APPENDIX A

LISTING OF KEY PROGRAMS: PHILLIPS LABORATORY
PHILLIPS LABORATORY

The Air Force's Phillips Laboratory is headquartered at Kirtland Air Force Base, New Mexico. It is part of Air Force Materiel Command and reports to and supports the Space and Missile Systems Center at Los Angeles Air Force Base, California.

The Laboratory is the Air Force's focal point for all space- and missile-related research and technology, including geophysics, propulsion, space vehicles, survivability, and directed-energy weapons. The Laboratory has nearly 1,900 military and civilian employees at three locations: Kirtland Air Force Base, New Mexico; Hanscom Air Force Base, Massachusetts; and Edwards Air Force Base, California.

Phillips Laboratory, one of the Air Force's four super laboratories, is set up to allow exploitation of the technologies involved in developing spacecraft, ballistic missiles, and directed-energy weapons. The Laboratory places a great emphasis on integrating and transitioning its research technology into military systems, which are used by operational commands and maintained by Air Force Materiel Command.

With a budget of more than $600 million this year, the Phillips Laboratory conducts its research through seven main technical directorates: propulsion, geophysics, space and missiles technology, lasers and imaging, advanced weapons and survivability, and space experiments.

The Advanced Weapons and Survivability Directorate develops high-energy plasma and microwave technologies, electromagnetic pulse hardening, space systems survivability, and advanced techniques and computer simulations for weapon effects.

The Geophysics Directorate conducts research to further Air Force understanding of the environment between the Earth and Sun and its effects on systems and operations. This work is conducted by Laboratory people at Hanscom Air Force Base.

Core technologies for the Lasers and Imaging Directorate involve demonstrating the technical and engineering feasibility of lasers and imaging systems.
The Propulsion Directorate focuses on advanced concepts involving motors, propellants and test techniques. Most of this work is performed by Phillips Laboratory employees at Edwards Air Force Base.

Researchers in the Space and Missiles Technology Directorate focus their work on spacecraft structures, power and thermal management, sensors, and electronics.

The Directorate of Space Experiments plans, manages and conducts space experiments—in a ground, balloon-borne, aircraft or space mode. Also included are related ground acceptance and space/launch environmental testing.

The Airborne Laser Program Directorate is developing an aircraft-based technology that will be able to acquire, track, and kill theater ballistic missiles during their boost phase.

Established in December 1990, the Laboratory replaced the Air Force Space Technology Center, which consisted of a headquarters at Kirtland and three laboratories: the Weapons Laboratory, also at Kirtland; the Geophysics Laboratory at Hanscom; and the Astronautics Laboratory at Edwards.


### PHILLIPS LABORATORY WORKFORCE

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(Current as of Nov 94)
United States Air Force
AIR FORCE MATERIEL COMMAND
Office of Public Affairs, Phillips Laboratory
3550 Aberdeen Ave SE, Kirtland AFB, NM 87117-5776
(505) 846-1911

PHILLIPS LABORATORY
SIGNIFICANT PROJECTS LISTING

This is a listing of some key programs within Phillips Laboratory's seven technology
directorates: Advanced Weapons and Survivability, Geophysics, Lasers and Imaging,
Propulsion, Space and Missiles Technology, Space Experiments, and Airborne Laser
Program.

Advanced Weapons & Survivability Directorate

ELECTROMAGNETIC APPLICATIONS — Program to integrate electromagnetic
source technology with effects studies and tests to answer Air Force operational user
requirements. Some planned demonstrations will apply high-power microwave
technology to two Air Force missions: Aircraft self-protection and Suppression of Enemy
Air Defense. Contractors: In-house R&D; Kaman Sciences, Dikewood Division;
Science and Engineering Associates; Ball Systems Engineering Division; BDM, Inc.
Status: Advanced R&D, technology demonstrations.

ELECTROMAGNETIC EFFECTS — Development of transient electromagnetic test
and prediction techniques, TEM effects database spanning components, modules,
subsystems and systems, and a predictive understanding of TEM coupling, scattering
effects, and systems response. Contractors: In-house R&D with BDM, UIE, Kaman
Dikewood, Fiore Industries. Status: Basic to advanced R&D.

ELECTROMAGNETIC SOURCES — Research and development of high peak power
and high average power sources of microwave radiation for both narrowband and ultra-
wideband applications, including ancillary components such as pulsed power generators,
mode converters, and antenna systems. Contractors: In-house R&D, many. Status:
Basic to advanced R&D, including technology demonstrations.
HIGH-ENERGY LASER EFFECTS — Investigation and measurement of laser effects on theater and strategic components and materials using two carbon-dioxide lasers (15 kw and 45 kw). Contractors: Logicon RDA, Kaman Sciences, GIE, in-house. Status: Basic to advanced research.

HIGH FREQUENCY ELECTROMAGNETIC HARDENING — Program to develop electromagnetic hardening methodologies and technologies for aircraft, missiles (strategic and tactical), and satellites. Contractors: UIE, Dikewood. Status: In-house advanced and applied R&D.

PLASMAS — Program of research and development on plasma acceleration, multitrillion-watt radiation sources, and multimegabar pressure sources, with primary effort toward compact toroids and multiple solid liner implosions. Potential applications include microfission and fusion and parallel processing applications. Contractors: Maxwell Laboratories, Inc., Mission Research Corp., PSI. Status: Basic and advanced R&D.

SATELLITE MODELING — Research into directed-energy weapons, kinetic-energy weapons, radio frequency satellite lethality and susceptibility, space radiation environments, and classified satellite descriptions. Assessment research analyzes the susceptibility of space satellites to directed-energy and other weapons. Contractors: Kaman Sciences, RDA, Ball Systems Engineering, GIE, Lockheed. Status: Exploratory and advanced research.

SATELLITE SIGNATURE AND IMAGING SIMULATION — Program to support space object identification and mission payload assessment by developing or integrating existing software modules. Contractors: Kaman Sciences, RDA, Ball Aerospace, Rockwell Power Systems, Battelle. Status: Exploratory and advanced research, technology demonstrations.

SATELLITE SURVIVABILITY AND VULNERABILITY — Program to provide assessments that help USAF agencies with survivability and vulnerability guidelines. Contractors: Kaman Sciences, RDA, Ball Systems Engineering. Status: Exploratory and advanced research, technology demonstration.

