

# Caleb J. Redding

NUCLEAR ENGINEER · LOW ENERGY PHYSICIST · EDUCATOR

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## Education

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### Ph.D. Nuclear Engineering

UNIVERSITY OF TENNESSEE

- Major Professor: Jason Hayward
- GPA: 3.96

*Knoxville, Tennessee*

*May 2021*

### M.S. Nuclear Engineering

UNIVERSITY OF TENNESSEE

- Major Professor: Lawrence Townsend
- GPA: 3.94

*Knoxville, Tennessee*

*Aug. 2017*

### Graduate Certificate: Nuclear Security Science & Analysis

UNIVERSITY OF TENNESSEE

*Knoxville, Tennessee*

*Aug. 2017*

### Professional Educator Certificate: Secondary Science

ALABAMA STATE DEPARTMENT OF EDUCATION

- Coursework completed at Delta State University - Cleveland, MS and Athens State University - Athens, AL

*Greensboro, Alabama*

*Sep. 2015*

### B.S. Physics

UNIVERSITY OF TENNESSEE

- Concentration: Academic Physics
- Summa Cum Laude

*Knoxville, Tennessee*

*May 2012*

## Training/Professional Development

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### SCALE ORIGEN/Couple

OAK RIDGE NATIONAL LAB

*Oak Ridge, TN*

*March 2023*

### Nuclear Weapons Orientation Course

DEFENSE NUCLEAR WEAPONS SCHOOL

*Albuquerque, NM*

*October 2022*

### Proposal Writing Workshop

SHIPLEY ASSOCIATES

*Virtual*

*January 2022*

### GADRAS Basics I,II

SANDIA NATIONAL LAB

*Virtual/Self-Led*

*September 2021*

### HYSPLIT Online Workshop

NOAA AIR RESOURCES LAB

*Virtual*

*June 2021*

# Research Experience

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## Oak Ridge National Laboratory: Nuclear Nonproliferation Division

Oak Ridge, Tennessee

RESEARCH AND DEVELOPMENT ASSOCIATE STAFF

May 2021 - Current

- NA-22, Researched HPIC radiochemical separations and analyte measurements, via counting and ICP-MS, towards shortening the analysis timeline. Organized and participated in relevant measurement campaigns to support this objective.
- NA-24, Proposed, and was awarded, a project to develop a tool to quickly simulate UMS detector responses to spent fuel sources.
- NA-22, Performed radiation measurements on fresh fission products.
- NA-83, Prepared and delivered training to DOE-DFO on DELFIC/FPTool and FIT. Support is also given to the testing and development of these tools.
- NA-22, Researched and produced uranium compounds for signature discovery.
- NA-22, Led a team of scientists through the process of analyzing historic debris (ongoing).
- NA-22, Researched methods to analyze historic debris samples.
- Multi., Researched a variety of literature as it pertains to nuclear fallout properties and analyses.
- NA-22, Researched and analyzed DOE Detonation Forensics Operations procedures as they pertain to sample triage.
- DOE-NE, Cooperated with a large multi-lab team to develop a plan for analyzing a SNF cask transport accident.
- DOE-NE, Researched NEPA policy and related DOE guidelines as they relate to SNF transport EIS requirements.
- SPP, Developed and delivered a dynamically linked library, for aircrew training purposes, which computes detector responses to a radioactive plume.
- SPP, Leveraged DELFIC, HYSPLIT, and MCNP6.2 to model the immersion and directional responses of a detector array to a radioactive plume.

## U. Tennessee - Dept. of Nuclear Engineering: RadIDEAS Group

Knoxville, Tennessee

GRADUATE STUDENT RESEARCH ASSOCIATE

Jul. 2017 - May 2021

- Performed comparative studies on novel and commercially available organic scintillators.
- Developed and validated a GEANT4 workspace to model radiation interactions and light transport within high-Z loaded organic scintillators, including those based on organometallics and nanocomposites.
- Developed and demonstrated a deconvolution method to separate x-ray escape peaks from photopeaks in low density, small volume gamma detectors.
- Expanded the methodology to compute the Cramér-Rao Lower Bound on timing resolution in a simple PE-TOF system.
- Utilized MCNP6.1 to calculate  $\gamma$ /neutron flux ratios for various configurations of detector,  $^{252}\text{Cf}$  and  $^{22}\text{Na}$  sources for gamma rejection studies.
- Conducted a rheologically-focused investigation to compare flexural moduli measurements of EJ200 performed in the time and frequency domains.

