

## LAWRENCE W. TOWNSEND

### Personal Data

Citizenship: United States of America  
Office Address: 211 Pasqua Engineering Building  
Department of Nuclear Engineering  
The University of Tennessee  
Knoxville, Tennessee 37996-2300  
Telephone: Office: (865) 974-7569 Fax: (865) 974-0668  
E-mail: LTOWNSEN@TENNESSEE.EDU

### Education

1980, Ph.D., Physics, University of Idaho (1977-1980)  
Dissertation Title: "Isobar Production in Heavy Ion Collisions."  
Dissertation Advisor: Prof. Philip A. Deutchman  
1970, M.S., Physics, U.S. Naval Postgraduate School, Monterey, CA (1969-1970)  
Thesis Title: "The Detection of Protons Scattered by High Energy Electrons."  
Thesis Advisor: Prof. John N. Dyer  
1969, B.S., Physics, U.S. Naval Academy, Annapolis, MD (1965-1969)

### Professional Experience

2001 – present Professor of Nuclear Engineering (Tenured)  
The University of Tennessee, Knoxville  
1995 - 2001 Associate Professor of Nuclear Engineering (Tenured - 2000)  
The University of Tennessee, Knoxville  
1981 - 1995 Senior Research Scientist (1988 - 1995)  
Research Scientist (1981 - 1988)  
NASA Langley Research Center, Hampton, VA  
1980 - 1995 Adjunct/Research Faculty in Physics Department  
Old Dominion University, Norfolk, VA  
1988 - 1995 Adjunct Faculty in Mathematics Department  
Christopher Newport University, Newport News, VA  
1969 - 1977 U.S. Navy Officer/Nuclear Submarine Engineer

## LAWRENCE W. TOWNSEND

### Honors and Awards

Fellow of the American Nuclear Society (elected in 2005)  
Fellow of the Health Physics Society (elected in 2006)  
Engineering Faculty Research Fellow (U. Tenn.) 2004, 2005, 2007  
Engineering Faculty Teaching Fellow (U. Tenn.) 2007  
Robert M. Condra Professorship (U. Tenn.) 2001-2003  
University of Tennessee Research and Creative Achievement Award 2001  
Moses E. & Mayme Brooks Distinguished Professor Award (U. Tenn.) 2001  
Leon and Nancy Cole Superior Teaching Award (U. Tenn.) 1998-1999  
U. Tennessee Nuclear Engineering Professor of the Year 1995-1996, 1999-2000, 2002-2003  
NASA Exceptional Scientific Achievement Medal 1993  
*For outstanding contributions to the understanding of nuclear interactions of cosmic radiation with matter and its implications for space-radiation exposure and shielding*  
NASA Langley Group Achievement Award 1990  
NASA Langley Special Achievement Award 1984, 1992  
NASA Langley Superior Accomplishment Award 1990, 1991  
NASA Langley Technical Excellence Award 1992  
NASA Langley Space Directorate Best Paper Award 1992  
NASA Langley Aero – Gas Dynamics Division Best Paper Award 1997  
Sigma Xi 1980 – present; Sigma Xi Outstanding Research Paper (Idaho Chapter) 1981  
Whittenberger Fellow 1979 - 1980  
American Men and Women of Science

### Memberships

American Nuclear Society, 1995 – present  
Fellow, 2005  
Oak Ridge/Knoxville Section, Chair 1999-2000, Vice Chair/Chair Elect, 1998-99,  
Board Member, 1997-1998, Scholarship Committee Chairman 1997-99;  
Radiation Protection and Shielding Division, Executive Committee 2003-present  
American Physical Society, Member, 1977 - present  
Division of Nuclear Physics; Southeastern Section; Forum on Industrial and Applied Physics  
Health Physics Society, 1995 – present  
Fellow, 2006  
Radiation Research Society, Member, 1988 – present  
Neutron Scattering Society of America, Member, 1999 – present  
Institute of Electrical and Electronics Engineers (IEEE) Nuclear and Plasma Sciences Society  
Senior Member, 2002 – present