SPACE SURVIVABILITY — Research centering on mission payload assessment for spacecraft, space environments interaction with spacecraft materials, and investigation hypervelocity impact physics for space debris and kinetic-energy weapons, quantification and mitigation of space debris, and passive hardening and survivability for BMDO assets in multithreat environments. Contractors: Many. Status: Basic R&D with technology infusion.
Geophysics Directorate

ATMOSPHERIC PREDICTION TECHNOLOGY — Program to develop numerical weather prediction models, satellite data inquest/assimilation techniques, diagnostic algorithms, and short-range forecast techniques to provide weather forecast support. Contractors: Many. Status: Continuing.

CHARGE CONTROL SYSTEM — Program to design, develop, fabricate, and test a prototype automatic active control to prevent charging buildup on high-altitude spacecraft. Contractors: Hughes, ATAC, Amptek. Status: Testing on DSCS satellite planned for 1996 launch.

ENVIRONMENTAL EFFECTS ON C^3I SYSTEMS — Investigation of ionospheric disturbances on theater C^3I systems that use high frequency through super high frequency and are located near the magnetic equator. Contractors: Multiple. Status: Continuing.


GEODETIC AND GRAVIMETRIC INSTRUMENTATION — Program to develop enabling technology base and techniques for compact, low-cost, high-reliability, autonomous, nonjammable, and virtually drift-free inertial systems for precise navigation, guidance, and pointing. Contractors: U. of Maryland, Mayflower Communications College, NAVSYS. Status: Continuing.

GEOPHYSICS FOR ENVIRONMENTAL QUALITY — Program to develop geophysical technology to address issues associated with global climatic change, as well as local area ground and air pollution. Contractor: Georgia Tech. Status: Continuing.

GEOPHYSICS FOR SYNTHETIC ENVIRONMENTS — Program to develop the capability to simulate the physical environment and its effects in order to mitigate and/or exploit environmental impact on system performance and operations. Contractors: Many. Status: Continuing.

HIGH FREQUENCY ACTIVE AURORAL RESEARCH PROGRAM (HAARP) — Explore and apply benefits of active ionospheric modification to C³I operational systems and enhance scientific data bases for future applications. **Contractor:** Arco Power Technology, Inc. (APTI). **Status:** Continuing.

IR BACKGROUND MODULES AND CODES — Program to measure, understand, model, set standards for, and simulate the optical environment of the atmosphere and celestial optical backgrounds. **Contractors:** Many. **Status:** Continuing.

NUCLEAR TEST-BAN TREATY VERIFICATION — Comprehensive seismic research and development program designed to study physical properties and behavior of Earth's interior as they pertain to monitoring underground nuclear tests. **Contractors:** Many. **Status:** Continuing.

PHOTOVOLTAIC ARRAY SPACEPOWER PLUS DIAGNOSTICS — Research to determine environmental effects of space on the operation and lifetime of photovoltaic spacepower systems. Joint development program among Phillips Laboratory, Wright Laboratory, and NASA. The first launches will be in the summer of 1994. **Contractor:** Amptek. **Status:** Integration, test.

SOLAR/SPACE WEATHER — Program to measure and model the transfer of energy from the sun through interplanetary space to Earth for its effect on Air Force satellites. **Contractors:** Many. **Status:** Continuing.

WEATHER IMPACT DECISION AIDS (WIDA) — Advanced development effort to develop and validate software that predicts the impact of weather on the performance of Air Force systems such as electro-optical weapons, target acquisition, and night vision goggles. This software is being designed for use in automated mission planning and execution systems. **Contractors:** TASC, HSTX, KRC. **Status:** Continuing.

WEATHER SIMULATION AND APPLICATIONS — Program to develop atmospheric simulation techniques to assess impact on military systems design, training, and operation. **Contractors:** Hughes STX, TASC. **Status:** Continuing.

Lasers & Imaging Directorate

ADVANCED ELECTRO-OPTICAL SYSTEM — Program to develop a four-meter-class telescope that will increase capabilities of the Air Force Maui Optical Station through installation of a large, state-of-the-art, electro-optical system to be operational by 1995. **Contractor:** Contraves (telescope). **Status:** Development.
ADVANCED IMAGING EFFORTS — Development of methods to remove atmospheric distortions from images of space objects. These methods include such computer post-processing techniques as speckle and hybrid imaging and preprocessing approaches with adaptive optical systems. Contractors: In-house, many. Status: Research, exploratory development, advanced development, technology transfer.

ADVANCED TRACKING — Investigation of acquisition, pointing, and tracking for laser systems in ground, air, and space experiments. The lab has developed in-house, advanced tracking systems to meet current and future requirements for active laser-illuminated and passive imaging and weapon-class systems. Contractors: In-house, many. Status: Research, exploratory development, advanced development.


ARGUS PROGRAM — An airborne optical data collection system based on a modified NC-135E aircraft to support a wide variety of testing, including observations of missile plumes, reentry vehicles, and space-related events. Contractors: In-house, many. Status: Operational and advanced development.

CHEMICAL OXYGEN IODINE LASER — Development of advanced technologies and demonstration of the scaling of chemical lasers to weapon-power levels for strategic and tactical applications. Investigation of methods to enhance laser performance and develop novel pumping mechanisms. Contractors: In-house, many. Status: Research, exploratory development, advanced development, technology transfer and transition.

NONLINEAR OPTICS CENTER OF TECHNOLOGY — Research into laser beam cleanup of system-induced distortions, correction of aberrations due to optical system imperfections and atmospheric effects for imaging applications, specific frequency generation for high-energy laser systems, laser device scaling through coupling of multiple devices, and novel nonlinear optical processing techniques. Contractors: Many. Status: Research, exploratory development, advanced development, technology transfer.

SEMICONDUCTOR LASER TECHNOLOGY — Program to develop new laser technology using semiconductor laser diodes and diode-pumped solid-state lasers for advanced applications. Contractors: Many. Status: Research, exploratory and advanced development, technology transfer.
STARFIRE OPTICAL RANGE — Range located at Kirtland AFB, N.M., that contains a 3.5 meter telescope, a 1.5-meter telescope, and auxiliary beam director with associated laboratories and control facilities for conducting night and daytime experiments. Contractor: Rockwell Power Systems, RDA, Contraves, U. of Arizona. Status: Advanced development, user facility.

Propulsion Directorate

ADVANCED SOLID AXIAL STAGE (ASAS) — Program to develop an advanced solid rocket stage for Theater Missile Defense (TMD) applications. The ASAS with thrust vector control provides increased velocity to kinetic kill vehicles while mitigating gross navigational error during interceptor fly outs. Contractor: Thiokol. Status: Advanced development.