## U. Tennessee - Dept. of Nuclear Engineering: NNbar Collab

Knoxville, Tennessee

GRADUATE STUDENT RESEARCH ASSOCIATE

Aug. 2015 - Jun. 2017

- Characterized the simulated source term for the European Spallation Source in the direction of the proposed NNBar experimental beamline.
- Developed a plan for conducting radiation shielding calculations on massive 200-m x 4-m beam line utilizing FW-CADIS for variance reduction.
- Performed deep penetration shielding calculations using MCNPX to generate the source term, ADVANTG to generate the FW-CADIS derived weight windows, and MCNP5 for the final  $n/\gamma$  transport.

## Oak Ridge National Laboratory - PI: Ali Passian

Oak Ridge, Tennessee

RESEARCH INTERN

May. 2011 - Aug. 2011

- Gained experience in the operation of a near-field scanning optical microscope (NSOM).
- Studied nanoscale light-matter interactions.
- Added spectroscopic capabilities to the NSOM via coupling of monochromator.

## U. Tennessee - Dept. of Physics: P. Dai's Condensed Matter Group

Knoxville, Tennessee

UNDERGRADUATE RESEARCH ASSISTANT

Jan. 2011 - May. 2012

- Manufactured high  $T_C$  superconducting crystals via self-flux method.
- Studied effects of annealing on NaFeAs crystals.
- Characterized crystals utilizing a PPMS.
- Participated in neutron scattering experiments at SNS to study underlying mechanisms of the NaFeAs class of superconductors.
- Coached and mentored upcoming undergraduate students to perform the necessary research responsibilities.

# Teaching Experience

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## U. Tennessee - Dept. of Nuclear Engineering

[Knoxville, Tennessee](#)

GRADUATE TEACHING ASSISTANT

Aug. 2015 - May 2017

- Lab section instructor for *Radiological Engineering Laboratory*
- Grader for two semesters of *Numerical Methods and FORTRAN*; developed Bash scripts to automate the majority of the grading for programming assignments
- Grader for *Reactor Systems and Safety*

## Greensboro High School

[Greensboro, Alabama](#)

PRIMARY SCIENCE & MATHEMATICS INSTRUCTOR

Aug. 2012 - May 2015

- Taught a variety of courses, including: *Physics, Pre-Calculus, Environmental Science, Forensic Science, Physical Science, Chemistry, and Biology*
- Held voluntary after-school office hours for tutoring students
- Co-founded and coached a B.E.S.T. robotics team which won second place in the charter year
- Managed and maintained student lab space
- Performed other school duties: sporting event ticket sales, concessions, football team statistician, etc.

## East Side High School

[Cleveland, Mississippi](#)

MATHEMATICS INSTRUCTOR

Jun. 2012 - Jul. 2012

- Taught a Summer Course in Algebra as part of a co-op. This served as a practicum for the Summer Teaching Institute for Teach for America initiates

## U. Tennessee - Depts. of Physics & Mathematics

[Knoxville, Tennessee](#)

PHYSICS AND MATHEMATICS TUTOR

Jan. 2010 - Dec. 2010

- Tutored undergraduate students in university physics and mathematics

## Volunteer State Community College

[Gallatin, Tennessee](#)

MATHEMATICS TUTOR

Jan. 2009 - May. 2009

- Tutored students in college algebra as part of a math practicum

# Employment

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## Oak Ridge National Laboratory

[Oak Ridge, Tennessee](#)

RESEARCH AND DEVELOPMENT ASSOCIATE STAFF

May 2021 - Current

- Address: 1 Bethel Valley Road, Oak Ridge, TN, 37830

## University of Tennessee

[Knoxville, Tennessee](#)

GRADUATE RESEARCH & TEACHING ASSISTANT

Aug. 2015 - May 2021

- Address: The University of Tennessee, Office of the Treasurer, Knoxville, TN, 37996

## Hale County Board of Education

[Greensboro, Alabama](#)

