EG&G

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UNSOLICITED PROPOSAL

FOR RESEARCH IN MONITORING LIVING PLANTS

APPROVED BY

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1972 25 YEARS Leadership in Science & Technology

ALBUQUERQUE DIVISION
GOVERNMENT & COMMERCIAL SYSTEMS GROUP
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CHAPTER 1
INTRODUCTION

1.1 GENERAL BACKGROUND

In 1966, a polygraph expert, Mr. Cleve Backster, tested a plant with a polygraph to see if he could get an indication of water rate absorption by the plant. Instead, he got a reaction on the strip chart record similar to the readout obtained from a human under stress. Highly intrigued, Mr. Backster soon discovered that the plant responded to his thoughts. The thought of harming the plant was sufficient to trigger a violent reaction that was clearly registered by the polygraph. Mr. Backster's continuing studies have indicated that further research in this area may open up some interesting and beneficial applications. Much of this early research has been directed toward finding out more about the nature of the communication response from plants. Mr. Frank Wilcoxson of EG&G has performed initial research in this area to the extent that he and EG&G researchers believe that some very beneficial practical applications of the principles already discovered are possible even before the nature of the communication phenomena are fully defined. Therefore, based on their initial research, EG&G is submitting this proposal to explore some of the more promising practical applications. The areas proposed for research are listed here for summary purposes and discussed in more detail later.

(1) Crop control system
(2) Natural disaster early warning system
(3) Communication system - plant to man
(4) Intruder alarm system
(5) Psychology tool and mental illness indicator.

Investigation of these areas appears feasible at this time based on research performed by Mr. Frank Wilcoxson of EG&G and as reported in the literature. A bibliography of this literature is provided at the end of this chapter. A brief discussion of prior research is included here as it pertains to each proposed area of investigation.

1.2 SUMMARY OF PROPOSED AREAS OF INVESTIGATION

1.2.1 Crop Control System

An article in the Soviet Newspaper Pravda dated 12 October 1966 describes the basic elements of a "crop control" system. The crop control investigation proposed here is similar to the one described and referred to as "things to come" in the article.

The technique involved is to select various crop plants such as corn, tomatoes, wheat, etc., and remove a number of the plants to a controlled environment. The plants will be grown under nearly identical conditions until they reach a monitorable size. The plants in the controlled environment can then be electronically monitored under varied conditions of nutrients, environment, etc., to determine the ideal conditions based on plant response. The data derived can then be used to improve soil or other conditions for the entire crop. Similar setups could be arranged for insect and disease treatment and control. The data derived could be fed into a computer memory bank — enabling the computer to derive the value of various nutrients and conditions. Since plants have been shown to be responsive to human presence, the data would have to be taken by remote monitoring and simple automatic triggering systems.

There is also the prospect that enough data on crop control could be accumulated during the first six months of a study to verify a crop control hypothesis, and the remaining six months of a one-year study could be devoted to a natural disaster warning concept research. This concept will be discussed next.

1.2.2 Early Warning of Natural Disasters (Earthquakes, Avalanches, etc)

The objective here is to find plants most receptive to that natural warning system that directs birds and animals to leave areas that will be affected by such disasters long before the event actually occurs. As indicated in the bibliography, this exodus from such areas has been observed many times. Once the plants that are most receptive to this warning system are found, the development of long-life monitoring equipment can be accomplished, as well as the design of systems used to tie the plant response data into a regional or national alert system.

1.2.3 Communication System - Plant to Man

Initial testing of the crop control system and natural disaster warning system requires the elimination of close proximity contact between man and plant. The investigation of this communication system will require the monitoring of plant and man simultaneously and the exclusion (as far as is possible) of all disturbances.

This concept of a man-to-plant tie of some sort must be investigated thoroughly, and the investigator will be challenged to find answers as to how to conduct this investigation in the best way.

