Tarleton State University

Radiation Safety Procedures and Program

Table of Contents

RADIATION SAFETY PROCEDURES

INTRODUCTION

The Tarleton State University accelerator is a NEC3-SDH Tandem Accelerator which is used for ion beam analysis of electronic materials. With a maximum terminal potential of 1.0 million volts, the machine is capable of supplying 10 nA to 1uA of 3.0 MeV He^{++} or 10 nA-100 nA of 2.0 MeV H^{+} ions on a target. The primary source of radiation from low current, low energy positive ion accelerators like the NEC 3-SDH is due to photons emitted by the de-acceleration of secondary electrons near the high voltage terminal. The NEC3-SDH accelerator is a modern pelletron accelerator with a magnetically suppressed ultra-high vacuum acceleration tube. This greatly reduces the emitted photon flux and its energy. Furthermore, the lower energy photons must then pass through the accelerators SF6 insulating gas and steel high-pressure tank before exiting the accelerator system. The NEC 3-SDH was initially designed to provide a maximum of 5mR/hr at the surface of the accelerator tank for full terminal voltage and 1 uA of beam. During its 18 years of operation at the California Institute of Technology (prior to arriving at Tarleton), the measured radiation field near the accelerator at full voltage was 0.01-0.02 mR/hr without beam and 1 mR/hr with beam. At a distance of 2 feet from the tank, the field was generally 0.05-0.1 mR/hr. Furthermore, according to the RSO at the California Institute of Technology, the accelerator's radiation monitor on the surface of the tank's trip point of 5 mR/hr was never exceeded during the 18 years of operation. Tarleton has observed similar radiation fields since the unit was received from the California Institute of Technology and placed into operation in 2004. Based on the above information, the California Institute of Technology suspended their radiation badge program and placed badges at select locations within the room. The absence of individual badging is consistent with the practice at other laboratories containing NEC pelletrons including the larger 5-SDH accelerator (1.7 million volts) at the U.S. Army Research Laboratory in Aberdeen, Maryland.

In 2004, an initial exposure assessment was performed under the direction of Dean Jones, Tarleton RSO (at the time) Personnel monitoring badges were worn by various individuals with area surveys being performed. The resulting Radiation Dosimetry Report reflected no exposure above TLD. Based upon this assessment badge monitoring was discontinued at that time. No system changes have occurred within the equipment or program that should require additional badge monitoring.

The procedures outlined in this manual define the Radiation Protection Program and the responsibilities thereof for Tarleton State University's main campus and all other university-controlled sites. These procedures shall be followed by all University personnel and by any other personnel of other organizations that utilize University facilities; who receive, possess, use, transfer, own, or acquire any source of ionizing/non-ionizing radiation or radiation producing device at Tarleton State University.

The room containing the Tarleton accelerator is located within the Science Building, Room 232 constructed in 2000. The room is 26 feet wide x 40 feet long (**See Appendix A**) The accelerator tank is 12 feet from either wall at the high voltage terminal and 19 feet from both the control console and target chamber. Both walls are conventional sheet rock walls and approximately 5 inches thick. On the west side immediately following the wall is a Biology Teaching Lab. On the east side immediately following the wall is a concrete firewall followed by an elevator shaft. Utility Room 232A is located in the southeast corner of the accelerator room. This utility room contains an air compressor, water chiller and a floor drain. The accelerator tank is 46 inches above the floor and 50 inches below the false ceiling. Above the false ceiling is an additional 3 feet clearance for electrical, HVAC, and water distribution followed by the 3rd Floor's concrete support. The floor above Room 232 contains a teaching lab. A geology storeroom and lab is located on the 1st floor located directly below room 232. No eating or drinking is allowed within the accelerator room. The accelerator operation does not utilize glove boxes, fume hoods, or filtration systems. Additionally, the accelerator operation doesn't require the handling gaseous, liquid, or solid waste handling systems. No animal facilities are incorporated or associated with the accelerator operation.

<u>Purpose</u>

The primary purposes of the Radiation Protection Program are to:

1. Ensure the safety of all personnel that use radioactive materials.

2. Ensure that members of the public will not be exposed to excessive radiation.

3. Ensure that a healthful environment is maintained in all areas of the University including those in which radioactivity is a factor.

4. Ensure that sources of ionizing radiation will be procured, used and disposed of in accordance with regulations and standards established by the Texas Department of State Health Services, Bureau of Radiation Control as found in 25 TAC 289.

5. Conduct inspections at appropriate intervals and locations to ensure that individual project(s) utilizing radiation are in compliance with stated procedures and with regulations established by the Texas Department of State Health Services, Bureau of Radiation Control.

6. Ensure that all usage of radioactive materials or radiation producing devices is being conducted under the supervision of a qualified, properly licensed or registered user.

<u>Regulations</u>

The University is required by Texas Department of State Health Services, Bureau of Radiation Control to:

1. Establish an appropriate administrative organization to handle matters dealing with radiation on campus.

2. Establish and maintain exposure records for personnel that work with ionizing radiation.

3. Assure that recognized safety and health procedures are followed.

4. Designate an institutional contact person to the Texas Department of State Health Services.

AUTHORITY

Tarleton State University operates under a specific license issued by the Texas Department of State Health Services, Bureau of Radiation Control. This license covers the procurement, use and disposal of radioactive material in accordance with the rules as identified in 25 TAC 289. Licensure of all radioactive material including naturally occurring, such as radium, and accelerator-produced radionuclides is required. Registration of all equipment designed to produce x-rays or other ionizing radiation is also required.

Any person(s) who intends to use any radioactive material or radiation producing device must complete and submit an application to University Compliance for authorization. The RSO within University Compliance will submit any requests to the Texas Department of State Health Services, Bureau of Radiation Control. Authorization from the Texas Department of State Health Services must be granted prior to beginning any work with these materials or machines.

RESPONSIBILITY FOR RADIATION PROTECTION PROGRAM

The President of Tarleton State University has designated the following organizational structure to ensure compliance with all safety aspects of the Radiation Protection Program:

1. Office of the President
2. University Compliance – Radiation Safety Officer
3. Risk Management & Safety

The responsibility and authority of these are further explained in the following text.

Office of the President

The President is the responsible officer of the University in all decisions and procedures must be consistent with established regulations and standards and with University policy and/or individual decisions made by the President.

University Compliance

University Compliance of Tarleton State University has been designated by the President to direct the Radiation Protection Program. As such, this office shall serve as the depository for the following records, reports, and documents:

1. The original copies of the *Radioactive Material License* and the *Certificate of Registration* as issued by the Texas Department of State Health Services, Bureau of Radiation Control.

2. Copies of all applications requesting that a Principal Investigator be added to the Radioactive Material License or that a device be added to the Certificate of Registration.

3. Copies of records of personnel radiation exposure.

4. Survey instrument calibration records.

5. Quarterly inventory reports of radioactive materials.

6. Disposal reports for radioactive materials.

7. Incidents reports involving radioactive materials.

8. Reports of wipe test(s) and area surveys.

9. Accelerator installation locations and monthly surveys.

University Compliance shall also perform the necessary office and administrative duties relating to the Radiation Protection Program.

Radiation Safety Officer

The Radiation Safety Officer acts under the authority of the University President and is charged to oversee the Radiation Protection Program at Tarleton State University including the main campus and all other university controlled sites. The Radiation Safety Officer shall be responsible for all administrative duties associated with the University's Radiation Protection Program.

The Radiation Safety Officer shall advise, assist and ensure that each Principal Investigator (PI) who is utilizing radioactive material has completed and submitted to the Environmental Health and Safety Office a Project Hazard Assessment for the project. The Project Hazard Analysis is a safety plan detailing how the ALARA concept and other safety measures will be implemented during the project.

Specifically, the duties of the RSO include, but are not limited to, the following:

1) to establish and oversee operating, safety, emergency, and as low as reasonably achievable (ALARA) procedures, and to review them at least annually to ensure that the procedures are current and conform with this chapter;
2) to oversee and approve all phases of the training program for operations and/or personnel so that appropriate and effective radiation protection practices are taught;
3) to ensure that required radiation surveys and leak tests are performed and documented in accordance with this chapter, including any corrective measures when levels of radiation exceed established limits;
4) to ensure that individual monitoring devices are used properly by occupationally-exposed personnel, that records are kept of the monitoring results, and that timely notifications are made in accordance with §289.203 of this title;
5) to investigate and cause a report to be submitted to the agency for each known or suspected case of radiation exposure to an individual or radiation level detected in excess of limits established by this chapter and each theft or loss of source(s) of radiation, to determine the cause(s), and to take steps to prevent a recurrence;
6) to investigate and cause a report to be submitted to the agency for each known or suspected case of release of radioactive material to the environment in excess of limits established by this chapter;
7) to have a thorough knowledge of management policies and administrative procedures of the licensee;
8) to assume control and have the authority to institute corrective actions, including shutdown of operations when necessary in emergency situations or unsafe conditions;
9) to ensure that records are maintained as required by this chapter;
10) to ensure the proper storing, labeling, transport, use and disposal of sources of radiation, storage, and/or transport containers;
11) to ensure that inventories are performed in accordance with the activities for which the license application is submitted;
12) to perform a physical inventory of the radioactive sealed sources authorized for use on the license every six months and make and maintain records of the inventory of the radioactive sealed sources authorized for use on the license every six months, to include, but not be limited to the following:
    (i) isotope(s); (ii) quantity(ies); (iii) activity(ies); (iv) date inventory is performed; (v) location; (vi) unique identifying number or serial number; and (vii) signature of person performing the inventory.
13) to ensure that personnel are complying with this chapter, the conditions of the license, and the operating, safety, and emergency procedures of the licensee;

The Radiation Safety Officer acts as the official liaison between Tarleton State University and the Texas Department of State Health Services on all matters pertaining to the University's Radiological Program.

Training

The primary responsibility for laboratory worker training rests with the Principal Investigator. The (PI) must train their personnel in procedures specific to their facilities and experimental protocols. Appropriate training, both general and specific, must be completed prior to commencement of work activities involving radioactive materials. University Compliance may be able to provide assistance with the training requirements

The PI shall maintain a file documenting internal training of their laboratory personnel. Documentation should include the training outline, date of training and names of those in attendance.

PROCEDURES FOR THE USE OF RADIOISOTOPES

Ordering Of Radioactive Material

The PI is responsible for ordering radioactive materials and for ensuring that the activity level of the requested isotope does not exceed the approved activity level as listed on the Radioactive Material License.

Tarleton State University anticipates utilizing sealed source radioactive materials for quality control and reference purposes for an academic and research linear accelerator registered in the State of Texas within the University Chemistry, Geoscience, and Physics Department used for non-medical purposes.

Receipt of Radioactive Material

The PI shall ensure that all incoming shipments of radioactive materials are inspected promptly. The following will be done by the sub-licensee:

1. Provide specific instructions to the vendor to ship the material directly to the PI's department and only during office hours.

2. Inform the departmental staff that a radioactive material shipment has been ordered and provide specific instructions as to what should be done once the shipment arrives.

3. Wipe test the outer package for contamination.

4. Open and inspect package immediately (wear proper gloves).

5. Assure that inner package agrees with name and quantity with packing slip.

6. Check for possible breakage of seals or containers, loss of liquid or change in color of absorbing material.

7. Wipe test of inner package.

8. Record type of activity, quantity present, and location of delivery using RADIOACTIVE MATERIAL CHECK-IN / DELIVERY REPORT (form RSP-

03). This report is to be maintained in the sub-licensee's permanent files and a copy sent to University Compliance.

9. Deliver package to proper laboratory storage.

10. If material has been packaged in dry ice, refrigerate or remove immediately to ultimate user.

11. If contamination, leakage or shortages are noted, notify the Vendor's Customer Service Department immediately.

Survey dose rate limits are 10 millirem per hour at a distance of three feet from the exterior surface of the package, or 200 millirem per hour on the exterior surface of the package. Removable contamination surveys results from the exterior of the package should not exceed 0.01 microcuries or 22,200 dpm per 100 CM^2 area.
Should radiation levels in excess of those listed above be noted, the PI shall notify University Compliance immediately. The RSO shall notify the final delivering carrier and the Texas Department of State Health Services, Bureau of Radiation Control, by telephone, mailgram, or facsimile.

Storage of Radioactive Material

Radioactive source materials shall be stored within the two (2) locked cabinets located within the northwest corner of the Accelerator Lab, Room 232. The PI is responsible to maintain an accurate and current RADIOACTIVE MATERIAL INVENTORY FORM (**See Appendix B**) correctly identifying the amount of material in storage and the amount of material that has either been disposed of or has been consumed in the project.

Waste Disposal Procedure

No radioactive containing waste generation is anticipated from the proper use of the Accelerator.

LABORATORY SAFETY GUIDELINES

The Accelerator Lab in which radioactive materials are stored or used shall be marked with "Caution Radioactive Materials" signs.

Notice to Employees signs (25 TAC 289.252) shall be posted within the Accelerator Lab in a conspicuous location. Notices and signs are available from University Compliance.

NO FOOD IS TO BE PREPARED, STORED, OR CONSUMED WITHIN THE ACCELERATOR LABORATORY.

This shall include, but not be limited to candies, gums, and smokeless tobacco. Hands should be thoroughly cleaned prior to eating and following work with radioactive materials.

Smoking and the use of smokeless tobacco is not allowed within Tarleton State University buildings.

Maintenance and custodial personnel shall be instructed as to what areas will be safe to work. Any work from outside support services will be coordinated and scheduled by the PI.

INSPECTIONS AND SURVEYS

Unannounced safety inspections will be made to the Accelerator Laboratory by the RSO or Risk Management & Safety.