PRIMARY INSTRUCTOR & SPORTS STATISTICIAN

Aug. 2012 - Jul. 2015

- Address: Hale County Board of Education, 1115 Powers Street, Greensboro, AL, 36744

## University of Tennessee

[Knoxville, Tennessee](#)

UNDERGRADUATE RESEARCHER & TUTOR

Jan. 2010 - May 2012

- Address: The University of Tennessee, Office of the Treasurer, Knoxville, TN, 37996

## Walmart Stores Inc.

[Springfield, Tennessee](#)

SALES ASSOCIATE

Apr. 2006 - Jul. 2009

- Address: 3360 Tom Austin Hwy., Springfield, TN, 37172

## Skills

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**Experimental**  $\gamma$  spectroscopy,  $\gamma$ /neutron PSD, single photon coincidence counting, photosensor calibration, charged particle spectroscopy, tensile and flexural testing of polymeric materials, dynamic mechanical analysis, scintillation light yield, gamma non-proportionality, near-field scanning optical microscopy, crystal growth using self-flux method

**Hardware** Digitizers based on flash ADC and domino ring sampling technology, wide range of NIM modules, photosensors, single photon counter based on APD, femtosecond pulsed diode laser, wide range of scintillators including CLYC/PVT composites, SSB-based charged particle spectrometers, motion stages and controllers, mechanical properties testing systems including dynamic mechanical analyzers, HPGe and CZT detectors,  $^3\text{He}$  based neutron counters, near field scanning optical microscope, general optics equipment, monochromators, spectrophotometers, tube furnaces, inert atmosphere glove boxes, welders, turbo vacuum pumps, propane torches, physical properties measurement system (PPMS), simple cryogenic systems

**Programming** Python, C++, Bash scripting, FORTRAN, JAVA (basic),  $\text{\LaTeX}$

**Applications** GEANT4, ROOT, MCNP(5,X,6), GADRAS, Maestro, MATLAB, CoMPASS, WaveDump, ADVANTG, ORIGEN-ARP, Mathematica, OpenMPI, Torque/Maui, SAS Enterprise, GnuPlot, Maple, LabVIEW

**Languages** English and basic Spanish

## Publications

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H. Yu, H. Zhao, C. Redding, T. Chen, T. Hajagos, G. Ferrelli, R. Zaldivar, J. Hayward, Q. Pei. *Organic Liquid and Nanocomposite Scintillators for Spectroscopic Detections*. Hard X-Ray, Gamma-Ray, and Neutron Detector Physics XXIII. Vol. 118338. SPIE, 2021.

Redding, Caleb J. *An Investigation of Plastic Scintillators for Radiation Sensing and Mechanical Applications*. PhD Diss., University of Tennessee, 2021.

T. Chen, H. Yu, X. Wen, C. Redding, T. Hajagos, H. Zhao, J.P. Hayward, C. Yang, Q. Pei. *A Plastic Scintillator Based on an Efficient Thermally Activated Delayed Fluorescence Emitter 9-(4-(4,6-diphenyl-1,3,5-triazin-2-yl)-2-methylphenyl)-3,6-dioctyl-9H-carbazole for Pulse Shape Discrimination Measurement*. *Advanced Optical Materials*. 2021, 2001975.

H. Zhao, H. Yu, C. Redding, Z. Li, T. Chen, Y. Meng, T.J. Hajagos, J.P. Hayward, and Q. Pei. *Scintillation Liquid Loaded with Hafnium Oxide Nanoparticles for Spectral Resolution of Gamma Ray*. *ACS Applied Nano Materials*. 2020.

C. Redding, A. Hackett, M. Laubach, R. Feng, P. Feng, C. Hurlbut, P. Liaw, and J.P. Hayward. *Tensile, flexural, and light output measurements of selected organic scintillators for evaluation of their potential as structural materials*. *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, **954**, 161448. October, 2018.

L.M. Wang, C.Y. Wang, U.C. Sou, H.C. Yang, L.J. Chang, C. Redding, Y. Song, P. Dai, and C. Zhang. *Longitudinal and transverse Hall resistivities in  $\text{NaFe}_{1-x}\text{Co}_x\text{As}$  single crystals with  $x = 0.022$  and  $0.0205$ : weak pinning and anomalous electrical transport properties*. *J. Phys.: Condens. Matter*, **25**, 395702. September 4, 2013.

