DOE-STD--101-92

DE92 011016

COMPILATION OF NUCLEAR SAFETY CRITERIA POTENTIAL APPLICATION TO DOE NONREACTOR FACILITIES

Published: March 1992

U.S. Department of Energy
Office of Nuclear Energy
Office of Nuclear Safety Policy and Standards
Washington,DC 20585

Order No. DE92011016

CONTENTS

FOREWORD

This document compiles nuclear safety criteria applied to the various areas of nuclear safety addressed in a Safety Analysis Report for a nonreactor nuclear facility (NNF). The criteria listed are derived from federal regulations, Nuclear Regulatory Commission (NRC) guides and publications, DOE and DOE contractor publications, and industry codes and standards. The titles of the chapters and sections of Regulatory Guide 3.26, "Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants" were used to format the chapters and sections of this compilation. In each section the criteria are compiled in four groups, namely: (1) Code of Federal Regulations, (2) USNRC Regulatory Guides, (3) Codes and Standards, and (4) Supplementary Information.

CHAPTER 1

INTRODUCTION

The Department of Energy (DOE) Order DOE 5480.5, "Safety of Nuclear Facilities," establishes nonreactor nuclear facility (NNF) safety requirements to assure that NNFs are sited, designed, constructed, modified, operated, maintained, and decommissioned in accordance with uniform standards, guides, and codes which are consistent with those applied to comparable NRC-licensed nonreactor nuclear facilities.

This document identifies nuclear safety criteria applied to the areas of safety addressed in the Safety Analysis Report for a NNF. The degree of application of these criteria to a DOE-owned NNF should be determined by the DOE and DOE contractor.

1.1 PURPOSE

This guide is a compilation and source list of nuclear safety criteria primarily used by the Nuclear Regulatory Commission (NRC) and private industry in commercial NNFs. Because the DOE, in some areas of NNF design, construction, operation, and decommissioning has taken the lead in developing NNF criteria, the guide also includes criteria used by the DOE and DOE contractors. Those criteria that are mandated by the DOE Orders shall be used in the design, construction, operation, or decommissioning of DOE NNFs. The remaining nuclear safety criteria listed in the guide should be evaluated by DOE and DOE contractors for application to the DOE-owned NNFs under their cognizance. The criteria listed are those that are applicable to the specific areas of nuclear safety addressed in the Safety Analysis Report of an associated NNF.

1.2 SOURCES OF CRITERIA AND FORMAT

The nuclear safety criteria identified in this guide are derived from federal regulations, USNRC regulatory guides and publications, DOE and DOE contractor publications, and industry codes and standards.

To assure that this guide includes the areas of nuclear safety addressed in a Safety Analysis Report, USNRC Regulatory Guide 3.26, "Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants," is used as a model to establish its fundamental format and content. To eliminate excessive repetition, criteria are identified only in those

subsections that address the thrust of the criteria. As an example, even though quality assurance is applicable to all areas of nuclear safety, quality assurance criteria are only listed in those sections that specifically pertain to quality assurance. The criteria applicable to each subsection or area of safety are presented in an outline format represented by the following four subsections.

1.2.1 Code of Federal Regulations

Generally, the criteria in this subsection are provided in federal regulations from specific sections of Title 10 of the Code of Federal Regulations (10 CFR). In addition, other federal regulations may be listed that are identified for application to licensed NNFs.

Depending on the type of facility, the NRC licenses NNFs under various Parts of 10 CFR. These Parts include the following:

A. Part 50, "Domestic Licensing of Production and Utilization Facilities."

B. Part 60, "Disposal of High-Level Radioactive Waste in Geologic Repositories."

C. Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

D. Part 70, "Domestic Licensing of Special Nuclear Material."

E. Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste."

1.2.2 Regulatory Guides

USNRC regulatory guides issued under Division 3, "Fuels and Materials Facilities," are primarily listed in this subsection. Regulatory guides from other divisions are also listed when pertinent to the areas of safety addressed in the Safety Analysis Report. The other divisions include the following:

A. Division 1, "Power Reactors."

B. Division 4, "Environmental and Siting."

C. Division 5, "Materials and Plant Protection."

D. Division 8, "Occupational Health."

1.2.3 Codes and Standards

The industry codes and standards listed in this subsection are those endorsed by the NRC and those specified in DOE and DOE contractor publications. In addition, appropriate industry codes and standards are listed.

Many of the industry standards specified in the NRC and/or DOE criteria have been revised, withdrawn or replaced by more recent standards. Most of these obsolete standards are no longer issued by their sponsoring organization and, therefore, are not readily available for use. In most instances, revised versions of obsolete standards are listed. These revised standards have generally incorporated supplemental requirements that often qualified the NRC endorsement of the original standards.

1.2.4 Supplementary Information

This subsection lists documents referenced in both NRC and DOE criteria that do not fall within one of the three preceding groups of nuclear safety criteria. It includes appropriate NRC Information Notices and Bulletins, NUREGs, guidance documents specified in NRC and DOE criteria, DOE contractor publications, and relevant industry reports and guides. Although these sources do not always specify requirements, they provide interpretations of the criteria and background information for consideration, as well as methods specified by or considered acceptable to the NRC and/or the DOE for implementing and satisfying the pertinent criteria.

1.3 SAFETY ANALYSIS REPORT CRITERIA

This section compiles the criteria that address the need, preparation, content, and revision of a Safety Analysis Report (SAR). It also contains general criteria that are applicable to many sections of an SAR and are listed here to avoid repetition throughout this guide.

1.3.1 Code of Federal Regulations

In addition to specific regulations listed in individual sections of this guide, the following regulations are applicable:

A. 10 CFR Part 20, “Standards for Protection Against Radiation.”

B. 10 CFR 50.33, “Contents of Applications, General Information.”

C. 10 CFR 50.34, “Contents of Applications, Technical Information.”

D. 10 CFR 50.36b, “Environmental Conditions.”

E. 10 CFR 50.55, “Conditions of Construction Permits.”

F. 10 CFR 50.59, “Changes, Tests, and Experiments.”

G. 10 CFR 50.71, “Maintenance of Records, Making Reports.”

H. 10 CFR 60.21, “Content of Application.”

I. 10 CFR 60.44, “Changes, Tests, and Experiments.”

J. 10 CFR 61.10, “Content of Application.”

K. 10 CFR 61.25, “Changes.”

L. 10 CFR 70.22, “Contents of Applications.”

M. 10 CFR 70.23, “Requirements for the Approval of Applications.”

N. 10 CFR 72.22, “Contents of Application: General and Financial Information.”

0. 10 CFR 72.24, “Contents of Application: Technical Information.”

P. 10 CFR 72.30, “Decommissioning Planning, Including Financing and Record Keeping.”

Q. 10 CFR 72.48, “Changes, Tests, and Experiments.”

1.3.2 Regulatory Guides

The regulatory guides listed below provide criteria for the format and content of SARs and license applications. To avoid repetition, since their criteria are pertinent to many sections of this guide, they are listed only in this subsection.

A. Regulatory Guide 3.15, “Standard Format and Content of License Application for Storage Only of Unirradiated Power Reactor Fuel and Associated Radioactive Material.”

B. Regulatory Guide 3.25, “Standard Format and Content of Safety Analysis Reports for Uranium Enrichment Facilities.”

C. Regulatory Guide 3.26, “Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants.”

D. Regulatory Guide 3.39, "Standard Format and Content of License Applications for Plutonium Processing and Fuel Fabrication Plants."

E. Regulatory Guide 3.44, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation (Water Basin Type)."

F. Regulatory Guide 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)."

G. Regulatory Guide 3.50, "Standard Format and Content for a License Application to Store Spent Fuel and High-Level Radioactive Waste."

H. Regulatory Guide 3.52, "Standard Format and Content for the Health and Safety Sections of License Renewal Applications for Uranium Processing and Fuel Fabrication."

I. Regulatory Guide 3.55, "Standard Format and Content for the Health and Safety Sections of License Renewal Applications for Uranium Hexafluoride Production."

J. Regulatory Guide 3.61, "Standard Format and Content for a Topical Safety Analysis Report for a Spent Fuel Dry Storage Cask."

K. Regulatory Guide 3.62, "Standard Format and Content for the Safety Analysis Report for Onsite Storage of Spent Fuel Storage Casks."

1.3.3 Codes and Standards

None.

1.3.4 Supplementary Information

A. To avoid repetition, since the criteria provided in these documents are pertinent to many sections of this guide, they are listed only in this subsection. The following documents provide criteria for the format and content of SARS and license applications.

1. LA-11661-MS, Vol. I, "Guidance for the Preparation of Safety Analysis Reports," Howard, H.H. et al., Los Alamos National Laboratory, June 1990.

2. NUREG-1199, Rev. 1, "Standard Format and Content of a License Application for a Low-Level Radioactive Waste Disposal Facility," January 1989.

3. NUREG-1200, Rev. 1, “Standard Review Plan for the Review of a License Application for a Low-Level Radioactive Waste Disposal Facility,” January 1988.

4. HEDL-MG-153, “Safety Analysis Guide for Non-reactor Nuclear Facilities,” Lucas, D.E., Hanford Engineering Development Laboratory, 1981.

5. BNWL-2086, “A Guide to Good Practice at Plutonium Facilities,” Faust, L.G. et al., Battelle Pacific Northwest Laboratories, September 1977.

B. The following document provides specific criteria for siting, design, construction, modification, operation, maintenance, or decommissioning of a NNF.

1. DOE/TIC-11603, Rev. 1, “Nonreactor Nuclear Facilities: Standards and Criteria Guide,” Brynda, W.J. et al., Brookhaven National Laboratory, September 1986.

CHAPTER 2

SITE CHARACTERISTICS

Site characteristics have influenced facility design and operating criteria for nuclear safety. This chapter identifies criteria for the geological, seismological, hydrological, and meteorological characteristics of the site and vicinity, as well as nearby population, transportation routes, and other facilities.

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 Code of Federal Regulations

A. 10 CFR 50 Appendix F, "Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities."

B. 10 CFR 60.15, "Site Characterization."

C. 10 CFR 60.17, "Contents of Site Characterization Plan."

D. 10 CFR 60.18, "Review of Site Characterization Activities."

E. 10 CFR 60.122, "Siting Criteria."

F. 10 CFR 61.12, "Specific Technical Information."

G. 10 CFR 61.50, "Disposal Site Suitability Requirements for Land Disposal."

H. 10 CFR 61.53, "Environmental Monitoring."

I. 10 CFR 72.24, "Contents of Application; Technical Information."

J. 10 CFR 72.40, "Issuance of License."

K. 10 CFR 72.90, "General Considerations."

L. 10 CFR 72.98, "Identifying Regions Around an ISFSI or MRS Site."

M. 10 CFR 72.100, "Defining Potential Effects of the ISFSI or MRS on the Region."

N. 10 CFR 72.102, “Geological and Seismological Characteristics.”

O. 10 CFR 100.10, “Factors to Be Considered When Evaluating Sites.”

P. 10 CFR 100, Appendix A, “Seismic and Geologic Siting Criteria for Nuclear Power Plants.”

2.1.2 Regulatory Guides

A. Regulatory Guide 3.53, “Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation.”

B. Regulatory Guide 4.9, “Preparation of Environmental Reports for Commercial Uranium Enrichment Facilities.”

C. Regulatory Guide 4.17, “Standard Format and Content of Site Characterization Plans for High-Level-Waste Geologic Repositories.”

D. Regulatory Guide 4.18, “Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste.”

E. Regulatory Guide 4.19, “Guidance for Selecting Sites for Near-Surface Disposal of Low-Level Radioactive Waste.”

2.1.3 Codes and Standards

A. None.

2.1.4 Supplementary Information

A. NUREG-0902, “Site Suitability, Selection, and Characterization,” 1982.

B. NUREG/CR-4161, “Critical Parameters for High-Level Waste Repository,” Binnall, E.P. et al. , Lawrence Berkeley National Laboratory, May 1985.

C. NUREG/CR-3583, “Evaluation of Low-Altitude Remote Sensing Techniques for Obtaining Site Characterization Information,” Estes, J.E., et al., University of California at Santa Barbara, April 1984.

D. NUREG/CR-3247, “Site Characterization Information Using LANDSAT and other Remote Sensing Data - Integration of Remote Sensing Data with Geographic Information Systems,” Camp-

bell, W.J. and Imhoff, M.L., National Aeronautics and Space Administration, June 1983.

E. NUREG/CR-2861, "Image Analysis for Facility Siting: A Comparison of Low and High Altitude Image Interpretability for Land Use/Land Cover Mapping."

F. NUREG/CR-2663, "Information Needs for Characterization of High-Level Waste Repository Sites in Six Geologic Media," Ertec Western, Inc., May 1985.

2.2 NEARBY INDUSTRIAL, TRANSPORTATION AND MILITARY FACILITIES

Criteria for the effects of postulated accidents in the vicinity of the facility from present or projected industrial, transportation, and military installations and operations are identified in this section.