Surveys are performed by University Compliance and are official records and do not relieve the PI of conducting timely surveys and wipe-tests of the laboratory work areas.

The following information is taken from the Bureau of Radiation Control REGULATORY GUIDE 3.3 which outlines the methods and frequency for conducting radiation surveys.

METHODS OF SURVEYS

Suggested methods for performing these two types of surveys are given below. Records of these surveys should be maintained for inspection by the Agency and for reference to determine whether the radiation levels or the contamination levels remain constant or increase over a period of time.

a) Radiation Level Surveys - A survey meter capable of measuring levels as low as 0.1 mR/h should be used and the results recorded on a standard form showing location, date, person performing survey, instrument used, exposure levels, and corrective action taken, if any. A sketch of the area should be used to make an easily prepared and easily understood survey record when annotated with this information.

b) Contamination Level Surveys - A series of wipes using filter papers or swatches of cloth should be taken from those surfaces where contamination could be expected to exist or where radiation levels are fairly high. (Areas where solutions are prepared, incoming packages received, pipetting is performed, etc., are areas that may be contaminated.) The wipes should be numbered or labeled and their location indicated on the sketch record as described above. The wipes should each be rubbed over a surface area of about 100 square centimeters to maintain a consistent means of determining the amount of removable contamination. The wipes may be counted using a gamma scintillation well counter, a Geiger counter, or any other detector capable of detecting the small amount of contamination on the sample.

   Area surveys and wipe tests will be performed only if there is evidence of a damaged sealed source, and to document radiation levels around sealed source storage locations.

ACCEPTABLE LIMITS

a) Radiation Levels - In no area that is unrestricted (uncontrolled) should radiation levels exist such that a person could receive 100 mR in any one year, or 2 mR in any one hour. If such areas are found, measures should be taken to eliminate the excessive radiation levels. Additional shielding or relocation of radioactive material may be required. For restricted areas, the applicant should establish acceptable radiation levels that are as low as reasonably achievable.

b) Contamination Limits - If the wipe samples counted indicate more than 1,000 disintegrations per minute (dpm), the area should be cleaned until the contamination has been removed. Since it is difficult to determine exactly when a wipe sample has 1,000 dpm, it is recommended that, when such samples show an easily detectable amount of activity above background, the contaminated areas be cleaned. This action should help prevent the spread of contamination and ingestion of activity by personnel whose hands or clothing become contaminated.

SPILLS AND ACCIDENTS

Emergency notification of the Office of Risk Management and Safety staff is made by calling 254-459-5458 during normal working hours and 254-968-9265 after hours and on weekends. Emergency procedures are included as **Appendix C**.

A copy of the appropriate emergency procedures should be posted in each laboratory where radioactive material is used or stored.

The Office of Risk Management and Safety (5458) or the University Control Center (9265) should be immediately notified of spills or accidents. Primary responsibility for cleanup of such spills rests with the PI. The Office of Risk Management and Safety and University Compliance will advise and assist the PI in decontamination. The PI should ensure that his / her lab personnel are available to assist in the decontamination of the facility.

PERSONNEL MONITORING

In 2004, an initial exposure assessment was performed under the direction of Dean Jones, Tarleton RSO (at the time) Personnel monitoring badges were worn by various individuals with area surveys being performed. The resulting Radiation Dosimetry Report reflected no exposure above TLD. Based upon this assessment badge monitoring was discontinued at that time. No system changes have occurred within the equipment or program that should require additional badge monitoring.

SURVEY INSTRUMENTS

Each laboratory or facility in which radioactive materials is utilized shall have available a survey instrument that is capable of detecting and measuring the radiation or radioactive material. This instrument shall be readily available to laboratory personnel and be utilized to detect any possible contamination of personnel and/or facilities.

Specific equipment that Tarleton utilizes includes the following:

Ludlum Model 3 Survey Meter, Sensitivity = 0-200 mR/Hour
Ludlum Model 44-9 Pancake GM Detector

The calibration of survey instruments will be performed by a firm(s) licensed for such calibration by the Texas Department of State Health Services. Survey instruments shall be calibrated at least once a year or as required by the manufacturer. In the event that a survey instrument requires repair, and/or new batteries, then recalibration will be required before the instrument is returned to service.

Calibration and service of equipment is performed by the following company:

Ludlum Measurements, Inc.
Post Office Box 810
501 Oak Street
Sweetwater, Texas 79556
Ph: 915-235-5494
Fax: 915-235-4672

A record of instrument calibration shall be filed in University Compliance.

LEAK TESTING

Leak testing will be performed by the following company (or other licensed leak test facility in the State of Texas):

Suntrac Services, Inc.
1818 East Main Street
League City, Texas 77573
Ph: 800-579-4513
Email: info@suntrac.com

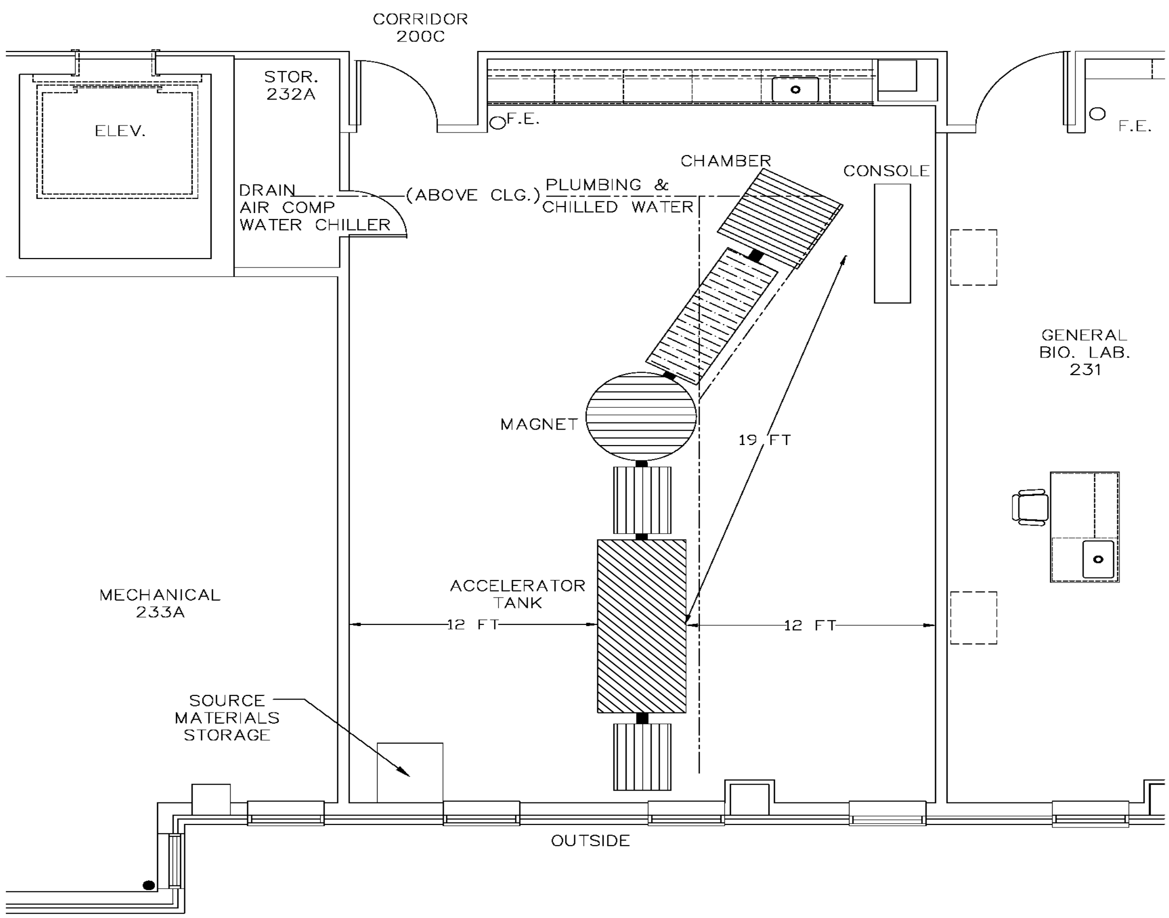
KEY PERSONNEL (See Appendix D for Complete Resume/Vita

Dr. Marble, Professor, Chemistry, Geoscience, and Physics Department, PI
Kent Styron, AVP, University Compliance, RSO

APPENDICES

APPENDIX A - FACILITY DRAWING

TARLETON STATE UNIVERSITY
ACCELERATOR LABORATORY
SCIENCE BUILDING
ROOM 232



ENGINEERING PHYSICS 232

SCIENCE BUILDING

APPENDIX B - MATERIALS INVENTORY FORM

OFFICE OF RISK MANAGEMENT AND SAFETY
BOX T-0830 λ STEPHENVILLE, TEXAS 76402
254-968-9237 λ FAX 254-968-9658

RADIOACTIVE MATERIAL INVENTORY FORM

Note: This form must indicate all transactions involving radioactive material. Indicate each receipt, transfer or disposal of radioactive material. This form must be kept as a permanent record pertaining to the use of radioactive material.

Page 1 of _____

Project Name	Building Name	Rm No.
Accelerator Laboratory	Science	232

RAM User	Signature	Date
Dr. Dan Marble		

INVENTORY OF RADIOACTIVE MATERIAL USAGE

Date of Transaction	Description of Material and Manufacturer	Volume of Material	Activity of Material	*Status	Inventory Ck. Date/ Initials	Inventory Ck. Date/ Initials	Inventory Ck. Date/ Initials	Inventory Ck. Date/ Initials	Inventory Ck. Date/ Initials	Inventory Ck. Date/ Initials

*** Status – Received, Transferred or Disposed**

APPENDIX C - EMERGENCY PROCEDURES

Emergency Procedures

INCIDENTS AND EMERGENCIES

PURPOSE AND SCOPE

In the event of a radiological incident or emergency Contact 911. The university control center will contact a representative of the Office of Risk Management and Safety (RMS) and University Compliance. In instances where there is doubt whether such notification is necessary, contact should be made to allow RMS to assess the situation and initiate an appropriate response.

RMS is on-call for emergency response 24-hours per day, seven days per week.

During normal business hours:

Contact (254) 459-5458

After normal business hours, weekends and holidays:

Contact University Control Center at (254) 968-9265

University Police Department (911)

What constitutes an Incident or Emergency

1. Loss or theft of any radioactive material or radiation producing device.

The following concerns are unlikely based on Tarleton's current operation utilizing only "sealed source" radioactive materials.

2. High or potentially high radiation exposure to an individual or to a member of the public.

3. Intake or potential intake of radioactive materials by inhalation, injestion, absorption through skin, or injection through skin or wound.

4. Deceptive or potentially deceptive exposure of a dosimeter.

5. Personnel contamination that cannot be completely removed after two washes with soap and water.

6. Spills involving any quantity of alpha emitting radionuclide, more than 1 microcure of iodine-125 or iodine-131, or spills involving more than 10 microcuries of any other radionuclide.

7. Any spill which is not or cannot be completely decontaminated before the end of that work day.

8. Identification of any contamination which is outside of the restricted area, such as spills tracked or otherwise spread into offices, hallways, vehicles, etc.

9. Accidental releases of radioactive materials to the environment.

10. Fires or floods which threaten to release radioactive materials to the environment or which threaten to expose emergency response personnel.

11. Any transportation accident, whether on-campus, involving radioactive materials.

12. Any personnel injuries which may involve radioactive contamination or radiation exposure.

Personnel Injury Involving Actual or Suspected Contamination or Exposure to Radiation

1. Provide first aid immediately for serious injuries.

2. Call 911 from a University phone or cell phone.

3. Notify University Control Center

4. As possible, without doing harm to the individual and remove contaminated clothing and gross personal contamination.

Decontamination of Personnel

1. Remove and bag all contaminated clothing.

2. Skin contamination should be cleaned using mild soap and tepid water. Use portable survey meter to monitor for remaining contamination. If not free of contamination, rewash and resurvey. Decontamination solutions which are formulated for use on skin may be used, if available.

3. Survey for contamination elsewhere on body as well as on clothes, shoes, floor, door handles, telephone, etc. Document the surveys.

4. If the contamination is in a wound rinse the wound with copious amounts of water.

Radioactive Spills or Releases

Decontamination shall be the responsibility of the group that created the release. For large spills (i.e., greater than 10 microcuries) or spills that are difficult to clean up, the work should be carried out under the direction of RMC. Appropriate protective clothing shall be worn during decontamination activities. Steps to respond to incidents are:

1. Stop work and confine spill immediately using absorbent, enclosure, etc. Call RMC.

2. Warn others of the hazard and isolate the area.

3. Monitor personnel during and after cleanup for contamination.

4. Collect all used cleanup materials as radioactive waste. Remove and bag all contaminated clothing or cleanable items for removal by RMC.

5. Commence wipe surveys and decontamination. Ensure wipe surveys of surrounding areas are performed to ensure all contaminated items are identified.

APPENDIX D - KEY PERSONNEL RESUME/VITA

Present Position

Associate Professor of Physics
Department of Engineering and Physics
Tarleton State University
Stephenville, Texas 76402
Telephone: 254-968-9863
Fax: 254-968-9503
e-mail: marble@tarleton.edu

DR. DANIEL MARBLE, Ph.D.

Personal Data

Date of Birth: 17 January 1962
Place of Birth: Norman, Oklahoma
Citizenship: U.S.A.
Spouse: Kathy Scott-Marble, M.S. in Counseling Psychology
Children: Christopher - born 3/16/94
Kassie - born 12/18/95

Education

Ph.D. Physics, University of North Texas, 1991.
M.S. Physics, North Texas State University, 1985.
B.S. Electrical Engineering, University of Houston, 1984.
A.A. PreMed and Physics, College of the Mainland, 1981.

