VI. APPENDICES

APPENDIX A

GLOSSARY OF TERMS

Action level - A guideline or recommendation established by the U.S. Environmental Protection Agency for lowering radon levels in homes in order to reduce risk; the current level is 4 pCi/L; this action level does not eliminate risk, it reduces risk.

Adsorption - Gathering or collecting on a surface; a charcoal canister works by means of adsorption.

Alpha particle - Two neutrons and two protons bound as a single, charged particle that is emitted fromthe nucleus of certain radioactive isotopes in the process of decay or disintegration; as radon decays it emits an alpha particle.

Alpha track detector - A long term testing device used to measure radon; it records the number of alpha particles which strike its pad during radon decay; the alpha track can be used for 3 months to a year.

Atom - The smallest component of an element, containing all the properties of the element; its structure is a center or nucleus containing protons and neutrons, and electrons orbiting the nucleus; determines the place of an element in the periodic table.

Atomic number - Represents the number of protons in the nucleus which in a neutral or stable atom equals the number of electrons orbiting the nucleus; determines the place of an element in the periodic table.

Beta particle - A charged particle emitted from a nucleus of certain radioactive isotopes in the process of decay or disintegration; the particle has the mass of an electron and (in

the case of isotopes in the U-238 decay series) has a negative charge; in the uranium decay chain protactinium, lead, and bismuth isotopes emit beta particles as they disintegrate.

Cancer - An invasive growth of abnormal cells that spreads in one or more of the body's organs or systems.

Cell - A self-contained unit capable of acting alone or interacting with other cells in performing all fundamental functions of life; the least structural unit of living matter capable of functioning independently.

Charcoal canister - A short term testing device used to measure radon; it is exposed to the air for 2-7 days and works by adsorption.

Curie (Ci) - Unit of radioactive measurement, corresponding to 37 billion disintegrations per second; radon is commonly measured in picocuries (pCi) which is a trillionth of a Curie.

Daughter - See decay product.

Decay product - An isotope formed as the result of a radioactive disintegration or breakdown; also referred to as daughter product or progeny.

DNA - Deoxyribonucleic acid, found in cell nuclei and the molecular basis of heredity in many organisms; it contains the basic instruction code determining cell function and replication.

Dose - The amount of radioactive energy that a given mass or material receives and absorbs.

Electret ion chamber - A test device used to measure radon; it is exposed to the air and records the alpha particles emitted during the decay of radon; it can be used for both short and long term tests.

Gamma rays - A high energy wave emitted from the nucleus of a radioactive atom during decay or disintegration.

Half-life - The time required for a radioactive substance to lose 50% of its activity by decay; different radioactive elements have varying half-lives: uranium-238 - 4.5 billion years, lead-214 - 27 minutes, and polonium-214 - 164 microseconds; different radioactive isotopes of the same element have varying half-lives: radon-222 - 3.8 days, radon-220 - 55.6 seconds, and radon-219 - 4 seconds.

Isotopes - Nuclides having the same number of protons in their nuclei, and therefore the same atomic number, but varying in the number of neutrons, so the mass is different. Chemical properties of isotopes of a particular element are almost identical, but half-life varies; the term isotope should not be used as a synonym for "nuclide".

Lifetime risk - The risk of dying from some particular cause over the whole of a person's life.

Mass number - The combined number of protons and neutrons in the nucleus of an atom; varying number of neutrons will result in different isotopes of an element.

Mitigation - The action of correcting, countering, or treating a problem, such as elevated radon levels; synonymous with the term remediation.

Neutron - A particle of an atom contained in the nucleus; it has no charge; it is the determinant of the mass number of an element and therefore its species of isotope.

Nucleus - The central structure of an atom; it is the location of protons and neutrons; the plural is nuclei.

Nuclide - A species of atom characterized by the make up of its nucleus, the number of protons, neutrons and its energy content.

Picocurie - A measurement of radioactive disintegrations; it is one trillionth of a curie.

Progeny - See decay product.

Proton - A particle of an atom located in the nucleus; it has mass and weight, and a positive charge.

Radiation - The emission of energy in the form of particles and waves.

Radioactivity - The spontaneous emission of energy or radiation from the nucleus of certain atoms during decay; the energy is emitted or released in the form of alpha or beta particles and may also be accompanied by gamma rays.

Relative risk - Comparative hazard or danger estimated for an exposed population as opposed to a population without exposure; expressed as a ratio.