2.2.1 Code of Federal Regulations

A. 10 CFR 60.121, "Requirements for Ownership and Control of Interests in Land."

B. 10 CFR 61.50, "Disposal Site Suitability Requirements for Land Disposal."

C. 10 CFR 72.40, "Issuance of License."

D. 10 CFR 72.90, "General Considerations."

E. 10 CFR 72.94, "Design Basis External Man-Induced Events."

F. 10 CFR 72.98, "Identifying Regions Around an ISFSI or MRS Site."

G. 10 CFR 100.10, "Factors to Be Considered When Evaluating Sites."

2.2.2 Regulatory Guides

A. Regulatory Guide 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants."

B. Regulatory Guide 4.9, "Preparation of Environmental Reports for Commercial Uranium Enrichment Facilities."

C. Regulatory Guide 4.18, “Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste.”

D. Regulatory Guide 4.19, “Guidance for Selecting Sites for Near-Surface Disposal of Low-Level Radioactive Waste.”

2.2.3 Codes and Standards

A. None.

2.2.4 Supplementary Information

A. NUREG-0902, “Site Suitability, Selection, and Characterization,” 1982.

2.3 METEOROLOGY

Criteria for regional climatology, local meteorology, onsite meteorological measurements program, and atmospheric diffusion estimates are identified in this section.

2.3.1 Code of Federal Regulations

A. 10 CFR 60.24, “Updating of Application and Environmental Report.”

B. 10 CFR 60.122, “Siting Criteria.”

C. 10 CFR 61.12, “Specific Technical Information.”

D. 10 CFR 61.50, “Disposal Site Suitability Requirements for Land Disposal.”

E. 10 CFR 61.53, “Environmental Monitoring.”

F. 10 CFR 72.122, “Overall Requirements.”

G. 10 CFR 100.10, “Factors to Be Considered When Evaluating Sites.”

2.3.2 Regulatory Guides

A. Regulatory Guide 1.145, “Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants.”

B. Regulatory Guide 3.8, “Preparation of Environmental Reports for Uranium Mills.”

C. Regulatory Guide 3.53, “Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation.”

D. Regulatory Guide 3.63, “Onsite Meteorological Measurement Program for Uranium Recovery Facilities-Data Requisition and Reporting.”

E. Regulatory Guide 4.9, “Preparation of Environmental Reports for Commercial Uranium Enrichment Facilities.”

F. Regulatory Guide 4.17, “Standard Format and Content of Site Characterization Plans for High-Level Waste Geologic Repositories.”

G. Regulatory Guide 4.18, “Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste.”

H. Regulatory Guide 4.19, “Guidance for Selecting Sites for Near-Surface Disposal of Low-Level Radioactive Waste.”

2.3.3 Codes and Standards

A. ANSI/ANS 2.3-1983, “Standard for Estimating Tornado and Extreme Wind Characteristics at Nuclear Power Sites.”

B. ANSI/ANS 2.5-1984, “Standard for Determining Meteorological Information at Nuclear Power Sites.”

2.3.4 Supplementary Information

A. Background Information, General Meteorology.

1. NUREG-0902, “Site Suitability, Selection, and Characterization,” 1982.

2. U.S. Department of Commerce, “Climatic Atlas of the United States,” Environmental Data Service, NOAA, June 1968.

3. U.S. Department of Commerce, “Local Climatological Data and Comparative Data,” Environmental Data Service, NOAA (Published Annually for all First-Order NWS Stations).

4. U.S. Department of Commerce, “State Climatological Summary,” Environmental Data Service, NOAA, (Published Annually by State).

B. Background Information, Specific Meteorological Conditions.

1. UCRL-53526, Rev. 1, “Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites,” Coats, D.W. , and Murray, R.C., Lawrence Livermore National Laboratory, 1985.

2. NUREG/CR-4461, “Tornado Climatology of the Contiguous United States,” Ramsdell, J.V. and Andrew, G.L., Battelle Pacific Northwest Laboratories, May 1986.

3. NUREG/CR-3882, “A Method to Characterize Local Meteorology at Nuclear Facilities for Application to Emergency Response Needs,” Lindsey, C.G. and Glantz, C.S., Battelle Pacific Northwest Laboratories, April 1986.

4. NUREG/CR-3759 , “Lightning Strike Density for the Contiguous United States from Thunderstorm Duration Records,” MacGorman, D.R. et al., National Oceanographic and Atmospheric Administration, May 1984.

5. NUREG/CR-3670, “Violent Tornado Climatology, 1880-1892,” Grazulis, T.P., Environmental Films, Inc., May 1984.

6. NUREG/CR-2890, “Historic Extreme Winds for the United States - Great Lakes and Adjacent Regions,” Changery, M.J., National Oceanographic and Atmospheric Administration, August 1982.

7. NUREG/CR-2639, “Historical Extreme Winds for the United States - Atlantic and Gulf of Mexico Coastlines,” Changery, M.J., National Oceanographic and Atmospheric Administration, May 1982.

8. NUREG/CR-2359, “Atmospheric Structure Prior to Tornados as Derived from Proximity and Precedent Upper Air Soundings, ” Taylor, G.E. et al., University of Missouri, May 1982.

9. NUREG/CR-2557, “Simulated Tornado Wind Fields and Damage Patterns,” Metcalf, D.R. et al., Texas Tech. University, February 1982.

10. NUREG/CR-2252, “National Thunderstorm Frequencies for the Contiguous United States,” Changery, M.J., National Oceanographic and Atmospheric Administration, November 1981.

11. NUREG/CR- 1390, “Probability Estimates of Temperature Extremes for the Contiguous United States,” National Oceanographic and Atmospheric Administration, May 1980.

12. NUREG/CR-1389, "Estimating Water Equivalent Snow Depth from Related Meteorological Variables," National Oceanographic and Atmospheric Administration, May 1980.

C. Background Information, Atmospheric Transport and Diffusion.

1. NUREG/CR-3368, "Diffusion Rates for Elevated Releases," Ramsdell, J.V., Battelle Pacific Northwest Laboratories, November 1983.

2. NUREG/CR-3250, "Atmospheric Transport and Diffusion Mechanisms in Coastal Circulation Systems," Kaleel, R.J. et al., TRC Environmental Consultants, Inc., June 1983.

3. NUREG/CR-3149, "Dispersion Coefficients for Coastal Regions," MacRae, B.L. et al., TRC Environmental Consultants, Inc., March 1983.

4. NUREG/CR-2754, "Critical Review of Studies on Atmospheric Dispersion in Coastal Regions," Shearer, D.L. et al., TRC Environmental Consultants, Inc., September 1982.

5. NUREG/CR-2521, "Method for Estimating Wake Flow and Effluent Dispersion Near Simple Block-Like Buildings," Hosker, R.P., National Oceanographic and Atmospheric Administration, June 1982.

6. NUREG/CR-2260, "Technical Basis for Regulatory Guide 1.145, Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Snell, W.G. and Jubach, R.W., NUS Corporation, October 1981.

7. NUREG/CR-1473, "The Wake and Diffusion Structure Behind a Model Industrial Complex," Kothari, K.M., Colorado State University, November 1981.

8. NUREG/CR-1835, "Application of LIDAR Techniques to Estimating Atmospheric Dispersion," SRI International, December 1980.

9. AP-101, "Mixing Heights, Wind Speeds and Potential for Urban Air Pollution Throughout the Contiguous United States," Holzworth, G.C., Office of Air Programs, USEPA, January 1972.

2.4 HYDROLOGIC ENGINEERING

Criteria for hydrologic design considerations such as flooding and ground water considerations are identified in this section.

2.4.1 Code of Federal Regulations

A. 10 CFR 60.24, “Updating of Application and Environmental Report.”

B. 10 CFR 60.122, “Siting Criteria.”

C. 10 CFR 61.12, “Specific Technical Information.”

D. 10 CFR 61.50, “Disposal Site Suitability Requirements for Land Disposal.”

E. 10 CFR 61.53, “Environmental Monitoring.”

F. 10 CFR 72.40, “Issuance of License.”

G. 10 CFR 72.90, “General Considerations.”

H. 10 CFR 72.92, “Design Basis External Natural Events.”

I. 10 CFR 72.94, “Design Basis External Man-Induced Events.”

J. 10 CFR 72.98, “Identifying Regions Around an ISFSI or MRS Site.”

K. 10 CFR 100.10, “Factors to Be Considered When Evaluating Sites.”

L. 10 CFR 100 Appendix A, “Seismic and Geologic Siting Criteria for Nuclear Power Plants.”

2.4.2 Regulatory Guides

A. Regulatory Guide 3.8, “Preparation of Environmental Reports for Uranium Mills.”

B. Regulatory Guide 3.40, “Design Basis Floods for Fuel Reprocessing Plants and for Plutonium Processing and Fuel Fabrication Plants.”

C. Regulatory Guide 3.49, “Design of an Independent Spent Fuel Storage Installation (Water-Basin Type).”

D. Regulatory Guide 3.53, “Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation.”

E. Regulatory Guide 3.60, “Design of an Independent Spent Fuel Storage Installation (Dry Storage).”

F. Regulatory Guide 4.9, "Preparation of Environmental Reports for Commercial Uranium Enrichment Facilities."

G. Regulatory Guide 4.17, "Standard Format and Content of Site Characterization Plans for High-Level Waste Geologic Repositories."

H. Regulatory Guide 4.18, "Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste."

I. Regulatory Guide 4.19, "Guidance for Selecting Sites for Near-Surface Disposal of Low-Level Radioactive Waste."

2.4.3 Codes and Standards

A. ANSI/ANS 2.8, 1981, "Determining Design Basis Flooding at Power Reactor Sites."

B. ANSI/ANS 2.17-1980 (R1989), "Evaluation of Radionuclide Transport in Ground Water for Nuclear Power Sites."

C. ANSI/ANS 2.19-1981 (R1990), "Guidelines for Establishing Site-Related Parameters for Site Selection and Design of an Independent Spent Fuel Storage Installation."

2.4.4 Supplementary Information

A. Background Information, General Hydrology.

1. Reports of the Corps of Engineers, U.S. Army. (These reports address many specific hydrology-related topics.)

2. Hydrometeorological Reports and Technical Papers of the U.S. Weather Bureau (now U.S. Weather Service, NOAA), Hydrometeorological Branch. (These reports address many specific hydrology related topics.)

3. NUREG/CR-4496, "A System for Generating Long Stream flow Records for Study of Floods of Long Return Period," Linsley, R.K. et al., Linsley, Kraeger and Associates, Ltd., February 1986.

4. NUREG/CR-4251, "Mitigative Techniques for Ground Water Contamination Associated with Severe Nuclear Accidents," Oberlander, P.L. et al., Battelle Pacific Northwest Laboratories, August 1985.

5. NUREG/CR-2803, "Improved Field Experimental Designs and Quantitative Evaluations of Aquatic Ecosystems," McKenzie, D.H. and Thomas, J.M., Battelle Pacific Northwest Laboratories, May 1984.

6. NUREG/CR-3583, "Evaluation of Low-Altitude Remote Sensing Techniques for Obtaining Site Characterization Information," Estes, J.E. et al., University of California at Santa Barbara, April 1984.

7. NUREG/CR-3392 , "Process Notebook for Aquatic Ecosystem Simulation," Sullivan, P.J. et al., University of Washington, July 1983.

8. NUREG/CR-3247, "Site Characterization Information Using LANDSAT and other Remote Sensing Data - Integration of Remote Sensing Data with Geographic Information Systems," Campbell, W.J. and Imhoff, M.L., National Aeronautics and Space Administration, June 1983.

9. NUREG/CR-3055, "Review and Evaluation of Paleohydrologic Methodologies," Foley, M.G. et al., Battelle Pacific Northwest Laboratories, December 1982.

10. NUREG/CR-2016, "A Review of Parameter Sensitivity Methods Applicable to Ecosystem Models," Rose, K.A., University of Washington, May 1981.

B. Background Information, Specific Hydrological Conditions.

1. UCRL-21045, "Preliminary Flood Hazard Estimates for Screening Department of Energy Sites," McCann, M.W. and Boissonnade, A.C., Lawrence Livermore National Laboratory, 1988.

2. UCRL-15746, "Natural Phenomena Hazards Modeling Project: Flood Hazard Models for Department of Energy Sites," Savy, J.B. and Murray, R.C., Lawrence Livermore National Laboratory, 1988.

3. NUREG/CR-2840, "Annotated Tsunami Bibliography 1962-1976," Dong, B. et al., International Tsunami Information Center, August 1982.

4. NUREG/CR-2555, "Data Requirements for the Evaluation of Storm Surge Models," Harris, D.L., University of Florida, February 1982.

5. UCLA-ENG-7423, "Estimates of the Risks Associated with Dam Failure," Ayyaswamy, P. et al., University of California, Los Angeles, March 1974.

C. Background Information, Hydrologic Transport and Dispersion.

1. NUREG-1054, "Simplified Analysis for Liquid Pathway Studies," Codell, R.B., U.S. Nuclear Regulatory Commission, August 1984.

2. NUREG-0868, "A Collection of Mathematical Models for Dispersion in Surface Water and Groundwater," Codell, R.B., U.S. Nuclear Regulatory Commission, June 1982.

3. NUREG/CR-3681, "Mitigative Techniques and Analysis of Generic Site Conditions for Ground-Water Contamination Associated with Severe Accidents," Shafer, J.M. et al., Battelle Pacific Northwest Laboratories, April 1984.