Work Experience

2006-Present Associate Professor of Physics at Tarleton State University

1998-2006 Assistant Professor of Physics at Tarleton State University
1994-1998 Assistant Professor at the U.S. Military Academy
1997-2005 Visiting Scientist Army Research Lab Materials Directorate
1994-1997 Visiting Scientist Army Research Lab Physical Sciences Directorate
1996-1998 Part Time Math Instructor at SUNY New Paltz
1991-1994 Postdoctoral Fellow and Adjunct Professor at University of North Texas
1993-1994 Part Time Physics Instructor at Tarrant County Junior College (Northeast Campus)
1984-1991 Graduate and Teaching Assistant at the University of North Texas
1980-1984 Physics Lab Assistant at College of the Mainland Junior College

Courses Developed or Taught

- Physics I
- Modern Physics
- Fortran Programming and Numerical Methods
- Physics II

- Electronics
- Electrical Engineering Individual Research
- Engineering Physics I
- Quantum Mechanics
- Electronics I for Non-Science Majors
- Engineering Physics II
- Nuclear Physics
- Electronics II for Non-Science Majors
- Astronomy
- Mathematical Methods for Physicists
- College Algebra
- Physical Science I
- Physics Individual Research
- Trigonometry
- Physical Science II
- Special Problems in Physics
- Contemporary Applications of Mathematics
- Medical Physics I
- Medical Physics II
- Intermediate Mechanics

Selected Colloquium or Invited Presentations

1999 - Army Research Laboratory Invited Colloquium (Dr. Ralph Adler)

1998 - 15th International Conference on the Applications of Accelerators in Research and Industry - Denton, Texas (Dr. Jerome L. Duggan)

1998 - Sixth Annual U.S. Army Research Laboratory/United States Military Academy Joint Technical Symposium – Army Research Laboratory, Aberdeen Proving Grounds (MAJ Mike Phillips)

1997- Fifth Annual U.S. Army Research Laboratory / United States Military Academy Joint Technical Symposium - West Point, New York (LTC Don Engen).

1997- United States Military Academy - Department of Physics (MAJ Toney Cariello)

1996- 14th International Conference on the Applications of Accelerators in Research and Industry - Denton, Texas (Dr. Jerome L. Duggan)

1996- Fourth Annual U.S. Army Research Laboratory / United States Military Academy Joint Technical Symposium - West Point, New York (MAJ Don Engen)

1995- Third Annual U. S. Army Research Laboratory / United States Military Academy Joint Technical Symposium - West Point, New York (MAJ Don Engen)

1995- United States Military Academy - Department of Physics (LTC James Nichols)

1994- Workshop on Teaching with Small Accelerators - Preceding the 13th International Conference on the Applications of Accelerators in Research and Industry - Denton, Texas (Drs. James Lambert and Jerome Duggan)

1994- United States Military Academy - Department of Physics (COL. Raymond Winkle)

1994- Middle Tennessee State University - Department of Physics (Dr. Robert Charlton)

1993- University of North Texas - Department of Physics (Dr. Don Kobe)

1993- Sandia National Laboratory - Materials Division (Dr. Barney Doyle)

1993- Austin College - Physics Department (Dr. Larry Robinson)

1993- East Texas State University - Physics Department (Dr. Ben Doughety)

Professional Workshops and Programs

1997 Workshop on Ferroelectric Thin Films, Fall 1997 MRS Meeting, Boston, Massachusetts

1994 Third Biannual Workshop on Teaching With Accelerators, Denton Texas

1994 New Instructor Training Program at U. S. Military Academy West Point New York From July 6 - August 10, 1994

1994 AAPT Teaching Workshop on Electrostatics

1992 Workshop on New Developments in Characterization of Materials With Ion Beams Preceding the 12th International Accelerator Conference, Denton Texas

1990 First Biannual Workshop on Teaching With Accelerators Preceding the 11th International Accelerator Conference, Denton Texas

1988 Accelerator Ion Source Workshop Preceding the 10th International Accelerator Conference, Denton Texas

1987 Summer Material Research Society Meeting and Workshop on Characterizing Materials, Dallas Texas

Professional Activities and Committee Work

1998 Math and Physics Recruitment Committee

1998-99 Developed New Engineering Physics Program

1998-99 Tarleton State University SPS Faculty Representative

1998 Chairman of a Session and Organizer of all Sessions on Undergraduate Teaching with Accelerators at the 15th International Conference on the Applications of Accelerators in Research and Industry - Denton, Texas (Dr. Jerome L. Duggan)

1996-98 Company G-4 Academic Counselor

1997 Ph.D. Thesis Committee Member at University of Missouri at Rolla for MAJ Peter Laky

1997 Physics Department Core Course Curriculum Assessment Committee

1996 Session Chairman at the 14th International Conference on the Applications of Accelerators in Research and Industry - Denton, Texas (Dr. Jerome L. Duggan)

1996 USMA Physics Department Open House (Modern Physics Display)

1995-6 Judge at the West Point Elementary and Junior High School Science Fairs

1984-93 Judge at the Annual High School Physics Olympics at UNT

1991-93 Member of the Rules Committee for the High School Physics Olympics at UNT

1985-89 Judge at the Lewisville School District Science Fair

1990-91 Treasurer of the UNT Chapter of the Society of Physics Students

Professional Awards and Scholarships (Accepted)

2004 Jack and Louise Arthur Excellence in Teaching Award

2003 Faculty Excellence in Scholarship Award

1998 Commander's Medal for Outstanding Civilian Service to the Department of the Army
1987 Who's Who in Physics at the University of North Texas
1987-91 Texas Instruments Predoctoral Fellowship in Physics
1981-84 University of Houston Cullen College of Engineering Scholarship
1981 Outstanding Physics Student Award by AAPT
1980 Dickinson Optimist Club Scholarship

Professional Organizations (Member)

American Association of Physics Teachers -- AAPT
National Society of Physics Students -- SPS
American Physical Society -- APS
National Honor Society of Physics Students -- Sigma Pi Sigma

National Engineering Honor Society -- Tau Beta Pi
National Honor Society of Electrical Engineers -- Eta Kappa Nu
National Honor Society for Scientific Research -- Sigma Xi
National Junior College Honor Society -- Phi Theta Kappa
North Texas Materials Characterization Society
Material Research Society -- MRS

Consulting and Refering

1997- Referee for AIP
1993-94 DSJ Systems of Dallas -- Development of Educational Software in Physics and Material Science
1993-94 Southwest Research Institute -- Nondestructive Techniques for Detection of Plastic Explosives Using Accelerators
1984-2002 8th, 9th, 10th, 11th, 12th, 13th,14th, 15th, 16th, and 17th International Conferences on the Application of Accelerators in Research and Industry

Research Interests

I. Physics And Science Education

- Advanced and Introductory Undergraduate Laboratory Experiments
- Development of Engineering and Physics Curriculums
- Secondary and Primary School Science Education
- Science Education for the General Public

II. Materials Science (Materials Characterization)

- Heavy Ion Backscattering (HIBS)
- Low Energy Time of Flight Elastic Recoil Detection Analysis (TOF-ERD)
- Ion Implantation (High and Low Energy)
- Particle Induced X-Ray Emission (PIXE)
- Nuclear Reaction Analysis (NRA)
- Rutherford Backscattering Spectrometry and Channeling (RBS)
- X-Ray and Synchrotron Radiation Fluorescence (XRF)
- Accelerator Mass Spectrometry (AMS)
- Elastic Recoil Detection Analysis (ERD)
- Secondary ion Mass Spectrometry (SIMS)
- Auger Electron Spectroscopy (AES)

III. Accelerator Based Atomic and Nuclear Physics

- Basic Ion-Atom Interactions Including Charge Exchange (Theory and Experiment)
- Nuclear Techniques for Detection of Plastic Explosives
- Nuclear Techniques for Dating Archaeological Artifacts (Arrowheads, etc...)

Research History

At present, my research interests are in science education, accelerator based atomic physics and the use of accelerators to characterize materials. In the process of my research, I have contained considerable technical experience in computer software and hardware, electronics, as well as vacuum and accelerator technology. I have either installed or made operational seven different accelerator systems: two 2.75 MV HVEC Van de Graaff accelerators, one 3 MV NEC Tandem accelerator, one 1.7 MV Nec Tandem accelerator, one 1 MV tandem accelerator, one 200 kV Texas Nuclear Cockcroft Walton accelerator, and one 400 kV HVEC Van de Graaff accelerator.

Science Education

Of special interest is the use of accelerators both for teaching advanced undergraduate physics and secondary school students. From 1984-1994, I was involved with Dr. Jerome L. Duggan to provide advanced accelerator and atomic physics labs for visiting student groups from small colleges. The response to these visits were very favorable and several students choose to attend graduate school at UNT. To expand our capabilities, we began developing a dedicated accelerator user facility in 1993 with a $300,000 grant from NSF and over $75,000 worth of equipment contributions from various companies including ORTEC and Tennelec. In addition, we expanded our user base to include both science and nonscience groups from community colleges as well as high school students. During this time, I designed and built several complete student labs including the development of all the written and visual materials that accompanied the labs. Among the labs developed were labs on Rutherford scattering, x-rays, measuring the speed of light using positron annihilation, charged particles in magnetic fields, conservation of momentum, measuring nuclear reactions. By providing instructors with both written and visual material of the labs prior to their arrival in Denton, instructors could choose the experiments that best suited their classes and prepare their students so as to maximize the learning experience. These labs were ran by students from several area high schools and community colleges as well as several colleges from Tennessee, Arkansas, New York, Oklahoma, and Texas. In all, more than 150 students visited the lab during its first year of operation and has the number has continued to increase during 1995.

After joining the physics department faculty at the United States Military Academy in 1994, I began working to develop an accelerator user facility by repairing the department’s 400 kV Van de Graaff accelerator. This machine which had been inoperable since the mid 1980’s is now completely renovated and operating up to terminal potentials of 600 kV. The facility has been expanded from 400 sq ft to 2000 sq ft to enable the accelerator to be used by visiting students from local high schools and colleges. These visits include both short lab classes as well as cooperative student research projects with some of the colleges. F During AY1997, I redesigned the senior nuclear physics class for to make extensive hands on use of the LC-400 accelerator. This included labs to measure the size of the nucleus, calibrate magnets using nuclear reactions and a lab to show the equivalence of mass and energy. Although the USMA accelerator facility still requires a considerable capital equipment investment to become a research grade material analysis facility, considerable progress has been made. While at West Point, I was able to obtain over $50K in Army Research Office and internal funds along with more than $75K of transfered and donated equipment for improving both the teaching and materials characterization capabilities of the USMA accelerator facility. While a faculty member at Tarleton State University, I was able to secure the donation of a 1 MV Tandem accelerator and associated hardware from CalTech as well as obtaining over $1,000,000 of internal and external research funding.

Material Science (Material Characterization)

Since 1985, I have been involved in the characterization of both thin films and bulk materials using ion beam techniques. In addition to collaborating with scientists in academia, this research has also included collaborations with scientists from both private industry and government laboratories including Drs. Mark Anthony, Bruce Gnade, and Joe Keenan of Texas Instruments, Dr. Syd Wilson of Motorola, Dr. Joe Kirchhoff of Charles Evans and Associates and Drs. Robert Pfeffer, J. Derek Demaree and James Hirvonen of the Army Research Laboratory.

While at West Point, I setup a characterization lab in the Department of Physics by repairing and improving their existing 400 kV Van de Graaff accelerator. My primary goal was to develop the capability to analyze materials using both Heavy Ion Backscattering Spectrometry (HIBS) and the related technique of low energy Time-of-Flight Elastic Recoil Detection (TOF-ERD). These techniques having been developed independently by Drs. Barney Doyle of Sandia National Laboratory and Robert Weller of Vanderbilt University are powerful techniques for detecting extremely low impurity concentrations of surface contaminants in semiconductor materials. Both techniques take advantage of the increase in the scattering cross section for both decreasing ion beam energy and increasing atomic number of the incident ion. Thus, a smaller accelerator than that used in conventional IBA techniques is required. My work centered on improving the energy stability of the machine that limited its mass resolution and hence its applicability as an analytical tool along with upgrading the vacuum system to allow for surface science measurements.

A second material research thrust involved a joint collaboration with Dr. Robert Pfeffer of the Physical Sciences Directorate (formerly ETDL) of the Army Research Laboratory and then with Drs. J. Derek Demaree and James Hirvonen of the Weapons and Materials Directorate to develop a Nuclear Reaction Analysis system for profiling hydrogen in metals, semiconductors, and ferroelectric materials using NRA. This research centered around the designing and building of a beamline, target chamber and detection system for measuring hydrogen in materials using the $^{1}H(^{15}N,ag\ )^{12}C$ nuclear reaction. Ferroelectric materials show great promise in a) developing uncooled planar arrays for night vision, b) radiation resistant memory devices and c) variable capacitors for integrated circuit technology. The primary methods of producing ferroelectric thin films are sol-gel deposition, pulsed laser deposition, RF sputtering, and CVD. Of these methods sol-gel deposition and CVD are the most useful. Sol-gel deposition is the easiest manner in which to produce high quality laboratory films. CVD, although extremely difficult to set up, is the best for scaling up to industrial sizes and quantities. Both of these methods, however, are known to produce films with significant hydrogen contents. Hydrogen incorporated in bulk ferroelectric crystals has been shown to affect the mobility of domain walls as well as to alter their dielectric spectra. Because of its high diffusivity and reactivity and the hygroscopic nature of perovskites, it may well be that hydrogen contamination is responsible for a good deal of the variability plaguing ferroelectric thin film device structures, commonly attributed to "uncontrolled processing parameters." Wide band gap materials including SiC and GaN have superior materials properties as compared to conventional silicon devices. Unfortunately, such materials are plagued by materials difficulties in producing materials of sufficient quality to manufacture actual devices. Recent processing techniques to overcome these difficulties including hydrogen cleaving and sputtering of SiC and the use of hydrogen to vary the emission wavelength of GaN lasers all show promise but have the potential for hydrogen contamination with possible detrimental effects. NRA will provide a bulk depth profiling technique for ARL as well as providing a means to standardize data taken at ARL using SIMS. During the summer of 1997, I constructed a new high sensitivity hydrogen detector system at ARL in collaboration with Drs. Hirvone and Demarree of ARL and Drs. Illa and Zimmerman of Alabama A&M as part of an ARO funded project. This detector system uses a coincidence configuration between the first escape peak from the primary gamma ray and the 511 keV escape gamma ray to reject cosmic ray background. During the summer 1998, the system was used to profile hydrogen in a wide variety of materials including wide band gap semiconductors, metals, and polymers in conjunction with the Naval Surface Warfare Center at Carderock. This research eventually culminated in a project at Tarleton State University's accelerator facility to improve background reduction and sensitivity through the design and construction of a new NRA detector externally funded through a grant from the National Science Foundation and Research Corp.

