Appendix E:
Description of Facilities

1 Facilities Description:

1.1 UPRM Atmospheric and Space Sciences Laboratory

The goal of the UPRM Atmospheric and Space Sciences Laboratory (UASSL) is to facilitate research in space and atmospheric sciences at UPRM. UASSL facilities include a dedicated and fully furnished structure in 10 acres of land in Aguadilla. The premise has hosted a 1.92MHz interferometer system to observe mesospheric tides. The land is administered by the Isabela Experimental Station of UPRM. Furthermore, the Isabela site has hosted the Cornell University Portable Radar Interferometer (CUPRI) to study mid-latitude sporadic-E layers at 50 MHz.

UASSL strives to maintain ever growing scientific and academic ties with the National Astronomy and Ionosphere Center (NAIC), the organization that operates the Arecibo Observatory (AO). UPRM faculty has used the AO facilities to carry out studies of: tilting of the F-region of the ionosphere, HF induced plasma interactions, coherent scattering from sporadic-E layers, waves and turbulence in the troposphere and stratosphere, and others.

1.2 Biomedical Instrumentation Research Laboratory (BIRLab)

The Biomedical Instrumentation Research Laboratory investigates novel technologies that can be applied towards the development of diagnostic and therapeutic medical devices. Current projects include the development of an acoustical system to monitor and guide intravascular catheters and the study of the electrical properties of molecularly imprinted polymeric matrices used to detect biological markers.

1.3 Cloud Microwave Measurements of Atmospheric Events (CLiMMATE)

1.3.1 Research

Understanding the role of clouds in the Earth's heat budget and the radiation transfer processes is vital for global climate models and meteorological studies. The research in this lab comprises the areas of remote sensing of the atmosphere, including rain and clouds, using microwave sensors such as radars and radiometers at various frequencies.

Microwave remote sensing has the advantage over optical remote sensing in that the information do not depend on the illumination by the Sun, therefore radars can "see" during the night as well as during the day. Radars can also penetrate clouds and provide information about the microphysical properties of clouds and rain. Several physical parameters important to weather prediction and climate modeling such as mean drop size diameter, and rain rate distribution can be retrieve from the information provided by these sensors.

1.3.2 About CLiMMATE

Some of our work includes the development of algorithms and the calibration of the atmospheric models to better retrieve the physical and radiative characteristics of the atmosphere, including water vapor content, liquid water, and raindrop distribution. In addition, we study the atmospheric attenuation suffered by the radar signal as it travels through the clear atmosphere due to water vapor and oxygen gases. This attenuation varies, among other factors, with frequency, radar scanning angle air temperature and pressure.

Data collected with the UMass Cloud Profiling Radar System (CPRS) operating at 33GHz and 95GHz is analyzed and presented here as well as preliminary data from the NOAA wind profiler, operating at 2.8GHz. This work is sponsored by NASA and NSF.

1.4 Communication and Signal Processing Laboratory

The Communication and Signal Processing Laboratory is the center for DSP hardware implementation in the department. Its main use is as the center of the undergraduate capstone course in the communication and signal processing area. In addition, the laboratory is used by graduate and undergraduate students performing research implementing various signal processing algoritms on DSPs and work in digital audio. In addition to the 15 PCs, the laboratory has various dsp platforms from TI and Analog Devices, 500MHz oscilloscopes, function generators, meters, and 2.4 GHz spectrum analysers.

1.5 Electric Energy Processing Systems Laboratory (E^2PSyL)

E^2PSyL is a leading facility in the Caribbean in electric energy research and in the education of researchers and professionals in the energy field. (E^2PSyL) has experimental and computational facilities for research in power electronics and power systems at UPRM. E^2PSyL also supports multi-disciplinary projects with Industrial and Mechanical Engineering. The laboratory was established under NSF grant ECS 9702860 (PECASE Award), it is part of the Center for Power Electronics Systems (CPES) under grant ECS 9731677, is being expanded by MRI grant ECS 0116314 and will also be supported by ECS 0134021 (CAREER Award) and ECS 0224743 (NSF/ONR EPNES Grant). There are three areas that comprise E^2PSyL: energy systems component testing and prototyping; energy systems component modeling and simulation; power quality and energy conversion.

