

NUCE 428 Radioactive Waste Control

Spring 2008

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Office Hours:

TR 2:30-3:30 pm
F 1:30-2:30 pm

Textbook (for reference): R.L. Murray, "*Understanding Radioactive Waste*"
Class Notes

Class Meetings:

TR 9:45-11:00 am 112 ENGR B

Summary

This course provides an introduction to the technical issues regarding the disposal of high-level and low-level radioactive waste, as a basis for understanding and discussing the environmental and societal impact of the problem. The topics covered range from a basic introduction to the nuclear fuel cycle, a historical perspective on radioactive waste, and basics of biological effects of ionizing radiation, to the alternatives considered for waste disposal, with emphasis on geologic disposal.

The focus of the course is interdisciplinary, combining nuclear engineering, geochemistry, chemical engineering, civil engineering and risk assessment, to correctly address the relevant technical issues. The course will include two group projects and class presentations and discussions on environmental aspects of radioactive waste disposal. In previous years, project topics included the environmental risks of energy technologies, options for disposition of excess weapons plutonium and the scientific basis for maximum radiation exposure levels. Each student will also present a topic of his/her choice during the semester.

The objective of the course is to make the students knowledgeable about the many issues related to the disposal of radioactive wastes, mainly from civilian nuclear power, so they can interact with specialists in the area, and know the fundamentals of the discipline well enough that they know where to seek further information. This course is part of the Environmental minor in the College, and can serve as a technical elective for undergraduate students or as an introductory course for graduate students who will perform work in environmental aspects of waste. No prerequisites are required, beyond basic Physics and Chemistry.

Grading

Grading for this course will have the following distribution:

| | | | |
|---------------------|-------------------------|------|--|
| Midterm Exam | 20% | | |
| Final Exam | 30% | | |
| Class Projects (2) | 30% (divided into: | | |
| | Individual Presentation | 15% | |
| | Pagoda Project | 15%) | |
| Homework | 10% | | |
| Quizzes | 5% | | |
| Class Participation | 5% | | |

It is expected that you will attend all classes; if you need to be absent, you need to notify the instructors by email prior to class.

| Section | Date | Topic |
|---------|----------------|--|
| 0 | 15-Jan | Introduction |
| 1 | 17-Jan | Basics of Nuclear Power and Radwaste |
| | 22-Jan | Definition and Classification/Activity and Volumes |
| 2 | 24-Jan | Biological Effects of Ionizing Radiation |
| | 29-Jan | History of waste disposal |
| | 31-Jan | Disposal Options |
| | 5-Feb | Clinical Effects |
| 3 | 7-Feb | Radioactive waste forms |
| | 12-Feb | Radioactive waste forms |
| 4 | 14-Feb | Radionuclide release from waste repositories |
| | 19-Feb | Radionuclide release from waste repositories |
| | 21-Feb | Radionuclide Migration in geologic media |
| | 26-Feb | Radionuclide Migration in geologic media |
| 5 | 28-Feb | Radionuclide Migration in geologic media |
| | 4-Mar | Performance assessment of waste repositories |
| | 6-Mar | First Midterm |
| | 11-Mar | SPRING BREAK |
| | 13-Mar | SPRING BREAK |
| 6 | 18-Mar | Performance assessment of waste repositories |
| | 21-Mar | Natural Analogues, Oklo |
| 7 | 25-Mar | Oklo (2) |
| | 27-Mar | Low level waste disposal |
| 8 | 1-Apr | Mill tailings and low level waste |
| | 3-Apr | Disposal problems in DOE complex |
| 9 | 8-Apr | Risk assessment of radioactive waste |
| | 10-Apr | GNEP program |
| | 15-Apr | Waste transportation |
| 10 | 17-Apr | Options of Choice in other countries |
| | 22-Apr | Options of Choice in other countries |
| 10 | 24-Apr | Pool Storage and Dry Cask storage |
| | 29-Apr | Radioactive waste and the future of nuclear power |
| | 1-May | Review |
| | 5-May 9-May | Final Exam week |

Reading/Reference List

Books

text: R. L. Murray, "Understanding Radioactive Waste," Third Ed., Battelle Press, 1989.

1. D. F. Lau, "Radioactivity and Nuclear Waste Disposal," John Wiley and Sons, Inc., 1987.
2. R. E. Berlin and C. C. Stanton, "Radioactive Waste Management," John Wiley & Sons, Inc., 1989.
3. M. Benedict, T. H. Pigford, H. W. Levi, "Nuclear Chemical Engineering," McGraw-Hill, 1981.
4. B. L. Cohen, "Before It's Too Late," Plenum Press, NY and London, 1983, "The Nuclear Energy Option," Plenum, 1990.
5. Y. S. Tang and J. H. Saling, "Radioactive Waste Management," Hemisphere, 1990.
6. R. Roy, "Radioactive Waste Disposal," Pergamon Press, 1982.
7. W. Lutze and R. C. Ewing eds., "Radioactive Waste Forms for the Future," North Holland, 1988.
8. J. R. Lamarsh, "Introduction to Nuclear Engineering," Addison Wesley, 1977.
9. J. H. Fremlin, "Power Production What are the Risks?" 2nd. Ed., Adam Hilger and Bristol, New York, 1989.
10. L. J. Carter, "Nuclear Imperatives and Public Trust," Resources for the Future, Washington 1987.
11. F. C. Shapiro, "RadWaste," Random House, 1981.
12. V. M. Oversby, "Nuclear Waste Materials," Ch. 12 in Nuclear Materials, B.R.T. Frost, ed., Vol 10B, "Nuclear Materials" in Materials Science & Technology Series, R. W. Cahn, P. Haasen and E. Kramer, eds. VCH, 1994, pp. 391-442.
13. The Geologic Disposal of Nuclear Waste, N. A. Chapman and I. G. McKinley, Wiley, 1982.
14. The Scientific and Regulatory Basis for Geological Disposal of Radioactive Waste, D.Savage, ed., Wiley, 1995.

Journals/Series

- MRS Symposia on Scientific Basis for Nuclear Waste Management I-XXI.
- Radioactive Waste Conference Series – R. G. Post, ed.
- Journal of Nuclear Materials 192 (1992) volume dedicated to Rad. Waste Management.
- Radioactive Waste Management and the Nuclear Fuel Cycle, Harwood Publishers, journal dedicated to rad waste.
- Health Effects of Exposure to Low Levels of Ionizing Radiation, BEIRV, NRC, 1990

General Articles

- Materials for Nuclear Waste Disposal, MRS Bulletin, 12/1994.
- N. Tsoulfanidis and R. G. Cochran, "Radioactive Waste Management," Nucl. Tech. Vol. 13, (1991) 263-304.
- R. L. Murray, "Radioactive Waste Storage and Disposal," Proc. IEEE 74 (1986) 552-579.

Additional References

- The Status of Near-Field Modeling. Proc. Tech Workshop, Cadarache, France, 11-13, May 1993. OECD, 1993.
- A. C. Lasaga, "Rate Laws of Chemical Reactions" in "*Kinetics of Geochemical Processes*," Reviews in Mineralogy, vol 8, 1981, A. C. Lasaga, R. J. Kirkpatrick, eds. Mineralogical Society of American. pp. 1-67.
- B. Jensen, "Migration Phenomena of Radionuclides into the Geosphere," Harwood, Brussels and Luxembourg, 1982.
- D. G. Brookins, "Geochemical Aspects of Radioactive Waste Disposal," Springer-Verlag, New York, 1984.