Prior to 1994, I was involved in a variety of research efforts involving both the use and development of material characterization techniques at the University of North Texas. This research grew significantly in 1987 with the building of the Ion Beam Modification and Analysis Laboratory (IBMAL) at UNT and again in 1992 with the formation of a National Science Foundation research center: Industry/University Cooperative Research Center for Nanostructural Materials. In the center, a wide range of techniques are available including Rutherford Backscattering Spectrometry (RBS), Particle Induced X-Ray Emission (PIXE), and Accelerator Mass Spectrometry (AMS).

Rutherford Backscattering using both helium and heavy ions was performed on a wide range of samples. Research using X-Ray Photoelectric Spectroscopy (XPS) and RBS with Baylor College of Medicine and Texas Instruments showed that oxide films on dental tooth amalgams were unstable and did not prevent the migration of mercury and other metals as previously thought. RBS and channeling was also performed on buried oxide layers in silicon after annealing to determine crystal quality. This research has demonstrated that Silicon-on-Insulator (SOI) materials formed by high dose oxygen ion implantation and subsequent epitaxial grown silicon layers are far superior to conventional Silicon-on-Sapphire (SOS) materials and therefore SOI is a leading candidate for Very Large Scale Integrated (VLSI) circuit applications. RBS was also performed on ZnS, diamond and GaAs wafers.

Nuclear Reaction Analysis (NRA) was used to detect and profile trace impurities of hydrogen, carbon, and fluorine in materials. NRA was used to detect hydrogen in steel, silicon, diamond, ZnS, and solar cell samples using both the $^{1}H(^{15}N,ag)^{12}C$ and $^{1}H(^{19}F,ag)^{16}O$ nuclear reactions. Hydrogen impurity levels to 100 ppm were measured using a BGO detector along with plastic scintillator and fast timing electronics acting as a veto detector to reduce cosmic ray noise. I developed software to enable hydrogen profiling of samples by complete computer control including control of the accelerator. Flexible analysis software was also produced in collaboration with Dr. Grygory Viskelethy of Idaho State University. The results have been compared favorably with depth and sensitivity to low energy ERD for hydrogen profiling. Fluorine profiling using an inverse reaction has also been performed to settle a patent infringement case for 16 Meg DRAMS. Low level carbon concentrations in BaSrTi on Pt on ZrO_2 structures have measured using both $^{12}C(p,p)^{12}C$ nuclear reaction and the $^{12}C(a\ ,a\ )^{12}C$ nuclear reaction at 4.29 MeV.

A unique feature of IBMAL is its stable isotope accelerator mass spectrometry system (AMS). The UNT AMS system which was built in collaboration with Texas Instruments is presently the only stable element accelerator mass spectrometry system in the world. When fully completed this system will allow for part per trillion impurity determination in semiconductors. I was involved in the retrofitting of the existing accelerator hardware, in the design and implementation of the computer control hardware, development of a new ultraclean ion source, and the design and implementation of the primary ion beam rastering and imaging systems. The AMS system has already exceeded the present capabilities of static Secondary ion Mass Spectrometry (SIMS) machines. Samples that have been analyzed by AMS include HgCdTl, GaAs, and Si wafers. Carbon rods from POCO Graphite have also been analyzed for sulfur contamination.

Finally, I have been involved in a wide variety of other research projects over the years including: single event upsets (IBIC) in semiconductors using an extracted helium beam with Dr. Tom Aton of Texas Instruments, X-Ray Fluorescence of steel turbine rotor blades with both synchrotron and radioactive light sources, Particle Induced X-Ray Emission (PIXE) studies of a wide variety of samples and ion implantation with Dr. Joe Kirchhoff of Charles Evans and Associates; characterizing tertiary and ternary films for diffusion barrier and high temperature resistor applications with Marc A. Nicolet of CalTech; characterizing wide band gap and magnetic materials with Carlos Gutteriez formerly of Texas State University. Presently, I am working to develop a PIXE capability for measuring trace element contaminants in soil, water, and samples for environmental applications.

Accelerator Based Atomic and Nuclear Physics

Since 1984, I have been involved in a wide range of experiments in both basic ion-atom interaction physics and in applying this information to solve unique problems in non-traditional physics research fields. My primary interests have been involved in both the study of heavy ion-atom collisions and medium energy collisions (incident ion scaled energy < 1 MeV/u) where present theories of x-ray cross sections for these ion-atom collisions deviate from experimental results. This is due partly to the difficulty of solving this quantum mechanical many body process in a region where the simplifying assumptions used in fast and slow collisions asymmetrical are no longer available. Additionally, many additional physical processes such as charge exchange, multiple ionization and molecular orbital ionization further complicate theoretical interpretation of the data mostly due to a lack of good experimental data caused by instrumentation limits. Theoretical improvements are essential to the development of PIXE on heavy ion microprobes such as the one being funded by the State of Texas and NSF for development at the University of North Texas. Heavy Ion PIXE would provide superior sensitivity to impurities that conventional proton based PIXE systems due to increasing cross section with the atomic number of the incident ion. Unfortunately, the technique is presently not feasible due to poor quantitative capabilities caused by the lack of a comprehensive theory to account for the complex nature of the physical processes including chemical effects, multiple ionization. However, recent improvements in x-ray detector technology for the semiconductor industry may provide the necessary tool to overcome these problems. These new detectors built for scanning electron microscopes have resolutions of less than 10 eV and efficiencies approaching that of Si(Li) detectors. If appropriately modified for ion-atom collisions, these detectors could provide a wealth of experimental results that were previously unattainable and greatly simplify data interpretation.

My research effort at West Point was in measuring L-shell and K-shell x-ray cross sections for 200-600 keV protons on selected targets including among others Fe, Cu, Ni, Rb, U, and Bi. At present, the West Point accelerator has been upgraded and a new multipurpose target chamber and beamline has been designed and constructed by an undergraduate student using equipment donated by both Dr. James Lambert of Georgetown and the Army Material Command as well as equipment purchased through internal funds from an Army Research Office account at West Point. This research was being performed in collaboration with Dr. Richard Wheeler of SUNY Cortland. The work supplements our previous work with 100-225 keV protons as well as that of other researchers at higher proton energies > 750 keV. The previous experimental work has shown that present theoretical methods such as the ECPSSR theory correctly calculate x-ray cross sections for protons on targets at proton energies > 1 MeV. These proton cross section measurements may be of use in future improvements in material characterization using PIXE if lower proton beam energies are required. Such beam energies may be necessary in order to be able to analyze contaminants in thin films without interferences from the bulk material in future semiconductor applications where film thickness will continue to decrease. This is in fact the driving force behind the development of new x-ray detectors where electron beam energies will have to be lowered substantially. Finally, these studies could be greatly expanded with the acquisition of the new high resolution detectors.

Since 1984, I have been involved in numerous other collaborations to measure x-ray production cross sections including research with Drs. R. Wheeler and R. Chaturvedi of the State University of New York at Cortland, Dr. Michael McNeir of the Army Research Laboratory in Aberdeen Maryland, Dr. V. Zoran of the Central Institute for Atomic Physics Research in Bucharest Romania, Dr. R. Mehta of Central Arkansas, Dr. G. Lapicki of East Carolina State University, Dr. Jack Price at the Naval Surface Warfare Laboratory in Silver Springs Maryland, as well as my former colleagues at the University of North Texas. One of the experimental problems that has plagued this field is the development of ultrathin and ultraclean solid targets that could provide single collision measurements. Such targets are essential for accurate charge transfer measurements without x-ray interferences from ppm level trace impurity elements. We developed a new method for producing ultraclean target foils with thickness less than 1 m g/cm^2. In the process, we discovered that many previous measurements at Oak Ridge and other facilities were flawed due to the use of peak fitting routines to remove the Na impurity peak from their spectra based on the detector's response to a characteristic x-ray. X-rays from electron bremsstrahlung also fall in this region of the spectra. The bremsstrahlung peak has a broader width than a characteristic Na x-ray peak. Also, the bremsstrahlung peak differs in its dependence on the incident ion's energy and atomic number than does the sodium photopeak.

Using new windowless Si(Li) x-ray detectors and ultraclean, ultrathin targets, a new method was developed to obtain accurate x-ray cross sections for low energy x-ray energies, < 1.2 keV.

I have also been involved in both the experimental measurement and theoretical prediction of chemical effects (multiple ionization) on x-ray cross section measurements using high resolution Si(Li) c-ray detectors. Si(Li) x-ray detectors and other energy dispersive spectrometers are superior to crystal spectrometers for most x-ray measurements due to their larger efficiencies. However, since they have poorer resolution, Si(Li) detectors are unable to resolve sub-multiples and other detail information in x-ray spectra. Unfortunately, the probability that an x-ray is produced in a heavy-ion collision depends on the number of electrons available since the atom may also deexcite by auger electron emission. The number of electrons available depends on the kinematics of the collision as well as chemical environment seen by the target atom. Thus, in order to properly compare experimental x-ray cross section measurements to theoretical ionization probabilities, corrections must be made for multiple ionization. In the past, these effects have been ignored or accounted for by simple binary collision techniques that have been shown to be inaccurate. With improved windowless Si(Li) detectors, attempts have been made to extract multiple ionization information from x-ray spectra by noting the shift in the energy of the x-ray photopeak. This is extremely difficult in the case of low energy x-ray peaks due to bremsstrahlung and other artifacts. This work as stated previously is important in the application of the new heavy ion microprobe as PIXE system. Furthermore, with the development of new high efficiency and high resolution detectors, this field shows greatly improved possibilities for important new discoveries and external funding.

All of the work previously mentioned has been necessary so that accurate cross section measurements could be performed. Over the last ten years, we have checked the accuracy of several theoretical models for ionization using a wide range of target and projectile combinations over a wide range of incident ion energies. In particular, we have examined the accuracy of the Nikolev formalism for predicting the electron capture contribution to the x-ray cross section. We have also examined the direct ionization and molecular orbital (Pauli excitation) contributions to the cross section. Experimental measurements of slow symmetrical collisions performed over the past five years at UNT and Bucharest have shown that the simple Nikitin model of molecular orbital ionization is valid for many ion-atom systems. This model which had previously been disregarded as incorrect, allows for the accurate calculation of x-ray cross sections for many ion-atom systems that would have been impossible using more sophisticated models.

A separate interest has been the in the use of atomic and nuclear physics techniques to solve problems in other branches of physics. One of the more successful of these ventures has been as a consultant on a project with Dr. Floyd McDaniel of the University of North Texas and Drs. Collin Nicholls, Ralph Hill and Mr. Derwin King of Southwest Research Institute at San Antonio Texas to demonstrate the feasibility of detecting of detecting plastic explosives in real time using gamma ray absorption. Gamma rays were created using the $^{13}C(p, g)^{14}N$ nuclear reaction. Since plastic explosives contain nitrogen, the absorption of the gamma ray from the reaction will be enhanced when the sample is at an angle where the energy of the gamma ray is Doppler shifted to match an energy level transition in the nitrogen nucleus. By measuring the dip in the transmitted gamma rays as a function of angle, the nitrogen concentration in the sample can be determined. A new proprietary technique is now being developed to distinguish plastic explosives from other nitrogen containing materials by determining the chemical environment on the nitrogen nucleus. Thus, the need to independently measure the carbon, oxygen and nitrogen concentrations would be eliminated allowing for real time analysis for airport use. A second project has been in the dating of flint archeological artifacts (arrow heads, etc..) by the amount of fluorine present. Preliminary studies in Paris have shown that fluorine concentration may be used as a reliable dating technique for arrow heads found in Europe. Such research was initiated while I was at UNT under the guidance of Dr. Sam Matteson of the Physics Department and Dr. Reed of the Archaeology Department using the $^{19}F(p, a\ g\ )^{16}O$ nuclear reaction to date artifacts from North America and Europe. This work has recently succeeded in obtaining external funding and a new accelerator is being dedicated to the project at UNT. Since the lower energy reactions can be performed on smaller machines, I am presently interested in attempting to follow up on this work at West Point using its lower energy accelerator to look at the large number of artifacts in the historically rich Hudson Valley region and nearby Mohawk Indian reservation.

Another interest is in the study of energy losses that an ion experiences when traveling through a solid. My main interest is in experimentally determining the energy loss of ions in the 100-500 keV region in compound materials especially ferroelectric, superconductors, and phosphor materials used in flat panel displays. Although considerable energy loss information exists for the use of many species of lower energy ions in ion implantation and the energy loss of ions at all energies in silicon, little data exists for nonstandard IBA ion energies for these new novel materials. Such information will be needed to fully exploit the usefulness of the new low energy ion beam techniques such as heavy ion backscattering and time-of-flight elastic recoil detection. Since the Bragg scaling law is known to be inaccurate for many compounds, it would be surprising if it should work for these materials. At present, there appears to be very little literature in this area except for a couple of papers at the most recent Ion Beam Analysis conference.