## LAWRENCE W. TOWNSEND

### National and International Committees

National Council on Radiation Protection and Measurements (NCRP), 1990 – present  
Council Member, 1998 - 2010  
Scientific Committee 75 (member), 1990 - 2000  
Scientific Committee 1-7 (chairman), 1995 - 2006  
Committee on Space Research (COSPAR)  
Scientific Sub-Commission F2-Radiation Biology, 1990 - present  
COSPAR Nominating Committee (North American Rep.), 1998-2002  
HUGS at CEBAF International Advisory Committee, 1986 - 95  
Medium Energy Nuclear Data Working Group (US DOE), 1986 - 88  
NASA NSCORT Review Panel, 1996  
NIOSH/FAA Flight Attendants Exposure Study Peer Review Panel, 1996  
NASA Space Radiation Health Review Panel, 1997, 2000  
NASA Mars 2003/2005 Space Radiation Health Panel (Chair), 1999  
NASA Task Group to Examine Radiation Issues for Manned Lunar  
and Mars Missions, 2004  
NASA Mars Human Precursor Science Steering Group, 2004  
NAS/NRC Workshop Organizing Committee on Solar and Space Physics and the Vision  
for Space Exploration, 2005  
NRC Committee on the Evaluation of Radiation Shielding for Space Exploration, 2006-  
2008

## LAWRENCE W. TOWNSEND

### University of Tennessee Committees

#### University-wide

Member, College of Engineering Dean Search Committee, 2002-03  
Faculty Committee to Evaluate University Center Director, 1998-99  
Member, Radiation Safety Committee, 2001-2006  
Member, Cumulative Review Committee for S. Sorenson, 2004  
Member, Radiation Safety Specialist Search Committee, 2004  
Member, Radiation Safety Officer Search Committee, 2004, 2005  
Member, Cumulative Review Committee for Soren P. Sorenson, 2004  
Member, Physics Department Academic Program Review Committee, 2005  
Member, Science Advisory Committee (SAC) on Governor's Chairs, 2006-07

#### College of Engineering

Member, Nominations and Awards Committee, 1995 - 2004  
Member, BE 101 Oversight Committee, 1995 - 96  
Member, Nuclear Engineering Department Head Search Committee, 1996 - 97  
Member, Maintenance Reliability Engineering Advisory Committee, 1997 – 2001  
Member, Cumulative Review Committee for J. E. Lyne, 2004  
Member, ad hoc Tenure & Promotion Policy Review Committee, 2004-2005  
Member, Electrical Engineering & Computer Science Department Head Search Committee, 2006-2007

#### Department of Nuclear Engineering

Chair, Awards Committee, 1997 – 2004  
Chair, Tenure Review Committee, 2002 - 2003  
Member, Undergraduate Curriculum Committee, 1997  
Member, Computer Committee, 1998-1999  
Faculty Advisor, Student Health Physics Society Chapter, 1996-2002  
Member, Cumulative Review Committee for Belle R. Upadhyaya, 2004  
Chair, UTNE Benchmarking Committee, 2004-2007

### Dissertation, Thesis Committees

#### Major Professor (University of Tennessee)

1995-1996	M.S. Nuclear Engineering	Steven G. Bier (Nuclear Fuels Engineer at Hope Creek Nuclear Power Plant, NJ)
1995-1996	M.S. Nuclear Engineering	William L. Maxson (Engineer, Areva Inc., Paris, France)
1996-1997	M.S. Nuclear Engineering	Garth Forde (Systems Engineer, Consolidated Edison Co., NY)

LAWRENCE W. TOWNSEND

Dissertation, Thesis Committees (cont.)

Major Professor (University of Tennessee) (cont.)