Remediation - See mitigation.

Risk estimate - The number of cases (or deaths) that are projected to occur in a specified exposed population per unit dose of a toxic or carcinogenic agent for a defined exposure route and time period.

Threshold - The level at which a response or effect is observable; currently there is no known safe threshold level for radon exposure; adverse effects have been observed at very low doses.

Uranium series - Radioactive-decay chain starting with uranium-238 and containing radon-222 and its decay products.

APPENDIX B

RESOURCES

1. State Radon Programs
2. Speakers/Field Trips
3. Equipment and Materials
4. Information and Resources
5. Illustrations and Maps
6. Additional Reading

1. State Radon Programs

Alabama: 800/582-1866
Alaska: 800/478-4845
Arizona: 602/255-4845
Arkansas: 501/661-2301
California: 800/745-7236
Colorado: 800/846-3986
Connecticut: 203/566-3122
Delaware: 800/554-4636
District of Columbia: 202/727-5728
Florida: 800/543-8279

Georgia: 800/745-0037
Hawaii: 808/586-4700
Idaho: 800/445-8647
Illinois: 800/325-1245
Indiana: 800/272-9723
Iowa: 800/383-5992
Kansas: 913/296-1560
Kentucky: 502/564-3700
Louisiana: 800/256-2494
Maine: 800/232-0842

Maryland: 800/872-3666
Massachusetts: 413/586-7525
Michigan: 517/335-8190
Minnesota: 800/798-9050
Mississippi: 800/626-7739
Missouri: 800/669-7236
Montana: 406/444-3671
Nebraska: 800/334-9491
Nevada: 702/687-5394
New Hampshire: 800/852-3345 x4674

New Jersey: 800/648-0394
New Mexico: 505/827-4300
New York: 800/458-1158
North Carolina: 919/571-4141
North Dakota: 701/221-5188
Ohio: 800/523-4439
Oklahoma: 405/271-5221
Oregon: 503/731-4014
Pennsylvania: 800/237-2366
Puerto Rico: 809/767-3563

Rhode Island: 401/277-2438
South Carolina: 800/768-0362
South Dakota: 605/773-3351
Tennessee: 800/232-1139

Texas: 512/834-6688
Vermont: 800/640-0601
Washington: 800/323-9727
Wisconsin: 608/267-4795
Utah: 801/538-6734
Virginia: 800/468-0138
West Virginia: 800/922-1255
Wyoming: 800/458-5847

2. Speakers/Field Trips

1. The American Association of Radon Scientists and Technologists (AARST) may be able to provide a speaker for your class who will talk about testing and/or mitigation. The Association's address is P.O. Box 70, Park Ridge, NJ 07656 and their phone number is 201/391-6445.

2. The following all have active educational programs which arrange for speakers and field trips. Speakers usually will come only to schools in their company's service area. Be sure to ask.

1. Atlantic Electric - 609/645-4545

2. GPU (Oyster Creek Nuclear Powerplant) - 609/971-4057

3. JCP&L - 201/455-8783

4. PSE&G - 201/430-5863
   Hope Creek Nuclear Powerplant - 609/935-2660

3. In the field of medicine, radiation has a major role in diagnosis and treatment. Many hospitals and medical centers have community affairs programs for area residents about a variety of health issues. Contact your area hospital about arranging a tour or hearing a presentation.

NOTES:

3. Equipment and Materials

M&M'S - On school letterhead, you may write to M&M/Mars requesting information about the company and a coupon towards the purchase of a bag of m&m's. Letters should be addressed to: M&M/Mars, Consumer Affairs, High Street, Hackettstown, NJ 07840.

NEW JERSEY ROAD MAPS - Contact: NJ Department of Commerce and Economic Development, 20 West State Street, CN-826, Trenton, NJ 08625 or call 609/292-2470.

RADIATION COUNTERS - These instruments (e.g., Geiger counter and micro-R meter) are useful means to demonstrate to students that although radiation cannot be seen, it is there. If you do not have access to a radiation counter, try to secure an instrument through one of the following:

1. Through your school or school district, you may want to purchase a radiation counter. Examples of companies that sell this type of equipment for schools are Edmund Scientific (609/573-6250) and Fisher Scientific/EMD (800/955-1177).

2. Speakers from the energy industry might be able to give a demonstration during a presentation. See Resources, Speakers/Field Trips.

