



## Nuclear Science And Technology



To earn this Interest Project Patch, girls 11-17 must complete:

- Two activities from the Skill Builders section
- One activity from the Technology section
- One activity from the Service Project section
- One activity from the Careers section
- Two additional activities from any sections

Radiation and radioactive materials are used in many ways that affect and improve our daily lives - - for example, diagnosing and treating cancer patients, producing heat in nuclear power plants that provide electricity, examining pipelines, improving our telephone wires, sterilizing medical products, preserving foods, and controlling agricultural pests. Working on these Project Patch requirements will help you better understand how nuclear science and technology are present in YOUR life.

### Skill Builders

1. ***First, master the lingo.*** Like many things, nuclear science is not so tough to understand if you can speak the language. Find some books and reading materials that describe nuclear terminology. Use these materials to define the following nuclear-science terms:

atom  
atomic nucleus  
chain reaction  
electron  
food irradiation  
fuel assembly (or fuel bundle)  
industrial radiation processing

ionizing radiation  
neutron  
nuclear medicine  
nuclear reactor  
plutonium  
proton  
radiation

half-life  
uranium  
fusion  
spent fuel  
fuel cycle  
radioactive waste  
fission

2. ***Get the big picture.*** Nuclear science is a relatively new field, beginning with the discovery of x-rays in 1895 by Wilhelm Roentgen. Since that time, the study of nuclear science has involved many incredible people, including those listed below. Create a time line of events in the history of nuclear science using the following list as a starting point. Include dates and a sentence or two describing key events or activities of these pioneers in nuclear science.

Henri Becquerel

Neils Bohr

James Chadwick

Marie Curie

Pierre Curie

John Dalton

Albert Einstein

Enrico Fermi

Hans Geiger and W. Müller

Otto Hahn

Werner Heisenberg

Irène Joliot-Curie

Ernest O. Lawrence

Lise Meitner

Ida Noddack

Dixy Lee Ray

Wilhelm Roentgen

Ernest Rutherford

Fritz Strassmann

Leo Szilard

Paul-Ulrich Villard

Rosalyn Yalow

3. ***Are you in touch with your surroundings?*** Radiation is all around us. It comes from natural as well as artificial sources. It exists in nature in the form of waves or atomic particles. Learn about five basic types of nuclear radiation: alpha, beta, gamma, neutrons, and x-rays. Describe each radiation type, how it can be detected, and from where it comes. Prepare a poster showing how different types of radiation are present in your life. What is your average annual radiation dose?
4. ***Get your hands dirty.*** Perform an experiment to see how radiation affects seeds. Plant a group of irradiated seeds and a group of nonirradiated seeds of the same kind. Grow both groups and monitor their growth daily. List the similarities and differences between the groups.

## **Technology**

1. ***Of what use is it?*** Irradiation, the process of treating something with radiation, is used many ways in agriculture, industry and medicine. List and describe five ways in which irradiation is used. Learn more about food irradiation by (a) visiting a food irradiation facility, or (b) inviting a professional in the field to talk to your troop about food preservation by irradiation.
2. ***Take a trip.*** Visit a hospital that uses nuclear techniques for diagnosis and treatment. Interview your tour guide and/or some other professionals you meet on your tour to learn about the various aspects of nuclear medicine. Ask about their

positions at the hospital, the types of nuclear-medicine tests that are performed, the precautions taken by people who work with radioactive materials at the hospital, and how they dispose of radioactive waste materials. Report your findings to your troop or another group.

3. ***Play a game.*** Find out what fission means and how it is used in a nuclear power plant. Then perform a demonstration of a nuclear chain reaction using dominoes. Arrange seven or more dominoes like bowling pins, representing neutrons striking atoms. How would you slow down or control this chain reaction? Move the blocks farther apart so that some fall down without hitting another block. How does this arrangement demonstrate "critical size"? Now hold pencils between the rows of dominoes so that some dominoes fall and hit a pencil without hitting another block. Compare the pencils to "control rods" in a nuclear reactor.
4. ***Get energized.*** Learn about nuclear power plants. Visit a nuclear power plant. Make a drawing showing how the plant works. Explain the differences or similarities of coal-fired and nuclear plants. OR Invite someone from a nuclear power plant or university nuclear engineering department or research lab to talk about where they work and the different types of power plants. OR Build a model of a nuclear reactor. Contact the American Nuclear Society (ANS) or your local utility to help with instructions on how to build this model. Explain to your troop or another group how it is used in the generation of electricity.
5. ***Don't take their word for it!*** Obtain a Geiger counter from a local school, a state or local emergency management organization, or the ANS. Learn how the counter functions and how to use it. Use the counter to measure radiation levels in various common materials. OR Purchase or make a "cloud chamber" and perform an experiment allowing you to "see" radiation. Purchase or borrow an exempt sealed radioactive source or use a common radioactive material (e.g. uranium-containing ore, piece of antique orange Fiestaware™, or a thorium-containing lantern mantle) as the cloud chamber source.
6. ***High-tech garbage.*** Learn about radioactive waste. What are the three main categories of radioactive waste in the United States? What would you find in each category and how are they different? Find out about how much waste there is in each category, what the sources are, and where it's currently stored. Call a local hospital, university, or industrial company that creates radioactive waste and learn how their waste is managed. What will be the final storage place for each of the three types of waste? If possible, visit a waste storage facility.

## Service Projects

1. ***Know how to protect yourself.*** Talk with a professional “health physicist” who works with radiation in a hospital, university, or industrial setting. Discuss safe levels of radiation exposure, regulatory limits for workers in the nuclear industry (compare them to your average annual exposure from Skill Builders 3, and how to control and measure your exposure to radiation. Teach your troop or a another group what you learned OR invite the health physicist to speak to your troop/the group.
2. ***Is it really safe?*** Discuss the safety of nuclear power plants with your troop and discover their concerns. Then talk with a nuclear professional, e.g., someone from a nuclear power plant, university engineering department, research lab, the Nuclear Energy Institute, or a regulatory agency [like the U.S. Nuclear Regulatory Commission (NRC) or your state department of radiation safety] to learn answers to the questions raised by your troop.
3. ***Hmmm...I wonder what she thinks?*** What’s your opinion on the use of nuclear energy for power generation and how does it compare to other people in your community, in the United States and worldwide? Create a survey containing questions based on what you’ve learned about nuclear power. For more ideas about questions, contact the Nuclear Energy Institute (NEI) to learn of surveys they have taken. Take your own survey and then survey at least 25 people in your family and community. Compare your personal answers to those you surveyed and to the results from NEI. Share your results.

## Career Exploration

1. ***What do you do everyday?*** Invite someone working in nuclear science (for example, from a nuclear power plant, university nuclear engineering department, or hospital radiation lab) to a meeting to speak about where they work, why they chose that career, and how they prepared for it.
2. ***Could this be me?*** Learn about at least five different careers in the nuclear science field. What are their job descriptions? What sort of education and training is required to do these jobs?
3. ***You might be surprised.*** Investigate three careers you are interested in. Learn how nuclear science may directly or indirectly impact that career.

\*To order this Interest Patch, contact the Trefoil Shop at 800-236-2710 ext. 1173 or 608-237-1173 or email [renae@girlscoutsofblackhawk.org](mailto:renae@girlscoutsofblackhawk.org).