1996-1997	M.S. Nuclear Engineering	E. Neal Zapp (Staff Scientist, NASA JSC, Houston, TX)
1996-1998	M.S. Nuclear Engineering	Chester R. Ramsey (Medical Physicist, Knoxville, TN)
1996-1998	Ph.D. Nuclear Engineering	Nazila H. Tehrani (Senior Nuclear Engineer, Progress Energy, Raleigh, NC)
1996-1998	M.S. Nuclear Engineering	Brian Bailey (Technical Staff, H&R Technical Associates, Oak Ridge, TN)
1998-1999	M.S. Nuclear Engineering	Jennifer Kasten (Systems Engineer, TVA, Watts Bar, TN))
1998-1999	M.S. Nuclear Engineering	Daniel L. Stephens (Staff Scientist, PNNL, Richland, WA)
1997-1999	M.S. Nuclear Engineering	Roger Gard (Internal Dosimetrist, Bechtel Jacobs, Oak Ridge, TN)
1996-2000	M.S. Nuclear Engineering	K. Martin Richardson (Medical Physics Assistant, Charlotte, NC)
1998-2000	Ph.D. Nuclear Engineering	Hanna Moussa (Res. Asst. Prof, University of Tennessee, Nuclear Eng. Dept..)
1998-2000	Ph.D. Nuclear Engineering	Chester R. Ramsey (Medical Physicist, Knoxville, TN)
1998-2000	M.S. Nuclear Engineering	Jennifer L. Parsons (Health Physicist, ORAU, Cincinnati, OH)
1998-2001	Ph.D. Nuclear Engineering	John Neal (Nuc. Sci. & Tech. Div., ORNL)
2000-2001	M.S. Nuclear Engineering	Scott Braley (USAF Officer on active duty)
2000-2001	M.S. Nuclear Engineering	Anne Shatara (Reactor Engineering, Diablo Canyon Power Plant, CA)

**LAWRENCE W. TOWNSEND**

**Dissertation, Thesis Committees (cont.)**

**Major Professor (University of Tennessee) (cont.)**

1999-2002	Ph.D. Nuclear Engineering	Daniel L. Stephens (Staff Scientist, PNNL)
2000-2002	M. S. Nuclear Engineering	Wesley Williams (Ph.D. student, MIT)
2000-2003	Ph.D. Nuclear Engineering	Jennifer L. Hoff (Health Physicist, ORAU)
2002-2003	M.S. Nuclear Engineering	Jennifer L. Wilson (Nuclear Chemist, TVA Watts Bar)
2001-2004	Ph.D. Nuclear Engineering	Thomas M. Miller (Research Staff, ORNL)
2002-2004	M.S. Nuclear Engineering	Martin Williamson (Engineer, Y-12)
2003-2005	M.S. Nuclear Engineering	Theodore Nichols (Ph.D. student, UT)
2003-2005	M.S. Nuclear Engineering	Christina Campbell (Nuclear Engineer, Areva, Inc.)
2004-2005	M.S. Nuclear Engineering	John Edwards (Engineering Staff, Duke Energy Co.)
2005-2006	M.S. Nuclear Engineering	Amy Street (Medical Phys., McComas Enterprises, Richmond, VA)
2005-2006	M.S. Nuclear Engineering	Brian Timm (Engineering Staff, Duke Energy Co.)
2005-2006	M.S. Nuclear Engineering	Youssef Charara (Ph.D. student, UT)
2005-present	Ph.D. Nuclear Engineering	Sirikul Indi Sriprisan (dissertation in prog.)
2005-present	Ph.D. Nuclear Engineering	Theodore F. Nichols (dissertation in prog.)
2005-present	M.S. Nuclear Engineering	Richard Hatcher (thesis TBD)
2006-2007	M. S. Nuclear Engineering	Robert A. Joseph (Ph.D. student, UT)

LAWRENCE W. TOWNSEND

**Dissertation, Thesis Committees (cont.)**

**Major Professor (University of Tennessee) (cont.)**

2006-present Ph.D. Nuclear Engineering Youssef Charara (dissertation in progress)  
2007-present Ph.D. Nuclear Engineering Jason M. Crye (dissertation TBD)  
2007-present Ph.D. Nuclear Engineering Carley Harris (dissertation in progress)  
2007-present M. S. Nuclear Engineering Kirk Sorenson (projects in progress)

**Committee Co-Chair (Old Dominion University)**

1986-1988 Ph.D. Physics Francis A. Cucinotta (NASA Johnson Space Center, Houston, TX)  
1987-1989 Ph.D. Physics Ferdous Khan (current position unknown)

