b. Physical parameters in solids by ultrasonic methods
- c. Shock and vibration recording and analysis
- d. Very low frequency acoustic measurements
- e. Vibrating-wire transducers for measurement of pressure, temperature, acoustic signals, and vibration

- f. Volume, density, and viscosity measurement by acoustic means

85. Physics

(See #19 - Chemical Physics)

(See #32 - Electron Physics - Basic Physics)

(See Basic Physics Laboratory)

86. Pollution

- a. Automobile exhaust
- b. Biological effects
- c. Cities
- d. Development of analytical techniques
- e. Effects of vegetation
- f. Industrial problems
- g. Particulate analysis
- h. Rivers and harbors
- i. Superactivated sludge process
- j. Toxicological and corrosion studies

87. Power

- a. Basic sources
- b. ● Conversion
- c. Distribution ●
- d. Suppression of radiation from power systems
- e. Transmission

88. Pressure Vessel Research

- a. Cyclic pressure tests
- b. Noncylindrical shells of revolution

- c. Submarine hull design
- d. Thermal stress distribution in pressure vessels
- e. Underwater exploration equipment

89. Process Development and Pilot Plant Studies

- a. Biological processing
- b. Burner efficiency
- c. Dust control
- d. Encapsulation processes
- e. Floor tile formulation and evaluation
- f. High energy materials
- g. Hydrocarbon separations
- h. Liquid petroleum gas problems
- i. Natural gas processing
- j. Particle entrainment and separation
- k. Particle size determination
- l. Permeation processes and industrial applications
- m. Plant diversification
- n. Plant waste disposal
- o. Process evaluations and control
- p. Saline water conversion
- q. Sulfur recovery processes
- r. Water evaporation control

90. Propellants and High Energy Materials

a. Analyses of propellants such as:

- (1) Analysis of propellants by nuclear spin resonance and other techniques
- (2) Catapult (seat ejection) studies
- (3) Corrosion studies
- (4) Kinetics of curing reactions
- (5) Leak detection in rocket and fuel systems
- (6) Quality control
- (7) Surveys and theoretical analyses
- (8) Theoretical studies
- (9) Toxicity studies

b. Boron, boron-beryllium and lithium based fuel experience

- (1) Evaluation
- (2) Pilot Plant
- (3) Synthesis

c. Microencapsulation of propellant components

91. Protective Equipment

a. Alarm systems

b. Detection systems

c. Special control systems

92. Quantum Electronics and Mechanics

a. Masers (Microwave and optical)

- (1) Low noise amplifiers
- (2) High stability oscillators
- (3) Coherent light sources

b. Nuclear and electron spin resonance

c. Nuclear quadrupole resonance

d. Resonant emission and absorption of radiation

e. Semiconductor mechanisms

f. Tunneling effect

93. Radiation Effects Research
(See #34 - Electromagnetic Wave Propagation)

- a. Effects of gamma radiation on fuels and lubricants under dynamic operating conditions
- b. Effects of gamma radiation on static samples, animate and inanimate
- c. Radioactive tracer applications to wear studies on fuel and lubricant additives; piston ring, cam follower and gear wear; oil filters and filter media

94. Refrigeration

- a. Advance absorption refrigeration cycle development
- b. Basic studies on relation of molecular structure to properties of absorbents and refrigerants
- c. Development of equipment

95. Reliability and Quality Control

- a. Optimum design
- b. Reliability systems analysis
- c. Special testing

96. Road and Field Evaluation

- a. Climatic effects as produced by variations in humidity, temperature, altitude, and solar radiation
- b. Driving condition effects
- c. High speed cornering evaluations of vehicles and tires
- d. Research and evaluation of fuels, lubricants, greases, tires, and other components, and automotive vehicles.