CARBON-CARBON DENSIFICATION — Program to develop a process that will significantly reduce the time to manufacture and consequently the cost of producing carbon-carbon composites. Several techniques, including plasma densification, will be used. The material will have low density gradients and superior properties, in addition to lower cost. Contractor: In-house. Status: Exploratory development.

ENVIRONMENTALLY ACCEPTABLE PROPELLANT DEVELOPMENT — Program to develop and demonstrate highly reliable low-cost solid propellants that meet current and anticipated environmental regulations for manufacturing, testing, emissions, and disposal. Contractors: Various. Status: Exploratory development.

HIGH-ENERGY-DENSITY MATERIALS DEVELOPMENT — Program to identify, produce, characterize, and stabilize molecular systems that have potential as high-energy-density materials in propellants. These include research into solid oxygen and hydrogen. Contractors: In-house, academic, and commercial research centers. Status: Applied research.

INTEGRATED POWERHEAD DEMONSTRATION — Program to demonstrate advanced turbopumps and their operation in an integral rocket engine environment through the use of existing preburners and gas generators currently under development. Contractor: TBD. Status: Contract awards being selected.

MISSILE COMPONENT INTEGRATION — Program to identify emerging technologies which then result in the design, fabrication, and test of advanced missile components in subscale to full-scale rocket motors. The primary focus is on technologies that when used in rocket propulsion will meet the Integrated High Payoff Rocket Propulsion Technology goals. Areas include composite case design, higher performing clean propellants, improved insulation systems, and improved nozzles. Contractor: In-house. Status: Advanced development.

PROCESS EFFICIENT MOTOR TECHNOLOGY — Program to develop and demonstrate an innovative manufacturing technology for next generation solution propellant solid rocket motors. Benefits include: reduced manufacturing costs, improved reliability/maintainability, reduced hazards, more environmentally benign, and easy disposal. Contractor: Aerojet. Status: Exploratory development.

SCAVENGED PROPellant TEST MOTOR — Project to evaluate and demonstrate a clean propellant candidate in a large-scale test motor. Contractor: Thiokol. Status: Advanced development.


SOLID PROPELLANT ENVIRONMENTAL ISSUES — Program to demonstrate environmentally acceptable manufacturing technologies that comply with current and anticipated environmental regulations. Contractors: Chemical Systems Division, Aerojet, and Thiokol. Status: Advanced development.

STRUCTURAL/BALLISTIC RISK ASSESSMENT METHODOLOGY — Program to develop and demonstrate an integrated structural and ballistic analysis methodology for solid rocket motors containing cracks, voids, or bondline debonds in the propellant grain. The focus of the program is development and interfacing of analysis modules to model flaw propagation, crack surface ignition, crack pressurization and motor structural response. Contractor: Thiokol. Status: Exploratory Development.


30-KILOWATT-CLASS ARCJET DEMONSTRATION — Project to develop a spaceflight configuration package consisting of a 26-kw low-impedance ammonia arcjet, power conditioning subsystem, diagnostic package, and control subsystem and to measure its integrated performance on Earth during flight qualification tests. Contractor: TRW. Status: Advanced development.
Space and Missiles Technology Directorate

ACCELERATED INSERTION OF STANDARD MICROELECTRONICS (AISM) — The objective of this program is to accelerate the insertion of microelectronics into future space systems. In order to assure the insertion of the technology proposed to be developed, the contractors are required to identify the systems that this technology will be inserted into. Multiple contracts are envisioned with a contract duration of three years. Contractors: TBD. Status: Contract awarded July 1994.

ADVANCED SPACE COMMUNICATIONS 60-GHz CROSSLINK — Program to demonstrate benchtop 60-GHz crosslink capability, pinpointing technology development required for future systems miniaturization. Contractors: Various. Status: Research and development.

ADVANCED SPACEBORNE COMPUTER MODULE (ASCM) — ADVANCED TECHNOLOGY INSERTION MODULE (ATIM) — Phillips Laboratory is developing and space qualifying two 32-bit processor modules for data and signal processing applications in future space systems. The program is designed to dramatically increase the satellite onboard processing capability. Included in the development are space qualified higher throughput 32-bit processors, higher density memories, advanced packaging to decrease the overall size of the electronics packages, and supporting software. Contractors: Loral Federal Systems, Honeywell. Status: Ongoing.

LASER COMMUNICATIONS CROSSLINK — Program to conduct a space demonstration of a laser crosslink, providing a high-data-rate link for satellite-to-satellite and satellite-to-ground communication. Contractors: Various. Status: Ongoing.


MINIATURIZED SATELLITE THREAT REPORTING SYSTEM (MSTRS) — Technology development program designed to create small, light-weight, low-power spacecraft sensors used to detect a variety of hostile attacks from ground and space based weapons. Contractors: AIL Systems, Litton Amecom, MITRE, Maxwell Laboratories S3 Division. Status: System architecture and sensor development ongoing.

SHUTTLE PALLET SATELLITE III RADIOMETER DEVELOPMENT — Program to develop an Infrared Radiometer utilizing state-of-the-art focal plane array and long life mechanical cryocooler technologies. The high performance radiometer will be capable of performing proof of principle/technology demonstrations as well as phenomenology data collection in support of Brilliant Eyes with applicability to Space Based Early Warning Systems. Contractor: Space Dynamics Lab. Status: Integration to be completed December 1994. Space platform to be determined.

SILICON HYBRID WITH INFRARED EXTRINSIC LONG-WAVE DETECTORS (SHIELD) — Program to identify shortfalls in technology, modeling, and cost in existing very-long wavelength infrared silicon hybrid technology programs, based on current BMDO requirements. Program to develop a research plan to eliminate shortfalls using new designs and fabrication approaches in an established processing line. Contractors: Rockwell, Hughes, Aerojet. Status: Contract awarded October 1992.

SPACE-BASED SURVEILLANCE TECHNOLOGIES — Program to advance state-of-the-art in multimode, multiphenomenology surveillance technologies. Effort includes advanced signal processing, sensor fusion, and automatic target recognition. Contractors: Several. Status: Ongoing and anticipated awards.

SPACE INTEGRATED CONTROLS EXPERIMENT — Program to demonstrate active structural control technology for precision pointing of large optical systems. The program recently demonstrated 75 to 1 RMS reduction in the farfield composite line-of-sight error for a full scale beam director using modern control methods. This is the first successful system-level demonstration of active structural control technology. The program is currently investigating advance system identification methods for rapid control system development.