**Service as Committee Member (UT unless otherwise indicated)**

Soon Park (M.S. Physics 1985 - Hampton University)  
Kelly Ausbrooks (M.S. Nuclear Engineering 1995)  
Yunnhon Lo (M.S. Nuclear Engineering 1996; Ph.D. Nuclear Engineering 2000)  
Cathy J. Lewis (M.S. Nuclear Engineering 1996)  
Kelly M. Spencer (M.S. Nuclear Engineering 1997)  
Lien K. Nguyen (M.S. Nuclear Engineering 1997)  
Thomas E. Byrne (M.S. Nuclear Engineering 1997)  
Zhong Cao (Ph.D. Nuclear Engineering 1997)  
Daniel L. Stephens (M.S. Physics 1997)  
Cynthia Maples (M.S. Nuclear Engineering 1998)  
Donald Marsh (M.S. Nuclear Engineering 1998)  
Daniel Chase (M.S. Nuclear Engineering 1998)  
Loong K. Yong (Ph.D. Nuclear Engineering 1998)  
Emran DaWoud (Ph.D. Nuclear Engineering 1998)  
Christina B. Pomatto (M.S. Nuclear Engineering 1998)  
Brian A. Thomas (M.S. Nuclear Engineering 1998)  
Rodney Harvill (M.S. Nuclear Engineering 1999)  
Mohammad K. Khan (M.S. Nuclear Engineering 1999, Ph.D. Nuclear Engineering 2002)  
W. David Pointer (M.S. Nuclear Engineering 1999; Ph.D. Nuclear Engineering 2001)  
J. Keith Waggoner (M.S. Nuclear Engineering 1999)  
Samuel Held (M.S. Physics 1999)

Dissertation, Thesis Committees (cont.)

Service as Committee Member (UTK unless otherwise indicated)(cont.)

Mat M. Tamimi (M.S. Nuclear Engineering 1999; Ph.D. Nuclear Engineering)  
Saskia Mioduszewski (Ph.D. Physics 1999)  
Alan S. Icenhour (Ph.D. Nuclear Engineering 2000)  
Andrew Stephan (M.S. Nuclear Engineering 1999)  
Daniel C. Evans (M.S. Nuclear Engineering 1999)  
William B. Bird (M.S. Nuclear Engineering 2000)  
Jason Crye (M.S. Nuclear Engineering 2001)  
Karen Brumley (M.S. Nuclear Engineering 2001)  
Thomas M. Miller (M.S. Nuclear Engineering 2001)  
William J. Marshall (M.S. Nuclear Engineering 2001)  
Omar Zeidan (Ph. D. Physics 2001)  
Ryan Scott Brame (Ph.D. Nuclear Engineering 2002)  
Susan Turner (M.S. Nuclear Engineering 2002)  
Michael Lane (M.S. Nuclear Engineering 2002)  
Brett Sumner (M. S. Nuclear Engineering 2002)  
Craig Smith (M. S. Nuclear Engineering 2002)  
Ahmed Abdul-Rahim (Ph.D. Nuclear Engineering 2003)  
Shane Parkey (M.S. Nuclear Engineering 2003)  
J. Patrick McClanahan (Ph.D. Nuclear Engineering 2003)  
Allan B. Wollaber (M.S. Nuclear Engineering 2003)  
Bob J. Gilliam (M.S. Nuclear Engineering 2003)  
Andrew Stephan (Ph.D. Nuclear Engineering 2003)  
Aaron Sawyer (M.S. Nuclear Engineering 2004)  
Ibrahim Attieh (Ph.D. Nuclear Engineering 2004)  
Joseph Bowling (M.S. Nuclear Engineering 2004)  
Robert Schlicht (M.S. Nuclear Engineering 2004)  
Henry Lynn (M.S. Nuclear Engineering 2004)  
Carlos Corredor (M.S. Nuclear Engineering 2004)  
Charles W. Alvord (M.S. Nuclear Engineering 2004; Ph.D. Nuclear Engineering)  
Andrew Glenn (Ph.D. Physics 2004)  
Baofu Lu (Ph.D. Nuclear Engineering 2004)  
Chrysos Kahambwe (M.S. Nuclear Engineering 2004)  
Mohammad Kasraie (M.S. Nuclear Engineering 2005)  
Mohammed N. Tantaway (Ph.D. Physics 2005)  
Scott R. Holcombe (M.S. Nuclear Engineering 2005)  
Joseph McConn (M.S. Nuclear Engineering 2005)  
Martin Djongolov (Ph.D. Physics 2006)  
Ralph Demeglio (M.S. Nuclear Engineering 2006)  
Matthew Miller (M.S. Nuclear Engineering 2006)

Dissertation, Thesis Committees (cont.)