Publications: Daniel K. Marble

Selected Invited Refereed Publications

1. "Using Small Accelerators to Teach Undergraduate Physics," D.K. Marble, Proceedings of the Fifteenth International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 4-10, 1998, Ed. by J.L. Duggan and I.L. Morgan, AIP Conference Proceedings (submitted for publication). (Refereed)
2. "Using a 400 kV Van de Graaff Accelerator to Teach Physics at West Point," D.K. Marble, S.E. Bruch, and T. Lainis, Proceedings of the Fourteenth International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 5-10, 1996, Ed. by J.L. Duggan and I.L. Morgan, AIP Conference Proceeding 392 Vol.2, pp 1127, 1997.
3. "Accelerator Based SIMS for Impurity Analysis," J.M. Anthony, J.F. Kirchhoff, D.K. Marble, S.N. Renfrow, Y.D. Kim, S. Matteson, and F.D. McDaniel, Proceedings of the 40th National Meeting of the American Vacuum Society, Orlando, Florida, November 15-19, 1993.
4. "Improved Trace Impurity Characterization in the Electronics Materials Industry by Accelerator Mass Spectrometry," F.D. McDaniel, J.M. Anthony, J.F. Kirchhoff, D.K. Marble, Y.D. Kim, S.N. Renfrow, and S. Matteson, Proceedings of the Fourth International Conference on Nuclear Microprobe Technology and Applications, Shanghai, China, October 10-14, 1994.
5. "Impact-Parameter-Averaged Probability of 3ds - Vacancy Sharing in Heavy Systems," D.K.

Marble, F.D. McDaniel, V. Zoran, Z. Szilagyi, I. Piticu, D. Fluerasu, A. Enulescu, D. Dumitriu, B.I. Bucur, and C. Ciortea, Proceedings of the Fourteenth International Workshop on High Energy Atomic Collisions, Oberstdorf, Germany, January 1993, p 32.

6. "Model of the Contamination Effect in Ion-Induced Electron Emission," A.M. Arrale, Z.Y. Zhao, J.F. Kirchhoff, D.K. Marble, D.L. Weathers, F.D. McDaniel, and S. Matteson, Proceedings of the Third European Conference on Accelerators in Applied Research and Technology, Orleans, France, August 31 - September 4, 1993.

7. "Impurity Detection In Electronic Materials By Accelerator Mass Spectrometry," F.D. McDaniel, J.M. Anthony, J.F. Kirchoff, D.K. Marble, Y.D. Kim, S.N. Renfro, E.C. Grannan, E.R. Reznik, G. Vizkelethy, and S. Matteson, Proceedings of the Third European Conference on Accelerators in Applied Research and Technology, Orleans, France, August 31 - September 4, 1993.

8. "L-shell X-ray Production Cross Sections for 29Cu, 31Ga, 32Ge, 35Br, 39Y, 60Nd, 64Gd, 67Ho, 70Yb, 79Au, and 82Pb for 2-25 MeV Carbon Ions," R. Mehta, J.L. Duggan, F.D. McDaniel, M.R. McNeir, Y.C. Yu, D.K. Marble, G. Lapicki, M.C. Andrews, P.D. Miller, P.L. Pepmiller, H.F. Krause, T.M. Rosseel, and L.A. Rayburn, Proceedings of the Twelfth International Conference on the Application of Accelerators in Research and Industry, Denton, Texas, November 2-5, 1992, Ed. by J.L. Duggan and I.L. Morgan, Nucl. Instrum. and Methods in Physics Research B79, (1993), 179.

9. "Characterization of Electronic Materials Using Accelerator Mass Spectrometry," F.D. McDaniel, J.M. Anthony, S. Matteson, D.L. Weathers, J.F. Kirchhoff, G. Vizkelethy, D.K. Marble, Y.D. Kim, I. Hassan, and Z. Zhao, Proceedings of the Third International Conference on Applications of Nuclear Techniques for Analytical and Industrial Applications, Mykonos, Greece, June 6-13, 1992, p. 179 (1993).

10. "Trace Element Analysis by Accelerator Mass Spectrometry," F.D. McDaniel, S. Matteson, D.L. Weathers, J.L. Duggan, D.K. Marble, I. Hassan, Z.Y. Zhao, and J.M. Anthony, Proceedings of the Eighth International Conference on Modern Trends in Activation Analysis, Vienna, Austria, September 16-20, 1991, Journal of Radioanalytical and Nuclear Chemistry 167, 423 (1993).

11. "Radionuclide Dating and Trace Element Analysis by Accelerator Mass Spectrometry," F.D. McDaniel, S. Matteson, D.L. Weathers, J.L. Duggan, D.K. Marble, I. Hassan, Z.Y. Zhao, and J.M. Anthony, Proceedings of the Second International Conference on Methods and Applications of Radioanalytical Chemistry, Kona, Hawaii, April 21-27, 1991, Journal of Radioanalytical and Nuclear Chemistry, Vol. 160, (1992), 119.

12. "Materials Characterization Using Accelerator Mass Spectrometry," J.M. Anthony, R.L. Beavers, T.J. Bennet, S. Matteson, D.K. Marble, D.L. Weathers, F.D. McDaniel, and J.L. Duggan, Proceedings of the Eleventh International Conference on the Application of Accelerators in Research and Industry, Denton, Texas, November 5-8, 1990, Ed. by J.L. Duggan and I.L. Morgan, Nucl. Instrum. and Methods in Physics Research B56/57, (1991), 873.

13. "Ion Beam Techniques for Materials Modification and Analysis," F.D. McDaniel, D.L. Weathers, J.L. Duggan, S. Matteson, and D.K. Marble, Proceedings of the Second International Conference on Applications of Nuclear Techniques, Heraklion, Crete, Greece, June 24-30, 1990, World Scientific Publishing Co., (1990), 307.

14. "X-Ray Production in Fluorine by Highly Charged Boron, Carbon, and Oxygen Ions," F.D. McDaniel, D.K. Marble, J.L. Duggan, M.R. McNeir, Y.C. Yu, D.L. Weathers, P.S. Elliott, R.M. Wheeler, R.P. Chaturvedi, and G. Lapicki, Proceedings of the Joint U.S.-Japan Seminar on

Dynamical Excitations by Highly Charged Ions , Anchorage, Alaska, June 18-22,1990, Nucl. Instrum. and Methods in Physics Research B56/B57, (1991),531.
15. "Application of Accelerator Mass Spectrometry to Electronic Materials," J.M. Anthony, S. Matteson, D.K. Marble, J.L. Duggan, F.D. McDaniel, and D.J. Donahue, Proceedings of the First European Conference on the Application of Accelerators in Applied Research and Technology, Frankfurt, FRG, September 4-9, 1989, Ed. by K. Bethge, F. Rauch and P. Misaelindes, Nucl. Instrum. and Methods in Physics Research B50, (1990), 262.

Selected Refereed Journals

16. "Experimental Evidence for a Discrete Transition to Channeling for 1.0 MeV Protons in <100> Si," Z.Y. Zhao, A.M. Arrale, S.I. Li, D.K. Marble, D.L. Weathers, S. Matteson, J.M. Anthony, B. Gnade, and F.D. McDaniel, Submitted for Publication in Physical Review A (1997).
17. "L-Shell X-Ray Production by 2-12 MeV Carbon Ions in Fifeteen Selected Elements From Copper to Lead," R. Mehta, H.L. Sun, D.K. Marble, J.L. Duggan, F.D. McDaniel, and G. Lapicki, J. Phys. B: At. Mol. Phys. 28 (1995), pp 1187-1200.
18. "L-Shell X-Ray Production Cross Sections in 26Fe, 28Ni, 29Cu, 30Zn, 31Ga, and 32Ge by 0.5 MeV to 8.0 MeV He Ions," by M.R. McNeir, Y.C. Yu, D.L. Weathers, D.K. Marble, Z.Zhao, J.L. Duggan, F.D. McDaniel, and G. Lapicki, J. Phys. B: At. Mol. Phys. 27 (1994), pp 5295-5308.
19. "Fabrication Of Silicon-Based Optical Elements For An Ultra-clean AMS Negative Ion Source," J.F. Kirchhoff, D.K. Marble, D.L. Weathers, F.D. McDaniel, S. Matteson, J.M. Anthony, R.L. Beavers, and T.J. Bennett, Review of Scientific Instruments, 1993.
20. "L-Shell X-Ray Production Cross Sections in 26Fe, 28Ni, 29Cu, 30Zn, 31Ga, and 32Ge by 0.5 to 5.0 MeV Protons," M.R. McNeir, Y.C. Yu, D.K. Marble, J.L. Duggan, F.D. McDaniel, and G. Lapicki, Phys. Rev. A, (1992).
21. "K-Shell X-Ray Production in 6C, 8O, 9F, 11Na, 12Mg, and 13Al by 0.5 to 0.8 MeV Helium Ions," Y.C. Yu, M.R. McNeir, D.L. Weathers, J.L. Duggan, F.D. McDaniel, D.K. Marble, Z.Y. Zhao, and G. Lapicki, Phys. Rev. A, (1992).
22. "Hydrogen in Metalorganic Chemical Vapor Deposited ZnS Thin Films Determined by Nuclear Resonance Reaction Analysis," P.B. Smith, B.E. Gnade, D.K. Marble, Journal of Thin Films, (1990).

Conference Proceedings: Refereed are Indicated

23. "Hydrogen Detection at WMRD Using Nuclear Reaction Analysis," D.K. Marble, J. D. Demaree, J.K. Hirvonen, R. Zimmerman, D. Ila, A. Samadicy, J.L. Price, N. Gardella, E. Swarz, Proceedings of the Sixth Annual ARL/USMA Technical Symposium, Aberdeen, Maryland, November 4, 1998.
24. "Hydrogen Detection in Metals Using a Coincidence Detector Configuration to perform Nuclear Reaction Analysis," D.K. Marble, L. Smith, J.D. Demaree, J.K. Hirvonen, R. Zimmerman, and M. Detone, Proceedings of the Fifth Annual ARL/USMA Technical Symposium, West Point, New York, October 31, 1997.
25. "Light Element Impurity Detection in Electronic Materials Using Nuclear Reaction Analysis," D.K. Marble and R.L. Pfeffer, Proceedings of the Fourth Annual ARL/USMA Technical Symposium, West Point, New York, November 1, 1996.

26. "Hydrogen Detection in Semiconductors Using the ^{1}H(^{15}N,ga)^{12}C Nuclear Reaction," D.K. Marble and R.L. Pfeffer, Proceedings of the Third Annual ARL/USMA Technical Symposium, West Point, New York, November 1-3, 1995.
27. "Impact-Parameter-Averaged Probability of 3ds - Vacancy Sharing In Heavy Systems," D.K. Marble, F.D. McDaniel, V. Zoran, Z. Szilagyi, I. Piticu, D. Fluerasu, A. Erulescu, D. Dumitriu, B.I. Bucur, C. Ciortea, Procedeedings of the Eighteenth International Conference on the Physics of Electronic and Atomic Collisions, March 1993. (Referenced).
28. "Correlation Between Energy Loss and Ion-Induced Electron Emission of 1 MeV Channeled Protons in <100> Direction of Silicon Foils," Z.Y. Zhao, A.M. Arrale, S.L. Li, F.D. McDaniel, D.L. Weathers, D.K. Marble, J.F. Kirchhoff, S. Matteson, J.M. Anthony, and B. Gnade, Proceedings of the 11th International Conference on Ion Beam Analysis, Budapest, Hungary, July 15-18, 1993, Nuclear Instrum. and Methods in Physics Research, B (1993). (Referenced).
29. "A Semi-Empirical Scaling for K-Shell Fluorescence Yields in Light Ions," V. Zoran, I. Piticu, D. Petrini, D.K. Marble, and F.D. McDaniel, Sixth International Conference on the Physics of highly Charged Ions, Manhattan, KS, September 27-October 2, 1992, Proceedings Series of the American Institute of Physics, NY (1993) p. 359. (Refereed)
30. "Trace Element Analysis of Steel Samples With Synchrotron Radiation," R.M. Wheeler, R.P. Chaturvedi, J.L. Duggan, and D.K. Marble, and D. Braswell, Proceedings of the Twelfth International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 2-5, 1992, Ed. by J.L. Duggan and I.L. Morgan, Nucl. Instrum. and Methods in Physics Research, B79, (1993), 545. (Refereed).
31. "Direct Ionization and Electron Capture in K-Shell X-Ray Production in Fluorine by Highly Charged Boron, Carbon, and Oxygen Ions," D.K. Marble, F.D. McDaniel, J.L. Duggan, M.R. McNeir, Y.C. Yu, Z.Y. Zhao, D.L. Weathers, P.S. Elliott, R.M. Wheeler, R.P. Chaturvedi, and G. Lapicki, Proceedings of the Eleventh International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 5-8, 1990, Ed. by J.L. Duggan and I.L. Morgan, Nucl. Instrum. and Methods in Physics Research B56/57 (1991), 33. (Refereed).
32. "L-Shell X-Ray Production Cross Sections in 20Ca, 26Fe, 28Ni, 29Cu, and 32Ge for 0.75 to 5 MeV H and Li Ions," M.R. McNeir, Y.C. Yu, D.L. Weathers, D.K. Marble, J.L. Duggan, F.D. McDaniel, and G. Lapicki, Proceedings of the Eleventh International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 5-8, 1990, Ed. by J.L. Duggan and I.L. Morgan, Nucl. Instrum. and Methods in Physics Research B56/57 (1991), 29. (Refereed).
33. "K-Shell X-Ray Production Cross Sections in 6C, 8O, 9F, 11Na, 12Mg, and 13Al for 0.75 to 5 MeV H and Li Ions," Y.C. Yu, M.R. McNeir, D.L. Weathers, D.K. Marble, J.L. Duggan, F.D. McDaniel, and G. Lapicki, Proceedings of the Eleventh International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 5-8, 1990, Ed. by J.L. Duggan and I.L. Morgan, Nucl. Instrum. and Methods in Physics Research B56/57 (1991), 118. (Refereed).
34. "The University of North Texas Atomic Mass Spectrometry Facility for Detection of Impurities in Electronic Materials," F.D. McDaniel, S. Matteson, D.L. Weathers, D.K. Marble, J.L. Duggan, P.S. Elliott, D.K. Wilson, and J.M. Anthony, Proceedings of the Fifth International Conference on Accelerator Mass Spectrometry, Paris, April 23-27, 1990, Ed. by F. Yiou and G.M. Raisbeck, Nucl. Instrum. and Methods in Physics Research B52, 310, (1991). (Refereed).
35. "An Ultra-Clean Microprobe Ion Source for Atomic Mass Spectrometry," S. Matteson, J.L.