1.2.4 Intruder Alarm System

Mr. Wilcoxson of EG&G has found that some plants will respond to the presence of strangers or intruders at distances up to 30 feet. This application seems highly feasible at this time. Here again, however, the optimum plant for the system must be found and checked for longevity of response life, etc. This plant must then be tied to a long-life electronic system capable of triggering an alarm of some type.

1.2.5 Psychology Tool and Mental Illness Monitor

As reported in the literature by Mr. Backster and verified by Mr. Wilcoxson of EG&G, plant response to human emotions is fairly well established. This principle could possibly be tied to the field of psychology and may be helpful in work related to the mentally ill and possibly with mentally disturbed children.

This particular area would require a great deal of research with both plants and patients and, at this time, would appear to be an area to be investigated slowly and thoroughly. If the plant served no other purpose other than to identify a person who is mentally ill, at a very early stage in that illness, then the research effort would be well spent.

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4. Lawrence, L. G.; "Electronics and the Living Plant," Electronics World, October 1969.

5. Shuvaton, L., trans.; "The Powerful Lilliputian," Pravda, No. 285, 12 October 1966; pg. 3; Foreign Technology Division USAF AD678622 FTD-HT-23-1161-67.

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CHAPTER 2
TECHNICAL DISCUSSION

2.1 INTRODUCTION

One must keep in mind that the field of investigation addressed in this proposal is, in essence, a new scientific area that will initially require establishment of a basic standard measurement or data gathering system. This will include the development of measuring techniques dependent on the specific area of investigation.

Investigation may reveal that electrode to electrode measurements will perform well in the exploration of the communication field described. A method of recording changes in the light passing characteristics of leaves may be more useful in the crop control system, etc. Assuming that magnetic charges occur in plants, measurement of this parameter may prove to be of great value.

Before any one area can be fully explored, researchers must confirm that data is repeatable, that available instrumentation is adequate, and that measurements are not being influenced by external electrical noise. The most active or receptive plants must be found and their useful time limits established. Some plants show a tendency to stop responding to certain stimulation after repeated exposure to the same stimulant day after day.

Standards must be derived that can be used for direct comparison with plant data obtained in the lab.

The basics for this new area must be established. Once this has been accomplished, specific areas of practical value can be investigated.

2.2 INVESTIGATION STEPS

The steps for establishing the basic investigation procedures and standards are outlined below:

(1) Various electronic probe systems will be tested in order to verify their value in the response studies and determine their shortcomings. This will include electrodes, light sensors, magnetic sensors, etc.

(2) Electronic components will be tested for drift and susceptibility to noise. These components must be capable of operation over long time spans.

(3) Probes and electronic components will be assembled as a unit and re-tested for drift, noise, etc.

(4) Plants will be selected and tested for response to stimulation of various kinds.

(5) Preliminary tests will be run to determine repeatability of response to various stimulation.

(6) The best combination of plant, probe, and electronic components can then be used to start the data gathering procedures.

(7) In addition to plant output data, environmental conditions will be recorded. This data will include temperature, humidity, barometric pressure, plant diets, soil conditions (acid, neutral, or alkaline), etc.

(8) To ensure maximum protection from outside electrical interference, all testing should be conducted in a screen room located within the hothouse. Assurance of data validity:

  (a) All test equipment will be subjected to calibration runs immediately prior to and after all test runs.

  (b) All test equipment will be checked for noise pickup at least every two weeks.

  (c) All test equipment will be calibrated every 30 days to ensure that no erroneous readings are introduced into the data due to incorrect equipment handling and/or adjustments. All critical data gathering equipment adjustment points will be sealed after calibration.

CHAPTER 3

SUMMARY OF CURRENT KNOWLEDGE ON PLANT ELECTRONICS

Mr. Cleve Backster first became aware of the plant electronics phenomena on February 2, 1966. He was testing a plant with a polygraph machine to see if he could get an indication of rate of water absorption by the plant and got a reaction (on the strip chart record) similar to the graphical readout obtained for a human when under stress.