1.6 Integrated Circuits Design Laboratory (ICDL)

The Integrated Circuits Design Laboratory (ICDL) mission is to study, develop, and disseminate knowledge on novel techniques for the design, modeling, and testing of analog, mixed-signal, and digital integrated circuits and systems. As part of its mission, the laboratory also provides the infrastructure to develop electronic circuits and systems strategies that target new application areas. ICDL's vision is to become the best university-level electronics design center in Puerto Rico, training students in innovative techniques and design methodologies as well as contributing to the advancement of the electronics area in general. The laboratory is equipped with state-of-the-art, industry-grade tools for the design, modeling, simulation, and validation of electronic circuits and systems, design and testing workstations, and specialized testing equipment. Current projects being carried in the lab include the development of CAD methodologies for automated circuit design, system-level characterization of circuit components for performance maximization, mixed-mode behavioral modeling of oversampled data converters, and novel telemetric strategies to monitor the condition of mechanical components in real time, among others.

1.7 Laboratory for Applied Remote Sensing and Image Processing

The UPRM Laboratory for Applied Remote Sensing and Image Processing (LARSIP) has extensive computing and image processing equipment and is continually involved in efforts to upgrade and extend the capabilities of the facility. Its 1506 sq. ft. location is divided in four rooms; two dedicated for student's research equipped with 20 PCs (w/ 19" monitors), and 7 SUN workstations (w/ 19" and 21" monitors). A total of six printers and one HP Scanjet 5370C scanner are installed in the laboratory facility for use by the student and technical staff, models are; HP Laserjet 4000DTN, HP Designjet 1055CM, HP Officejet 1070, HP Officejet G85, Tektronix Phaser 740, Kodak 8650. The PCs feature 2.7 GHz CPU, 1 GB of

RAM, 40 GB of hard disk running Windows XP Professional operating system. The UNIX workstations are sun ultra 2, 5, 10 and Sunblade 2000. A 42" Panasonic plasma display, Polycom conference phone and laptop are used by students to participate in video and teleconferences with education and research partners. The third room is dedicated to servers, cameras, instruments, and technical staff. The laboratory runs with 3 servers; 2 for UNIX clients (Sun Ultra Enterprise 3000 and Enterprise 450) and 1 for PC clients (Dell PowerEdge 4200). Servers have a memory range of 1GB to 4GB and storage capacity on the range of 40GB to 100GB. Network communications are mostly carryout by four main switches; HP Procurve 8000M, 2 HP Procurve 2626 and a GigaEthernet Fiber Foundry switch, this last maintains the connection between LARSIP and the Electrical and Computer Engineering Department network. The fourth room has two offices for visiting faculty and post-docs, and lounge area for the use of students and administrative staff. The laboratory is powered backup with a 36KVA UPS.

For validation experiments, we have 2 VIS hyperspectral cameras (SOC-700 Hyperspectral Imager from Surface Optics Inc and a CCD camera with a VariSpec™ tunable imaging filter), a MikroScan 7515 LWIR (broadband thermal camera in the 8.0 to 14.0 μm spectral range) camera, and a GER 1500 VIS spectrometer. The SOC-700 Hyperspectral Imager is comprised of a high-speed, low-noise visible camera, high quality visible spectrometer and an integrated scanning system and software. The VariSpec™ tunable imaging filters are high-quality interference filters, but the color of the light transmitted is electronically controllable, providing rapid, vibration less, and noiseless selection of any wavelength in the visible and near-IR ranges. We also have a modified GER-1500 spectrometer enclosed within a custom underwater housing. The GER 1500 is a relatively small field-portable instrument, measuring just 15x8x26 cm, that has the advantageous capability of functioning in a stand alone operation. It uses a silicone diode array to measure 512 spectral bands in the range from 350 to 1050 nm, with a nominal bandwidth of 1.5 nm and automated dark current corrections. Available light collecting optics include a full-angle 8° and 4° lenses and measurement acquisition is aided by an onboard sighting laser.

1.8 Power Electronics Laboratory

Power Electronics Lab is used for graduate research in the fields of Switching Power Supplies, Low temperature electronics, maximum power tracking from solar panels, motor control, and EMI investigations in Power Electronics and Drive Systems. Under graduate research projects in power electronics are also being carried out. The laboratory is also used to teach a course in Power Electronic Design for undergraduate students.

1.9 Process Instrumentation and Control Laboratory

The Process Instrumentation and Control Laboratory includes 21 PC workstations of varying ages, ranging from 486 to Pentium III with data acquisition equipment and software. It includes demonstrative control equipment such as inverted pendulum, fluid level control, magnetic levitation, vibration control, and others for simple projects to supplement three courses in the automatic control area.