SPACE NUCLEAR POWER (TOPAZ INTERNATIONAL PROGRAM) — TIP is an effort to test and evaluate a complete, unfueled Russian thermionic space reactor power system using electric heaters to simulate nuclear fuel. Data will be transitioned to the U.S. nuclear industry for use in our space program. Contractors: In-house (U.K., French, Russian participants) Status: On-going.

SPACE SOLAR POWER — Program to develop and flight qualify advanced solar cells, arrays, batteries, and power conditioning systems for satellites. Goals include high efficiency, low cost, long-life power components/systems. Contractors: Martin Marietta, Boeing, Spectrolab, Eagle Picher, Various. Status: Research and development

SPACE TECHNOLOGIES MODELING AND SIMULATION — Program to push exploratory and advanced development of spacecraft payload and bus technology models, including computer and hardware simulations of active and passive sensors, communications, signal and data processors, internal and external environmental effects, target and background phenomenology, orbital scenarios, and system-level engineering models. Contractors: Several. Status: Models in development.
Space Experiments Directorate

HIGH-ALTITUDE BALLOON EXPERIMENT – Program to conduct balloon-borne, high-accuracy acquisition, tracking, pointing, and fire-control experiments against thrusting boosters. Contractors: In-house, many. Status: Flight experimentation.

INTEGRATED PRODUCT DEVELOPMENT LABORATORY – Laboratory to develop and expand efficient concurrent engineering capability for Phillips Laboratory using state-of-the-art CAD/CAE tools. Contractors: In-house, many. Status: Concept development, initial hardware procurement.

INTEGRATED SPACE TECHNOLOGY FLIGHTS – Program to demonstrate space control, force enhancement, and space support technologies. Contractor: TBD. Status: Preprocurement, requirements definition.


MINIATURE SENSOR TECHNOLOGY INTEGRATION – Technology demonstration space platform serving as test-bed for developing and validating LEAP seeker technology and conducting other experiments critical to kinetic-kill vehicle development. MSTI will also serve as a space observation base for actual LEAP engagements. Contractors: In-house, many. Status: Ongoing.

PAYLOAD OPERATIONS CENTER – Data fusion center for Phillips Laboratory balloon and space experiments where information will be sorted, processed, and distributed to investigators. Contractors: In-house, many. Status: Operational.


Airborne Laser Program Directorate

AIRBORNE LASER (ABL) — Program to develop an airborne demonstrator using a high-energy laser for defense against theater missiles in the boost phase. Contractors: Two teams. Boeing (lead), TRW, Lockheed; Rockwell (lead), Hughes, E Systems. Status: Concept definition, contracts awarded FY 94-97.

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(Current as of June 1994)
Fact Sheet

United States Air Force
AIR FORCE MATERIEL COMMAND
Office of Public Affairs, Phillips Laboratory
3550 Aberdeen Ave SE, Kirtland AFB, NM 87117-5776
(505) 846-1911

HIGH ALTITUDE BALLOON EXPERIMENT

The High Altitude Balloon Experiment (HABE) is a research program to validate acquisition, tracking, and pointing technologies for directed energy weapon systems (lasers) that could be used for ballistic missile defense. The program is managed by the Air Force's Phillips Laboratory at Kirtland Air Force Base, New Mexico, for the Ballistic Missile Defense Organization.

Under the program, the Laboratory will design and fly a complex electro-optical payload aboard a high-altitude balloon to validate technologies that could be deployed from an airplane or spacecraft. This four-year program will consist of a series of high-altitude balloon experiments which began in June 1993 from Clovis, New Mexico.

The Air Force is conducting this research from a high-altitude balloon because it is a relatively inexpensive method (compared to the cost of satellites) to lift payloads above the majority of the atmosphere. Eventually the laser acquisition, tracking, and pointing systems being tested could be incorporated on space or airborne platforms.

During the HABE tests a high-altitude balloon will lift the payload to approximately 85,000 feet. Testing will grow progressively more complex with the initial flights used to checkout many of the payload and balloon systems. Experiment flights will progress from carrying a complete optics package used to first track stars, then a boosting target, and finally using a laser to illuminate the missile target.

Program management and payload development and integration occurs at Phillips Laboratory, Kirtland Air Force Base, with several directorates supporting the project. Laboratory personnel assigned to Hanscom Air Force Base, Massachusetts, and Holloman Air Force Base, New Mexico, are providing expertise in balloon systems and launch operations. Additionally, several contractors are supporting the HABE program.

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Current as of October 1993
The Starfire Optical Range (SOR) is a world-class optical research facility operated by the USAF's Phillips Laboratory and located on a hilltop site (6,200 feet above sea level) in the southeastern portion of Kirtland Air Force Base, New Mexico. The primary mission of the SOR is to perform field experiments and analyses leading to solutions of the problems imposed by atmospheric turbulence upon propagating optical radiation.

Primary experiments consist of using adaptive optics to perform real-time compensation for aberrations induced by the atmosphere. Pioneering research in laser guidestar adaptive optics was performed at the SOR. Other research is conducted in space object imaging, advanced tracking, non-linear optics, and atmospheric physics.

The laser guidestar technique involves a laser fired toward space. Portions of that laser beam reflect back to earth, providing scientists with information on the distortions caused by the atmosphere. Adaptive optics is then used to correct for the distortion. Phillips Laboratory has produced improvements greater than a factor of 25 over conventional astronomical imaging and demonstrated that artificial beacon technology can virtually eliminate turbulence-induced distortions. Data from the Phillips Laboratory experiments are of great interest to astronomers and will save them at least 10 years of research. Efforts are underway to transfer much of this Air Force technology and techniques to the worldwide astronomical community.

Equipment at the Starfire Optical Range includes a 1.5-meter aperture telescope, a one-meter aperture coelostat beam director, smaller telescopes used for atmospheric measurements, and an extensive adaptive optics laboratory including a newly developed second generation adaptive optics system and four deformable mirrors.
Recently constructed additions for the SOR include a 3.5-meter telescope and 22,000 square-foot laboratory. The telescope is the largest in the Department of Defense, the fifth largest in the United States, and the largest known capable of tracking low-earth orbit satellites. The telescope stands 35 feet high and weighs approximately 275,000 pounds. Like the present 1.5-meter telescope, the new telescope has a coude optical path which will bring the light from the telescope to a central optics room, which will include the primary adaptive optics and tracking systems. From that point, the compensated or uncompensated beam can be sent to any one of the four laboratories, one of which will be reserved for visiting experimenters.