Service as Committee Member (UTK unless otherwise indicated)(cont.)

Benjamin Robison (M.S. Nuclear Engineering 2006)  
Caleb Bastian (M.S. Nuclear Engineering 2006)  
Zhanwen Ma (Ph.D. Physics 2006)  
Kyle Kleinhans (M.S. Nuclear Engineering 2006)  
Irakli Garishvili (Ph.D. Physics 2006)  
Piotr Borycki (Ph.D. Physics 2006)  
Kyungyuk Chae (Ph.D. Physics 2006)  
Clarence R. Willis (M.S. Nuclear Engineering 2006)  
Dang Ho (M.S. Nuclear Engineering 2006)  
Jeff Preston (M.S. Nuclear Engineering 2006; Ph.D. Nuclear Engineering)  
E. Neal Zapp (Ph.D.-Physics, University of Houston 2007)  
Bryan Tylor (M.S. Nuclear Engineering 2007)  
Lukus Barnes (M.S. Nuclear Engineering 2007)  
Carley Harris (M.S. Nuclear Engineering 2007)  
Lee H. Hosack (M.S. Nuclear Engineering 2007)  
Thomas Anderson (M.S. Nuclear Engineering 2007)  
Juan Pablo Urrego-Blanco (Ph.D. Physics)  
Mark Wyatt (Ph.D. Nuclear Engineering)  
Catherine Large (Ph.D. Nuclear Engineering)  
Brian Moazen (Ph.D. Physics)  
Matthew Francis (Ph.D. Nuclear Engineering)  
Mustafa Rajabali (Ph.D. Physics)  
Erika Bailey (M.S. Nuclear Engineering)  
Elton Freeman (M.S. Physics)

**LAWRENCE W. TOWNSEND**

**Teaching Experience**

**Graduate Level**

The University of Tennessee

- NE 551 Radiation Protection (3 credits) F98/F99/F00/F01/F02/F03/F04/F05/F07
- NE 572 Nuclear System Design (3 credits) S00
- NE 597 Special Topics: Charged Particle Transport and Interactions (3 Credits) S97/F98
- NE 597 Special Topics: Neutron Science and Engineering Applications (3 Credits) F99
- NE 597 Special Topics: Space Radiation Protection (3 Credits) F00
- NE 597 Special Topics: Nuclear Cross Section Modeling (3 Credits) Su04
- NE 621 Special Topics: Charged Particle Transport and Interactions (3 Credits)  
F98/Su07/F07
- NE 621 Special Topics: Space Radiation Protection (3 Credits) F00
- NE 697 Special Topics: Neutron Science and Engineering Applications (3 Credits) F99
- NE 697 Special Topics: Charged Particle Transport and Interactions (3 Credits) F01
- NE 697 Special Topics: Nuclear Cross Section Modeling (3 Credits) F02/S07

Old Dominion University

- PHYS 722/822\* - Nuclear Physics (3 Credits) F83/S86/S90
- PHYS 681 - Topics: Heavy Ion Reaction Theory (3 Credits) F80
- PHYS 862\* - Advanced Topics in Nuclear Physics (3 Credits) S87
- (\* indicates equivalent to UTK 600-level)

George Washington University (NASA Langley extension campus)

- ApSc 211 - Analytical Methods in Engineering I (3 Credits) S82

**LAWRENCE W. TOWNSEND**

**Teaching Experience (cont.)**

**Undergraduate Level**

The University of Tennessee

BE 201 - Numerical Techniques (2 Credits) F95/F96/F97  
NE 301 – Fundamentals of Nuclear  
and Radiological Engineering (3 Credits) F04/F05/S06(DE)/F06  
NE 404 - Nuclear Fuel Cycle (3 Credits) S96/S97/S98/S99/S00/S02/S03/S04  
NE 431 - Radiation Protection (3 credits) S06/S07  
NE 433 - Radioassay and Dosimetry Laboratory (3 Credits) F95/F96/F97  
NE 470 - Nuclear Reactor Theory I (3 credits) S98/S99/S01/S02  
NE 472 - Nuclear System Design (4 credits) S00