97. Sanitary Engineering
(See #86 - Pollution)

Waste treatment and disposal system

98. Soil Mechanics

- a. Design of foundations for unstable soil
- b. Investigations of strength of rock under triaxial load
- c. Studies of stabilization and trafficability
- d. Theoretical studies of soil behavior under static and dynamic loads

99. Sonics

- a. Analysis
- b. Instrumentation
- c. Systems development
- d. Ultrasonic imaging
- e. Ultrasonic propagation

100. Space Electronics

- a. Communications and telemetry
- b. Instrumentation

101. Strength of Materials and Structures

- a. Cyclic pressure tests for pressure vessels, nozzle connections and reinforcement
- b. Creep, stress - rupture, and fatigue properties
- c. Experimental stress analysis for design evaluation, defects, failure
- d. Failure theories
- e. Fatigue test and analysis
- f. Investigation of strength of solid propellant grains
- g. Photostress and photoelastic analysis

- h. Research into properties of materials under dynamic loading
- i. Thermal stress characteristics

102. Structural Research

- a. Airport runway designs
- b. Analysis of blast resistant structures
- c. Analysis of stiffened thin shells
- d. Design of offshore drilling facilities
- e. Design of reinforced plastic structures
- f. Evaluation of blast loading on aircraft, ships, and structures
- g. Feasibility studies for structures of deep diving submarines
- h. Improved concrete floor slabs for unstable soil
- i. Optimization of flat slab design criteria
- j. Prestressed concrete and structural components
- k. Structural design of ships
- l. Studies of buckling strength of structures

103. Submarine Design

- a. Design and development of cargo submarines
- b. Oceanographic research vehicles for operation at great depths
- c. Sandwich construction

104. Surveys (Technical and Economic) of Mineral Deposits -
Metallic, Nonmetallic and Solid Fuels

- a. • All phases of mineral development, from exploration through processing and marketing
- b. Mineral audits and surveys by county, state or country

105. Systems Analysis

- a. Feasibility
- b. Optimum design
- c. Over-all performance
- d. Specifications

106. Thermal Dynamics Analysis

- a. Determination of modeling techniques to study temperature and thermal stress distribution in engine parts, pressure vessels and structures
- b. Heat transfer studies
- c. Theoretical and experimental studies of thermally induced stress wave propagation

107. Thermodynamics

(See #52 - Heat Transfer Research)
(See #53 - High Temperature Chemistry)

108. Training Devices

- a. Instrumentation
- b. Simulators

109. Transducers

- a. Development of special acoustical transducers for liquid, solid and gas media
- b. Electroacoustic
- c. Electromagnetic

110. Ultrasonics

- a. Imaging
- b. Instrumentation
- c. Propagation

111. Vehicle Dynamics

Vehicle dynamic studies including steering, mobility, and tracking

112. Vibration and Dynamics

- a. Shock and impact effects upon structures and materials
- b. Theoretical and experimental analyses of stress wave propagation
- c. Vibration analyses of all types of structures
- d. Weapons effects on buildings

113. Welding

- a. Development of semi-automatic and automatic techniques
- b. Evaluation of effects of welding on materials
- c. Flux and electrode coating analysis and development

SPECIALIZED FACILITIES

Southwest Research Institute has approximately 168,000 square feet of floor space dedicated to research, development, and engineering.

While it is impractical to describe all of the Institute's facilities in detail, certain of them, such as those listed hereafter, are somewhat unique and not normally available in research organizations.

BALLISTICS LABORATORY

This is an experimental laboratory equipped for research and development on propellants and propellant containing devices such as rockets, gas generators and catapults. It contains a special loading room for handling explosives and propellants and a static firing stand with high response electronic measuring and recording equipment. Special underground storage facilities are nearby.

BASIC PHYSICS LABORATORY

Basic Physics uses the instrumentation of Chemical Physics and the Solid State laboratories for the study of molecular spectroscopy. Apparatus of various types is available for the study of solid chemical dosimeters, thin films study, battery research, optics, and organic semiconductors, as well as the conventional types. A Bausch and Lomb Dual Grating Spectrograph and accessories are part of the equipment available.