4. NUREG/CR-2506, "Uncertainties and Geologic Disposal of High-Level Waste - Groundwater Transport of Radionuclides and Radiological Consequences," Kocher, D.C., et al., Oak Ridge National Laboratory, July 1983.

5. NUREG/CR-2917, "Review of Ground Water Flow and Transport Models in the Unsaturated Zone," Oster, C.A., Battelle Pacific Northwest Laboratories, November 1982.

6. NUREG/CR-1030, "Sediment and Radionuclide Transport in Rivers," Walters, W.H. et al., Battelle Pacific Northwest Laboratories, 1982.

7. NUREG/CR-1597, "A Model for Radioactive Transport in the Aquatic Ecosystem," Niemczyk, S.J., Sandia National Laboratories, May 1981.

2.5 GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING

Criteria for geologic and seismic information [vibratory ground motion], surface faulting, and the stability of subsurface materials and foundations are identified in this section.

2.5.1 Code of Federal Regulations

A. 10 CFR 60.15, "Site Characterization."

B. 10 CFR 60.17, "Contents of Site Characterization Plan."

C. 10 CFR 60.18, "Review of Site Characterization Activities."

D. 10 CFR 60.24, “Updating of Application and Environmental Report.”

E. 10 CFR 60.122, “Siting Criteria.”

F. 10 CFR 61.12, “Specific Technical Information.”

G. 10 CFR 61.50, “Disposal Site Suitability Requirements for Land Disposal.”

H. 10 CFR 61.53, “Environmental Monitoring.”

1. 10 CFR 72.40, “Issuance of License.”

J. 10 CFR 72.90, “General Considerations.”

K. 10 CFR 72.92, “Design Basis External Natural Events.”

L. 10 CFR 72.98, “Identifying Regions Around an ISFSI or MRS Site.”

M. 10 CFR 72.102, “Geological and Seismological Characteristics.”

N. 10 CFR 100.10, “Factors to Be Considered When Evaluating Sites.”

0. 10 CFR 100, Appendix A, “Seismic and Geologic Siting Criteria for Nuclear Power Plants.”

2.5.2 Regulatory Guides

A. Regulatory Guide 3.53, “Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation.”

B. Regulatory Guide 4.9, “Preparation of Environmental Reports for Commercial Uranium Enrichment Facilities.”

C. Regulatory Guide 4.17, “Standard Format and Content of Site Characterization Plans for High-Level-Waste Geologic Repositories.”

D. Regulatory Guide 4.18, “Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste.”

E. Regulatory Guide 4.19, “Guidance for Selecting Sites for Near-Surface Disposal of Low-Level Radioactive Waste.”

2.5.3 Codes and Standards

A. ANSI/ANS 2.7-1982, "Criteria and Guidelines for Assessing Capability for Surface Faulting at Nuclear Power Plant Sites."

B. ANSI/ANS 2.11-1978 (R1989), "Guidelines for Evaluating Site-Related Geotechnical Parameters at Nuclear Power Sites."

C. ANSI/ANS 2.19-1981 (R1990), "Guidelines for Establishing Site-Related Parameters for Site Selection and Design of an Independent Spent Fuel Storage Installation."

D. NE F9-2T, "Seismic Requirements for Design of Nuclear Power Plants and Nuclear Test Facilities," USDOE, February 1985.

2.5.4 Supplementary Information

A. UCRL-53582 Rev. 1, "Natural Phenomena Hazard Modeling Project: Seismic Hazard Models for Department of Energy Sites," Coats, D.W. and Murray R.C., Lawrence Livermore National Laboratory, 1984.

B. NUREG-0902, "Site Suitability, Selection, and Characterization," 1982.

C. NUREG-0625, "Report of Siting Policy Task Force," USNRC, August 1979.

D. NUREG-0406, "Method for Prediction of Strong Earthquake Ground Motion," Volumes 1 and 2, USNRC, January 1978.

E. NUREG-0402, "Analysis of a Worldwide Strong Motion Data Sample to Develop an Improved Correlation Between Peak Acceleration, Seismic Intensity and Other Physical Parameters," USNRC, September 1977.

F. NUREG/CR-3805, "Engineering Characterization of Ground Motion," Kennedy, R.P. et al., Structural Mechanics Associates, May 1984.

G. NUREG/CR-3756, "Seismic Hazard Characterization of the Eastern United States," Bernreuter, D.L. et al., Lawrence Livermore National Laboratory, April 1984.

H. NUREG/CR-3380, "Current Methodologies for Assessing Seismically Induced Settlements in Soil," Ledbetter, R., Army Engineer Waterways Experiment Station, August 1983.

I. NUREG/CR-3102, "Effects of Earthquake Rupture Shallowness and Local Soil Conditions on Simulated Ground Motions," Apsel, R.J. et al., March 1983.

J. NUREG/CR-2991, "Evaluation of Potential Surface Faulting and Other Tectonic Deformation," Bonilla, M.G., Department of Interior, Geological Survey, October 1982.

K. NUREG/CR-2532, "Catalog of Earthquakes Felt in the Eastern U.S. Megalopolis 1850-1930," Winker, L., Pennsylvania State University, July 1982.

L. NUREG/CR-2103, "Scaling and Estimation of Earthquake Ground Motion as a Function of the Earthquake Source Parameters and Distance," Bernreuter, D.L., Lawrence Livermore National Laboratory, June 1981.

M. NUREG/CR-1978, "State-of-the-Art Study Concerning Near-Field Earthquake Ground Motion," Swanger, H.J. et al., Systems, Sciences and Software, March 1981.

N. NUREG/CR-1804, "Reevaluation of Modified Mercalli Intensity Scale for Earthquakes Using Distance as Determinant," National Oceanographic and Atmospheric Administration, December 1980.

0. NUREG/CR-1805, "An Analysis of Earthquake Intensities with Respect to Attenuation, Magnitude and Rate of Recurrence," National Oceanographic and Atmospheric Administration, December 1980.

P. NUREG/CR-1457, "Regional Relationships Among Earthquake Magnitude Scales," Lawrence Livermore National Laboratory, September 1980.

Q. NUREG/CR-1641, "Statistical Analysis of Earthquake Ground Motion Parameters," Shannon and Wilson, Agbabian Associates, September 1980.

R. NUREG/CR-1660, "Compilation, Assessment and Expansion of the Strong Earthquake Ground Motion Data Base," Lawrence Livermore National Laboratory, September 1980.

S. "Earthquake History of the United States (1971-76 Supplement)," Publication 41-1, National Oceanic and Atmospheric Administration, U.S. Department of Commerce; Geological Survey, U.S. Department of Interior, 1979.

T. "Earthquake History of the United States," U.S. Geological and Solar Terrestrial Data Center, NOAA.

U. Historical Earthquake Data File, National Geophysical and Solar Terrestrial Data Center, NOAA.

V. ORNL-6139, “Guidelines for Ground Motion Definition for the Eastern United States,” Gwaltney, R.C., et al., Oak Ridge National Laboratory, June 1985.

W. “Earthquake Research for the Safer Siting of Critical Facilities,” National Academy of Sciences, 1980.

X. “Geologic Criteria for Repositories for High-Level Radioactive Wastes,” National Academy of Science, August 1978.

Y. “Tectonic Map of the United States,” Cohee, G.V., U.S. Geological Survey and American Association of Petroleum Geologists, 1962.

CHAPTER 3

DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS

This chapter identifies the principal architectural and engineering criteria for the design of structures, components, equipment, and systems important to safety.

3.1 CONFORMANCE WITH NRC GENERAL DESIGN CRITERIA

Criteria for establishing the general design criteria for items important to safety are identified in this section.

3.1.1 Code of Federal Regulations

A. 10 CFR 50.34, “Contents of Applications; Technical Information.”

B. 10 CFR 50, Appendix F, “Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities.”

C. 10 CFR 60.101, “Purpose and Nature of Findings.”

D. 10 CFR 60.102, “Concepts.”

E. 10 CFR 60.130, “Scope of Design Criteria for the Geologic Repository Operations Area.”

F. 10 CFR 60.131, “General Design Criteria for the Geologic Repository Operations Area.”

G. 10 CFR 60.132, “Additional Design Criteria for Surface Facilities in the Geologic Repository Operations Area.”

H. 10 CFR 60.133, “Additional Design Criteria for the Underground Facility.”

I. 10 CFR 60.134, “Design of Seals for Shafts and Bore Holes.”

J. 10 CFR 60.135, “Criteria for the Waste Package and its Components.”

K. 10 CFR 61.51, “Disposal Site Design for Land Disposal.”

L. 10 CFR 61.52, “Land Disposal Facility Operation and Disposal Site Closure.”

M. 10 CFR 61.54, “Alternative Requirements for Design and Operations.”

N. 10 CFR 72.120, “General Considerations.”

O. 10 CFR 72.122, “Overall Requirements.”

P. 10 CFR 72.124, “Criteria for Nuclear Criticality Safety.”

Q. 10 CFR 72.126, “Criteria for Radiological Protection.”

R. 10 CFR 72.128, “Criteria for Spent Fuel, High-Level Radioactive Waste, and Other Radioactive Waste Storage and Handling.”

S. 10 CFR 72.130, “Criteria for Decommissioning.”

3.1.2 Regulatory Guides

A. Regulatory Guide, 3.10, “Liquid Waste Treatment System Design Guide for Plutonium Processing and Fuel Fabrication Plants.”

B. Regulatory Guide 3.12, “General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants.”

C. Regulatory Guide 3.20, “Process Offgas Systems for Fuel Reprocessing Plants.”

D. Regulatory Guide 3.32, “General Design Guide for Ventilation Systems for Fuel Reprocessing Plants.”

E. Regulatory Guide 3.38, “General Fire Protection Guide for Fuel Reprocessing Plants.”

F. Regulatory Guide 3.56, “General Guidance for Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills.”

3.1.3 Codes and Standards

A. ANSI/ANS 2.19-1981 (R1990), “Guidelines for Establishing Site-Related Parameters for Site Selection and Design of an Independent Spent Fuel Storage Installation (Water Pool Type).”

B. ANSI/ANS 57.3-1983, "Design Requirements for New Fuel Storage Facilities at Light Water Reactors."

C. ANSI/ANS 57.7-1988, "Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type)."

D. ANSI/ANS 57.9-1984, "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)."

3.1.4 Supplementary Information

None.

3.2 CLASSIFICATION OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS

Criteria for classifying seismic systems are identified in this section.

3.2.1 Code of Federal Regulations

A. 10 CFR 61.12, "Specific Technical Information."

B. 10 CFR 72.120, "General Considerations."

C. 10 CFR 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants."

3.2.2 Regulatory Guides

A. Regulatory Guide 1.29, "Seismic Design Classification."

B. Regulatory Guide 3.14, "Seismic Design Classification for Plutonium Processing and Fuel Fabrication Plants.

3.2.3 Codes and Standards

None.

3.2.4 Supplemental Information

A. UCRL-15910, "Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards," Kennedy, R.P., et al., Lawrence Livermore National Laboratory, 1990.

B. LBL-9143, "Seismic Safety Guide, "Eagling, D.G., Lawrence Berkeley Laboratory, 1983.

3.3 WIND AND TORNADO LOADINGS

Criteria for considering loads resulting from wind and tornado are identified in this section.

3.3.1 Code of Federal Regulations

A. 10 CFR 60.21, “Content of Application.”

B. 10 CFR 60.131, “General Design Criteria for the Geologic Repository Operations Area.”

C. 10 CFR 61.12, “Specific Technical Information.”

D. 10 CFR 72.40, “Issuance of License.”

E. 10 CFR 72.90, “General Considerations.”

F. 10 CFR 72.92, “Design Basis External Natural Events.”

G. 10 CFR 72.98, “Identifying Regions Around an ISFSI or MRS Site.”

H. 10 CFR 72.122, “Overall Requirements.”

I. 10 CFR 100, Appendix A, “Seismic and Geologic Siting Criteria for Nuclear Power Plants.”

3.3.2 Regulatory Guides

A. Regulatory Guide 1.76, “Design Basis Tornado for Nuclear Power Plants.”

B. Regulatory Guide 3.10, “Liquid Waste Treatment Design Guide for Plutonium Processing and Fuel Fabrication Plants.”

C. Regulatory Guide 3.12, “General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants.”

D. Regulatory Guide 3.16, “General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants.”

E. Regulatory Guide 3.18, “Confinement Barriers and Systems for Fuel Reprocessing Plants.

F. Regulatory Guide 3.20, “Process Offgas Systems for Fuel Reprocessing Plants.”

G. Regulatory Guide 3.31, "Emergency Water Supply Systems for Fuel Reprocessing Plants."

H. Regulatory Guide 3.32, "General Design Guide for Ventilation Systems for Fuel Reprocessing Plants."

I. Regulatory Guide 3.38, "General Fire Protection Guide for Fuel Reprocessing Plants."

J. Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation, (Water Basin Type)."