The elevation over azimuth gimbal for the 3.5-meter telescope was built by Contraves USA, while the lightweight, honeycombed borosilicate primary mirror was manufactured by the University of Arizona's Steward Observatory. The telescope is protected by an innovative, collapsing dome, built by Coast Steel, which leaves the entire telescope exposed to the atmosphere during operations. This design will significantly reduce local turbulence effects, as well as facilitate the high system azimuth rates necessary for satellite tracking with a large telescope. First light for the new telescope is scheduled for the spring of 1994.

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(Current as of January 1994)
APPENDIX B

LISTING OF STUDENT PROGRAMS: PHILLIPS LABORATORY
STUDENT PROGRAMS

The Air Force's Phillips Laboratory sponsors and participates in many programs for high school and college students who have exceptional abilities in science, mathematics, and related fields. In these programs the Laboratory offers employment, tours, mentorship guidance, or shares resources. Phillips Laboratory is involved in the following special programs offered to specially selected, outstanding middle and high school students:

Air Force Introduction to Engineering (AFITE): Week-long summer program sponsored by the Laboratory to introduce and motivate ninth graders to consider engineering careers. Contact: UNM College of Engineering, 505-277-1403.

Space Science Program: Laboratory-sponsored science and engineering competition for high school students, who take part in designing a space experiment. Contact: Casey Deraad, 505-846-6067.

New Mexico High School Science Fairs: Judges provided by the Laboratory for three regional fairs and the statewide competition. Contact: Public Affairs, 505-846-1911.

Intelligent Tutor Project: Laboratory-sponsored project with the State of New Mexico to implement a "fundamental skills" computerized learning system in the state's educational system, with pilot programs at two high schools (Los Lunas and Bernalillo) selected by the New Mexico Governor. Contact: Capt. Mary Boom, 505-846-6448.


Outstanding Student Summer Hire Program: Full-time summer jobs for outstanding high school and college students. Contact: Kirtland Civilian Personnel Office, Alice Baca, 505-846-9832.

Mathematics, Engineering, Science Achievement (MESA): Annual Laboratory tour for high school students participating in the New Mexico MESA program, a private, not-for-profit organization which encourages pre-college minority students to pursue careers in mathematics, engineering, and science-related fields. Contact: UNM College of Engineering, 505-277-5831.

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High School Apprenticeship Program: Eight weeks of paid employment (June - August) at the Laboratory offered to high school students to stimulate interest in pursuing careers in science and engineering. Contact: Chief Scientist's Office, Richard Keppler, 505-846-1327.

Albuquerque Public Schools Gifted Student Program: Laboratory-sponsored mentorship program offered to gifted students in Grades 10, 11, and 12; internship at the Laboratory for grades 11 and 12. Contact: Chief Scientist's Office, Ruth Konst, 505-846-0861.

Project Uplift Career Expo: Displays and Laboratory tour for eighth graders participating in Project Uplift, a private, non-profit organization effort to encourage science and engineering careers. Contact: Project Uplift, 505-265-4464.

Palace Knight and Senior Knight Program: Air Force education and employment programs to bring promising college students into civil service research jobs at the Laboratory, with the Air Force paying for their master’s and doctorate degrees. Contact: Chief Scientist's Office, Lt. Col. Howard Meyer, 505-846-1327.

Air Force Laboratory Graduate Fellowship Program: Air Force program to financially assist college graduates in obtaining doctorate degrees in mathematics, engineering, and scientific areas. Contact: Chief Scientist's Office, Richard Keppler, 505-846-1327.


Graduate Student Research Program: Air Force-sponsored, paid research program at Phillips Laboratory for eight to 12 weeks for graduate students with bachelor of science or master’s of science degrees. Contact: Chief Scientist's Office, Richard Keppler, 505-846-1327.

Federal Junior Fellowship Program: Year-round, part-time employment during college years offered to graduating high school seniors who demonstrate academic excellence in high school, financial need, and interest in federal employment following college graduation. Contact: Kirtland Civilian Personnel Office, Alice Baca, 505-846-9832.

Cooperative Education Program: Employment at the Laboratory for undergraduate (sophomore or higher) and graduate students who are enrolled in their institution’s cooperative education curriculum. Contact: Kirtland Civilian Personnel Office, Alice Baca, 505-846-9832.

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(Current as of January 1994)
APPENDIX C

PHILLIPS LABORATORY EXPENDITURES & EMPLOYMENT
FY94
## FY94 Distribution of PL Funds in New Mexico

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</tr>
<tr>
<td>Gas</td>
<td>480.xx</td>
<td>3.370</td>
</tr>
<tr>
<td>Other (specify)</td>
<td>480.xx</td>
<td>0.000</td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment Equipment</td>
<td>14x</td>
<td>0.178</td>
</tr>
<tr>
<td>Expense Equipment</td>
<td>62x, 63x</td>
<td>1.841</td>
</tr>
<tr>
<td>Travel</td>
<td>40x,421</td>
<td>3.162</td>
</tr>
<tr>
<td>Transportation of Things</td>
<td>45x, 46x</td>
<td>0.064</td>
</tr>
<tr>
<td>Communication Services</td>
<td>49x</td>
<td>0.496</td>
</tr>
<tr>
<td>Printing &amp; Reproduction</td>
<td>50x</td>
<td>0.150</td>
</tr>
<tr>
<td>Facilities Projects, CE Services</td>
<td>52x, 53x plus PK &amp; FM</td>
<td>0.275</td>
</tr>
<tr>
<td>Supplies, Material &amp; Fuels</td>
<td>60x, 61x</td>
<td>3.005</td>
</tr>
<tr>
<td>Education Services &amp; Training</td>
<td>55x</td>
<td>0.230</td>
</tr>
<tr>
<td>Contractual Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>54x, 56x</td>
<td>0.340</td>
</tr>
<tr>
<td>Rentals</td>
<td>43x, 47x</td>
<td>0.165</td>
</tr>
<tr>
<td>Contracts with other than R&amp;D</td>
<td>58x</td>
<td>4.100</td>
</tr>
<tr>
<td>R&amp;D Funding Transfers (MIPRs, PDs, POs, etc)</td>
<td>(37.575+1.901)</td>
<td>10.418</td>
</tr>
<tr>
<td>R&amp;D Contracts (BBER Survey, IPAs)</td>
<td></td>
<td>39.476</td>
</tr>
<tr>
<td>Misc. Contractual Services (AF Fm 9)</td>
<td></td>
<td>0.250</td>
</tr>
<tr>
<td>Construction Contracts</td>
<td></td>
<td>6.722</td>
</tr>
</tbody>
</table>