Duggan, D.K. Marble, F.D. McDaniel, D.L. Weathers, D.K. Wilson, J.M. Anthony, and R.L. Beavers, Proceedings of the Fifth International Conference on Accelerator Mass Spectrometry, Paris, April 23-27, 1990, Ed. by F. Yiou and G.M. Raisbeck, Nucl. Instrum. and Methods in Physics Research B52, 327, (1991). (Refereed).
36. "Atomic Mass Spectrometry of Materials," J.M. Anthony, S. Matteson, J.L. Duggan, P.S. Elliott, D.K. Marble, F.D. McDaniel, and D.L. Weathers, Proceedings of the Fifth International Conference on Accelerator Mass Spectrometry, Paris, April 23-27, 1990, Ed. by F. Yiou, and G.M. Raisbeck, Nucl. Instrum. and Methods in Physics Research B52, 493, (1991). (Refereed).
37. "Molecular-Interference-Free Accelerator Mass Spectrometry," S. Matteson, D.K. Marble, L.S. Hodges, J.Y. Hajsaleh, A.M. Arrale, M.R. McNeir, J.L. Duggan, F.D. McDaniel, and J.M. Anthony, Proceedings of the Ninth International Conference on Ion Beam Analysis, Queen's University, Kingston, Ontario, Canada, June 26-30, 1989, Nucl. Instrum. and Methods in Physics Research B45, 575 (1990). (Refereed).
38. "Molecular Dissociation in Accelerator Mass Spectrometry for Trace Impurity Characterization in Electronic Materials," F.D. McDaniel, S. Matteson, D.K. Marble, L.S. Hodges, A.M. Arrale, J.Y. Hajsaleh, M.R. McNeir, J.L. Duggan, and J.M. Anthony, Proceedings of the High Energy and Heavy Ion Beams in Materials Analysis Workshop, Albuquerque, NM, June 14-16, 1989, Ed. J.R. Tesmer, C.J. Maggiore, M. Nastasi, J.C. Barbour, and J.W. Mayer, Materials Research Society, Pittsburgh, PA, 1990, p. 269. (Refereed).
39. "M-Shell X-Ray Production in Gold, Lead, Bismuth, Thorium, and Uranium by 70-200 keV Protons," J.D. Gressett, D.K. Marble, F.D. McDaniel, J.L. Duggan, J.F. Culwell, and G. Lapicki, Proceedings of the Tenth International Conference on the Application of Accelerators in Research and Industry, Denton, Texas, November 7-9, 1988, Nucl. Instrum. and Methods in Physics Research B40/B41, 116, (1989). (Refereed).
40. "L-Shell X-Ray Production in Copper, Germanium, Rubidium, Strontium, and Yttrium by 100- 225 keV Protons," D.K. Marble, J.D. Gressett, F.D. McDaniel, J.L. Duggan, J.F. Culwell, and G. Lapicki, Proceedings of the Tenth International Conference on the Application of Accelerators in Research and Industry, Denton, Texas, November 7-9, 1988, Nucl. Instrum. and Methods in Physics Research B40/B41, 98, (1989). (Refereed).

Abstracts: Daniel K. Marble

National and International Conferences Invited Papers: (Refereed as Indicated)

1."Hydrogen Detection at WMRD Using Nuclear Reaction Analysis," D.K. Marble, J. D. Demaree, J.K. Hirvonen, R. Zimmerman, D. Ila, A. Samadicy, J.L. Price, N. Gardella, E. Swarz, Book of Abstracts for the Sixth Annual ARL/USMA Technical Symposium, Aberdeen, Maryland, November 4, 1998.
2. "Using Small Accelerators to Teach Undergraduate Physics," D.K. Marble, Book of Abstracts for the Fifteenth International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 4-10, 1998, Ed. by J.L. Duggan and I.L. Morgan. (Refereed)
3. "Hydrogen Detection in Metals Using a Coincidence Detector Configuration to perform Nuclear Reaction Analysis," D.K. Marble, L. Smith, J.D. Demaree, J.K. Hirvonen, R. Zimmerman, and M. Detone, Book of Abstracts for the Fifth Annual ARL/USMA Technical Symposium, West Point, New York, October 31, 1997
4. "Using a 400 kV Van de Graaff Accelerator to Teach Physics at West Point," D.K. Marble and S.E. Bruch, Book of Abstracts for the Fourteenth International Conference on the Application of

Accelerators in Research and Industry, Denton, TX, November 5-10, 1996, Ed. by J.L. Duggan and I.L. Morgan. (Refereed)
5. "L-Shell X-Ray Production Cross Sections for 150-450 keV Protons on Copper, Germanium, Rubidium, Strontium, and Yttrium," D.K. Marble, P.G. Lakey, and C. Ralls, Book of Abstracts for the Fourteenth International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 5-10, 1996, Ed. by J.L. Duggan and I.L. Morgan. (Refereed)
6. "Fluorine K-Shell X-Ray Cross Section Measurements for ^{7}Li, ^{10}B, ^{12}C, ^{14}N, and ^{16}O Ions on Ultra-clean, Ultra-thin YF_3 Solid target Foils," D.K. Marble, M.R. McNeir, Y.C. Yu, F.D. McDaniel, J.L. Duggan, R. Wheeler, and R.P. Chaturvedi, Book of Abstracts for the Fourteenth International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 5-10, 1996, Ed. by J.L. Duggan and I.L. Morgan. (Refereed)
7. "Light Element Impurity Detection in Electronic Materials Using Nuclear Reaction Analysis," D.K. Marble and R.L. Pfeffer, Book of Abstracts for the Fourth Annual ARL/USMA Technical Symposium, West Point, New York, November 1, 1996.
8. "Hydrogen Detection in Semiconductors Using the ^{1}H(^{15}N,ga)^{12}C Nuclear Reaction," D.K. Marble and R.L. Pfeffer, Book of Abstracts for the Third Annual ARL/USMA Technical Symposium, West Point, New York, November 1-3, 1995.
9. "L-Shell and M-Shell X-Ray Production Cross sections for Selected Elements for 0.1 to 2.5 MeV Protons," F.D. McDaniel, J.L. Duggan, J.D. Gressett, D.K. Marble, J.F. Culwell, and G. Lapicki, Abstracts for International Conference on Spectroscopy and Collisions of Few Electron Ions, Bucharest, Romania, August 29-September 2, 1988 (Central Institute of Physics, Bucharest, 1988), p. 44. (Refereed)
10. "Applications of Accelerator Mass Spectrometry to Electronic Materials," J.M. Anthony, S. Matteson, D.K. Marble, J.L. Duggan, F.D. McDaniel, and D.J. Donahue, First European Conference on Accelerators in Applied Research and Technology, Frankfurt, FRG, September 5-9, 1989. (Refereed)
11. "X-Ray Production in Fluorine by Highly Charged Boron, Carbon, and Oxygen Ions," F.D. McDaniel, D.K. Marble, J.L. Duggan, M.R. McNeir, Y.C. Yu, D.L. Weathers, P.S. Elliott, R.M. Wheeler, R.P. Chaturvedi, and G. Lapicki, Proceedings of the Joint U.S.-Japan Seminar on Dynamical Excitations by Highly Charged Ions, Anchorage, Alaska, June 18-22,1990. (Refereed)
12. "Ion Beam Techniques for Materials Modification and Analysis," F.D. McDaniel, D.L. Weathers, J.L. Duggan, S. Matteson, and D.K. Marble, Proceedings of the Second International Conference on Applications of Nuclear Techniques, Heraklion, Crete, Greece, June 24-30, 1990. (Refereed)
13. "Materials Characterization Using Accelerator Mass Spectrometry," J.M. Anthony, R.L. Beavers, T.J. Bennet, S. Matteson, D.K. Marble, D.L. Weathers, F.D. McDaniel, and J.L. Duggan, Bull. Am. Phys. Soc. 35, 1738 (1990), Proceedings of the Eleventh International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 5-8, 1990, Ed. by J.L. Duggan and I.L. Morgan. (Refereed)
14. "Radionuclide Dating and Trace Element Analysis by Accelerator Mass Spectrometry," F.D. McDaniel, S. Matteson, D.L. Weathers, J.L. Duggan, D.K. Marble, I. Hassan, Z.Y. Zhao, and J.M. Anthony, Second International Conference on Methods and Applications of Radioanalytical Chemistry, Kona, Hawaii, April 21-27, 1991. (Refereed)
15. "Trace Element Analysis by Accelerator Mass Spectrometry," F.D. McDaniel, S. Matteson, J.M. Anthony, D.L. Weathers, J.L. Duggan, D.K. Marble, I. hassan, Z.Y. Zhao, A.M. Arrale, and

Y.D. Kim, Eighth International Conference on Modern Trends in Activation Analysis, Technical University of Vienna, Vienna, Austria, September 16-20, 1991. (Refereed)
16. "Characterization of Electronic Materials Using Accelerator Mass Spectrometry," F.D. McDaniel, J.M. Anthony, S. Matteson, D.L. Weathers, J.F. Kirchhoff, G. Vizkelethy, D.K. Marble, Y.D. Kim, I. Hassan, and Z.Y. Zhao, Third International Conference on Applications of Nuclear Techniques, Mykonos, Greece, June 6-13, 1992. (Refereed)
17. "L-Shell X-Ray Production Cross Sections for $_{29}$Cu, $_{31}$Ga, $_{32}$Ge, $_{35}$Br, $_{39}$Y, $_{60}$Nd, $_{67}$Ho, $_{70}$Yb, $_{79}$Au, and $_{82}$Bi for 2-25 MeV Carbon Ions," Twelth International Conference on the Applications of Accelerators in Research and Industry, Denton, TX, November 2-5 1992. (Refereed)
18. "Applications of Accelerator Mass Spectrometry to material Science," S. Matteson, J.M. Anthony, F.D. McDaniel, D.L. Weathers, J.F. Kirchhoff, D.K. Marble, and G. Vizkelethy, Abstracts for Twelfth International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 2-5, 1992, p. 12. (Refereed)
19. "AMS Ion Source for Stable Elements," J.M. Anthony, S. Matteson, F.D. Mcdaniel, J.F. Kirchhoff, G. Vizkelethy, D.K. Marble, and D.L. Weathers, Abstracts for Twelfth International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 2-5, 1992, p. 88. (Refereed)
20. "Impurity Determination in Electronic Materials by Accelerator Mass Spectrometry," F.D. McDaniel, J.M. Anthony, J.F. Kirchhoff, D.K. Marble, Y.D. Kim, S.N. Renfrow, E.C. Grannan, E.R. Reznik, G. Vizkelethy, and S. Matteson, Third European Conference on Accelerators in Applied Research and Technology, Orleans, France, August 31-September 4, 1993. (Refereed)
21. "Improved Trace Impurity Characterization in the Electronics Materials Industry by Accelerator Mass Spectrometry," F.D. McDaniel, J.M. Anthony, J.F. Kirchhoff, D.K. Marble, Y.D. Kim, S.N. Renfro, and S. Matteson, '93 Inter. Symp. on High-Tech Industries and Products (HIPS '93), Shanghai, China, November 9-12, 1993. (Refereed)

National and International Conferences Contributed Papers: Refereed

22. "X-Ray Energy and Intensity Ratio Shifts in MeV/amu Fe, Co, Ni, and Bi Collisions," A. Berinde, C. Ciortes, D. Dumitrin, A. Euulescu, D. Fluerasu, D.K. Marble, F.D. McDaniel, I. Piticu, Z, Szilagyi, and V. Zoran, XIX Inter. Conference on the Physics of Electronic and Atomic Collisions, Wistler British Columbia, Canada, July 1995
23. "Accounting for Outer-Shell Ionization in Measurements of the 3ds -Vacancy Production and Sharing," I. Piticu, C.Ciortea, F.D. McDaniel, D. Dumitrin, A.Enulescu, D.K. Marble, Y. Sun, Z.Szilagyi, and V. Zoran, XIX Inter. Conference on the Physics of Electronic and Atomic Collisions, Wistler British Columbia, Canada, July 1995.
24. "On the SCA Description of the 3ds Molecular Orbital Direct Ionization," C. Ciortea, H. Brauning, M. Danrau, D. Dumitriu, A. Enulescu, D. Fluerasu, D.K. Marble, F.D. McDaniel, I. Piticu, H. Schmidt-Bocking, Z. Szilagyi, and V. Zoran, XIX Inter. Conference on the Physics of Electronic and Atomic Collisions, Wistler British Columbia, Canada, July 1995.
25. "The Impact Parameter Dependence of the 3ds Vacancy Sharing Probability in 87 MeV Ni+Pb Collisions," V. Zoran, H. Brauning, C. Ciortea, M. Damrau, A. DeMian, A. Enulescu, D.K. Marble, F.D. McDaniel, H. Schmidt-Bocking, and Z. Szilagyi, XIX Inter. Conference on the Physics of Electronic and Atomic Collisions, Wistler British Columbia, Canada, July 1995.
26. "Accelerator Based SIMS for Impurity Analysis," J.M. Anthony, J.F. Kirchhoff, D.K. Marble, S.N. Renfro, Y.D. Kim, S. Matteson, and F. McDaniel, 40th National Meeting of the