Mr. Backster was first to note plant reaction to human thought and emotion, first to tie plant response to the death of brine shrimp, etc., and is presently, as far as can be ascertained, investigating the possibility of a cell-to-cell communication system and the possibility that memory, etc., may exist at the cell level.

He has made many plant experiments, including using a plant to point out a student who destroyed another plant in the same room; the student was selected by the plant from five possible choices. Mr. Backster is also attempting to teach plants to recognize objects, and he has recorded the response of one egg when another was broken.

An article by Mr. L. G. Lawrence listed in the bibliography in Chapter 1 describes various systems for monitoring plant reactions via electronic and other means and describes some of the work done by Mr. Backster. He also verifies the plant memory theory and points out another way of training plants by the use of electric shock. An article appeared in the Soviet newspaper, Pravda, that describes the basic ingredients for a crop control system similar to that described in this proposal. The author of that article would have one believe that the article was a prediction of things to come. However, it is highly possible that the article describes an existing test facility.

Other sources of data are available, but extremely hard to get since investigators are reluctant to disclose data that is not yet complete.

Mr. Wilcoxson of EG&G has verified some of Mr. Backster's data and also looked at areas not covered in the known published data as follows:

(1) Questions have been presented to plants by simply thinking of these questions and recording the plant's reaction on a strip chart recorder. The object here was to try to establish a "yes" or "no" and/or "0 to 1" state by human mental stimulation of the test plant. No "yes" or "no" response could be established as the plant's reaction to this human mental stimulation resulted in a complex waveform. A different waveform was recorded for each different question presented to the plant. The test plants responded to 56 percent of the questions presented.

(2) While running a test on a cactus plant, an erratic full swing to the left was noted and subsequent investigation of the immediate test area revealed that a stranger had approached the test area and departed without letting his presence be known to the test area occupants. This test was repeated a week later and four such close passages of strangers to the test area were recorded. Two of the four indicated trespasses were verified and two could not be verified.

(3) An attempt to run tests on several previously responsive plants failed when testing was conducted during a severe wind storm. The test plants would not settle down to what had been previously observed to be a normal state on the records. After the storm, normal response was resumed.

(4) An eyewitness has been found that has described a test run on a tree in the vicinity of a snow slide in Colorado two or three years ago. The witness indicated that analysis of the data obtained showed a definite disturbance in the tree's response curve that started two hours before the snow slide occurred and returned to normal after the slide was over. The test tree was about 600 yards from the slide area.

(6) Tests run on wild bird eggs indicated a response to thoughts of breaking the egg. This curve was identical to that obtained on a plant under threat except that it was opposite in polarity.

(7) Mr. Wilcoxson has started testing tomato plants on a varied diet basis as described previously in this proposal.

CHAPTER 4

TIME AND COST ESTIMATES FOR PLANT ELECTRONICS

The materials cost and labor figures shown below are based on a concentrated one-year research effort.

Labor	$51,293.00
Consultants	$20,382.00
Botanist	
Psychologist	
Chemist	
Materials	$19,817.00
Hothouse and associated equipment	
Electronics equipment	
Plants, planting materials	
Misc. cables, connectors, etc.	
Total:	$91,492.00

It should be noted that the material cost would apply to the entire program as an initial expense. The labor figures could encompass a two-year, one-half time effort, etc.

Some data related to the natural disaster early warning system would probably be forthcoming during this initial effort due to the fact that the Albuquerque area, where testing would be conducted, is subject to earth tremors, severe electrical storms, and occasional severe wind storms.

There is also the prospect that enough data on crop control could be accumulated during the first six test months to verify the crop control system hypothesis, and that the remaining six months could be devoted to the disaster warning concept research.

Extensive testing of the disaster warning system would require field testing, more elaborate electronics equipment, and extensive travel time.

Investigators would also expect to derive some data related to the man-to-plant communication theories stated. This would be a natural side product of the test records. Complete investigation of this communication aspect would require a separate program utilizing much more refined electronics test equipment and more elaborate facilities.