K. Regulatory Guide 3.53, "Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation."

L. Regulatory Guide 3.60, "Design of an Independent Spent Fuel Storage Installation (Dry Storage)."

3.3.3 Codes and Standards

A. ANSI/ANS 2.3-1983, "Standard for Estimating Tornado and Extreme Wind Characteristics at Nuclear Power Sites."

B. ANSI/ANS 57.7-1988, "Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type)."

C. ANSI/ANS 57.9-1984, "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)."

3.3.4 Supplementary Information

A. UCRL-15910, "Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards," Kennedy, R.P., et al., Lawrence Livermore National Laboratory, 1990.

B. UCRL-21131, "Structural Details for Wind Design," McDonald, J.R., Lawrence Livermore National Laboratory, 1988.

C. UCRL-53526, Rev. 1, "Natural Phenomena Hazard Modeling Project: Extreme Wind/Tornado Models for Department of Energy Sites," Coats, D.W., Lawrence Livermore National Laboratory, August 1985.

D. NUREG/CR-3874, "Near-Ground Tornado Wind Fields," McDonald, J.R., Texas Tech. University, July 1984.

E. NUREG/CR-3848, "Experimental Investigation of Unsteady Tornadic Wind Loads on Structures," Jischke, M.C., Oklahoma Teaching Hospitals, June 1984.

F. NUREG/CR-3058, "A Methodology for Tornado Hazard Probability Assessment," McDonald, J.R., Texas Tech. University, October 1983.

G. NUREG/CR-2944, "Tornado Damage Risk Assessment," Reinhold, T.A. and Ellingwood, B., National Bureau of Standards, February 1983.

H. NUREG/CR-2565, "Structural Performance of HEPA Filters Under Simulated Tornado Conditions," Horak, H.L. and Smith, P.R., Los Alamos National Laboratory, May 1982.

I. NUREG/CR-2014, "Kinematics of Translating Tornado Wind Fields," Peterson, R.E., Texas Tech. University, April 1981.

J. NUREG/CR-1585, "Modeling Tornado Dynamics," Aeronautical Research Association, September 1980.

3.4 WATER LEVEL (FLOOD) DESIGN

3.4.1 Code of Federal Regulations

A. 10 CFR 60.122, "Siting Criteria."

B. 10 CFR 60.131, "General Design Criteria for the Geologic Repository Operations Area."

C. 10 CFR 61.12, "Specific Technical Information."

D. 10 CFR 61.50, "Disposal Site Suitability Requirements for Land Disposal."

E. 10 CFR 72.40, "Issuance of License."

F. 10 CFR 72.90, "General Considerations."

G. 10 CFR 72.92, "Design Basis External Natural Events."

H. 10 CFR 72.94, "Design Basis External Man-Induced Events."

I. 10 CFR 72.98, "Identifying Regions Around an ISFSI or MRS Site."

J. 10 CFR 72.122, "Overall Requirements."

K. 10 CFR 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants."

3.4.2 Regulatory Guides

A. Regulatory Guide 3.10, "Liquid Waste Treatment Design Guide for Plutonium Processing and Fuel Fabrication Plants."

B. Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills."

C. Regulatory Guide 3.18, "Confinement Barriers and Systems for Fuel Reprocessing Plants.

D. Regulatory Guide 3.31, "Emergency Water Supply Systems for Fuel Reprocessing Plants."

E. Regulatory Guide 3.40, "Design Basis Floods for Fuel Reprocessing Plants and for Plutonium Processing and Fuel Fabrication Plants."

F. Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation, (Water Basin Type)."

G. Regulatory Guide 3.53, "Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation."

H. Regulatory Guide 3.60, "Design of an Independent Spent Fuel Storage Installation (Dry Storage)."

3.4.3 Codes and Standards

A. ANSI/ASCE 1-82, "Guidelines for Design and Analysis of Nuclear Safety-Related Structures."

B. ANSI/ANS 2.8-1981, "Determining Design Basis Flooding at Power Reactor Sites."

C. ANSI/ANS 57.7-1988, "Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type)."

D. ANSI/ANS 57.9-1984, "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)."

3.4.4 Supplementary Information

A. UCRL-21045, "Preliminary Flood Hazard Estimates for Screening Department of Energy Sites," McCann, M.W., and Boissonnade, A.C., Lawrence Livermore National Laboratory, 1988.

B. UCRL-15910, “Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards,” Kennedy, R.P., et al., Lawrence Livermore National Laboratory, 1990.

C. UCRL-15746, “Natural Phenomena Hazards Modeling Project: Flood Hazard Models for Department of Energy Sites,” Savy, J.B. and Murray, R.C., Lawrence Livermore National Laboratory, 1988.

D. UCLA-ENG-7423, “Estimates of the Risk Associated With Dam Failure,” UCLA School of Engineering and Applied Science, March 1984.

E. NUREG/CR-2678, “Flood Risk Analysis Methodology Development Project - Final Report,” Wagner, D.P. et al., Oak Ridge National Laboratory, July 1982.

3.5 MISSILE PROTECTION

Criteria for protection against missiles generated because of internal events, events near the site, and natural phenomena are identified in this section.

3.5.1 Code of Federal Regulations

A. 10 CFR 60.122, “Siting Criteria.”

B. 10 CFR 60.131, “General Design Criteria for the Geologic Repository Operations Area.”

C. 10 CFR 61.12, “Specific Technical Information.”

D. 10 CFR 72.40, “Issuance of License.”

E. 10 CFR 72.90, “General Considerations.”

F. 10 CFR 72.92, “Design Basis External Natural Events.”

G. 10 CFR 72.94, “Design Basis External Man-Induced Events.”

H. 10 CFR 72.98, “Identifying Regions Around an ISFSI or MRS Site.”

I. 10 CFR 72.122, “Overall Requirements.”

3.5.2 Regulatory Guides

A. Regulatory Guide 3.10, "Liquid Waste Treatment Design Guide for Plutonium Processing and Fuel Fabrication Plants."

B. Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants."

C. Regulatory Guide 3.16, "General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants."

D. Regulatory Guide 3.18, "Confinement Barriers and Systems for Fuel Reprocessing Plants."

E. Regulatory Guide 3.20, "Process Offgas Systems for Fuel Reprocessing Plants."

F. Regulatory Guide 3.31, "Emergency Water Supply Systems for Fuel Reprocessing Plants."

G. Regulatory Guide 3.32, "General Design Guide for Ventilation Systems for Fuel Reprocessing Plants."

H. Regulatory Guide 3.38, "General Fire Protection Guide for Fuel Reprocessing Plants."

I. Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation, (Water Basin Type)."

J. Regulatory Guide 3.53, "Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation."

K. Regulatory Guide 3.60, "Design of an Independent Spent Fuel Storage Installation (Dry Storage)."

3.5.3 Codes and Standards

A. ANSI/ANS 2.3-1983, "Standard for Estimating Tornado and Extreme Wind Characteristics at Nuclear Power Sites."

B. ANSI/ANS 57.7-1988, "Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type)."

c. ANSI/ANS 57.9-1984, "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)."

D. DOE/TIC-11268, "A Manual for the Prediction of Blast and Fragment Loading on Structures," Southwest Research Institute, November 1980.

E. TM5-1300, "Structures To Resist the Effects of Accidental Explosions," Army Technical Manual, June 1969.

3.5.4 Supplementary Information

A. UCRL-53526, Rev. 1, "Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites," Coats, D.W., Lawrence Livermore National Laboratory, August 1985.

B. NUREG-0533, "Aircraft Impact risk Assessment, Data Base for Assessment of Air Carrier Impact Risk in the Vicinity of Airports," USNRC, July 1979.

C. NUREG/CR-2462, "Capacity of Nuclear Power Plant Structures to Resist Blast Loading," Kennedy, R.P. et al., Sandia National Laboratories, September 1983.

D. NUREG/CR-2859, "Evaluation of Aircraft Crash Hazards for Nuclear Power Plants," Kot, C.A. et al., Argonne National Laboratory, September 1982.

E. EPRI NP-148, "Full Scale Tornado - Missile Impact Tests," Electric Power Research Institute, April 1976.

F. BC-TOP-9A, "Topical Report - Design of Structures for Missile Impact," Linderman, R.B. et al., Bechtel Power Corporation, September 1974.

3.6 SEISMIC DESIGN

This section identifies criteria for seismic input; analysis of Category I structures, systems, and components; and seismic instrumentation.

3.6.1 Code of Federal Regulations

A. 10 CFR 60.122, "Siting Criteria."

B. 10 CFR 60.131, "General Design Criteria for the Geologic Repository Operations Area."

C. 10 CFR 61.12, "Specific Technical Information."

D. 10 CFR 70.22, "Contents of Applications."

E. 10 CFR 70.23, "Requirements for the Approval of Applications."

F. 10 CFR 72.40, “Issuance of License.”

G. 10 CFR 72.90, “General Considerations.”

H. 10 CFR 72.92, “Design Basis External Natural Events.”

I. 10 CFR 72.98, “Identifying Regions Around an ISFSI or MRS Site.”

J. 10 CFR 72.102 “Geological and Seismological Characteristics.”

K. 10 CFR 72.122, “Overall Requirements.”

L 10 CFR 100, Appendix A, “Seismic and Geologic Siting Criteria for Nuclear Power Plants.”

3.6.2 Regulatory Guides

A. Regulatory Guide 3.10, “Liquid Waste Treatment Design Guide for Plutonium Processing and Fuel Fabrication Plants.”

B. Regulatory Guide 3.12, “General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants.”

C. Regulatory Guide 3.14, “Seismic Design Classification for Plutonium Processing and Fuel Fabrication Plants.”

D. Regulatory Guide 3.16, “General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants.”

E Regulatory Guide 3.17, “Earthquake Instrumentation for Fuel Reprocessing Plants.”

F. Regulatory Guide 3.18, “Confinement Barriers and Systems for Fuel Reprocessing Plants.

G. Regulatory Guide 3.20, “Process Offgas Systems for Fuel Reprocessing Plants.”

H. Regulatory Guide 3.31, “Emergency Water Supply Systems for Fuel Reprocessing Plants.”

I. Regulatory Guide 3.32, “General Design Guide for Ventilation Systems for Fuel Reprocessing Plants.”

J. Regulatory Guide 3.38, “General Fire Protection Guide for Fuel Reprocessing Plants.”

K. Regulatory Guide 3.49, “Design of an Independent Spent Fuel Storage Installation, (Water Basin Type).”

L. Regulatory Guide 3.53, “Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation.”

M. Regulatory Guide 3.60, “Design of an Independent Spent Fuel Storage Installation (Dry Storage).”

3.6.3 Codes and Standards

A. ANSI/ANS 2.2-1988, “Earthquake Instrumentation Criteria for Nuclear Power Plants.”

B. ANSI/ANS 57.7-1988, “Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type).”

C. ANSI/ANS 57.9-1984, “Design Criteria for an Independent Fuel Storage Installation (Dry Storage Type).”

D. NE F9-2T, “Seismic Requirements for Design of Nuclear Power Plants and Nuclear Test Facilities,” USDOE, February 1985.

3.6.4 Supplementary Information

A. Background Information

1. LBL-9143, “Seismic Safety Guide,“ Eagling, D.G., Lawrence Berkeley National Laboratory, September 1983.

2. UCRL-53582, Rev. 1, “Natural Phenomena Hazards Modeling Project: Seismic Hazard Models for Department of Energy Sites,” Coats, D.W. and Murray, R.C., Lawrence Livermore National Laboratory, November 1984.

3. UCRL-52786, “Seismic Safety of LLL Plutonium Facility (Building 332),” Tokarz F. and Shaw, G., Lawrence Livermore National Laboratory, January 1980.

4. UCRL-52167, “Seismic Analysis of Large Pools,” Dong, R.G. and Tokarz, F.J., Lawrence Livermore Laboratory, November 1976.

5. NUREG/CR-1069, “Effects of Earthquakes on Underground Facilities: Literature Review and Discussion,” Carpenter, D.W. and Chung, D.C., Lawrence Livermore National Laboratory, June 1986.

6. NUREG/CR-3805, “Engineering Characterization of Ground Motion,” Chang, C.Y. et al., Woodward-Clyde Consultants, February 1986.

7. NUREG/CR-4328, “Probability Based Load Combination Criteria for Design of Shear Wall Structures,” Hwang, H. et al., Brookhaven National Laboratory, January 1986.

8. NUREG/CR-4293, “Reliability Analysis of Shear Wall Structures,” Wang, P.C. et al., Brookhaven National Laboratory, January 1986.

9. NUREG/CR-4182, “Verification of Soil Structure Interaction Methods,” Miller, C.A. et al., Brookhaven National Laboratory, July 1985.

10. BNL-NUREG-36473, “Procedure for Determining the SSE Response from the OBE Response,” Curreri, J., Brookhaven National Laboratory, 1985.

11. NUREG/CR-2077, “Uncertainty in Soil-Structure Interaction Analysis Arising from Differences in Analytical Techniques,” Maslenikov, O.R. et al., Lawrence Livermore National Laboratory, November 1983.

12. NUREG-0967, “Seismic Hazard Review for the Systematic Evaluation Program - A Use of Probability in Decision Making,” Reiter, L. and Jackson, R.E., U.S. Nuclear Regulatory Commission, March 1983.