CHEMICAL PHYSICS LABORATORY

This laboratory is equipped to do work on photoconductivity of biological and chemical systems, as well as free radical and unpaired electron investigations. Included are studies on cancer, chemical kinetics, electron transport, molecular structure, research on characterization of rocket propellants, as well as functional automation problems dealing with chemical processes such as rocket propellants and moisture in starch.

This is one of the best trained and equipped Spin Resonance laboratories in the country. It includes broad line nuclear magnetic resonance, high resolution magnetic resonance, electron paramagnetic resonance equipment of various types, both purchased and constructed therein.

An RCA electron microscope is available for studies of solid state phenomena, X-ray and electron diffraction equipment for the study of crystalline materials. Solar and arc-imagino furnaces capable of over $600/\text{cal}/\text{cm}^2$ ($2300 \text{ BTU}/\text{Sg}^2/\text{sec}$) per second are available for the study of absolute surface temperatures of materials and investigation of ablation phenomena on re-entry problems, as well as the investigation of phase changes of materials at elevated temperatures.

CREEP TEST FACILITY

A special facility has been constructed in which the effect of creep on the collapse strength of shells subjected to external pressure up to 200 psi and temperature up to 500°F can be determined.

DIRECTION FINDING LABORATORY

This unique laboratory is fully equipped and staffed to evaluate the performance of direction finding equipment, new direction finding methods, and has specialized in problems arising in the field of high frequency, and very high frequency, noncooperative direction finding. Of particular interest has been work utilizing unorthodox multiloop antenna arrangements to reduce error under adverse siting conditions. Experienced investigations are available for wide aperture arrays and Beverage arrays.

Equipment is available which can simulate reradiated and interfering field configurations, such as exist on shipboard, for the purpose of predicting antenna performance prior to shipboard installation. The laboratory also has available new bearing error calibration equipment which may be used with a variety of direction finding equipment. The laboratory includes a rigidly controlled 160-acre site for performance and experimentation tests.

DUST ANALYSIS LABORATORY

This laboratory is instrumented to conduct research into the physical characteristics of any type of powdered material. It includes a Sharples Micromerograph and Roller Particle Size Analyzer, isokinetic dust sampler, petrographic analytical equipment, and submicron particle evaluation apparatus. A dust tunnel is equipped for the measurement of abrasive, erosive, or penetrative effects of powder and is able to integrate wind velocity, temperature, and humidity into any evaluations made.

ENVIRONMENTAL RESEARCH LABORATORY

Small test chambers are available for conducting high temperature, low temperature, humidity, salt spray, altitude, explosion, and dust tests. The laboratory has been qualified by the Air Force to conduct certain environmental tests. Its personnel are quite familiar with effects of the various environmental factors and are able to assist in the development of material required to withstand environmental extremes.

FIRE RESEARCH LABORATORY

This laboratory is equipped to conduct experimental and applied research directed toward the definition of fire hazards, the development of fire test methods, and product development for improved performance under fire exposure.

Large scale facilities are available for evaluating flame spread and fire resistance of building constructions. These include a 25' flame spread tunnel furnace, a 30' beam furnace and a 20' x 60' structure for evaluating floor, roof, and roof framing systems.

FLUID FLOW LABORATORY

Special design service can be provided for pneumatic, hydraulic systems including piping, compression equipment, pumps, and motors.

Special purpose analogues and compressible flow facility are available for this type of analysis and design work.

GAMMA RADIATION LABORATORY

This laboratory and its radiation source is unique in that it can supply gamma fluxes of the order of 10^7 Roentgens per hour. The facility is designed to be widely adaptable to the irradiation of materials, dynamic test machinery, and biological specimens.

The source can be quickly stored and its 32 radiation tapes easily handled with manipulators. All of the activities are at ground level - visible and not requiring water shielding - which permits a flexibility found only in this radiation effects laboratory.

HIGH-TEMPERATURE FUELS RESEARCH LABORATORY

This laboratory has unique facilities to conduct research on the stability of liquid fuels at high temperatures. Both "non-flow" and "flow" type test apparatus, capable of subjecting liquid fuels to temperatures exceeding 1000°F are available for various research applications.