3. In New Jersey, you may contact the state Radon Program. The Program has a limited number of micro-R meters which may be available for loan at certain times. See Resources, State Programs.

4. Some county and local health offices and some colleges have counters. You might contact health offices and colleges in your area to find out if they have such equipment and if they would be able to give a demonstration.

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4. Information Resources

LIBRARIES - In 1986, New Jersey libraries began a network system in order to "provide...residents with full and equal access to library materials and programs not currently available within their communities". The counties were grouped into regions (total of six). Each region coordinates and oversees the provision of library services for the residents of its respective area. The entire network is overseen and funded by the New Jersey State Library. Any library can become a participant in the regional network, and many have, including a number of school libraries.

When you are researching information for these lesson plans or seeking additional reference materials, be sure to speak with your school librarian and/or the local public librarian about the New Jersey Library Network.

Region 1 - Hunterdon, Morris, Somerset, Sussex, and Warren counties

Region 2 - Bergen and Passaic counties

Region 3 - Essex and Hudson counties

Region 4 - Middlesex and Union counties

Region 5 - Mercer, Monmouth, and Ocean counties

Region 6 - Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, and Salem counties

ARTICLES - Most newspapers do not publish indexes of their news articles, but almost every newspaper maintains a library. Contact your local area papers and ask the librarian for assistance.

LEGISLATION - In New Jersey, the Office of Legislative Services produces a pamphlet called, "The Legislative Process in New Jersey". Call 1-800/792-8630 for copies.

MITIGATION/REMEDIATION - In New Jersey, only businesses certified by the state may conduct mitigation/ remediation work. Contact the New Jersey Radon Program (see State Radon Programs) for a list of certified businesses. See Speakers/Field Trips regarding arranging a presentation about this topic.

PATENTS - In New Jersey, there are only two patent depository libraries; Newark Public Library and Rutgers University. Your school or local librarian should be able to help you find out the procedures for viewing patent documents.

POSTER - In New Jersey, a free copy of a radon poster/chart prepared by the US Environmental Protection Agency is available from: NJDEPE/Radon Program, ATTN: Communications/Outreach, CN-415, Trenton, NJ 08625. Please be sure to state that you want the USEPA radon poster/chart.

TESTING - In New Jersey, only businesses certified by the state may conduct testing and sell test devices. Contact the New Jersey Radon Program (see State Radon Programs) for a list of certified businesses, and only work with these businesses if you are going to do any testing.

VIDEO - Copies of a video prepared by the American Lung Association, "Radon: The Hazard in Your Home" have been distributed to the county AVA commissions and are available for loan. Additional copies are available from the New Jersey Radon Program (see State Radon Programs) and can be provided to a school district for use in its schools.

NOTES :

5. Illustrations/Maps

On the following pages are illustrations and maps provided for your use with the *Radon Alert* lesson plans and activities. You may want to use them to make overheads and/or photocopy for distribution to the students.

Additional copies of the Geologic Map of New Jersey may be purchased, at $.50/copy, from Maps and Publications, Bureau of Revenue, CN-417, Trenton, NJ 08625. Their telephone number is 609/777-1039.

6. Additional Reading

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Green, L., "Radon: Comparing Risk", Home Mechanix, June 1988.

Hanson, D., "Low-level Risk May Be Underestimated", C&E News, January 1, 1990.

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Klement, A.W., Jr. (ed), CRC Handbook of Environmental Radiation, CRC Press, Boca Raton, Florida, 1982.

Lao, K.Q., Controlling Indoor Radon: Measurement, Mitigation, and Prevention, Van Nostrand Reinhold, New York, 1990

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_____, Health Effects of Exposure to Low Levels of Ionizing Radiation (BEIR V), National Academy Press, Washington, D.C., 1990.

Nazaroff, W.W. and Nero, A.V., Jr. (eds), Radon and Its Decay Products in Indoor Air, Wiley-Interscience Publication, John Wiley & Sons, New York, 1988.

New Jersey Department of Environmental Protection and Energy, Radon Program, "Information You Should Know About Radon", July 1992.

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Texley, J., "A Rational Approach to Radon", Science Scope, January 1989.

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Wilkening, M., Radon in the Environment, Studies in Environmental Science; 40, Elsevier Science Publishing, New York, 1990.

Wilson, R., "Risk Assessments and Comparisons", Science, April 17, 1987.

Zeckhauser, R., "Risk Within Reason", Science, May 4, 1990.