Christopher Newport University

MATH 130 - Precalculus (3 Credits) S94/F94  
MATH 140 - Calculus & Analytical Geometry (4 Credits) F89/F91/S92  
MATH 240 - Intermediate Calculus (4 Credits) S88/S89/F90/F92

University of Idaho

PHYS 105 - Physics & Society (3 Credits) Su78  
PHYS 221 - Engineering Physics II (3 Credits) Su79

University of South Carolina (Navy PACE Program)

PHY 101 - Introduction to Physical Science (4 Credits) F75

## Research Interests

### 1. Nucleon-Nucleus/Nucleus-Nucleus Collision Theory

Quantum-mechanical, optical potential descriptions of nuclear collisions for use in predicting nucleon- and nucleus-nucleus total cross sections (elastic and inelastic), elastic differential cross sections, spallation/fragmentation yields, pion production cross sections, and angular and spectral distributions of secondary neutrons and light ions are being developed. These theoretical models are used for a variety of applications including space radiation protection of astronauts, radiotherapy using heavy charged particles, and production of radioactive ion beams for nuclear structure and reaction studies. I have also developed models of Electromagnetic dissociation of nuclei in these collisions using a modified Weiszacker-Williams approach. [Collaborators: R. K. Tripathi (NASA Langley Research Center), F. A. Cucinotta (NASA JSC), E. N. Zapp (NASA JSC), J. W. Norbury (NASA Langley Research Center), L. H. Heilbronn (LBNL) and several UT students].

### 2. Radioactive Ion Beam Production

A model to predict the production and decay over time of radioactive ions from nuclear collisions is being developed. Radioactive decays over time are calculated using numerical solutions to the coupled rate equations. A comprehensive database of decay constants for over 2800 nuclides has been developed. This radioactive decay model will be coupled to an optical potential spallation model (see 1. above) originally developed for space radiation protection studies. The spallation model is being extended to heavy nuclei, such as uranium, by incorporating a fission channel. The ion decay model can be used for estimating production yields of exotic nuclear species for fundamental physics studies. It can also be used to assess radiological health requirements for handling radioactive targets.

### 3. Heavy, Charged-Particle Transport

For about 15 years I was part of the space radiation protection research group at NASA Langley Research Center. We developed the deterministic space radiation transport codes, BRYNTRN and HZETRN, and their extensive nuclear atomic interaction databases. Recently, with NASA funding, a project to incorporate high energy, heavy ion interaction databases and transport models into the HETC Monte Carlo computer code system for Human Exploration in Space applications. [Collaborators: T. A. Gabriel (ORNL), and various UT students]. I was also the PI and leader of the NASA Space Radiation Transport Consortium (2002-2007). This consortium was tasked with completing the development of a suite of Monte Carlo and deterministic radiation transport codes for NASA's use in developing space radiation shielding and risk assessments for astronauts on near-Earth and interplanetary missions. [Consortium members: UT, University of Houston, Roanoke College, NASA Langley Research Center, NASA Marshall Space Flight Center, NASA Johnson Space Center, CERN, University of Southern Mississippi, and SID, Inc.].

**Research Interests (cont.)**

4. Space Radiation Protection

I have spent most of the past three decades developing methods of estimating doses and equivalent doses received by astronauts in deep space from exposure to galactic cosmic rays (GCR) and energetic solar particle events (SPEs). Present research efforts are focused on estimating dose rates to critical body organs as a function of time during major SPEs. In addition, new, innovative, real-time methods of predicting the buildup of organ doses as a function of time since event onset are being developed using (1) Bayesian inference and (2) a new type of artificial neural network (patent pending) developed for this purpose. The idea is to use several dosimeter readings early in the event to project future doses during the event. I have also made an extensive study of the Carrington Event of 1859, the largest solar energetic particle event of the past 500 years. [Collaborators: E. N. Zapp (NASA Johnson Space Center), J.W. Hines (UT), J.L. Hoff (ORAU), T. F. Nichols (UT student) and J. S. Neal (ORNL)].