1.10 Radiation Laboratory

The UPRM Radiation Laboratory was established through the NSF Major Research Instrumentation Grant ECS-9977178 in 2000. The laboratory research focuses on the development of microwave and millimeter-wave circuits and antennas and atmospheric radar systems. The Radiation Laboratory houses microwave instrumentation operating up to 50 GHz including a 8530A/8510C network analyzer and a spherical near-field antenna measurement system, several computer workstations with Agilent's ADS, Ansoft's Designer and HFSS and Remcom's XFDTD, and a LPKF milling machine for prototyping. The laboratory is a

partner in the Center for Collaborative and Adaptive Sensing of the Atmosphere, a NSF Engineering Research Center led by the University of Massachusetts. In addition, the laboratory faculty has ongoing research collaborations with LARSIP, the UPRM Physics Department, the University of Colorado at Boulder and the Georgia Institute of Technology.

1.11 Rapid Systems Prototyping Laboratory (RASP)

The main mission of the Rapid Systems Prototyping Laboratory is to conduct academic- and industrial-level research to develop methodologies, tools, and structures to enable the rapid prototyping of hardware systems in general, with especial emphasis in digital hardware, embedded systems, and digital signal processing applications in particular. The Rapid Systems Prototyping Laboratory has as its vision to develop the most advanced environment for rapid systems prototyping at the university-level in Puerto Rico. The laboratory infrastructure provides programming tools for hardware description languages and general programming. It also provides modeling and simulation tools, reconfigurable hardware platforms, testing equipment, and system development tools. Current projects in the lab include research in 3-D scalable arithmetic hardware methods, software methods for power efficiency in embedded systems, DSP systems for sensor array structures, and hardware methods for Fuzzy systems, among others.

1.12 Robotics Laboratory

The Robotics and automatization laboratory is used for education, the INEL 5516 Robotics and Automatization course, and graduate and undergraduate research. The Lab has two modern CRS mechanical arms, and one vintage IBM arm. It also has varied computational resources, 6 computers in all, where four are dedicated to the Robotics course. The computers have process control and manufacturing simulators, Visual C++ and Labview abmong others. In addition, two of the computers have hardware and software to permit computer vision, one with both color and b/w cameras. There two computers are generally used in research projects. The Laboratory also has modular AROMAT PLCs, both large and small and of high capacity. The modules include input and output expansions and both manual and computer based programmers. The laboratory also has a pneumatic learning station.

1.13 Space Information Laboratory

The Space Information Laboratory (SIL) is charged with receiving data from satellites and making it available to the user components within the NASA project Tropical Center for Earth and Space Studies (TCESS) and to the academic research community at large. The laboratory has an L-band HRPT receiving station for the reception of NOAA satellites. The station has also been receiving and processing SeaWiFs satellite telemetry thanks to the cooperation of Dr. Fernando Gilbes (Geology Department), and his students.

An X-band ground station capable of receiving RADARSAT 1, LANDSAT 7, and the MODIS sensor aboard the TERRA is also operated by SIL. Our station is certified to receive and process up to Level 0 commercial images for RADARSAT 1. The LANDSAT 7 reception system is able to process telemetry up to Level 1G and 1R. .This is a reconfigurable processor based on field-programmable gate arrays (FPGAs) developed by Vexcel Corporation. The MODIS processing system, also developed from Vexcel, has been performing flawlessly.

The Space Information Laboratory (SIL) represents a significant research and educational tool at the service of the university faculty and students. The SIL has supported a Ph.D. student (Marine Sciences) and several master's students. Numerous undergraduates have learned to operate a satellite ground station

and to process the resulting telemetry into imagery for diverse uses. The SIL welcomes students with skills in communications, networking, image processing, and programming.

1.14 Atmospheric Phenomena Laboratory (APL)

The Atmospheric Phenomena Laboratory is involved in the detection of lightning discharges and related physics. Current projects include the maintenance of the existing system (upgrading from W95 to WXP, fixing antenna design defects), study of the impact of climate on urban development.

Table F-1: Summary of Available Equipment and Computing Resources at ECE Laboratories Supporting the Graduate Program.