C. Zhang, H. Li, Y. Song, Y. Su, G. Tan, T. Netherton, C. Redding, S.V. Carr, O. Sobolev, A. Schneidewind, E. Faulhaber, L.W. Harriger, S. Li, X. Lu, D.X. Yao, T. Das, A.V. Balatsky, T. Brückel, J.W. Lynn, and P. Dai. *Distinguishing  $S^\pm$  and  $S^{++}$  electron pairing symmetries by neutron spin resonance in superconducting  $\text{NaFe}_{0.935}\text{Co}_{0.045}\text{As}$* . *Phys. Rev. B*, **88**, 064504. August 9, 2013.

## Presentations

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C. Redding, R. Hunt, T. Keever, J. Ladd-Lively, M. Vick, A. Braatz, A. McAlister. *Uranium Production and Sampling Efforts at ORNL*. External Review Panel. Oak Ridge, Tennessee. September, 2023.

C. Redding and V. Jodoin. *Triage Data Evaluation*. R<sup>3</sup> Third Annual Review. Richland, Washington. August, 2023.

V. Jodoin, C. Redding, M. Krupcale, R. Lee. *DELFIc Fallout Planning Tool Version 2.3*. DFO DELFIc/NARAC Training. Albuquerque, New Mexico. August, 2023.

R<sup>3</sup> Venture TA3 Team. *OUO Title*. External Review Panel. Livermore, California. June, 2023.

R<sup>3</sup> Venture TA2 Team. *Enabling Early-Time Actionable Data*. External Review Panel. Livermore, California. June, 2023.

N. Rao, C. Redding, D. Hooper, J. Ladd-Lively *Selection of Training Sets for U-235 Source Detection Classifiers Using Gamma Signatures*. IEEE Symposium on Radiation Measurements and Applications. Ann Arbor, Michigan. June, 2023.

C. Redding and V. Jodoin. *Triage Data Evaluation*. R<sup>3</sup> Second Annual Review. Livermore, California. August, 2022.

J. Lefebvre and C. Redding. *Fallout Inject Tool (FIT) v1.0 Training*. DOE Detonation Forensics Operations - Geek Rodeo. Albuquerque, New Mexico. June, 2022.

C. Delzer, J. Cates, N. Cherepy, S. Payne, S. Alcorn, X. Wen, B. Musico, C. Redding, K. Joshi, G. England, and J.P. Hayward. *Performance of Partial Volume Alpha Particle Scintillators for Associated Particle Imaging*. IEEE-NSS/MIC Conference. Virtual - Tokyo, Japan. October, 2021.

Q. Zhou, C. Redding, H. Qi, and J.P. Hayward. *Agile Path Planning for Radiation Source Searching with Aerial Drones*. IEEE-NSS/MIC Conference. Virtual - Tokyo, Japan. October, 2021.

C. Redding, C. Delzer, and J.P. Hayward. *Optical Surface Model Selection in GEANT4 for High Aspect Ratio EJ-200*. SORMA West 2021 Conference. Virtual - San Francisco, California. May, 2021.

C. Redding, C. Delzer, Q. Pei, and J.P. Hayward. *Simulating Radiation Interaction and Light Collection in High-Z Loaded Plastic Scintillators*. IEEE-NSS/MIC Conference. Virtual - Boston, Massachusetts. November, 2020.

C. Redding, Q. Pei, H. Qi, J.P. Hayward, R. Feng, C. Hurlbut, Z. Li, P. Liaw, T. Naderi, H. Yu, R. Zhao, and Q. Zhou. *IDeAS to Advance Autonomous Radiological/Nuclear Search*. DTRA Basic Research Project Review. Remote. May, 2020.

C. Redding, A. Hackett, M. Laubach, R. Feng, P. Feng, C. Hurlbut, P. Liaw, and J.P. Hayward. *Tensile, flexural, and light output measurements of selected organic scintillators for evaluation of their potential as structural materials*. SORMA 2018 Conference. Ann Arbor, Michigan. June, 2018.

C. Redding and L. Townsend. *Source Term Analysis for NNBAR Radiation Shielding at ESS*. International NNBAR Collaboration Meeting. Lund, Sweden. December, 2016.