5. Radiological Engineering/Health Physics

Modifications to the ICRP respiratory tract model are being investigated. Present research focuses on calculating dose deposition in the tissues of the ET1 (extra-thoracic) region (nose) resulting from beta decays by airborne sources. The work uses the MCNP4B computer code to estimate the doses. New models of the ET1 region geometry are being investigated. [Collaborators: K.F. Eckerman (ORNL) and H. Moussa (UT)].

6. Generation IV Modular Reactor Plant Development

A conceptual design for an economical, safe, modularized, proliferation-resistant, Generation IV light-water reactor plant system is being developed. [Collaborators: F. M. Mynatt (UT), L.F. Miller (UT)]

LAWRENCE W. TOWNSEND

Grants and Contracts (PI unless otherwise indicated)

<u>Date</u>	<u>Project Title</u>	<u>Funding Source</u>	<u>Awarded</u>
<u>Completed</u>			
1996-98	Nuclear Database Development	NASA Langley Res. Ctr.	\$44,000
1996-98	Dose-Time Profiles of Major Solar Energetic Particle Events	NASA Johnson Space Ctr.	\$104,631
1996	COSPAR XXXI Scientific Travel Grant	UTK Professional Development Fund	\$2,200
1996	Spallation Yields From Nuclear Collisions	Oak Ridge National Laboratory	\$15,255
1997	Development of Neutron Optics And Guides for Cf-252 Sources	UTK Scholarly Activities Research Incentive Fund	\$4,372
1998-99	Fission and Spallation Yields For Constructing the NISOL Facility at the SNS Site	Oak Ridge National Laboratory	\$49,278
1998	COSPAR XXXII Scientific Assembly Travel Grant	UTK Professional Development Fund	\$3,000
2000	COSPAR XXXII Scientific Assembly Travel Grant	UTK Professional Development Fund	\$3,100
2000-01	Worst Case Crew Exposure Due To An Energetic Solar Particle Event	Wyle Laboratories, Inc.	\$32,932
1999-01	Predicting Astronaut Radiation Dose from Solar Energetic Particle Events Using Bayesian Methods	NASA Johnson Space Ctr.	\$44,000
1999-02	Measurements of Secondary Neutron and Charged Particle Spectra	NASA Johnson Space Ctr.	\$66,000

LAWRENCE W. TOWNSEND

**Grants and Contracts (cont.)**

<u>Date</u>	<u>Project Title</u>	<u>Funding Source</u>	<u>Awarded</u>
<u>Completed (con't.)</u>			
2001-02	Vortex Reactor Assessment for Newport News Shipbuilding (Co-I)	Newport News Shipbuilding	\$14,000
1998-02	Radiation Transmission Properties of In-Situ Materials	Lawrence Berkeley National Laboratory	\$188,424
2000-03	Design and Layout Concepts for Compact, Factory-Produced, Transportable, Generation IV Reactor Systems (Co-I)	US DOE	\$649,244
2002	Balance of Plant Design for the IRIS Reactor System	Tennessee Valley Authority	\$27,000
2002-03	Transportable Modular Balance of Plant Study for Small Nuclear Power Plants	Tennessee Valley Authority	\$51,233
2000-2004	Development of a Monte Carlo Radiation Transport Code System For HEDS	NASA Marshall Space Flight Center	\$227,000
2002-05	Continuous Cross Section Database Development for Generalized Three Dimension Radiation Transport Codes	NASA Marshall Space Flight Center	\$72,000
2002-06	Advanced Warning Methodologies For Solar Particle Event Radiation Exposures	NASA Goddard Space Flight Center	\$348,813
2002-06	Radiation Transport Code Development for Space Radiation Shielding Applications	NASA Marshall Space Flight Center	\$1,924,198
2003-06	Particle Transport Assessment of GCR Shielding Materials	Oak Ridge National Lab	\$75,000

LAWRENCE W. TOWNSEND

Grants and Contracts (cont.)