CHAPTER 5
EG&G AND ALBUQUERQUE DIVISION BACKGROUND

5.1 CORPORATE HISTORY

In 1947, the MIT-based partnership of Edgerton, Germeshausen and Grier (EG&G) formed a company to continue classified research, development, and instrumentation work previously performed under their direction for the Manhattan Project. For the first few years, the company was primarily a contractor to government agencies, providing timing and firing control, diagnostic instrumentation systems, and field operational support. The company now is diversified into commercial electronics, oceanography, instrumentation operations, and other specialized technology, in many parts of the world. It specializes in the sophisticated instrumentation needed for today's technology, both in connection with other projects and separately. Environment monitoring systems have been set up with computer controlled functions and complete meteorological data gathering and processing systems have been fielded and are being operated by EG&G. Other weather modification programs, including cloud seeding and fog dispersal, have been performed.

Upon entering the commercial products market, EG&G first produced new versions of electronic flash tubes and flash equipments developed years earlier by the partnership. Next were standard ceramic-metal hydrogen thyratrons and rectifiers, and special-purpose instruments for ultra-high-speed measurements. An airborne instrumentation system was produced for the Air Force and this was followed by a great number of special projects ranging from electromagnetic pulse simulation to laser scanning systems.

Dr. Harold E. Edgerton's personal interest in underwater photography led to the development of cameras and light sources for ocean-bottom research and exploration. The long standing problem of positioning cameras and lights at a known distance above the bottom of the ocean was solved by developing a compact, accurate sonar pinger system. This was soon followed by the development of powerful acoustic transducers for ocean-bottom profile survey work. EG&G underwater equipment is extensively used in searches for sunken ships, submarines, etc. For example, EG&G equipment

located the submarine Thresher, and recently was used to locate a sunken freighter in the Gulf of Mexico.

The company's growth was steady during the late 1950's and early 1960's. The small, commercial products and oceanographic business, plus a technological backlog built up over the years, provided a sound base for accelerated growth and increased diversification.

Company resources were applied to the development of new products and an advanced technological capability in the fields in which it had an established position: high-energy pulse discharge components and systems, ultra-fast measurements, electronic flash components and systems, nuclear instrumentation, and oceanography. Company-funded research and development was a key element in the expansion (see Figure 5-1).

Today, EG&G is a multi-element company with broad technical capabilities and business interests. Research and development, instrumentation system design, engineering service work and manufacturing encompass the fields of physics, electronics, optics, nuclear science, and computer sciences. In the non-government business areas, EG&G companies are engaged in the fabrication of new products and large-scale field support services work. This background and technology base provides a good reservoir of skill and knowledge to support research in the new area of research and monitoring responses of living plants.

5.2 ALBUQUERQUE DIVISION ORGANIZATION

Just seven years ago, the entire EG&G operation at Albuquerque consisted of 15 employees housed in a modest office. Today, 400 EG&G personnel are employed in a spacious, modern facility occupying approximately six acres of the University of New Mexico Industrial Park.

This phenomenal growth rate is a direct result of the professional capabilities of the Division's personnel. Individually and collectively, they provide both specialized and interdisciplinary scientific knowledge which can then be applied toward the solution of almost any state-of-the-art problem.

Enhancing this capability is the broad scope of the Division's operations which covers an extremely wide range of scientific disciplines.