13. NUREG/CR-2236, “Seismic Resistance Capacity Evaluation of Spent Fuel Storage Racks and Fuel at West Valley New York,” Johnson, N.E. et al., Science Applications International Corp., December 1981.

14. NUREG/CR-2451, “Behavior Model for Reinforced Concrete Panels Under Cyclic Shear,” Tseng, T. et al., Massachusetts Institute of Technology, December 1981.

15. NUREG/CR-2310, “Seismic Response of Nonlinear Systems,” Endebrock, E. and Dove, R., Los Alamos National Laboratory, October 1981.

16. NUREG/CR-1582, “Seismic Hazard Analysis,” Bernreuter, D.L., Lawrence Livermore National Laboratory, October 1981.

17. NUREG/CR-1752, “Simulating and Analyzing Artificial Non-Stationary Earthquake Ground Motion,” Lawrence Livermore National Laboratory, November 1980.

18. NUREG/CR-1489, "Best Estimate Method vs. Evaluation Method: A Comparison of Two Techniques in Evaluating Seismic Analysis and Design," Lawrence Livermore National Laboratory, July 1980.

19. NUREG/CR-1429, "Seismic Review Table," Brookhaven National Laboratory, May 1980.

20. EGG-M-10085, "Structural Performance of the DOE's Idaho National Engineering Laboratory During the 1983 Borak Peak Earthquake," Guenzler, R.C. et al., Idaho National Engineering Laboratory, 1985.

21. LA-UR-85-725, "Seismic Tests on Models of Reinforced Concrete Category I Buildings," Dove, R.C. et al., Los Alamos National Laboratory, 1985.

22. CERL-TR-M-114 , "Guidelines for Developing Design Earthquake Response Spectra," Hays, W.W., Army Construction Engineering Research Laboratory, U.S. Geological Survey, June 1975.

23. IE Bulletin 79-14, Rev. 1, "Seismic Analysis for As-Built Safety-Related Piping Systems," USNRC.

B. Facility Specific

1. UCRL-52159, "Evaluation of Methods for Seismic Analysis of Nuclear Fuel Reprocessing and Fabrication Facilities," Arthur, D.F., et al., Lawrence Livermore National Laboratory, February 1978.

2. UCRL-51928, "Evaluation Methods for Seismic Analysis of Mixed-Oxide Fabrication Plants," Tokay, F. J. et al., Lawrence Livermore National Laboratory, 1975.

3.7 DESIGN OF CATEGORY I STRUCTURES

Criteria for concrete and steel Category I structures are identified in this section.

3.7.1 Code of Federal Regulations

A. 10 CFR 50.59, "Changes, Tests, and Experiments."

B. 10 CFR 50, Appendix F, "Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities."

C. 10 CFR 60.130, "Scope of Design Criteria for the Geologic Repository Operations Area."

D. 10 CFR 60.131, “General Design Criteria for the Geologic Repository Operations Area.”

E. 10 CFR 60.141, “Confirmation of Geotechnical and Design Parameters.”

F. 10 CFR 61.12, “Specific Technical Information.”

G. 10 CFR 61.50, “Disposal Site Suitability Requirements for Land Disposal.”

H. 10 CFR 72.40, “Issuance of License.”

I. 10 CFR 72.90, “General Considerations.”

J. 10 CFR 72.92, “Design Basis External Natural Events.”

K. 10 CFR 72.98, “Identifying Regions Around an ISFSI or MRS Site.”

L. 10 CFR 72.102, “Geological and Seismological Characteristics.”

M. 10 CFR 72.120, “General Considerations.”

N. 10 CFR 72.122, “Overall Requirements.”

O. 10 CFR 100, Appendix A, “Seismic and Geologic Siting Criteria for Nuclear Power Plants.”

3.7.2 Regulatory Guides

A. Regulatory Guide 3.9, “Concrete Radiation Shields.”

B. Regulatory Guide 3.12, “General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants.”

C. Regulatory Guide 3.18, “Confinement Barriers and Systems for Fuel Reprocessing Plants.

D. Regulatory Guide 3.32, “General Design Guide for Ventilation Systems for Fuel Reprocessing Plants.”

E. Regulatory Guide 3.38, “General Fire Protection Guide for Fuel Reprocessing Plants.”

F. Regulatory Guide 3.40, “Design Basis Floods for Fuel Reprocessing Plants and for Plutonium Processing and Fuel Fabrication Plants.”

3.7.3 Codes and Standards

A. ANSI/ACI 349-1985, "Code Requirements for Nuclear Safety-Related Concrete Structures."

B. ANSI/AISC N690-1984, "Nuclear Facilities - Steel Safety-Related Structures for Design, Fabrication, and Erection."

C. ANSI/AISC TR 215, "Seismic Design Practice for Steel Buildings."

D. ANSI/ANS 57.7-1988, "Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type)."

E. ANSI/ANS 57.9-1984, "Design Criteria for an Independent Spent Fuel Storage Installation [Dry Storage Type]."

F. ASCE N-725, "Guidelines for Design and Analysis of Nuclear Safety-Related Earth Structure."

G. Tri-Services Manual, "Seismic Design for Buildings," Departments of the Army (TM-5-809-10), Navy (NAVFAC P-355), and Air Force (AFM 88-3, Chapter 13), February 1982.

3.7.4 Supplementary Information

A. Background Information.

1. LBL-9143, "Seismic Safety Guide," Eagling, D.G., Lawrence Berkeley Laboratory, September 1983.

2. UCRL-15815, "Practical Equipment Seismic Upgrade and Strengthening Guidelines," EQE Incorporated, Lawrence Livermore National Laboratory, September 1986.

3. UCRL-15714, "Suspended Ceiling System Survey and Seismic Bracing Recommendations," EDZ International, Lawrence Livermore National Laboratory, August 1985.

4. NUREG/CR-3342, "Probabilistic Models for Operational and Accidental Loads on Seismic Category I Structures," Hwang, H. et al., Brookhaven National Laboratory, December 1983.

5. NUREG/CR-3157, "Design of Reinforced Concrete Containment Wall Elements Under Combined Action of Shear and Tension," Calvo, J., Massachusetts Institute of Technology, March 1983.

6. NUREG/CR-2945, “Characterization of Earthquake Forces for Probability-Based Design of Nuclear Structures,” Ellingwood, B and Batts, M., National Bureau of Standards, Brookhaven National Laboratory, February 1983.

7. NUREG/CR-2638, “Snow Loads for the Design of Nuclear Power Plant Structures,” Ellingwood, B. et al., National Bureau of Standards, April 1982.

8. NUREG/CR-2062, “Foundation Considerations in Siting of Nuclear Facilities in Karst Terrains and Other Areas Susceptible to Ground Collapse,” Franklin, A.G., Army Engineer Waterways Experiment Station, April 1981.

9. NUREG/CR-2013, “A Lightning Damage Assessment of the United States: January 1968-December 1977,” Henz, J.F. and Pearl, E.W., Geophysical Research and Development Corp., April 1981.

10. NUREG/CR-1979, “Probability-Based Load Criteria for the Design of Nuclear Structures - A Critical Review of the State-of-the-Art,” Shinozuka, M. et al., Brookhaven National Laboratory, April 1981.

11. NUREG-0484, “Methodology for Combining Dynamic Responses,” U.S. Nuclear Regulatory Commission, May 1980.

12. NUREG/CR-1423, “Structural Building Response Review,” Lawrence Livermore National Laboratory, May 1980.

B. Facility Specific.

1. UCRL-52159, “Evaluation of Methods for Seismic Analysis of Nuclear Fuel Reprocessing and Fabrication Facilities,” Arthur, D.F. et al., Lawrence Livermore National Laboratory, February 1978.

2. UCRL-51928, “Evaluation of Methods for Seismic Analysis of Mixed-Oxide Fabrication Plants,” Tokay, F.J. et al., Lawrence Livermore National Laboratory, 1975.

3.8 MECHANICAL SYSTEMS AND COMPONENTS

3.8.1 Code of Federal Regulations

A. 10 CFR 50, Appendix F, “Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities.”

B. 10 CFR 60.130, “Scope of Design Criteria for the Geologic Repository Operations Area.”

C. 10 CFR 60.131, “General Design Criteria for the Geologic Repository Operations Area.”

D. 10 CFR 61.12, “Specific Technical Information.”

E. 10 CFR 70.23, “Requirements for the Approval of Applications.”

F. 10 CFR 72.120, “General Considerations.”

G. 10 CFR 72.122, “Overall Requirements.”

3.8.2 Regulatory Guides

A. Regulatory Guide 3.10, “Liquid Waste Treatment Design Guide for Plutonium Processing and Fuel Fabrication Plants.”

B. Regulatory Guide 3.12, “General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants.”

C. Regulatory Guide 3.14, “Seismic Design Classification for Plutonium Processing and Fuel Fabrication Plants.”

D. Regulatory Guide 3.16, “General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants.”

E. Regulatory Guide 3.18, “Confinement Barriers and Systems for Fuel Reprocessing Plants.

F. Regulatory Guide 3.20, “Process Offgas Systems for Fuel Reprocessing Plants.”

G. Regulatory Guide 3.31, “Emergency Water Supply Systems for Fuel Reprocessing Plants.”

H. Regulatory Guide 3.32, “General Design Guide for Ventilation Systems for Fuel Reprocessing Plants.”

I. Regulatory Guide 3.37, “Guidance for Avoiding Intergranular Corrosion and Stress Corrosion in Austenitic Stainless Steel Components of Fuel Reprocessing Plants.”

J. Regulatory Guide 3.38, “General Fire Protection Guide for Fuel Reprocessing Plants.”

K. Regulatory Guide 3.49, “Design of an Independent Spent Fuel Storage Installation, (Water Basin Type).”

L. Regulatory Guide 3.53, “Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation.”

M. Regulatory Guide 3.60, “Design of an Independent Spent Fuel Storage Installation (Dry Storage).”

3.8.3 Codes and Standards

A. Piping Components.

1. ASME/ANSI B16.5-1988, “Pipe Flanges and Flanged Fittings.”

2. ANSI B16.11, “Forged Steel Fittings, Socket-Welding and Threaded.”

3. ASME/ANSI B16.34-1988, “Valves-Flanged, Threaded and Welding End.”

4. ANSI/ASME B16.9-1986, “Factory-Made Wrought Steel Buttwelding Fittings.”

5. ANSI N278.1-1975 (R1985), “Functional Specification Standard for Self-Operated and Power-operated Safety-Related Valves.”

B. Pressure Vessels and Piping.

1. Section III, Division 1 and Division 2, Subsection NCA, “General Requirements,” ASME Boiler and Pressure Vessel Code.

2. Section III, Division 1, Subsection ND, “Class 3 Components, ” ASME Boiler and Pressure Vessel Code.

3. Section VIII, Division 1, “Pressure Vessels,” ASME Boiler and Pressure Vessel Code.

4. Section X, “Fiberglass Reinforced Plastic Pressure Vessels,” ASME Boiler and Pressure Vessel Code.

5. Section XI, “Rules for Inservice Inspection of Nuclear Power Plant Components,” ASME Boiler and Pressure Vessel Code.

C. Tanks (Low Pressure or Atmospheric).

1. ASME/ANSI B96.1-1989, “Welded Aluminum-Alloy Storage Tanks.”

2. ANSI/API 620-1986, "Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks."

3. ANSI/API 650-1980, "Welded Steel Tanks for Oil Storage."

4. ANSI/AWWA D100-1984, "Welded Steel Tanks for Water Storage."

5. ANSI/NFPA 22-1987, "Standard for Water Tanks for Private Fire Protection."

D. Pumps

1. ANSI/ASME B73.lM-1984, "Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process."

2. ANSI/ASME B73.2M-1984, "Specification for Vertical In-Line Centrifugal Pumps for Chemical Process."

3. ANSI/NFPA 20-1990, "Centrifugal Fire Pumps."

4. ANSI/API 610-1981, "Centrifugal Pumps for General Refinery Services."

5. ANSI/UL 448-1985, "Pumps for Fire Protection Service."

E. Heat Exchangers.

1. TEMA Class "B," "C," or "R" Heat Exchangers Mechanical Standards, Sixth Ed., 1978 and 1982 Addenda, Tubular Exchanger Manufacturers Association.

F. Cranes.

1. ANSI/ASME B30.2-1990, "Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)."

2. ANSI/ASME B30.11-1988, "Monorails and Underhung Cranes."

3. ANSI/ASME B30.17-1985, "Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)."

4. CMAA-70, "Specification for Electric Overhead Traveling Cranes," Crane Manufacturers Association of America.

5. NE F8-6T, "Hoisting and Rigging of Critical Components and Related Equipment," USDOE, November 1985.

3.8.4 Supplementary Information

A. Background Information.

1. NUREG-0554, “Single-Failure Proof Cranes for Nuclear Power Plants,” U.S. Nuclear Regulatory Commission, May 1979.

2. NUREG-0484, “Methodology for Combining Dynamic Responses,” U.S. Nuclear Regulatory Commission, May 1980.

3. NUREG/CR-3996, “Response Margins of the Dynamic Analysis of Piping Systems,” Johnson, J.J. et al., Lawrence Livermore National Laboratory, October 1984.