Amer. Vac. Soc., Orlando, Fl., November 15-19, 1993.
27. "Model Of The Contamination Effect In Ion-Induced Electron Emission," A.M. Arrale, Z.Y. Zhao, J.F. Kirchhoff, D.K. Marble, D.L. Weathers, F.D. McDaniel, J.L. Duggan, and S. Matteson, Contributed Abstract for the Third European Conference on Accelerators in Applied Research and Technology, Orleans, France, August 31 - September 4, 1993.
28. "Impact-Parameter-Averaged Probability of 3dd -Vacancy Sharing in Heavy Systems," D.K. Marble, F.D. McDaniel, V. Zoran, Z. Szilagyi, I. Piticu, Daniela Fluerasu, A. Enulescu, Dana Dumitriu, B.I. Bucur, and C. Ciortea, XVIII Inter. Conference on the Physics of Electronic and Atomic Collisions, July 21-27, 1993, Aarhus, Denmark, Book of Abstracts, p. 536.
29. "Correlation Between Energy Loss and Ion-Induced Electron Emission of 1 MeV Channeled Protons in <100> Directions of Silicon Foils," Z.Y. Zhao, A.M. Arrale, S.L. Li, F.D. McDaniel, D.L. Weathers, D.K. Marble, J.F. Kirchhoff, S.Matteson, J.M. Anthony, and B. Gnade, 11th Intern. Conference on Ion Beam Analysis, Budapest, Hungary, July 15-18, 1993.
30. "Impact-Parameter-Averaged Probability of 3dd -Vacancy Sharing in Heavy Systems," D.K. Marble, F.D. McDaniel, V. Zoran, Z. Szilagyi, I. Piticu, Daniela Fluerasu, A. Enulescu, Dana Dumitriu, B.I. Bucur, and C. Ciortea, 14. Arbeitsbericht Energiereiche Atomare Stosse, Oberstdorf, Germany, January 1993 (14th Inter. Workshop on High Energy Collisions).
31. "Trace Element Analysis of Steel Samples with Synchrotron Radiation," R.M. Wheeler, R.P. Chaturvedi, J.L. Duggan, D.K. Marble, and D. Braswell, Twelth International Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 2-5, 1992.
32. "A Semi-Emperical Scaling for K-Shell Fluorescence Yields in Light Ions," V. Zoran, I. Piticu, D. Petrini, D.K. Marble, and F.D. McDaniel, Sixth International Conference on the Physics of Highly Charged Ions, Manhattan, KS, September 27-October 2, 1992.
33. "K-Shell X-Ray Production Cross Sections for $_{6}$C, $_{8}$C, $_{9}$F, $_{11}$Na, $_{12}$Mg, and $_{13}$Al by Protons, Alphas, and Lithium Ions in the Energy range 0.75 to 5 MeV," Y.C. Yu, M.R. McNeir, D.L. Weathers, D.K. Marble, J.L. Duggan, F.D. McDaniel, and G. Lapicki, Sevententh International Conference on the Physics of Electronic and Atomic Collisions, Brisbane, Australia, July 10-16, 1991.
34. "L-Shell X-Ray Production Cross Sections for $_{20}$Ca, $_{26}$Fe, $_{28}$Ni, $_{29}$Cu, and $_{32}$Ge by Protons, Alphas, and Lithium Ions in the Energy Range 0.75 to 5 MeV," M.R. McNeir, Y.C. Yu, D.L. Weathers, D.K. Marble, J.L. Duggan, F.D. McDaniel, and G. Lapicki, Seventeenth International Conference on the Physics of Electronic and Atomic Collisions, Australia, July 10-16, 1991.
35. "Direct Ionization and Electron Capture in K-Shell X-Ray Production in Fluorine by Highly Charged Boron, Carbon, and Oxygen Ions," D.K. Marble, F.D. McDaniel, J.L. Duggan, M.R. McNeir, Y.C. Yu, Z.Y. Zhao, D.L. Weathers, P.S. Elliott, R.M. Wheeler, R.P. Chaturvedi, and G. Lapicki, Bull. Am. Phys. Soc. 35, 1714 (1990), Proceedings of the Eleventh International Accelerator Conference on the Application of Accelerators in Research and Industry, Denton, TX, November 5-8, 1990, Ed. by J.L. Duggan and I.L. Morgan.
36. "The University of North Texas Atomic Mass Spectrometry Facility for Detection of Impurities in Electronic Materials," F.D. McDaniel, S. Matteson, D.L. Weathers, D.K. Marble, J.L. Duggan, P.S. Elliott, D.K. Wilson, and J.M. Anthony, Ninith Annual Symposium on Electronic Materials, Proceeising, and Characterization, Richardson, TX, June 4-5, 1990.
37. "Accelerator Mass Spectrometry of Semiconductor Materials," S. Matteson, D.K. Marble, A.M. Arrale, M.R. McNeir, L.S. Hodges, J.L. Duggan, and F.D. McDaniel, Ninth Annual Symposium on Electronic Materials, Proceeising, and Characterization, Richardson, TX, June 4-5, 1990.

38. "Atomic Mass Spectrometry of Materials," J.M. Anthony, S. Matteson, J.L. Duggan, P.S. Elliott, D.K. Marble, F.D. McDaniel, D.L. Weathers, Proceedings of the Fifth International Conference on Accelerator Mass Spectrometry, Paris, France, April 23-27, 1990.
39. "An Ultra-Clean Microprobe Ion Source for Atomic Mass Spectrometry," S. Matteson, J.L. Duggan, D.K. Marble, F.D. McDaniel, and D.L. Weathers, Proceedings of the Fifth International Conference on Accelerator Mass Spectroscopy, Paris, April 23-27, 1990.
40. "The University of North Texas Atomic Mass Spectrometry Facility for Detection of Impurities in Electronic Materials," F.D. McDaniel, S. Matteson, D.L. Weathers, D.K. Marble, J.L. Duggan, P.S. Elliott, D.K. Wilson, and J.M. Anthony, Proceedings of the Fifth International Conference on Accelerator Mass Spectrometry , Paris, April 23-27, 1990.
41. "Molecular-Interference-Free Accelerator Mass Spectrometry," S. Matteson, D.K. Marble, A.M. Arrale, L.S. Hodges, J.L. Duggan, and F.D. McDaniel, Ninth International Conference on Ion Beam Analysis, Queen's University, Kingston, Ontario, Canada, June 26-30, 1989.
42. "Molecular Dissociation in Accelerator Mass Spectrometry for Trace Impurity Characterization in Electronic Materials," F.D. McDaniel, S. Matteson, D.K. Marble, L.S. Hodges, A.M. Arrale, J. Hajsaleh, M.R. McNeir, J.L. Duggan, and J.M. Anthony, Workshop on High Energy and Heavy Ion Beams in Material Analysis, Albuquerue, NM, June 14-16, 1989.
43. "M-Shell X-Ray Production Cross Sections for 70 to 200 keV Incident Protons on Selected Targets from Z=79 to Z=92," J.D. Gressett, D.K. Marble, F.D. McDaniel, J.L. Duggan, J.F. Culwell, and G. Lapicki, Tenth Conference on the Applications of Accelerators in Research and Industry, Denton, TX, November 7-9, 1988, Bull. Am. Phys. Soc. 33, 1775 (1988).
44. "L-Shell X-Ray Production Cross sections for 100 to 225 keV Incident Protons on Selected Targets from Z=29 to Z=39," D.K. Marble, J.D. Gressett, F.D. McDaniel, J.L. Duggan, J.F. Culwell, and G. Lapicki, Tenth Conference on the Applications of Accelerators in Research and Industry, Denton, TX, November 7-9, 1988, Bull. Am. Phys. Soc. 33, 1775 (1988).

National and International Conferences: Contributed

45. "Hydrogen Depth Profiling Using Nuclear Reaction Analysis (NRA)," D.K. Marble, J.F. Kirchhoff, G. Vizkelethy, C. Trail, F.D. McDaniel, J.L. Duggan, S.N. Renfro, Z.Y. Zhao, H.L. Sun, S. Matteson, B. Gnade, J. Keenan, and J.M. Anthony, Joint APS, AAPT, SPS Meeting, Texas Pan American University, Edinburg, TX, March 12-13, 1993, Bull. Am. Phys. Soc., (1993).
46. "Computer Control of an Ultra Clean Ion Source for Accelerator Mass Spectrometry (AMS)," D.K. Marble, G. Vizkelethy, J.D. Gressett, D.L. Weathers, F.D. McDaniel, J.L. Duggan, S.N. Renfro, Z.Y. Zhao, H.L. Sun, S. Matteson, B. Gnade, J. Keenan, and J.M. Anthony, Joint APS, AAPT, SPS Meeting, Texas Pan American University, Edinburg, TX, March 12-13, 1993, Bull. Am. Phys. Soc., (1993).
47. "L-Shell X-Ray Production Cross Sections of 29Cu, 31Ga, 32Ge, 35Br, 39Y, 42Mo, 47Ag, 50Sn, 57La, 60Nd, 64Gd, 67Ho, 70Yb, 79Au, and 82Pb for 2-12 MeV Carbon Ions," H.L. Sun, D.K. Marble, J.F. Kirchhoff, J.L. Duggan, F.D. McDaniel, R. Mehta, and G. Lapicki, Joint APS, AAPT, SPS Meeting, Texas Pan American University, Edinburg, TX, March 12-13, 1993, Bull. Am. Phys. Soc., (1993).
48. "Accelerator Mass Spectrometry Studies of Highly-Charged Molecular Ions," Y.D. Kim, S. Matteson, J.L. Duggan, D.L. Weathers, D.K. Marble, F.D. McDaniel, P. Marshall, J.M. Anthony, and M.A. Douglas, Joint APS, AAPT, SPS Meeting, Texas Pan American University, Edinburg,

TX, March 12-13, 1993, Bull. Am. Phys. Soc., (1993).
49. "Relationship Between Energy Loss and Ion Induced Electron Emission of Channeled Protons in Crystalline Silicon Foil," Z.Y. Zhao, A.M. Arrale, S.L. Li, D.K. Marble, F.D. McDaniel, J.L. Duggan, S. Matteson, J.M. Anthony, B. Gnade, Joint APS, AAPT, SPS Meeting, Texas Pan American University, Edinburg, TX, March 12-13, 1993, Bull. Am. Phys. Soc., (1993).
50. "Particle Induced X-Ray Emission (PIXE) Measurements for X-Rays below 1 keV," G. Johnson, J.L. Duggan, H.L. Sun, and D.K. Marble, Joint APS, AAPT, SPS Meeting, Texas A&M University, College Station, Texas, October 22-23, 1993.
51. "Time of Flight Experiments for the Advanced Atomic-Nuclear Undergraduate Physics Laboratory," D.K. Marble, J.L. Duggan, and J.R. Sybert, Joint APS, AAPT, SPS Meeting, Texas A&M University, College Station, Texas, October 22-23, 1993.
52. "Ion Induced Electron Emission of 1 MeV Channeled Protons in Crystalline Silicon Foil," Z.Y. Zhao, A.M. Arrale, S.L. Li, D.K. Marble, J.F. Kirchhoff, D.L. Weathers, S. Matteson, F.D. McDaniel, and J.M. Anthony, Joint APS, AAPT, SPS Meeting, Teaxs A&M University, College Station, Texas, October 22-23, 1993.
53. "A Simple Mass Spectrometry Lab for Undergraduates Using a 2.5 MeV Accelerator," D.K. Marble, J.L. Duggan, and J.R. Sybert, Joint APS, AAPT, SPS Meeting, Texas A&M University, College Station, Texas, October 22-23, 1993.
54. "Thin Film Thickness Determination Using Rutherford Backscattering Spectrometry: An Advanced Undergraduate Physics Laboratory Experiment," D.K. Marble, J.L. Duggan, and J.R. Sybert, Joint APS, AAPT, SPS Meeting, Texas A&M University, College Station, Texas, October 22-23, 1993.
55. "Accelerator Mass Spectrometry Studies of Dissociation Processes of Molecular Ions," Y.D. Kim, F.D. McDaniel, D.L. Weathers, D.K. Marble, S. Matteson, and J.M. Anthony, Joint APS, AAPT, SPS Meeting, Rice University, Houston, TX, November 7-8, 1992, Bull. Am. Phys. Soc., (1992).
56. "Accelerator Mass Spectrometry Using a 9SDH Tandem Accelerator Under Computer Control," D.K. Marble, J.F. Kirchhoff, G. Viskelethy, D.L. Weathers, F.D. McDaniel, J.L. Duggan, A.M. Arrale, Y.D. Kim, S.N. Renfrow, Z. Zhao, S. Matteson, B. Gnade, J. Keenan, and J.M. Anthony, Joint APS, AAPT, SPS Meeting, Rice University, Houston, TX, November 7-8, 1992, Bull. Am. Phys. Soc., (1992).
57. "Multi-purpose Beam Line for Energy Loss of Channeling Experiments," Z. Zhao, D.K. Marble, J.F. Kirchhoff, S.L. Li, W.G. Kim, A.M. Arrale, and F.D. McDaniel, Joint APS, AAPT, SPS Meeting, Rice University, Houston, TX, November 7-8, 1992, Bull. Am. Phys. Soc., (1992).
58. "Accounting for Multiple Ionization in the Analysis of Heavy Ion-Induced X-Rays of Light Elements Measured with Si(Li) Detectors," D.K. Marble, F.D. McDaniel, V. Zoran, and I.C. Legrand, Division of Atomic, Molecular, and Optical Physics Meeting of the American Physical Society, Chicago, IL, May 20-22, 1992, Bull. Am. Phys. Soc. 37, 1116 (1992).
59. "Energy Loss of Channeled He Ions in Crystalline Silicon Foil," Z.Y. Zhao, G. Viskelethy, D.K. Marble, A.M. Arrale, F.D. McDaniel, S. Matteson, J.M. Anthony, and B. Gnade, Joint APS, AAPT, SPS Meeting, Southwest Texas State University, San Marcos, TX, March 6-7, 1992, Bull. Am. Phys. Soc., (1992).
60. "Ion-Induced Electron Emission from Thin Carbon Foils," A.M. Arrale, J.F. Kirchhoff, D.L. Weathers, D.K. Marble, Z.Y. Zhao, F.D. McDaniel, J.L. Duggan, and S. Matteson, Joint APS, AAPT, SPS Meeting, Southwest Texas State University, San Marcos, TX, March 6-7, 1992,