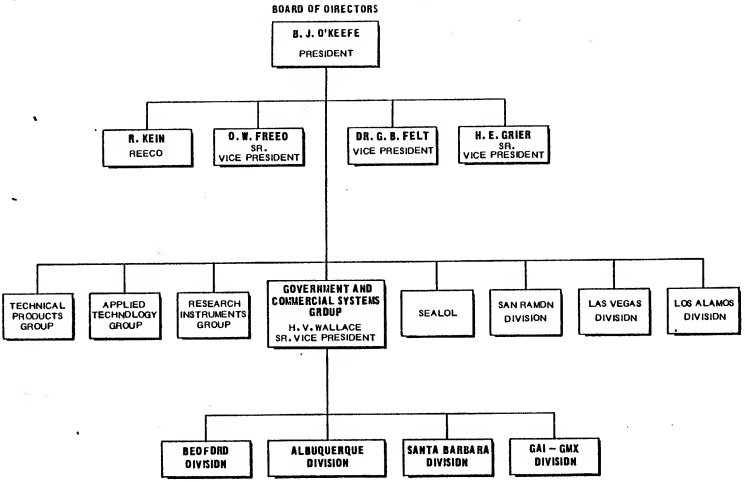


Figure 5-1. EG&G Corporate Organization

For example, EG&G Albuquerque has proven capabilities in systems engineering, program management, conceptual design, advanced design, planning, testing, evaluation, operation, and data analysis.

The Albuquerque Division is directed by Dr. James L. Dick, General Manager, who reports to H. V. Wallace, Senior Vice President of EG&G. A chart of the Albuquerque Division organization is shown in Figure 5-2.

The Albuquerque Division of EG&G is assigned to the Government and Commercial Systems group of EG&G. The entire group is made up of the Bedford, Albuquerque, and Santa Barbara Divisions as well as GAI/GMX. As indicated on the Albuquerque Division Organization Chart, the Division is organized into major directorates that are described in the following paragraphs.

5.3 ALBUQUERQUE DIVISION DIRECTORATES

5.3.1 Engineering Directorate

The Engineering Directorate encompasses the technology of electronic/electrical, mechanical, and electro-optical engineering, and theoretical and analytical physics. The directorate has a proven capability in analysis and the application of computer oriented techniques to scientific problems. Capabilities and experience have been demonstrated in the following general areas:

(1) Design and development of special-purpose electronic, digital and analog data acquisition, microwave data, and electro-optical (including photo, optical, laser, television) systems.

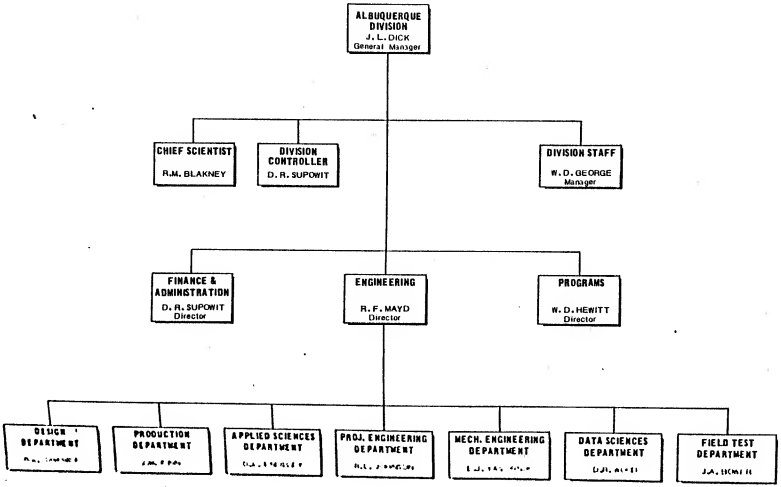
(2) Design, installation, and operation of EMP diagnostic instrumentation.

(3) Design of timing and firing/command and control systems.

(4) Design of mechanical systems requiring high precision fabrication.

(5) Development of special purpose packaging techniques.

(6) Systems engineering and integration.



Organization

Expertise has been developed in the following fields:

(1) Ground Motion Research: nuclear device and induced shock propagation, ground motion predictions, and structural response analysis.

(2) Analytical Instrumentation Modeling: research and development in the physical and mathematical modeling of specialized nuclear and non-nuclear instrumentation transducers.

(3) Data and Information Systems Software Design: high-volume data handling requirements specifications, information storage and retrieval, and scientific programming.

(4) Nuclear Test Studies: conceptual design analysis, experiment development, and data analyses.