4. NUREG/CR-3811, “Alternate Procedures for the Seismic Analysis of Multiple Supported Piping Systems,” Subudhi, M. et al., Brookhaven National Laboratory, October 1984.

5. NUREG/CR-3599, “Sources of Uncertainty in the Calculations of Loads on Supports of Piping Systems,” Rodabaugh, E.C., Oak Ridge National Laboratory, July 1984.

6. NUREG/CR-3526, “Impact of Changes in Damping and Spectrum Peak Broadening on the Seismic Response of Piping Systems,” Chuang, T.Y. et al., Lawrence Livermore National Laboratory, March 1984.

7. NUREG/CR-3086, “Investigation of the Conservatism Associated with Different Combinations Between Primary and Secondary Piping Response,” Wang, Y.K. et al., Brookhaven National Laboratory, January 1983.

8. NUREG/CR-2032, “Single vs. Dual Snubber Installations,” Onesto, A.T., Energy Technology Engineering Center, May 1981.

9. NUREG/CR-1980, “Dynamic Analysis of Piping, Using the Structural Overlap Method,” Curreri, J. et al., Brookhaven National Laboratory, March 1981.

10. NUREG/CR-1330, “Review of Methods and Criteria for Dynamic Combinations in Piping Systems,” Brookhaven National Laboratory, March 1980.

11. IE Bulletin 79-02, “Pipe Support Base Plate Designs Using Concrete Expansion Anchor Bolts,” USNRC.

12. IE Information Notice 80-21, “Anchorage and Support of Safety-Related Electrical Equipment,” USNRC.

13. IE Information Notice 86-94, “HILTI Concrete Expansion Anchor Bolts,” USNRC.

14. NRC Information Notice 90–30, “Ultrasonic Inspection Techniques for Dissimilar Metal Welds,” USNRC.

15. Generic Letter 89-13, “Service Water System Problems Affecting Safety-Related Equipment,” USNRC, July 1989.

3.9 SEISMIC AND DYNAMIC QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT

3.9.1 Code of Federal Regulations

None.

3.9.2 Regulatory Guides

A. Regulatory Guide 1.61, “Damping Values for Seismic Design of Nuclear Power Plants.”

B. Regulatory Guide 1.92, “Combining Modal Responses and Spatial Components in Seismic Response Analysis.”

C. Regulatory Guide 1.100, “Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants.”

3.9.3 Codes and Standards

A. ANSI N278.1-1975 (R1985), “Self-Operated and Power Operated Safety-Related Valves Functional Specification Standard.”

B. ANSI/IEEE 344-1987, “IEEE Recommended Practice for Seismic Qualification of Class lE Equipment for Nuclear Power Generating Stations.”

C. ANSI/IEEE 382-1985, “IEEE Standard for Qualification of Actuators for Power Operated Valve Assemblies With Safety-Related Functions for Nuclear Power Plants.”

D. ANSI/IEEE C37.81-1990, “Seismic Qualification of Class lE Metal-Enclosed Power Switchgear Assemblies.”

E. ANSI/IEEE C37.98-1978, “Standard Seismic Testing of Relays.”

3.9.4 Supplementary Information

A. NUREG–103O, “Seismic Qualification of Equipment in Operating Nuclear Power Plants,” USNRC, February 1987.

B. NUREG/CR-3914, “Pump and Valve Qualification Review Guide,” Miller, B.E., Brookhaven National Laboratory, October 1985.

C. NUREG/CR-3875, “The Use of In-Situ Procedures for Seismic Qualification of Equipment in Currently Operating Plants,” Sadik, S. et al., EG&G Inc., June 1984.

D. NUREG/CR-3266, “Seismic and Dynamic Qualification of Safety-Related Electrical and Mechanical Equipment in Operating Nuclear Power Plants,” Curreri, J. et al., Brookhaven National Laboratory, September 1983.

3.10 ENVIRONMENTAL DESIGN AND QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT

3.10.1 Code of Federal Regulations

A. 10 CFR 50.49, “Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants.”

3.10.2 Regulatory Guides

A. Regulatory Guide 1.89, “Environmental Qualification of Certain Electrical Equipment Important to Safety for Nuclear Power Plants.”

B. Regulatory Guide 1.158, “Qualification of Safety-Related Lead Storage Batteries for Nuclear Power Plants.”

C. Regulatory Guide 3.49, “Design of an Independent Spent Fuel Storage Installation (Water Basin Type).”

D. Regulatory Guide 3.60, “Design of an Independent Spent Fuel Storage Installation (Dry Storage).”

3.10.3 Codes and Standards

A. ANSI/ANS 57.7-1988, “Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type).”

B. ANSI/ANS 57.9-1984, “Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type).”

C. ANSI/IEEE 323-1984 (R1991), “IEEE Standard for Qualifying Class lE Equipment for Nuclear Power Generating Stations.”

D. ANSI/IEEE 382-1985, “IEEE Standard for Qualification of Actuators for Power Operated Valve Assemblies With Safety-Related Functions for Nuclear Power Plants.”

E. ANSI/IEEE 420-1982, “IEEE Standard for the Design and Qualification of Class lE Control Boards, Panels, and Racks Used in Nuclear Power Generating Stations.”

F. ANSI/IEEE 535-1986, “IEEE Standard for Qualification of Class lE Lead Storage Batteries for Nuclear Power Generating Stations.”

G. ANSI/IEEE 649-1980, “IEEE Standard for Qualifying Class lE Motor Control Centers for Nuclear Power Generating Stations.”

H. ANSI/IEEE 650-1979, “IEEE Standard for Qualification of Class 1E Static Battery Chargers and Inverters for Nuclear Power Generating Stations.”

I. ANSI/IEEE C37.82-1987, “IEEE Standard for Qualification of Switchgear Assemblies for Class lE Applications in Nuclear Power Generating Stations.”

J. ANSI/IEEE C37.105-1984, “IEEE Standard for Qualifying Class IE Protective Relays and Auxiliaries for Nuclear Power Generating Stations.”

3.10.4 Supplementary Information

A. NUREG/CR-3424, “Equipment Qualification Research Test Program and Failure Analysis of Class lE Solenoid Valves,” Franklin Research Center, November 1983.

3.11 DECOMMISSIONING

3.11.1 Code of Federal Regulations

A. 10 CFR 50.75, “Reporting and Record Keeping for Decommissioning Planning.”

B. 10 CFR 50.82, “Application for Termination of License.”

C. 10 CFR 50, Appendix F, “Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities.”

D. 10 CFR 60.46, “Particular Activities Requiring License Amendment.”

E. 10 CFR 60.51, “License Amendment for Permanent Closure.”

F. 10 CFR 60.52, “Termination of License.”

G. 10 CFR 60.61, “Provision of Information.”

H. 10 CFR 60.102, “Concepts.”

I. 10 CFR 60.112, “Overall System Performance Objective for the Geologic Repository After Permanent Closure.”

J. 10 CFR 60.113, “Performance of Particular Barriers After Permanent Closure.”

K. 10 CFR 61.12, “Specific Technical Information.”

L. 10 CFR 61.14, “Institutional Information.”

M. 10 CFR 61.23, “Standards for Issuance of a License.”

N. 10 CFR 61.24, “Conditions of Licenses.”

O. 10 CFR 61.28, “Contents of Application for Closure.”

P. 10 CFR 61.29, “Post Closure Observation and Maintenance.”

Q. 10 CFR 61.30, “Transfer of License.”

R. 10 CFR 61.31, “Termination of License.”

S. 10 CFR 61.40, “General Requirement.”

T. 10 CFR 61.42, “Protection of Individuals From Inadvertent Intrusion.”

U. 10 CFR 61.44, “Stability of the Disposal Site After Closure.”

V. 10 CFR 61.52, “Land Disposal Facility Operation and Disposal Site Closure.”

W. 10 CFR 61.53, “Environmental Monitoring.”

X. 10 CFR 61.62, “Funding for Disposal Site Closure and Stabilization.”

Y. 10 CFR 70.25, “Financial Assurance and Record Keeping for Decommissioning.”

Z. 10 CFR 70.38, “Expiration and Termination of Licenses.”

AA. 10 CFR 72.30, “Decommissioning Planning Including Financing and Record Keeping.”

AB. 10 CFR 72.40, “Issuance of License.”

AC. 10 CFR 72.54, “Application for Termination of License.”

AD. 10 CFR 72.130, “Criteria for Decommissioning.”

3.11.2 Regulatory Guides

A. Regulatory Guide 3.65, “Standard Format and Content of Decommissioning Plans for Licensees Under 10 CFR Parts 30, 40, and 70.”

3.11.3 Codes and Standards

A. ANSI/ASTM E1167-1987, “Standard Guide for a Radiation Protection Program for Decommissioning Operations.”

B. ANSI/ASTM E1278-1988, “Standard Guide for Radioactive Pathway Methodology for Release of Sites Following Decommissioning.”

C. ANSI/ASTM E1281-1989, “Standard Guide for Nuclear Facility Decommissioning Plans.”

3.11.4 Supplementary Information

A. NUREG-0436, Rev. 1 and Supplements 1 and 2, “Plan for Reevaluation of NRC Policy on Decommissioning of Nuclear Facilities,” USNRC, December 1978.

B. NUREG-0278, Vol. 1 & Vol. 2, “Technology, Safety, and Costs of Decommissioning a Reference Nuclear Fuel Reprocessing Plant,” Schneider, K.J. et al., Battelle Pacific Northwest Laboratory, October 1977.

C. NUREG/CR-1754, Addendum 1, “Technology, Safety, and Costs of Decommissioning Reference Non-Fuel–Cycle Nuclear Facilities,” Short, S.M., Pacific Northwest Laboratory, October 1989.

D. NUREG/CR-4519, “Technology, Safety and Costs of Decommissioning Reference Nuclear Fuel Cycle Facilities - Classification of Decommissioning Wastes,” Pacific Northwest Laboratory, 1986.

E. NUREG/CR-3293, “Technology, Safety and Costs of Decommissioning Reference Nuclear Fuel Cycle and Non-Fuel-Cycle Facilities Following Postulated Accidents,” Elder, H.K., Pacific Northwest Laboratory, May 1985.

F. NUREG/CR-2210, “Technology, Safety and Costs of Decommissioning Reference Independent Spent Fuel Storage Installations,” Ludwick, J.D. and Moore, E.B., Pacific Northwest Laboratory, January 1984.

G. NUREG/CR-3550, “Evaluation of Nuclear Facility Decommissioning Projects,” Miller, R.L. and Baumann, B.L., United Nuclear Industries, Inc., January 1984.

H. NUREG/CR-2241, “Technology and Cost of Termination Surveys Associated with Decommissioning of Nuclear Facilities,” Witherspoon, J., Oak Ridge National Laboratory, February 1982.

I. NUREG/CR-1754, “Technology, Safety and Costs of Decommissioning Reference Non-Fuel-Cycle Nuclear Facilities,” Murphy, E.S., Pacific Northwest Laboratory, February 1981.

J. NUREG/CR-1915, “Decontamination Processes for Restorative Operations and as a Precursor to Decommissioning,” Nelson, J.L. and Devine, J.R., Battelle Pacific Northwest Laboratory, May 1981.

K. NUREG/CR-1757, “Technology, Safety and Costs of Decommissioning a Reference Uranium Hexafluoride Conversion Plant,” Elder, H.K., Pacific Northwest Laboratory, October 1981.

L. NUREG/CR-1266, “Technology, Safety and Costs of Decommissioning a Reference Uranium Fuel Fabrication Plant,” Elder H.K. and Blahnik, D.E., Pacific Northwest Laboratory, October 1980.

M. NUREG/CR-0570, “Technology, Safety and Costs of Decommissioning a Reference Low-Level Waste Burial Ground,” Pacific Northwest Laboratory, 1980 and Addendum, 1981.

N. NUREG/CR-0129, “Technology, Safety and Costs of Decommissioning a Reference Small Mixed Oxide Fuel Fabrication Plant,” Pacific Northwest Laboratory, 1979.

O. NUREG/CR-0130, “Decommissioning of Nuclear Facilities - An Annotated Bibliography,” Pacific Northwest Laboratory, 1979.

P. NUREG/CR-0671, “Decommissioning of Nuclear Facilities - A Review and Analysis of Current Regulations,” Pacific Northwest Laboratory, 1979.

Q. UNI-SA-118, “DOE Decontamination and Decommissioning Program Experiences,” Dabrowski, T.E., UNC Nuclear Industries, Inc., 1983.

R. DOE/TIC-3391, “Decontamination and Decommissioning: A Bibliography,” McLaren, L.H., US DOEst
, November 1982.

S. ORNL/EIS-154, “Nuclear Facility Decommissioning and Site Remedial Actions: A Selected Bibliography,” Owen, P.T. et al., Oak Ridge National Laboratory, September 1982.

CHAPTER 4

ENGINEERED SAFETY FEATURES AND SAFETY-RELATED PROCESS SYSTEM FEATURES

This chapter identifies criteria for engineered safety features and the system design features and characteristics that are commonly used to prevent and limit the consequences of postulated accidents.