C. Redding and L. Townsend. *Developing a Shielding Model for the  $n, \bar{n}$  Beamline at the European Spallation Source*. SESAPS 2016 Conference. Charlottesville, Virginia. November, 2016.

C. Redding and L. Townsend. *Source Term Creation for NNBAR Radiation Shielding at ESS*. International NNBAR Collaboration Meeting. Lund, Sweden. August, 2016.

C. Redding and L. Townsend. *Radiation Shielding for the  $n, \bar{n}$  Experiment at ESS* International NNBAR Collaboration Meeting. Knoxville, Tennessee. June, 2016.

## Reports

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J. Ladd-Lively, D. Abrecht, D. Duckworth, et al. *NA-22 Annual Report Uranium Processing Signatures for Nuclear Forensics*. ORNL/SPR-2023/3219. Oak Ridge, Tennessee. November, 2023.

C. Redding and K. Connolly. *On the Utility of MACCS for Analyses of Cask Transport Accidents with Release - Interim Report*. ORNL/SPR-2023/2989. Oak Ridge, Tennessee. July, 2023.

C. Redding, V. Jodoin, T. Keever, B. Roach, J. Giaquinto. *Relevant Analytes Targeted by RAPID*. ORNL PUB-ID: 204722. Oak Ridge, Tennessee. April, 2023. Classified.

K. Connolly, A. Adeniyi, M. Fialkoff, J. Karcz, B. Loftin, O. Martinez, C. Redding, C. Samuels, K. Banerjee, C. Condon, M. Feldman, D. Goodman, E. Kennedy, S. Maheras, D. Richmond, A. Rigato, K. Thomas, V. Wilson, M. Atz, D. LePoire, M. MacDonell, M. Abkowitz. *Transportation Risk Assessment: Spent Nuclear Fuel Accident Analysis Process Plan*. ORNL/SPR-2022/2511. Oak Ridge, Tennessee. In Review.

C. Redding, T. Norby, V. Jodoin, J. Lefebvre. *Detonation Response Modeling for Aircrew Training*. ORNL/TM-2022/2379. Oak Ridge, Tennessee. March, 2022.

A. Addazi, K. Anderson, S. Ansell, K. Babu, J. Barrow, D.V. Baxter, P.M. Bentley, Z. Berezhiani, R. Bevilacqua, C. Bohm, G. Brooijmans, J. Broussard, R. Biondi, B. Dev, C. Crawford, A. Dolgov, K. Dunne, P. Fierlinger, M.R. Fitzsimmons, A. Fomin, M. Frost, S. Gardner, A. Galindo-Uribarri, E. Golubeva, S. Girmohanta, G.L. Greene, T. Greenshaw, V. Gudkov, R. Hall-Wilton, L. Heilbronn, J. Herrero-Garcia, G. Ichikawa Ito, E. Iverson, T. Johansson, L. Joensson, Y.J. Jwa, Y. Kamyshev, K. Kanaki, E. Kearns, M. Kitaguchi, T. Kittelmann, E. Klinkby, L.W. Koerner, B. Kopeliovich, A. Kozela, V. Kudryatsev, A. Kupsc, Y. Lee, M. Lindroos, J. Makkinje, J.I. Marquez, R. Mohapatra, B. Meirose, T.M. Miller, D. Milstead, T. Morishima, G. Muhrer, H.P. Mumm, K. Nagamoto, V.V. Nesvizhevsky, T. Nilsson, A. Oskarsson, E. Paryev, R.W. Pattie Jr., S. Penttil, Y.N. Pokotilovski, I. Potashnikova, C. Redding, J.M. Richard, D. Ries, E. Rinaldi, A. Ruggles, B. Rybolt, V. Santoro, U. Sarkar, A. Saunders, G. Senjanovic, A.P. Serebrov, H.M. Shimizu, R. Shrock, S. Silverstein, D. Silvermyr, W.M. Snow, A. Takibayev, L. Townsend, I. Tkachev, L. Varriano, A. Vainshtein, J. de VRies, R. Woracek, Y. Yamagata, A.R. Young, L. Zanini, Z. Zhang, O. Zimmer. *New high-sensitivity searches for neutrons converting into antineutrons and/or sterile neutrons at the European Spallation Source*. arXiv preprint, arXiv:2006.04907. June 8, 2020.