Laboratory	Equipment and Computing Resources	Location	Size (sq. ft)
Atmospheric Phenomena Laboratory (APL)	**Workstations:** 5 PCs with LabView **Testing:** 6 Funcion Generators 4 A/D Data Acquisition Cards (National Labs) 3 Atmospheric parameter modules (PTV) 4 dual-loop lightning detector antennas 1 high voltage arc discharge unit (Tesla Coil)	S-120A (Also UPR Cayey & Arecibo)	200
Aguadilla Radar Facility	**Workstations:** 1PC **Testing:** 1 100 MHz Spectrum Analyzer/Modem Unit (Genesis Software Pty Ltd) **Measurements:** 3 dual inverted V receivers 1.92 MHz 1 10kW 1.92 MHz 4 dipole transmitter	Finca Montaña (Rt 459)	100
Biomedical Instrumentation Research Laboratory (BIRLab)	**Workstations**:4 PCs, Pentium 3 or higher. Laser and Inkjet Printers, Hydrophones (Reson), Miniature Speakers and Microphones, 60 MHz Oscilloscope (Agilent), 15 MHz Waveform Generator (Agilent), Voltmeter (Agilent), Triple Output Power Supply (Agilent), Electronic components Data acquisition board (National Instruments) LabVIEW Software Matlab	S-215	331
Cloud Microwave Measurements of Atmospheric Events (CLiMMATE)	**Workstations**: 1 Linux workstation 800Mhz, 512MB RAM with IDL license; 1 PC, 2GHz, 256MB RAM , 40GB HD, Win XP with Fortran, IDL, Adobe PhotoShop, Macromedia Illustrator, Java2; 1PC 866MHz, 384MB RAM, 70GB HD, Win XP IDL license; 1PC 866mhZ, 128MB RAM, 60GB HD, WIN 98 & IDL; 1PC 866MHZ, 384MB RAM, 8.5GB HD, WIN XP, IDL.	S-201	462
Communication and Signal Processing Laboratory	**Workstations**:14 PIII-550, 256 MB RAM, 10 GB HD, 19" Display **Testing:** 15 500MHz Oscilloscopes 15 Function Generators 15 Multimeters	S-222E	758

	4 2.3 GHz Spectrum Analysers		
Electric Energy Processing Systems Laboratory (E^2PSyL)	**Server:** SUN Enterprise 250 server, **Workstations**: Three SUN Ultra workstations and 15 Pentium PCs. **Testing:** *Measurements* • *1GHz* Oscilloscope (Tektronics). Digital scope - HP 54602B, *150 MHz*. One portable three-phase scope meters(Tektronics THS720P), three portable single-phase scopemeters (Fluke 43). High voltage and high current probes. HP table multimeters. QUADTech 2200 Transformer Test System. • Mikkon Thermal Imaging Camera *Motor drives testing equipment* • Magtrol HD-705-6 Dynamometer (max. torque *50 lb-in., 1.4 kW* max - 5 min) • 1 Magtrol HD-815-6N Dynamometers; DSP-6000, 5410 (max. torque *250 lb-in., 7.025 kW* max - 5 min) • Brushless DC *1 hp* motor (APIGettys) • Several *fractional horsepower* three-phase induction motors • Circuit boards for controller implementation: Analog Devices ADSP 2102, ADMC200-EVAL; DSPACE DS1102 DSP Controller Board (TI's C31). • HP function generators • Power supplies from fraction volts to 500 Vdc • Motor Control Card (dSpace ACE1103, CP1103) • 5 hp motors *Power Quality & Energy Conversion* • Three phase power quality monitoring system • Schaffner surge generator (Schaffner NSG 2050, PNW 2050-2225, CDN 133/153) for generation of transient disturbances. • Two photovoltaic systems with a combined energy output of 1 kW. Systems include BP Solar panels, AC Delco Lead-Acid Sealed Deep Cycle Batteries of 105 Ah @ 12 volts (4 pieces), Trace SW 2512 True-Sine Wave Inverter, 2500 W, 12 volts DC, 120 VAC 60Hz, GC-1000 Intertie True-Sine Wave Inverter, 1000W, 48 volts DC, 120 VAC 60Hz, Trace Charge Controller Regulator Model C40 for 12, 24, and 48	CID 212, 217, 204, 206	 358 391 347