### Total FY94 PL Program

- **(All Locations):** 572.151
- **(New Mexico Only):** 151.852
**FY94 PL Personnel in New Mexico**

### Total Civilian Employment In FY94

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time—Annual-average-employed</td>
<td>n/a</td>
</tr>
<tr>
<td>Full-time -- at the end of FY94</td>
<td>668</td>
</tr>
<tr>
<td>Part-time—Annual-average-employed</td>
<td>n/a</td>
</tr>
<tr>
<td>Part-time -- at the end of FY94</td>
<td>8</td>
</tr>
<tr>
<td>Number employed in Stay-in-School (SIS) Program</td>
<td>80</td>
</tr>
<tr>
<td>Number employed in Summer Hire Program</td>
<td>75</td>
</tr>
<tr>
<td><strong>(During the summer school break (May '94- Sep '94); 75 were on-board)</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Total Military Employment in FY94

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Officer—Annual-average-employed</td>
<td>n/a</td>
</tr>
<tr>
<td>Officer -- at the end of FY94</td>
<td>338</td>
</tr>
<tr>
<td>Enlisted—Annual-average-employed</td>
<td>n/a</td>
</tr>
<tr>
<td>Enlisted -- at the end of FY94</td>
<td>123</td>
</tr>
</tbody>
</table>

### IPAs in FY94

<table>
<thead>
<tr>
<th>Category</th>
<th>Actual &quot;Head Count&quot;</th>
<th>Manyear Equiv.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total employed in FY94</td>
<td>41 (11 Full-time)</td>
<td>25.2</td>
</tr>
<tr>
<td>Number at the end of FY94</td>
<td>35 (11 Full-time)</td>
<td>22.4</td>
</tr>
<tr>
<td>Total cost for FY94</td>
<td></td>
<td>$1,900,683</td>
</tr>
<tr>
<td>Total salary &amp; benefits for FY94</td>
<td></td>
<td>$1,535,891</td>
</tr>
</tbody>
</table>

n/a = not available
Comparison of FY93/94 PL Economic Impact Data

<table>
<thead>
<tr>
<th></th>
<th>FY93</th>
<th>FY94</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IPAs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># Employed</td>
<td>40</td>
<td>41</td>
<td>3%</td>
</tr>
<tr>
<td>Salaries &amp; Fringe</td>
<td>$1.577</td>
<td>$1.536</td>
<td>(3%)</td>
</tr>
<tr>
<td><strong>In-State Fund Transfers (MIPRs, POS, etc.)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Funding Transferred</td>
<td>$15.875</td>
<td>$10.418</td>
<td>(34%)</td>
</tr>
<tr>
<td># Employed</td>
<td>103</td>
<td>54</td>
<td>(48%)</td>
</tr>
<tr>
<td>Salaries &amp; Fringe</td>
<td>$7.963</td>
<td>$6.873</td>
<td>(14%)</td>
</tr>
<tr>
<td><strong>FY93 Lab Quality Survey (LQS)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of Add'l On-Site Contractors</td>
<td>232</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>Estimated Cost of Salaries &amp; Fringe</td>
<td>$20.100</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td><strong>Military Construction Projects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># Employed (Manyyear Equivalent)</td>
<td>n/a</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Total Construction Expenditures in NM</td>
<td>n/a</td>
<td>$6.722</td>
<td></td>
</tr>
<tr>
<td>Estimated Cost of Salaries &amp; Fringe</td>
<td>n/a</td>
<td>$1.817</td>
<td></td>
</tr>
</tbody>
</table>
### Comparison of FY93/94 PL Economic Impact Data

<table>
<thead>
<tr>
<th></th>
<th>FY93</th>
<th>FY94</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Budget ($M)</td>
<td>$808,993</td>
<td>$572,151</td>
<td>(29%)</td>
</tr>
<tr>
<td>Expenditures in NM ($M)</td>
<td>$194,795</td>
<td>$131,652</td>
<td>(22%)</td>
</tr>
<tr>
<td>Full-time Military &amp; Civilian Employees</td>
<td>1203</td>
<td>1129</td>
<td>(6%)</td>
</tr>
<tr>
<td>Part-time Civilian Employees</td>
<td>201</td>
<td>163</td>
<td>(19%)</td>
</tr>
<tr>
<td>Salaries ($M)</td>
<td>$60,715</td>
<td>$61,761</td>
<td>2%</td>
</tr>
<tr>
<td>Fringe Benefits ($M)</td>
<td>$8,461</td>
<td>$6,620</td>
<td>(22%)</td>
</tr>
<tr>
<td>Health Benefits ($M)</td>
<td>$1,696</td>
<td>$1,390</td>
<td>(18%)</td>
</tr>
<tr>
<td>Expenditures for Contractual Services in NM:</td>
<td>$104,143</td>
<td>$61,471</td>
<td>(44%)</td>
</tr>
</tbody>
</table>