C. Redding. *Developing a Shielding Model for the  $n$ ,  $\bar{n}$  Beamline at the European Spallation Source*. Master's Project Report. Knoxville, Tennessee. July, 2017.

C. Redding. *An Assessment of the Radiological Environment and Hazards Related to the NNBAR Beam Line*. Master's Project Report. Knoxville, Tennessee. July, 2017.

## Honors & Awards

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2021	<b>Volunteer of Distinction for Professional Promise</b> , University of Tennessee	<a href="#">Knoxville, TN</a>
2014	<b>Principal's Award for Outstanding Service</b> , Greensboro High School	<a href="#">Greensboro, AL</a>
2012	<b>Distinguished Graduate in Physics</b> , University of Tennessee	<a href="#">Knoxville, TN</a>
2012	<b>James W. McConnell Award for Academic Excellence</b> , UT-Physics	<a href="#">Knoxville, TN</a>
2011	<b>Physics Departmental Scholarship</b> , UT-Physics	<a href="#">Knoxville, TN</a>
2011	<b>Outstanding Physics Tutor</b> , UT-Physics	<a href="#">Knoxville, TN</a>
2010	<b>Outstanding Physics Student</b> , UT-Physics	<a href="#">Knoxville, TN</a>
2008	<b>Math &amp; Science Scholarship</b> , Joseph C. Watlington Foundation	<a href="#">Gallatin, TN</a>
2007	<b>Eagle Scout Award</b> , Boy Scouts of America	<a href="#">Cedar Hill, TN</a>

## Service Activities

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### Volunteer Musician

[Various Locales](#)

LEAD GUITARIST

2003 - Current

- Serve on a weekly to four times per week basis (5hrs.-15hrs.) up until July 2021. I currently fill in as needed, usually once a quarter.

### Neighborhood Engagement

[Knoxville, Tennessee](#)

DESIGNER & FUNDRAISER

May 2019

- Designed vector graphics for replacement neighborhood entry sign
- Raised funds for sign replacement and entryway landscaping

### Science Department Chair

[Greensboro, Alabama](#)

Aug. 2014 - May 2015

- Administered science department resources as needed
- Acquired additional lab supplies & activity sets
- Led bi-weekly meetings with department stakeholders

### Robotics Coach & Sponsor

[Greensboro, Alabama](#)

Aug. 2012 - May 2015

- Encouraged and developed student interest in engineering design and robotics
- Facilitated a culture of teamwork to achieve collective goals
- Organized student trips and engagements to expose them to industrial robotics applications

### **Volunteer Tutor**

- Tutored students in math, science, and ACT prep
- 5hrs per week

*Greensboro, Alabama*

*Aug. 2012 - May 2015*

### **FAFSA Night**

ORGANIZER & DELIVERER

- Organized a FAFSA night so students and their parents could complete the FAFSA

*Greensboro, Alabama*

*Jan. 2015*

### **AmeriCorps**

TEACH FOR AMERICA MEMBER

- Learned about & engaged in activities to diminish the achievement gap

*Greensboro, Alabama*

*Sep. 2012 - Jun. 2014*

### **Habitat for Humanity**

FRAMER/ROOFER/LABORER

- Worked as a part of a team to construct a habitat home
- An alternative spring break activity

*McAllen, Texas*

*Mar. 2012*

### **Boy Scouts of America**

EAGLE SCOUT PROJECT

- Organized, designed, and constructed an entry way to a non-profit youth camp

*Adams, Tennessee*

*May 2007*

## **Committees**

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2014-15 **Member**, School Merger Planning

*Greensboro, AL*

2014-15 **Chair**, School Safety

*Greensboro, AL*

2013-15 **Member**, Graduation Committee

*Greensboro, AL*

2013-15 **Member**, Prom Planning

*Greensboro, AL*

2011-12 **Member**, Dean Student Advisory Council

*Knoxville, TN*

## **Extracurricular Hobbies & Interests**

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- Composing and playing music
- Hiking
- Hunting & fishing
- Competitive Shooting
- Kayaking & canoeing
- Camping
- Gardening
- Photography
- Soccer, volleyball, & Frisbee
- Baking breads, pastries, & pizza