HIGH TEMPERATURE LUBRICATION RESEARCH LABORATORY

This laboratory is equipped to conduct research on the lubrication of gears, bearings and other sliding devices, at high speeds, loads and temperatures. Available are a gear research machine capable of operating at speeds up to 30,000 rpm (460ft/sec pitch-line velocity), temperatures up to 800°F , and tooth loads up to 6000 lb/in.; a "dry" journal bearing test machine capable of operating at temperatures up to 2000°F and at vacuums up to 10^{-6} mmHg; and a research apparatus for basic studies of lubrication and friction phenomena under cryogenic conditions. The laboratory has also developed numerous test devices to study the thermal and oxidative stability of liquid lubricants at high temperatures.

HIGH-TEMPERATURE PHYSICS LABORATORY

This facility is designed to provide a pure thermal flux input to materials at rates of $600 \text{ cal/cm}^2/\text{sec}$ ($2300 \text{ BTU-ft}^2/\text{sec}$). Instrumentation is provided for accurate control of heating rate and duration of exposure of samples, for measurements of temperature-time history in samples, for high speed photography at samples under test, and for obtaining emission and absorption spectra from samples and ablation products. Black body calorimetry is used for calibration. Provisions are included for control of pressure and chemical composition of the atmosphere surrounding the irradiated sample.

The facility is especially applicable to the determination of the thermo-physical properties of materials, studies of thermal ablation phenomena and evaluation of materials for high-temperature application.

The 500 kw continuous rating rectifier which supplies power to the electric arc which serves as the source of thermal flux is adaptable to a variety of problems - including the development of high-temperature chemical processes and plasma physics.

MICRO-VIBRATION ANALYSIS FACILITY

This facility is designed to provide generation, measurement, and analysis of extremely small amplitude vibrations in the sonic and subsonic range. Instruments are available for the measurement of vibration amplitude in the order of 10^{-9} cm .

MINERAL EVALUATION FACILITY

This unit is outstanding for its personnel and facilities for dealing with evaluation and treatment of hard minerals. A specialty is work in the field of ceramic raw materials for the glass, structural clay products, refractories, whitewares, construction materials, and related industries.

NONDESTRUCTIVE MEASUREMENTS FACILITIES

These special skills and facilities are well-known for the use of electronic, spin resonance, magnetic, eddy current, and ultrasonic techniques in the development of nondestructive methods of measurement, analysis, and process controls.

ORDNANCE CORPS FUELS AND LUBRICANTS RESEARCH LABORATORY

A fuels and lubricants laboratory is operated by an Institute Staff exclusively for the Office of the Chief of Ordnance. Facilities for chemical, bench and engine laboratory research are applied to the development of fuel and lubricant qualification techniques; investigation of new product performance and fundamental studies of fuel, lubricant and additive performance phenomena.

PILOT PLANT ROTARY KILN

This unit is 12' long by 14" I. D. with provisions for variable rotational speed, slope, and low or moderate temperature (2200°F maximum) conditions.

PRESSURE VESSEL RESEARCH LABORATORY

Two test facilities are available, one capable of exerting 10,000 psi and the other 4,000 psi, external pressure on a submarine model or model of an oceanographic research vehicle. A cycling device is also available which can supply as many as 5 pressure cycles per minute.

These facilities were used in the design of the well-known 15,000 foot deep-diving submarine, Aluminaut.

SHOCK TUBE FACILITY

A shock tube facility has been developed for the study of rapid gas-phase chemical reactions such as partial oxidation and combustion reactions. This "shock-quench reactor" subjects a gaseous mixture to a pressure-temperature pulse of known intensity and brief duration. Heating is achieved by the passage of a shock wave through the gas, and subsequent cooling is accomplished by passage of the shock gas through a stationary expansion wave. The nature and extent of the induced reactions are detected by appropriate observations during the reaction interval or by subsequent examination of the reaction products, such as by means of gas chromatography. Reaction times in the range of one to three thousandths of a second can be employed with reaction temperatures and pressures up to 3000°F and 150 psig, respectively.