4.1 CONFINEMENT SYSTEM

Criteria for the barrier and its associated systems between areas of a NNF and the environment are identified in this section.

4.1.1 Code of Federal Regulations

A. 10 CFR 60.132, "Additional Design Criteria for the Surface Facilities in the Geologic Repository.

B. 10 CFR 60.133, "Additional Design Criteria for the Underground Facility.

C. 10 CFR 60.134, "Design of Seals for Shafts and Boreholes."

D. 10 CFR 60.135, "Criteria for the Waste Package and its Components."

E. 10 CFR 61.51, "Disposal Site Design for Land Disposal."

F. 10 CFR 72.122, "Overall Requirements."

G. 10 CFR 72.128, "Criteria for Spent Fuel, High-Level Radioactive Waste, and Other Radioactive Waste Storage and Handling."

4.1.2 Regulatory Guides

A. Regulatory Guide 3.7, "Monitoring of Combustible Gases and Vapors in Plutonium Processing and Fuel Fabrication Plants."

B. Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants."

C. Regulatory Guide 3.16, “General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants.”

D. Regulatory Guide 3.18, “Confinement Barriers and Systems for Fuel Reprocessing Plants.”

E. Regulatory Guide 3.30, “Selection, Application, and Inspection of Protective Coatings (Paint) for Fuel Reprocessing Plants.”

F. Regulatory Guide 3.32, “General Design Guide for Ventilation Systems in Fuel Reprocessing Plants.”

G. Regulatory Guide 3.49, “Design of an Independent Spent Fuel Storage Installation (Water Basin Type).”

H. Regulatory Guide 3.60, “Design of An Independent Spent Fuel Storage Installation (Dry Storage).”

4.1.3 Codes and Standards

A. ANSI/ACI 349-85, “Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-85) and Commentary ACI 349 R-85.”

B. ACI 307-69, “Specification for the Design and Construction of Reinforced Concrete Chimneys.”

C. ANSI/ANS 16.1-1986, “Measurement of the Leachability of Solidified Low-Level Radioactive Wastes.”

D. ANSI/ANS 57.7-1988, “Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type).”

E. ANSI/ANS 57.9-1984, “Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type).”

F. ANSI N512-1974, “Protective Coatings (Paints) for the Nuclear Industry.”

G. ANSI/ASTM C852-87, “Standard Guide for Design Criteria for Plutonium Glove Boxes.”

H. ASTM Special Technical Publication STP-719, “Building Air Change Rate and Infiltration Measurements,” American Society for Testing and Materials, 1980.

I. ASTM D01.43, “Manual of Coating Work for Light Water Nuclear Power Plant Primary Containment and Other Safety-Related Facilities,” 1979.

J. IES-CC-009-84, "Compendium of Standards, Practices, Methods, and Similar Documents Relating to Contamination Control," Institute of Environmental Sciences.

4.1.4 Supplementary Information

A. TID-16020, "Report on Glove Boxes and Containment Enclosures."

B. TID-24896, "Glove Box Window Material."

C. NUREG/CR-4477, "Methodologies for Assessing Long-Term Performance of High-Level Radioactive Waste Packages," Stephens, S.K. et al., Aerospace Corp., January 1986.

D. NUREG/CR-4194, "Low-Level Nuclear Waste Shallow Land Burial Trench Isolation," McCray, J.G., et al., University of Arizona, May 1985.

E. NUREG/CR-3973, "Alternative Containers for Low-Level Wastes Containing Large Amounts of Tritium," Gause, E.P. et al., Brookhaven National Laboratory, November 1984.

F. NUREG/CR-3909, "Solidification and Leaching of Boric Acid and Resin LWR Wastes," Arrora, H. et al., Brookhaven National Laboratory, October 1984.

G. NUREG/CR-3218, "Evaluation of Engineering Aspects of Backfill Placement for High-Level Nuclear Waste (HLW) Deep Geologic Repositories," Roberds, W., et al., Golder Associates, April 1984.

H. NUREG/CR-3168, "Technical Considerations for High-Integrity Containers for the Disposal of Radioactive Ion-Exchange Radioactive Waste," Picivlo, P.L., Brookhaven National Laboratory, October 1983.

I. NUREG/CR-3144, "Trench Design and Construction Techniques for Low-Level Radioactive Waste Disposal," Tucker, P.G., Army Engineer Waterways Experiment Station, February 1983.

J. NUREG/CR-1151, "Infiltration of Particulate Matter into Buildings," Sandia National Laboratories, March 1980.

4.2 VENTILATION SYSTEMS AND PROCESS OFFGAS SYSTEMS

Criteria for process offgas systems and safety-related ventilation systems that are often an integral part of a confinement system are identified in this section. This section supplements Section 4.1.

4.2.1 Code of Federal Regulations

A. 10 CFR 60.132, “Additional Design Criteria for Surface Facilities in the Geologic Repository Operations Area.”

B. 10 CFR 72.122, “Overall Requirements.”

4.2.2 Regulatory Guides

A. Regulatory Guide 3.2, “Efficiency Testing of Air-Cleaning Systems Containing Devices for Removal of Particles.”

B. Regulatory Guide 3.12, “General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants.”

C. Regulatory Guide 3.20, “Process Offgas Systems for Fuel Reprocessing Plants.”

D. Regulatory Guide 3.32, “General Design Guide for Ventilation Systems for Fuel Reprocessing Plants.”

E. Regulatory Guide 3.49, “Design of an Independent Spent Fuel Storage Installation (Water Basin Type).”

F. Regulatory Guide 3.60, “Design of an Independent Spent Fuel Storage Installation (Dry Storage).”

4.2.3 Codes and Standards

A. ANSI/ANS 57.7-1988, “Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type).”

B. ANSI/ANS 57.9-1984, “Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type).”

C. ANSI/ANS 59.2-1985, “Safety Criteria for HVAC Systems Located Outside Primary Containment.”

D. ANSI N101.1-1972, “Efficiency Testing of Air Cleaning Systems Containing Devices for Removal of Particles.”

E. ANSI N303-1978, “Guide for Control of Gasborne Radioactive Materials at Nuclear Fuel Reprocessing Facilities.”

F. ANSI/ASME AG-1, “ASME Code on Nuclear Air and Gas Treatment.”

G. ANSI/ASME N509-1989, “Nuclear Power Plant Air Cleaning Units and Components.”

H. ANSI/ASME N510-1980, “Testing of Nuclear Air Cleaning Systems.”

I. IES-RP-CC-001-86, “HEPA Filters.”

J. IES-RP-CC-002-86, “Laminar Flow Clean Air Devices.”

K. IES-RP-CC-008-84, “Gas-Phase Adsorber Cells.”

L. MIL-F-51068C, “Filter, Particulate, High-Efficiency, Fire-Resistant.”

M. MIL-F-51079A, “Filter Medium, Fire-Resistant, High-Efficiency.”

N. UL-586-1977, “High-Efficiency Air Filtration Units.”

O. NE F3-41T, “In-Place Testing of HEPA Filter Systems by the Single-Particle, Particle-Size Spectrometer Method,” USDOE, December 1981.

P. NE F3-42, “Operating Policy of DOE Filter Test Program,” USDOE, October 1988.

Q. NE F3-45, “Specifications for HEPA Filters Used by DOE Contractors,” USDOE, October 1988.

4.2.4 Supplementary Information

A. NUREG/CR-4225, “Summary of Efficiency Testing of Standard and High-Capacity Particulate Air Filters Subjected to Simulated Tornado Depressurization and Explosive Shock Waves,” Smith, P.R. and Gregory, W.S., Los Alamos National Laboratory, April 1985.

B. NUREG/CR-1599, “Iodine, Krypton and Xenon Retention Efficiencies of Silver-Impregnated Silica Gel Media with Different Silver Loadings and Under Different Test Conditions,” Motes, B.G. et al., Idaho National Engineering Laboratory, May 1983.

C. NUREG/CR-2565, “Structural Performance of HEPA Filters Under Simulated Tornado Conditions,” Horak, H.L. and Smith, P.R., Los Alamos National Laboratory, May 1982.

D. IE Information Notice No. 85-31, “Buildup of Enriched Uranium in Ventilation Ducts and Associated Effluent Treatment Systems,” USNRC.

E. ICP-1157, “Removal of Particulate Solids from the Off-Gas of the WCF and NWCF” (Waste Calcining Facility and New Waste Calcining Facility), Schindler, R.E., Idaho National Engineering Laboratory, June 1978.

F. LA-6546, “Performance of Multiple HEPA Filters Against Plutonium Aerosols,” Gonzales, M. et al., Los Alamos National Laboratory, November 1976.

G. ERDA 76-21, “Nuclear Air Cleaning Handbook, Burchsted, C.A. et al., Oak Ridge National Laboratory, March 31, 1976.

H. MSAR 71-45, “Entrained Moisture Separators for Fine (1-10) Water-Air-Steam Service: Their Performance, Development and Status,” Griwatz, G.H., Friel, J.V., and Bicehouse, J.L., Mine Safety Appliances Research Corporation, 1971.

4.3 NUCLEAR CRITICALITY SAFETY

General criteria for nuclear criticality safety are identified in this section.

4.3.1 Code of Federal Regulations

A. 10 CFR 60.131, “General Design Criteria for the Geologic Repository Operations Area.”

B. 10 CFR 70.24, “Criticality Accident Requirements.”

C. 10 CFR 72.124, “Criteria for Nuclear Criticality Safety.”

4.3.2 Regulatory Guides

A. Regulatory Guide 3.1, “Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material.”

B. Regulatory Guide 3.4, “Nuclear Criticality Safety in Operations With Fissionable Materials at Fuels and Materials Facilities.”

C. Regulatory Guide 3.43, “Nuclear Criticality Safety in the Storage of Fissile Materials.”

D. Regulatory Guide 3.45, “Nuclear Criticality Safety for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials.”

E. Regulatory Guide 3.47, "Nuclear Criticality Control and Safety of Homogeneous Plutonium-Uranium Fuel Mixtures Outside Reactors."

F. Regulatory Guide 3.58, "Criticality Safety for Handling, Storing, and Transporting LWR Fuel at Fuels and Materials Facilities."

G. Regulatory Guide 8.12, "Criticality Accident Alarm System."

4.3.3 Codes and Standards

A. ANSI/ANS 8.1-1983 (R1988), "Nuclear Criticality Safety in Operations With Fissionable Materials Outside Reactors."

B. ANSI/ANS 8.3-1986, "Criticality Accident Alarm System."

C. ANSI/ANS 8.5-1986, "Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material."

D. ANSI/ANS 8.6-1983 (R1988), "Safety in Conducting Subcritical Neutron-Multiplication Measurements In Situ."

E. ANSI/ANS 8.7-1975 (R1987), "Guide for Nuclear Criticality Safety in the Storage of Fissile Materials."

F. ANSI/ANS 8.9-1987, "Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Material."

G. ANSI/ANS 8.10-1983 (R1988), "Criteria for Nuclear Criticality Safety Controls in Operations With Shielding and Confinement."

H. ANSI/ANS 8.12-1978, "Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors." (This standard was revised and issued as ANSI/ANS 8.12-1987, "Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors.")

I. ANSI/ANS 8.15-1981 (R1987), "Nuclear Criticality Control of Special Actinide Elements."

J. ANSI/ANS 8.17-1984 (R1989), "Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors."

K. ANSI/ANS 8.19-1984 (R1989), "Administrative Practices for Nuclear Criticality Safety."

L. ANSI N13.3-1969 (R1982), "Dosimetry for Criticality Accidents."

4.3.4 Supplementary Information

A. DOE/TIC-4633, "Nuclear Criticality Safety Training: Guidelines for DOE Contractors," Crowell, M.R., Oak Ridge National Laboratory, September 1983.

B. TID-26286, "Nuclear Criticality Safety," USAEC, 1974.

C. TID-7028, "Critical Dimensions of Systems Containing U-235, Pu-239, and U-233," Paxton, H.C. et al., USAEC, June 1964.

D. NUREG/CR-3448, "Uranium Holdup Modeling," Picard, R.R. and Marshall, R.S., Los Alamos National Laboratory, January 1984.

E. NUREG/CR-2517, "Effect of Radiolytic Gas on Nuclear Excursions in Aqueous Solutions," Forehand, H.M., University of Arizona, January 1982.

F. NUREG/CR-2127, "Improved Criticality Search Techniques for Low- and High-Enriched Systems," Lorek, M.J., Oak Ridge National Laboratory, August 1981.

G. NUREG/CR-1616, "The Effect of Reflector Location on Array Criticality," Oak Ridge National Laboratory, December 1980.

H. NUREG/CR-1615, "Solid Angle and Surface Density as Criticality Parameters," Oak Ridge National Laboratory, October 1980.

I. NUREG/CR-0095, "Nuclear Safety Guide, TID-7016," Rev. 2, USDOE, 1978.

J. ARH-600, "Criticality Handbook" (3 volumes), Carter, R.D. et al., Atlantic Richfield Hanford Company, June 28, 1968.

K. DP-104, "Critical and Safe Masses and Dimensions of Lattices of U and UO_2 Rods in Water," Clark, H.K., Savannah River Laboratory, February 1966.