	VDC.		
High Tech Tools and Toys Laboratory	**Workstations**:12 P-4 1.4 Ghz, 256 MB RAM, 40 GB HD, 19" Display	S-222H	241
Integrated Circuits Design Laboratory (ICDL)	**Server:** Sun Sparc Ultra Enterprise 450, 4 x 400 Mhz, 1.6GB RAM, 54 GB HD, Solaris **Workstations**: Sun Blade, 512MB, 30GB **Testing**: 4 PCs P4, LabView, Sun Sparc 2-based TI VLCT	S-210	600
Laboratory for Applied Remote Sensing and Image Processing (LARSIP)	**Servers:** (1) Sun Sparc Ultra Enterprise 450, 4x480 Mhz, 4GB RAM, 100GB HD, Solaris (2) Sun Sparc Ultra Enterprise 3000, 2x250 Mhz, 1GB RAM, 40GB HD, Solaris, (3) DELL PowerEdge 4200, 2x300 Mhz, 256 MB RAM, Windows NT-4 **Workstations:** 6 Sun Wks (Ultra 1, 2, 5, 10, SunBlade 2000), 4 DELL Dimension 8100, 1.7Ghz, 1GB RAM, 36GB HD, Windows 2K, 8 DELL Optiplex 240, 2.2 Ghz, 1GB RAM, 20GB HD, Windows XP, 3 Gateway Professionals, 1.5Ghz, 1GB RAM, 36GB HD **Imaging**: Surface Optics hyperspectral imager, CCD camera with LCD tunable filter for hyperspectral imaging.	CID 218 220 219 221 224	 175 175 552 506 276
Power Electronics Laboratory	**Workstations:** 3 Gateway2000 PCs, 1 Sun Workstation. **Testing:** Tektronix TDS 754A,2430A,2245A Oscilloscopes, Storage Oscilloscopes, LISN, Sun environmental chamber, Harmonic analyser, Electronic loads, Power Supplies, function generators, Solar panels, HP measuring instruments, Leader oscilloscope and multimeters, etc.	S-101	367
Process Instrumentation and Control Laboratory	**Workstations**:9 Gateways 4DX2-66, 16 MB RAM, 340 MB HD, 15" Display, Windows NT 1 Gateway P4D-66, 16 MB RAM, 340 MB HD, 15" Display, Windows 95 1 Gateway P5-100, 32 MB RAM, 2 GB HD, 15" Display, Windows 95 1 Dell Dimension PIII-933, 128 MB RAM, 8 GB HD, 17" Display 8 Gateway E4200 PII-400, 128 MB RAM, 8 GB HD, 17" Display 1 Gateway Pentium 133, 32 MB RAM, 17" Display Several experimental setups for experiments in	S-213	671

	control systems		
Radiation Laboratory	**Workstations**: HP Visualize 2 PA-RISC x 500 MHz, 4GB RAM, 3 x 18 GB HD IBM RS/6000 2 PowerPC, 1GB, 2 x 18 GB HD, 2x Dell Precision 530 Dual Xeon @ 2.3GHz, 1GB RAM, 40 GB HD **Testing:** 8530A/8510C Microwave Receiver/Network Analyzer (50 GHz), 8719ES Network Analyzer (13.2 GHz), E4433B Signal Generator (4 GHz), 83650B Synthesized Sweeper (50 GHz), E4419 Dual Power Meter, 8565EC Spectrum Analyzer (50 GHz), NSI Spherical Near-Field Antenna Measurement System (40 GHz), **Prototyping:** LPKF Protomat C60 Milling Machine	S-120	447
Rapid Systems Prototyping (RASP)	**Workstations**:8 P-III PCs-900, 128 MB RAM, 20 GB HD **Testing**: Scope, Logic Analyzer, Xilinx Virtex II boards, Spartan	S-114B	220
Robotics Laboratory	**Workstations**:6 PCs, two modern CRS mechanical arms, and one vintage IBM arm, AROMAT PLCs.	S-102	562
Space Information Laboratory	**Server:** 1. Dell PowerEdge 2200 – PII-233 Mhz, 128MB RAM, 9GB HD, 15” Monitor, Win2k Server 2. P4-1.4 Ghz, 1GB RAM, 100GB HD, 19” Monitor, Win2k Server **Workstations:** 1. DELL Precision 220, Dual P3-733 Mhz, 256MB RAM, 120 GB HD, 19” Monitor, Win2k Pro 2. Gateway Select, Athlon 800 Mhz, 768MB RAM, 40GB HD, 19” Moin, Win2k Pro 3. Duron 1Ghz, 128 MB RAM, 8GB HD, 17” Monitor, Win2k Pro 4. Sun Ultra 5 Sparc, 128 MB RAM, SunOS 5.7 5. HP Vectra, PII-400 Mhz, 384MB RAM, 10GB HD, 15” Monitor, WinNT 4 6. Origin 200, 4xMIPS R10000, 1.5GB RAM, 9GB HD, 200GB Fiber channel HD, IRIX 6.5 7. DELL, P2-450 Mhz, 384MB RAM, 80GB HD, 15” Monitor, Win2k Pro	CID	900

	8. Gateway 2000, PPro-200Mhz, 48MB RAM, 4GB HD, 15” Monitor, Win2k Pro 9. 2xDell Dimiension 8200, P4-2 Ghz, 1GB RAM, 120GB HD, 21” Monitor, Win2k Pro 10. P4-1.5 Ghz, 512 MB RAM, 40GB HD, Linux 11. Sun SparcStation 20, 384MB RAM, SunOS 5.7		