Bull. Am. Phys. Soc., (1992).
61. "Computer Automation of a 9-SDH Tandem Accelerator for Material Analysis and Atomic Physics," D.K. Marble, G. Viskelethy, S.E. Matteson, J.F. Kirchhoff, D.L. Weathers, F.D. McDaniel, J.L. Duggan, Y.D. Kim, J.M. Anthony, J. Keenan, and B. Gnade, Joint APS, AAPT, SPS Meeting, Southwest Texas State University, San Marcos, TX, March 6-7, 1992, Bull. Am. Phys. Soc., (1992).
62. "Pulse Height Defect Studies in Heavy Ion Spectroscopy," R. Gasior, J.L. Duggan, S.E. Matteson, D.K. Marble, and F.D. McDaniel, Joint APS, AAPT, SPS Meeting, University of North Texas, Denton, TX, Nov. 1-2, 1991, Bull. Am. Phys. Soc., (1991).
63. "Molecular Dissociation in Accelerator Mass Spectrometry for Trace Impurity Characterization in Electronic Materials," I. Hassan, F.D. McDaniel, J.L. Duggan, S.E. Matteson, D.L. Weathers, M.R. McNeir, D.K. Marble, J.M. Anthony, and M.A. Douglas, Joint APS, AAPT, SPS Meeting, University of North Texas, Denton, TX, Nov. 1-2, 1991, Bull. Am. Phys. Soc., (1991).
64. "Sputter Deposition of Thin Molybedenum and Copper Foils by an Argon Plasma Discharge," R.B. Escue, S.E. Matteson, J.L. Duggan, M.R. McNeir, A. Azordegan, A. Bigelow, H.L. Sun, D.L. Weathers, F.D. McDaniel, and D.K. Marble, Joint APS, AAPT, SPS Meeting, University of North Texas, Denton, TX, Nov. 1-2, 1991, Bull. Am. Phys. Soc., (1991).
65. "A Study of L-Shell X-Ray Production Cross Sections and a Test of the ECPSSR Theory for Incident 1H, 4He, and 7Li Ions in the Energy Range 0.5 to 5.0 MeV for Targets With X-Ray Energies From 341 to 1188 eV," M.R. McNeir, Y.C. Yu, D.L. Weathers, D.K. Marble, Z. Zhao, J.L. Duggan, F.D. McDaniel, and G. Lapicki, Joint APS, AAPT, SPS Meeting, University of North Texas, Denton, TX, Nov. 1-2, 1991, Bull. Am. Phys. Soc., (1991).
66. "L-Shell X-Ray Production Cross Sections for 29Cu, 31Ga, 32Ge, 35Br, and 39Y by Incident Carbon Ions," R. Mehta, M.R. McNeir, Y.C. Yu, D.K. Marble, J.L. Duggan, F.D. McDaniel, and G. Lapicki, Joint APS, AAPT, SPS Meeting, University of North Texas, Denton, TX, Nov. 1-2, 1991, Bull. Am. Phys. Soc., (1991).
67. "Electron Bremsstrahlung Interferances in Heavy Ion X-Ray Cross Section Measurements," D.K. Marble, M.R. McNeir, Y.C. Yu, Z.H. Zhao, D.L. Weathers, F.D. McDaniel, S.E. Matteson, J.L. Duggan, R.B. Escue, G. Lapicki, R.M. Wheeler, R.P. Chaturvedi, and V. Zoran, Joint APS, AAPT, SPS Meeting, University of North Texas, Denton, TX, Nov. 1-2, 1991, Bull. Am. Phys. Soc., (1991).
68. "Design Considerations for Alignment of Off Axis Post Accelerator Beams From Tandem Accelerators Using an Octupole Doublet," L.S. Hodges, D.K. Marble, and S.E. Matteson, Joint APS, AAPT, SPS Meeting, University of North Texas, Denton, TX, Nov. 1-2, 1991, Bull. Am. Phys. Soc., (1991).
69. "A Test of the ECPSSR Theory Through K-Shell X-Ray Production Cross Sections for Elements with X-Ray Energies from 282 to 1485 eV by Incident 1H, 4He, 7Li Ions in the Energy Range 0.5 to 5.0 MeV," Y.C. Yu, M.R. McNeir, D.L. Weathers, D.K. Marble, Z.Y. Zhao, J.L. Duggan, F.D. McDaniel, and G. Lapicki, 1991 Fall Meeting of the American Physical Society, Denton, TX, November 1-2, 1991, Bull. Am. Phys. Soc. 37, 1170, (1992).
70. "Efficiency Determination for a Windowless Ge X-Ray Detector for Photon Energies Below 5 keV," D.L. Weathers, M.R. McNeir, J.L. Duggan, Y.C. Yu, D.K. Marble, and F.D. McDaniel, Joint APS, AAPT, SPS Meeting, College of the Mainland, Texas City, TX, Nov. 9-10, 1990, Bull. Am. Phys. Soc., (1990).
71. "Direct Ionization and Electron Capture in K-Shell X-Ray Production in Fluorine by Highly-

Charged Lithium and Boron Ions," D.K. Marble, M.R. McNeir, Y.C. Yu, D.L. Weathers, Z.Y. Zhao, D.K. Wilson, F.D. McDaniel, J.L. Duggan, and G. Lapicki, Joint APS, AAPT, SPS Meeting, College of the Mainland, Texas City, TX, Nov. 9-10, 1990, Bull. Am. Phys. Soc., (1990).

72. "Computer Automation of 30 and 90 Degree Analyzing Magnets on Tandem Accelerators," D.K. Marble, S. Matteson, D.L. Maxson, H.J. Mackey, J.L. Duggan, F.D. McDaniel, L.S. Hodges, M.R. McNeir, G.L. Albert, B. Gasior, J.D. Gressett, and J.M. Anthony, Joint APS, AAPT, SPS Meeting, University of Houston, Houston, TX, March 2-4, 1989, Bu ll. Am. Phys. Soc. 34, 1849, (1989).

73. "Computer Automation of the NEC 9SDH Tandem Accelerator for Accelerator Mass Spectrometry," D.K. Marble, S. Matteson, D.L. Weathers, J.L. Duggan, F.D. McDaniel, M.R. McNeir, D.K. Wilson, L.S. Hodges, and J.M. Anthony, Joint APS, AAPT, SPS Meeting, Texas Christian University, Fort Worth, TX, March 2-3, 1990, Bull. Am. Phys. Soc. 35, 1335, (1990).

74. "Hydrogen Depth Profiles of ZnS Films Using Nuclear Reaction Analysis," B.E. Gnade, J.A. Keenan, D.L. Weathers, J.L. Duggan, D.K. Marble, and S.E. Matteson, Joint APS, AAPT, SPS Meeting, Texas Christian University, Fort Worth, TX, March 2-3, 1990, Bull. Am. Phys. Soc. 35, 1335 (1990).

75. "M-Shell X-Ray Production Cross Sections for 50 to 200 keV Protons Incident on 79Au, 82Pb, and 83Bi," J.D. Gressett, D.K. Marble, J.L. Duggan, F.D. McDaniel, J. Culwell, and G. Lapicki, Joint APS, AAPT, SPS Meeting, Texas A&I University, Kingsville, Tx, Nove. 6-7, 1987, Bull. Am. Phys. Soc. 33, 1344, (1988).

76. "L-Shell X-Ray Production Cross Sections for 50 to 2500 keV Incident Protons for Selected Target Elements from Z=28 to Z=46," D.K. Marble, J.D. Gressett, J.L. Duggan, F.D. McDaniel, J. Culwell, and G. Lapicki, Joint APS, AAPT, SPS Meeting, Texas A&I University, Kingsville, TX, Nov. 6-7, 1987, Bull. Am. Phys. Soc. 33, 1344, (1988).

77. "Uniformity of Thin Gold Films Using TEM and RBS," J.K. Hoodenpyle, H. Kassenbig, J.D. Gressett, D.K. Marble, F.D. McDaniel, and R.F. Pinizzotto, Joint APS, AAPT, SPS Meeting, Texas A&I University, Kingsville, TX, Nov. 6-7, 1987, Bull. Am. Phys. Soc. 33, 1341, (1988).

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EDUCATION

Tarleton State University – Masters of Business Administration, May 2003
Tarleton State University-Bachelor of Business Administration, August 1987
Texas State Technical College-Associate of Applied Science, February 1994
Hazardous Materials Management & Occupational Safety and Health

EXPERIENCE

Tarleton State University, 2000-Present
Current Position: AVP, University Compliance, RSO

Served in the role as the University Radiation Safety Officer since 2007 performing monthly surveys, building inspections, assisting with Bureau of Radiation Control inspections, inspecting leak survey information, documenting survey meter annual calibration certifications, and other requirements of the Radiation Protection Program and the Bureau of Radiation Control.

Previous Position: Director of Risk Management & Compliance
Provided University personnel with training and updating of programs on emergency preparedness, responses and contingency planning. Identifies and implements faculty/staff/student development and training requirements pertaining to health and safety topics. Responds to all emergencies on campus. Obtains updates on all threats that may affect facilities on the campus and keeps Physical Facilities staff up-to-date on procedures. Represents Tarleton at meetings with city and county on emergency preparedness. Represents the Associate Vice President on the University Crisis Management Team as required. Conducts inspections for asbestos or other hazardous material and provides documentation and approval prior to construction on any project. Manages all life safety and fire prevention programs for University. Serves as local authority manager for all life safety and fire prevention programs for the University. Serves as local authority for the campus and all properties under control of Tarleton regarding National Fire Codes, Life Safety Codes, and Fire Prevention best practices. Conducts fire inspections and investigates fire incidents providing reports as required to State Fire Marshall. Maintains records of all testing of fire alarm systems, fire extinguishers, sprinkler systems, emergency light and exit signs, and emergency generators. Develops, maintains, and administers comprehensive programs on Hazardous Waste Management, Lead Based Paint, Asbestos Management, and other environmental programs. Represents Tarleton when meeting with other state agencies such as TCEQ or in meeting with city and county official as relates to safety and risk management. Maintains current Asbestos Management Planner/Inspector license as well as asbestos

Contractor license for the University. Provides safety training for all University personnel. Conducts environmental health and safety studies as needed.

Eagle Construction and Environmental Services, Inc., 1995-2000
Position: Health and Safety Director
Supervised three managers and three site safety officers in 6 regional offices. Corporate responsibilities included Environmental Health and Safety, Training, Fleet Operations & Human Resource Management. Coordinate all emergency response actions for West Texas Region including train derailments, tractor/trailer rollovers, and hazardous chemical spills where Level A through Level D Personal Protective Equipment (PPE) was utilized.

CERTIFICATIONS & LICENSES

32 Hour Radiation Safety Officer's Course, UT Health Science Center, San Antonio
8 Hour Radiological Emergency Preparedness, Department of State Health Services
National Incident Management System (NIMS) 100, 200, 300, 700, 800 Certification
24 Hour Threat & Risk Assessment Course, Department of Homeland Security
Core Disaster Life Support Training Course, American Medical Association
40 Hour HAZWOPER (Hazardous Waste Operations and Emergency Response) Training
32 Hour Incident Response to Terrorist Bombings Course, New Mexico Tech, EMRTC
8 Hour OSHA Supervisory Training (29 CFR 1910.120)
16 Hour OSHA Confined Space Entry & Rescue Training (29 CFR 1910.146)
40 Hour Asbestos Certified Supervisor (NESHAP)
TCEQ Type A & B Licensed UST Supervisor (Installation, Repair and Removal)
Lead Awareness Trained, OSHA 29 CFR 1926.62
Union Pacific Railroad Track Safety Training
Burlington Northern Sante Fe Track Safety Training
8 Hour Excavation and Trenching Competent Person Certified
First Aid & CPR Trained
40 Hour ACBM Contractor Supervisor NESHAP Training
TDSHS Asbestos Manager and Inspector License, No. 205500
Completed 16 Hour Environmental Auditing Course
Construction Health and Safety Technician (CHST) Designation from ASSE
24 Hour Life Safety Code Training, National Fire Protection Association
14 hour Safety Supervision of Motor Fleets - TEES, TMTA
16 Hour Strategies for Conducting Meaningful Microbial IAQ Investigations