(5) Nuclear Phenomenology: gamma, neutron, X-ray, EMP, thermal, blast, and shock effects.

(6) Electromagnetic Pulse Simulation and Analysis: Corona studies, and EMP interactions with electrical and electronic systems and dielectric/conductive envelopes.

This Directorate also provides a capability for the operation, maintenance, engineering modification, and fielding of complex electronic, mechanical, electro-optical, and photo-optical instrumentation systems. The technologies encompassed include the following systems: timing, RF, photographic, particulate sampling and dosimetry, servo, line of sight pipe diagnostics instrumentation, spectral measurement, and analog and digital data.

The Directorate maintains and operates a computer-oriented data reduction facility, which incorporates analog-to-digital conversion, data playback, and conversion of hard copy data and film utilized in position triangulation.

This Directorate provides a focal point for all electronic and mechanical technicians, who are supplied to the operating directorates on a programmatic basis. It provides the facilities and services of an R&D

Laboratory, a Fabrication Laboratory, a Metrology Laboratory, an Environmental Test Laboratory, a Model Shop, and a Drafting Section.

5.3.2 Programs Directorate

The Programs Directorate provides the Division with the capability for continuity for major programs by ensuring that the most applicable management techniques are being supplied and that the program managers are utilizing those personnel whose talents are best fitted to each program. This frees the other directors to administer and develop the resources under them and to develop oncoming programs. The Programs Director reports to the Division Manager as to the progress of each program and implements methods whereby the program's objectives might be more expeditiously accomplished.

5.3.3 Administration and Finance Directorate

This Directorate provides administrative and cost support to the scientific and technical functions of the other directorates. It also performs financial accounting, cost tracking and reporting, property management, data processing, and publications support for the Albuquerque Division.

APPENDIX A
RESUMES

EG&G

FRANK W. WILCOXSON

Senior Technologist
Albuquerque Division

EDUCATION

New Mexico State University, Mechanical Engineering, 1949 to 1951
ICS, Industrial Engineering, 1949 to 1951

EXPERIENCE SUMMARY

Mr. Wilcoxson is group leader and head of the EG&G Albuquerque Division Product Design Group responsible for product prototype packaging. This group places emphasis on design for mass production and consequent cost savings in manufacturing new products. Mr. Wilcoxson is also responsible for providing consulting support to engineers regarding electronic packaging, EM shielding systems, and EMP simulator designs.

For the past six months, Mr. Wilcoxson has been the senior experimenter on a program to study response of plants to such stimuli as human emotion, mental thought transmission to plants, and various plant responses to other living creatures such as birds and animals.

Previously, Mr. Wilcoxson was a senior technologist and group leader of electronic packaging group responsible for all packaging functions, design of EMP simulator structures, design of EM shielding systems, and all design of optical-mechanical laser systems. He was also responsible for bids, proposals, and detail designs of classified weapons systems. Systems designed and now operational include the ARES simulator shield system, SAFEGUARD simulator and its associated shield system, rotated EMP simulator built for AFWL at Kirtland AFB, and a shield system for the ALECS simulator at Kirtland Air Force Base. Earlier, Mr. Wilcoxson worked as a technologist responsible for all electronic packaging and shield room designs. Projects ranged from electronic packages built to withstand 100 g shock loads to miniature packages capable of withstanding 5000 g shock loads, light pipe trigger units for shield rooms and boxes, and various packaging of miniature and micro-miniature electronic packages. He has also worked as a technical supervisor at EG&G Albuquerque, responsible for electronic packaging and complete drafting department operation.

Before joining EG&G, Mr. Wilcoxson was a packaging engineer at the University of New Mexico Physics Department. He was responsible for the design, fabrication, and environmental testing of an optical-mechanical satellite package and an electronic satellite package for use in the OGO and OSO satellite series. Both units were orbited.

He also worked as chief draftsman for the Eberline Instrument Company where he was responsible for all packaging and machine design as well as supervision of drafting department operations.