<u>Date</u>	<u>Project Title</u>	<u>Funding Source</u>	<u>Awarded</u>
<u>Completed (con't.)</u>			
2007	HZETRN 2005 Benchmarking and Validation Using HETC-HEDS	NASA Langley Research Center	\$169,541
<u>In Progress</u>			
2005-09	Lunar Reconnaissance Orbiter CRaTER Detector	NASA Goddard Space Flight Center (Boston U. Subcontract)	\$376,069
2006-09	Advanced Forecasting Methodologies for Solar Particle Event Radiation Exposures	NASA Goddard Space Flight Center	\$416,636
2006-11	Earth-Moon-Mars Radiation Exposure Module (EMMREM)	NASA	\$497,682
2007-08	Software Development for Nowcasting SEP Event Total Doses	Wyle Laboratories, Inc.	\$60,000

## LAWRENCE W. TOWNSEND

### JOURNAL ARTICLES (All Peer-Reviewed)

1. Deutchman, P.A.; and Townsend, L.W.: Coherent Isobar Production in Peripheral Relativistic Heavy-Ion Collisions. Physical Review Letters, Vol. 45, No. 20, November 1980, pp. 1622-1625. (collaborator with dissertation advisor)
2. Townsend, L.W.; and Deutchman, P.A.: Isobar Giant Resonance Formation in Self-Conjugate Nuclei. Nuclear Physics A, Vol. 355, No. 2, March 1981, pp. 502-532. (principal author; publication of dissertation work)
3. Wilson, J.W.; and Townsend, L.W.: An Optical Model for Composite Nuclear Scattering. Canadian Journal of Physics, Vol. 59, No. 11, November 1981, pp. 1569-1576. (collaborator and author of manuscript)
4. Deutchman, P.A.; and Townsend, L.W.: Isobars and Isobaric Analog States. Physical Review C, Vol. 25, No. 2, February 1982, pp. 1105-1107. (collaborator with dissertation advisor)
5. Townsend, L.W.; and Wilson, J.W.: Comment on Nucleus-Nucleus Total Reaction Cross Sections. Physical Review C, Vol. 25, No. 3, March 1982, pp. 1679-1681. (principal author)
6. Townsend, L.W.; Wilson, J.W.; and Bidasaria, H.B.: On the Geometric Nature of High-Energy Nucleus-Nucleus Reaction Cross Sections. Canadian Journal of Physics, Vol. 60, No. 10, October 1982, pp 1514-1518. (principal author)
7. Townsend, L.W.: Abrasion Cross Sections for  $^{20}\text{Ne}$  Projectiles at 2.1 GeV/Nucleon. Canadian Journal of Physics, Vol. 61, No. 1, January 1983, pp. 93-98. (sole author)
8. Bidasaria, H.B.; Townsend, L.W.; and Wilson, J.W.: Theory of Carbon-Carbon Scattering from 200 to 290 MeV. Journal of Physics G: Nuclear Physics, Vol. 9, No. 1, January 1983, pp. L17-L20. (principal author; supervisor of postdoc - HBB)
9. Townsend, L.W.; Bidasaria, H.B.; and Wilson, J.W.: Eikonal Phase Shift Analyses of Carbon-Carbon Scattering. Canadian Journal of Physics, Vol. 61, No. 6, June 1983, pp. 867-871. (principal author; supervisor of postdoc - HBB)
10. Deutchman, P.A.; Madigan, R.L.; Norbury, J.W.; and Townsend, L.W.: Pion Production Through Coherent Isobar Formation in Heavy-Ion Collisions. Physics Letters B, Vol. 132, Nos. 1-3, November 24, 1983, pp. 44-46. (collaborator)

LAWRENCE W. TOWNSEND

JOURNAL ARTICLES

11. Bidasaria, H.B.; and Townsend, L.W.: Microscopic Optical Potential Analyses of Carbon-Carbon Elastic Scattering. Canadian Journal of Physics, Vol. 61, No. 12, December 1983, pp. 1660-1662. (principal author; supervisor of postdoc - HBB)
12. Townsend, L.W.: HZE Particle Shielding Using Confined Magnetic Fields. Journal of Spacecraft and Rockets, Vol. 20, No. 6, November/December 1983, pp 629-630. (sole author)
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## LAWRENCE W. TOWNSEND

### Other Research and Creative Accomplishments

#### Inventions

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