### BBER Contractor Survey

<table>
<thead>
<tr>
<th></th>
<th>FY93</th>
<th>FY94</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td># Contractors surveyed (All contracts)</td>
<td>54</td>
<td>31</td>
<td>(43%)</td>
</tr>
<tr>
<td># Contractors surveyed (NM=PPP contracts)</td>
<td>36</td>
<td>31</td>
<td>(14%)</td>
</tr>
<tr>
<td># Contracts in survey (All)</td>
<td>142</td>
<td>76</td>
<td>(46%)</td>
</tr>
<tr>
<td># Contracts in survey (NM=PPP)</td>
<td>62</td>
<td>76</td>
<td>23%</td>
</tr>
<tr>
<td>% Contractors responding (All)</td>
<td>48%</td>
<td>19%</td>
<td>(60%)</td>
</tr>
<tr>
<td>% Contractors responding (NM=PPP)</td>
<td>50%</td>
<td>19%</td>
<td>(62%)</td>
</tr>
<tr>
<td>FY Funding on All contracts</td>
<td>$131,855</td>
<td>$69,041</td>
<td>(48%)</td>
</tr>
<tr>
<td>FY Funding on NM=PPP contracts</td>
<td>$72,095</td>
<td>$39,041</td>
<td>(47%)</td>
</tr>
<tr>
<td>All Contract Expenditures in NM: Extrapolated</td>
<td>$82,900</td>
<td>$37,575</td>
<td>(40%)</td>
</tr>
<tr>
<td>% of Contract Funding in Responses (All)</td>
<td>48%</td>
<td>54%</td>
<td>13%</td>
</tr>
<tr>
<td>% of Contract Funding in Responses (NM=PPP)</td>
<td>64%</td>
<td>54%</td>
<td>(16%)</td>
</tr>
<tr>
<td># of people employed by contracts (All)</td>
<td>493</td>
<td>201</td>
<td>(59%)</td>
</tr>
<tr>
<td># of people employed by contracts (NM=PPP)</td>
<td>463</td>
<td>201</td>
<td>(57%)</td>
</tr>
<tr>
<td># of people employed (NM=PPP): Extrapolation</td>
<td>3497.3</td>
<td>3357.2</td>
<td>(19%)</td>
</tr>
<tr>
<td>Salaries &amp; Fringe (All contracts)</td>
<td>$23,741</td>
<td>$13,042</td>
<td>(45%)</td>
</tr>
<tr>
<td>Salaries &amp; Fringe (NM=PPP contracts)</td>
<td>$22,134</td>
<td>$13,042</td>
<td>(41%)</td>
</tr>
<tr>
<td>Salaries &amp; Fringe (NM=PPP contracts): Extrapolation</td>
<td>$35,800</td>
<td>$23,214</td>
<td>(35%)</td>
</tr>
<tr>
<td>Funding for Subcontractors &amp; Services (All)</td>
<td>$10,115</td>
<td>$4,403</td>
<td>(56%)</td>
</tr>
<tr>
<td>Funding for Subcontractors &amp; Services (NM=PPP)</td>
<td>$9,310</td>
<td>$4,403</td>
<td>(53%)</td>
</tr>
<tr>
<td>Funding for Subs &amp; Serv.: (NM=PPP): Extrapolation</td>
<td>$13,985</td>
<td>$7,499</td>
<td>(46%)</td>
</tr>
</tbody>
</table>
APPENDIX D:

PHILLIPS LABORATORY CONSTRUCTION DATA
GROUND-BREAKING FOR NEW AEROSPACE ENGINEERING BUILDING

KIRTLAND AIR FORCE BASE, N. M.--New Mexico elected officials and senior Air Force officers joined to break ground on a $3 million Aerospace Engineering Facility for the Air Force Phillips Laboratory here today (Feb. 15). Participating in the ceremony were Governor Bruce King; U.S. Senators Jeff Bingaman and Pete Domenici; U.S. Congressman Steve Schiff; Brig. Gen. Eugene Tattini, vice commander of the Space and Missile Systems Center in Los Angeles; and Phillips Laboratory commander Col. Richard W. Davis.

Located on the west side of Kirtland, this facility will be used to test components, as well as integrate and test payloads, for near-space (balloon and sounding rockets) and space flights.

Slated for completion next winter, this 16,000-square-foot facility will test payloads for mechanical vibration, shock, acceleration, and thermal variations. Phillips Laboratory experimenters and contractors will operate integrated payloads under realistic test environments, conducting "dress rehearsals" for sounding-rocket, high-altitude-balloon, and orbital-spacecraft flights.
The Aerospace Engineering Facility will house a 40-foot-high, 4,500-square-foot high bay area for assembling space payloads. It will include an overhead rail system and two 7.5-ton cranes that can be used for assembling payloads. There will also be a 550-square-foot, class 100 clean room and a thermal cycling chamber capable of evaluating test articles 4-foot-square. A vibration table will be able to exert 30,000 pounds of force on small satellites of up to 200 pounds. This will enable researchers to evaluate the survivability of these satellites during launch. Also included within the facility will be a conference room, a computer room, and several small laboratories. Phillips Laboratory's Space Experiments Directorate will operate the new facility and collocate their offices nearby.

This new state-of-the-art building for conducting space-related experiments marks the important first step in an expanded future for Phillips Laboratory at Kirtland. It furthers the laboratory's world-class space research and development capability, providing the infrastructure to help attract and keep talented scientists and engineers. In December 1991 the secretary of the Air Force approved the partial consolidation of Phillips Laboratory at Kirtland. This decision paved the way to begin moving 177 Phillips Laboratory manpower positions to Kirtland from Hanscom and Edwards Air Force Bases. Last year the Air Force determined that there would be no significant environmental impact to moving the split directorates to Kirtland in the next few years.
In 1994, the Air Force's Phillips Laboratory will begin construction of two new research laboratories on the west side of Kirtland Air Force Base, New Mexico — a Space Structures Laboratory and a Composites Laboratory. Both laboratories will be housed within a single structure one block east of the present Phillips Laboratory headquarters on Aberdeen Avenue.

In October 1993, Congress approved the necessary military construction (MILCON) money for these two laboratories in the Fiscal Year 1994 Department of Defense budget. Construction will begin in February 1994, with completion expected one year later.

The $6.4 million Space Structures Laboratory will provide 31,900 square feet of research space, with several high-bay rooms built with isolation foundations. Acoustical and vibrational damping controls built into the walls will allow researchers to conduct experiments on sensitive space structures.

The 30,000-square-foot Composites Laboratory will be constructed at a cost of $5.9 million. It will house composites equipment to build lightweight devices used in structures and controls experiments.

Phillips Laboratory decided to collocate the two new laboratories to take advantage of the synergistic work they will perform and because it will be more economical for them to share heating, ventilation, air conditioning, and other common building support systems. Both laboratories will be used by Phillips' Space and Missiles Technology Directorate.

Current as of November 1993
March 29, 1994
PL RELEASE NO: 94-26
CONTACT: Kari J. Paseur
PHONE: (505) 846-6315

PHILLIPS LAB BEGAN CONSTRUCTION OF $12 MILLION SPACE RESEARCH FACILITY

KIRTLAND AIR FORCE BASE, N.M. -- Air Force and Congressional leaders presided at a ground-breaking ceremony for a $12 million space technologies facility for Phillips Laboratory on Kirtland, Tuesday, March 29. Officiating at the 2:00 p.m. ceremony were Phillips Laboratory Commander Col. Richard W. Davis, U.S. Senator Pete Domenici, and U.S. Congressman Steve Schiff. The 60,000-square-foot facility, called the Space Structures and Composites Laboratory, will be located one block east of the present Phillips Laboratory headquarters on Aberdeen Avenue on the west side of the base.

The research facility will be used to develop advanced space structures and controls technology for future Air Force space and ballistic missile systems. Slated for completion in 1995, this premier research laboratory will bring together, under one roof, 60 Phillips Laboratory researchers and $50 million of experimental hardware currently housed in eight buildings at Kirtland AFB and Edwards AFB, Calif.