EG&G

DR. ROBERT M. BLAKNEY
Chief Scientist
Albuquerque Division

EDUCATION

PhD. University of Rochester, 1955, Physics and Optics
BA. Williams College, 1943, Physics

EXPERIENCE SUMMARY

Dr. Blakney is the Chief Scientist and scientific adviser in optics and electro-optics for the Albuquerque Division. He has approximately 14 years of experience managing and working in electro-optics for industry, approximately 6 years in teaching at the Institute of Optics at the University of Rochester, and 3 years as Principal Investigator in research involving physical measurements of thermal radiation in association with the study of flash burns.

Prior to coming to the Albuquerque Division, Dr. Blakney was General Manager and Director of Research and Engineering for the Santa Monica Division of EG&G for 5 years, primarily engaged in application of lasers to classified military projects requiring prototype design, fabrication, and testing. He also worked with electro-optical systems, both imaging and non-imaging. Other work included experimental research on the effects of atmospheric turbulance on the propagation of optical signals. He has performed optical systems analyses for many of the projects just described.

Prior to his work at EG&G, Dr. Blakney did work with photographic emulsions and worked with solid-state aspects of Xerographic plates. He was granted patents for Xerographic processes and processes for treating selenium.

Dr. Blakney has numerous publications in the electro-optical field and in areas recovered by this resume. He is a member of the American Physical Society, the Optical Society of America, and Sigma Xi. He was President of the Rochester Section of the Society for Engineering Education.

EG&G

DR GLEN J. MORRIS
Sr. Scientific Specialist
Albuquerque Division

EDUCATION

University of Utah, PhD in Physics, Mathematics Minor, 1956
University of Utah, MS in Mathematics, Physics Minor, 1951
University of Utah, BS in Mathematics, Physics Minor, 1949. Graduated with honors.

EXPERIENCE SUMMARY

Dr. Morris specializes in plasma physics, electro-optics, and astrophysics. He has been working primarily with electro-optical system design and EMP studies. His work includes development of an electro-optic E-field sensor for EMP simulator applications. His most recent work is an airborne laser propagation experiment using scintillation to measure atmospheric turbulence at altitudes from 5 kft to 40 kft along horizontal paths between two NC-135 aircraft.

Previously, he was a senior basic research scientist with Plasma Physics Laboratory, Boeing Scientific Research Laboratories, where he conducted basic research in plasma physics, including laser production and heating of plasmas in and out of a magnetic field. He constructed a high power pulsed CO_2 laser and an Argon ion laser for diagnostics. He used other kinds of lasers routinely for various purposes and conducted other basic research in plasma physics, including studies of some astrophysical plasmas. He developed a photomultiplier radiometer for detection of radio-frequency intensity modulated light signals from plasmas, and a resonance probe apparatus and experimental technique for resonance probe measurements at microwave frequencies. He also developed a graphical digitizer for direct reading of existing x-y plots, digitizing the data for read-in to a computer and replotting after computer processing of one or more plots.

Earlier, as an assistant professor of physics at San Diego State College, he taught physics courses in eletromagnetic theory, optics, and advanced mechanics. He also has worked as a staff member at Los Alamos Scientific Laboratory in the Test Division, Group J-12. He participated in weapons testing at Eniwetok and Nevada Test Site and worked on development of a fast risetime photomultiplier between tests.

Dr. Morris also developed several types of electron guns, including hot cathode types and gas type guns. He developed a fast-beam switching gun for beam-plasma interaction studies, including plasma oscillation damping measurements and did experimental studies of positive ion focusing of electron beams including holding electron beams together over long ranges. He performed thin sheet analyses and water tank analyses of electron gun configurations to achieve optimum operation. These various guns were used routinely over a period of three years to exite oscillations in plasmas, etc.

Dr. Morris has an extensive number of publications relating to his experience (approximately 25.) He is a member of the American Physical Society, Sigma Xi, and Sigma Pi Sigma.