-MORE-
This new laboratory will be used to conduct research on the effects of the space environment on structures, fabricate experimental space structures and controls hardware, and conduct experiments to demonstrate and validate the performance of advanced hardware and control techniques. These technologies will enable substantial performance increases and cost savings for future Air Force systems and can be transferred for civilian applications.

The research facility will have several high-bay rooms built with isolation foundations. Acoustical and vibrational damping controls built into the walls will allow researchers to conduct experiments on sensitive space structures. Also included in the building will be composites equipment to build lightweight devices used in structure and control experiments. This facility arose from the vision of collocating all the Air Force's space technology research at one location--Phillips Laboratory at Kirtland AFB. This construction is a major step toward realizing this vision. The decision to consolidate the laboratory's split directorates at Kirtland was approved by the secretary of the Air Force in December 1991. This Pentagon decision paved the way for 177 positions from Phillips Laboratory to move from California and Massachusetts to Kirtland over the next few years.
APPENDIX E

BBER CONTRACTOR SURVEY
(Cover letter and questionnaire)
Dear Contract/Program Manager:

There have been many changes occurring in the Department of Defense because of the end of the cold war. Decisions are made daily that could result in positive or negative effects on New Mexico. One major concern is the retention and expansion of New Mexico jobs.

Last year the University of New Mexico’s Bureau of Business and Economic Research (BBER) completed a study that assessed the economic impact in FY93 of the Phillips Lab on the New Mexico economy. This research revealed that the Lab was a major contributor to the state in jobs and income. All surveyed contractors that had requested the report were sent copies.

Work is now underway to measure the FY94 impact. The information we request within will enable us to better understand the economic role of the Lab in New Mexico and help provide rationale for continued growth of the Phillips Lab mission and responsibilities within the Air Force.

We ask you to complete the attached survey requesting reasonable estimates, or best guesses, of your company’s activity in New Mexico. Your participation is vital to this assessment and would be greatly appreciated. To minimize your effort and the time required to respond please limit your information to the FY94 (October 1, 1993 - September 30, 1994) accounting period. Please be assured that your company information will be protected and that individual contractor data will not be released.

The final report on the assessment is scheduled for summer 1995. If you would like a copy please be sure to check the appropriate box on the survey.

Please return your completed survey by December 20, 1994. For your convenience you may FAX your input to us at (505) 277-7066. If you have any questions, please call Mr. Ed Tull at (505) 846-8933. Again, your cooperation and response is extremely valuable and will be greatly appreciated.

Sincerely,

John Temple,  
Asst. Director  

JT/b1  
Enclosure
SURVEY OF PHILLIPS LABORATORY CONTRACTOR ACTIVITY for FY94
In the
STATE OF NEW MEXICO

Contract #:

Title of Effort:

The following data is requested as it relates to this contract only.

Please indicate whether your figures are actual, estimated or based on rough percentages. Include any notes or explanations on the back or on a separate sheet of paper.

Contract expenditures in FY94:
Total contract spending in New Mexico:

Total NM contract employment in FY94:

Full-time

Part-time

Distribution of spending within New Mexico exclusively for FY94:
NM salaries (do not include fringe benefits)
NM fringe benefits
    Health care (actual amount or total % of salary)

Purchase/lease of goods & services from NM sources:
(include equipment, supplies & materials, office space, etc.)

Subcontracts issued to firms or universities in NM:
(specific firms on back of this page)

Point of Contact (if follow-up required): ________________________________
(name and phone number)

☐ Yes, please send a copy of the final report to:


Please return to:
Bureau of Business & Economic Research
1920 Lomas NE
Albuquerque, NM 87131-6021
or FAX: (505) 277-7066

Questions ??
Contact: Ed Tull
(505) 846-8933

Econ Impact Worksheet 3A
APPENDIX F

DESCRIPTION OF BBER'S FOR-UNM MODEL
The FOR-UNM (pronounced ‘forum’) model is a PC-based econometric model of the New Mexico economy, which uses quarterly income and employment data to estimate statistical relationships of an economic nature. These relationships (known as ‘regression equations’) are then used to forecast income and employment (and other) variables for the New Mexico economy. The model consists of 169 equations. Of these, 114 are behavioral equations, which estimate statistical relationships among the various data series, and the remaining 55 are structural, or identity, equations, which specify the theoretical relationships among the behavioral equations (that is, how the behavioral equations are related to other behavioral equations).

Variables forecast include the following:

New Mexico personal income and components (wage & salary disbursements, dividends/interest/rent income, transfer payments, farm proprietors’ income, nonfarm proprietors’ income and other labor income)

New Mexico real disposable income

Personal income for the state’s three Metropolitan Statistical Areas (MSA’s) [Albuquerque, Las Cruces and Santa Fe]

Nonagricultural employment by two-digit Standard Industrial Classification (SIC) code sectors for New Mexico, Albuquerque, Las Cruces and Santa Fe. The sectors include trade, services, government, manufacturing, mining, transportation/communications/utilities, finance/insurance/real estate, and construction. In addition, military employment is also forecast. In some cases, employment is forecast in greater sub-sector detail. For example, trade employment is estimated for both retail trade and wholesale trade and government employment is estimated for state, local and federal levels. Mining employment is estimated for metal mining, oil and natural gas extraction and coal/nonmetals mining.

Oil and natural gas production

Oil and natural gas well completions

Single and multi-family housing unit authorizations for the state and MSA’s.

Civilian labor force and unemployment rates for the state and MSA’s
Average weekly wages for the most important sectors of the New Mexico and Albuquerque MSA economies

The dollar value of construction contracts for residential, non-residential buildings and non-buildings categories.

The FOR-UNM model is of the type known as a 'top-down' model; that is, the FOR-UNM forecasts are tied to the forecasts of another econometric model for a larger geographical area, which are used as inputs, or 'exogenous variables'. [Exogenous variables are variables whose values are determined outside to scope of a particular model, while endogenous variables are variables whose values are determined within the model. Thus, the FOR-UNM model has 169 endogenous variables, and uses about 100 exogenous variables.] In our case, this other model is the Mark 10 model of the U.S. economy owned and operated by The WEFA Group of Bala Cynwyd, Pennsylvania. Thus, the forecasts of the FOR-UNM model reflect what is expected to occur at the national level. In addition, the FOR-UNM model contains behavioral equations which estimate statistical relationships among strictly New Mexico variables, so the FOR-UNM forecasts also reflect combinations of factors which are unique to New Mexico and not the same as at the national level.