L. HW-81460, "Technical Criteria for the Prevention of Criticality," Frank, W.S., U.S. Atomic Energy Commission, Hanford Atomic Products Operation, April 8, 1964.

M. HW-68929, "Nuclear Safety in Chemical and Metallurgical Processing of Plutonium," Clayton, E.D., U.S. Atomic Energy Commission, Hanford Atomic Products Operation, April 1961.

N. LA-3366, "Criticality Control in Operations With Fissile Materials," Paxton, H.C., Los Alamos Scientific Laboratory, November 1972.

O. ORNL/TM-6458, "Criticality Analysis of Aggregations of Actinides from Commercial Nuclear Waste in Geological Storage," Allen, E.J., Oak Ridge National Laboratory, August 1978.

P. TREE-1277, "Selection of a Criticality Monitoring Technique for a Transuranic Waste Incinerator," Nieschmidt, E.B. and Vegors, S.H., EG&G, Idaho, July 1978.

Q. NRC Information Notice No. 90-63, "Management Attention to the Establishment and Maintenance of a Nuclear Criticality Safety Program," USNRC.

R. NRC Information Notice No. 89-24, "Nuclear Criticality Safety," USNRC.

S. Information Notice No. 82-24, "Nuclear Criticality Safety, " USNRC.

4.4 COOLING WATER SYSTEMS

Criteria for safety-related cooling water systems are identified in this section.

4.4.1 Code of Federal Regulations

A. 10 CFR 60.131, "General Design Criteria for the Geologic Repository Operations Area."

B. 10 CFR 72.122, "Overall Requirements."

C. 10 CFR 72.128, "Criteria for Spent Fuel, High-Level Radioactive Waste and Other Radioactive Waste Storage and Handling."

4.4.2 Regulatory Guides

A. Regulatory Guide 3.31, "Emergency Water Supply Systems for Fuel Reprocessing Plants."

B. Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation (Water-Basin Type)."

C. Regulatory Guide 3.54, “Spent Fuel Heat Generation in an Independent Spent Fuel Storage Installation.”

4.4.3 Codes and Standards

A. ANSI/ANS 57.7-1988, “Design Criteria for an Independent Spent Fuel Storage Installation (Water-Basin Type).”

B. ANSI/ASME B31.1-1989, “Power Piping.”

C. ANSI/AWWA D120-1984, “Thermosetting Fiberglass-Reinforced Plastic Tanks.”

D. ANSI/ASME OM-1987, “Operation and Maintenance of Nuclear Power Plants,” Part 2 - “Requirements for Performance Testing of Nuclear Power Plant Closed Cooling Water Systems.”

E. Appropriate Codes and Standards listed in Section 3.3.3.

4.4.4 Supplementary Information

A. Background Information.

1. LA-8230-MS, “Heat Pipe Cooling System for Underground Radioactive Waste Storage Tanks,” Cooper, K.C. et al., Los Alamos National Laboratory, February 1980.

2. HEDL-TME-78-37, “Maximum Allowable Temperature for Storage of Spent Nuclear Reactor Fuel, an Interim Report,” Blackburn, L.D., et al., Hanford Engineering Development Laboratory, May 1978.

3. Generic Letter 89-13, “Service Water System Problems Affecting Safety-Related Equipment,” USNRC, July 1989.

4.5 PROCESS SYSTEMS

Criteria for safety-related process systems or portions of process systems are identified in this section.

4.5.1 Code of Federal Regulations

A. 10 CFR 60.135, “Criteria for the Waste Package and its Components.”

B. 10 CFR 61.55, “Waste Classification.”

C. 10 CFR 61.56, “Waste Characteristics.”

D. 10 CFR 61.58 "Waste Classification and Characteristics."

E. 10 CFR 70.58, "Fundamental Nuclear Material Controls."

F. 10 CFR 72.122, "Overall Requirements."

G. 10 CFR 72.128, "Criteria for Spent Fuel, High-Level Radioactive Waste, and Other Radioactive Waste Storage and Handling."

4.5.2 Regulatory Guides

A. Regulatory Guide 3.7, "Monitoring of Combustible Gases and Vapors in Plutonium Processing and Fuel Fabrication Plants."

B. Regulatory Guide 3.10, "Liquid Waste Treatment System Design Guide for Plutonium Processing and Fuel Fabrication Plants."

C. Regulatory Guide 3.20, "Process Offgas Systems for Fuel Reprocessing Plants."

D. Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation (Water-Basin Type)."

E. Regulatory Guide 3.53, "Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Facility."

F. Regulatory Guide 3.60, "Design of an Independent Spent Fuel Storage Installation (Dry Storage Type)."

G. Regulatory Guide 5.8, "Design Considerations for Minimizing Residual Holdup of Special Nuclear Material in Drying and Fluidized Bed Operations," Rev. 1.

H. Regulatory Guide 5.25, "Design Considerations for Minimizing Residual Holdup of Special Nuclear Material in Equipment for Wet Process Operations."

I. Regulatory Guide 5.42, "Design Considerations for Minimizing Residual Holdup of Special Nuclear Material in Equipment for Dry Process Operations."

4.5.3 Codes and Standards

A. ANSI/ANS 57.7-1981, “Design Criteria for an Independent Spent Fuel Storage Installation (Water-Basin Type) .“ (This standard was revised and issued as ANSI/ANS 57.7-1988, “Design Criteria for an Independent Spent Fuel Storage Installation (Water-Basin Type).”)

B. ANSI/ASME OM-1987, “Operation and Maintenance of Nuclear Power Plants,” Part 3 - “Requirements for Preoperational and Initial Startup Vibration Testing of Nuclear Power Plant Piping Systems.”

C. ANSI/ANS 57.9-1984, “Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type).”

D. ANSI/ASTM C1010-1983 (R1988), “Standard Guide for Acceptance, Checkout, and Pre-Operational Testing of a Nuclear Fuels Reprocessing Facility.”

E. ANSI/ASTM C1062-1986, “Standard Guide for Design, Fabrication, and Installation of Nuclear Fuel Dissolution Facilities.”

F. ANSI/ASTM C1068-1986, “Standard Guide for Qualification of Measurement Methods by a Laboratory Within the Nuclear Industry.”

G. ANSI/ASTM C1112-1988, “Standard Guide for Application of Radiation Monitors to the Control and Physical Security of Special Nuclear Material.”

4.5.4 Supplementary Information

A. TID-10620, “Report on Glove Boxes and Containment Enclosures,” USAEC.

B. NUREG/CR-4215, “Technical Factors Affecting Low-Level Waste Form Acceptance Criteria,” Mackenzie, D.R., et al., Brookhaven National Laboratory, May 1985.

C. NUREG/CR-4056, “Particulate and Gas Release from Light Water Reactor (LWR) Fuel Rods Stored in Inert and Dry Atmospheres,” Oslen, C.S., EG&G, Inc., January 1985.

D. NUREG/CR-3798, “Characterization of Cement and Bitumen Waste Forms Containing Simulated Low-Level Waste Incinerator Ash,” Westsik, J.H., Battelle Pacific Northwest Laboratories, August 1984.

E. NUREG/CR-3714, "On the Development of Environmental Radiation Standards for Geologic Disposal of High-Level Radioactive Wastes," Locher, D.C., July l984.

F. NUREG/CR-3678, "Estimation Methods for Process Holdup of Special Nuclear Materials," Pillay, K.S., et al., Los Alamos National Laboratory, July 1984.

G. NUREG/CR-3658, "Considerations Relevant to the Dry Storage of LWR Fuel Rods Containing Water," Woodley, R.E., Hanford Engineering Development Laboratory, June 1984.

H. NUREG/CR-3489, "Assessment of Retrieval Alternatives for the Geologic Disposal of Nuclear Waste," Kendorski, F. et al., Engineers International, Inc., May 1984.

I. NUREG/CR-2614, "Identification of Characteristics which Influence Repository Design - Tuff," Rawlings, G. et al., Golder Associates, April 1984.

J. NUREG/CR-2613, "Identification of Characteristics which Influence Repository Design - Domal Salt," Rawlings, G. et al., Golder Associates, April 1984.

K. NRC Information Notice No. 91-44, "Improper Control of Chemicals in Nuclear Fuel Fabrication," USNRC.

L. NRC Information Notice No. 89-78, "Failure of Packing Nuts on One-Inch Uranium Hexafluoride Cylinder Valves," USNRC.

M. NRC Information Notice No. 89-24, "Nuclear Criticality Safety," USNRC.

N. NRC Information Notice No. 87-48, "Gaps in Neutron-Absorbing Material in High-Density Spent Fuel Storage Racks," USNRC.

O. NRC Information Notice No. 87-26, "Cracks in Stiffening Rings on 48-Inch-Diameter UF_6 Cylinders," USNRC.

CHAPTER 5

INSTRUMENTATION AND CONTROLS

This chapter identifies criteria for safety class and nonsafety class instrumentation and control (I&C) systems, and safety class protection systems.

5.1 SAFETY CLASS INSTRUMENTATION, CONTROLS, AND PROTECTION SYSTEMS

This section identifies federal regulations, criteria, and regulatory guidelines considered relevant to the design and maintenance of safety class instrumentation, controls, and protection systems in nuclear facilities.

5.1.1 Code of Federal Regulations

A. 10 CFR 50.36, "Technical Specifications."

B. 10 CFR 50.55a, "Codes and Standards."

C. 10 CFR 60.131, "General Design Criteria for the Geologic Repository Operations Area."

D. 10 CFR 60.132, "Additional Design Criteria for Surface Facilities in the Geologic Repository Operations Area."

E. 10 CFR 70.24, "Criticality Accident Requirements."

F. 10 CFR 72.24, "Contents of Application; Technical Specifications."

G. 10 CFR 72.120, "General Considerations."

H. 10 CFR 72.122, "Overall Requirements."

I. 10 CFR 72.124, "Criteria for Nuclear Criticality Safety."

J. 10 CFR 72.126, "Criteria for Radiological Protection."

5.1.2 USNRC Regulatory Guides, SRP Branch Technical Positions and Appendices

A. Regulatory Guide 1.12, "Instrumentation for Earthquakes."

B. Regulatory Guide 1.68.3, “Preoperational Testing of Instrument and Control Air Systems.”

C. Regulatory Guide 1.75, “Physical Independence of Electric Systems.”

D. Regulatory Guide 1.105, “Instrument Setpoints for Safety-Related Systems.”

E. Regulatory Guide 3.6, “Content of Technical Specifications for Fuel Reprocessing Plants.”

F. Regulatory Guide 3.7, “Monitoring of Combustible Gases and Vapors in Plutonium Processing and Fuel Fabrication Plants.”

G. Regulatory Guide 3.10, “Liquid Waste Treatment System Design Guide for Plutonium Processing and Fuel Fabrication Plants.”

H. Regulatory Guide 3.17, “Earthquake Instrumentation for Fuel Reprocessing Plants.”

I. Regulatory Guide 3.20, “Process Offgas Systems for Fuel Reprocessing Plants.”

J. Regulatory Guide 3.22, “Periodic Testing of Fuel Reprocessing Plant Protection System Actuation Functions.”

K. Regulatory Guide 3.49, “Design of an Independent Spent Fuel Storage Installation (Water-Basin Type).”

L. Regulatory Guide 3.53, “Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation.”

M. Regulatory Guide 3.60, “Design of an Independent Spent Fuel Storage Installation (Dry Storage).”

N. Regulatory Guide 8.12, “Criticality Accident Alarm Systems.”

5.1.3 Codes and Standards

A. ANSI/ANS 57.7-1988, “Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type).”

B. ANSI/ANS 57.9-1984, “Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type).”

C. ANSI/ANS 59.3-1984, "Safety Criteria for Control Air Systems."

D. ANSI/IEEE 336-1985, "IEEE Standard for Installation, Inspection, and Testing Requirements for Power, Instrumentation and Control Equipment at Nuclear Facilities."

E. ANSI/IEEE 338-1987, "IEEE Standard Criteria for the Periodic Testing of Nuclear Power Generating Station Class lE Power and Protection Systems."

F. ANSI/IEEE 379-1988, "IEEE Standard for Application of the Single Failure Criterion to Nuclear Power Generating Station Class lE Systems."

G. ANSI/IEEE 384-1981, "IEEE Standard Criteria for Independence of Class lE Equipment and Circuits."

H. ANSI/IEEE 603-1980, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations."

I. ANSI/ISA-S67.02-1980, "Nuclear Safety-Related Instrument Sensing Line Piping and Tubing Standards for Use in Nuclear Power Plants."

J. ANSI/ISA-S67.04-1988, "Setpoints for Nuclear Safety-Related Instrumentation."

5.1.4 Supplementary Information

A. NUREG/CR-5519 , "Aging of Control and Service Air Compressors and Dryers Used in Nuclear Power Plants," Moyers, J.C., Oak Ridge National Laboratory, July 1990.

B. NUREG/CR-4992, "Aging and Service Wear of Multistage Switches Used in Safety Systems of Nuclear Power Plants, Roberts, G.C. et al., Oak Ridge National Laboratory, September 1987.

C. NUREG/CR-4819, "Aging and Service Wear of Solenoid-Operated Valves Used in Safety Systems of Nuclear Power Plants," Bacanskas, V.P. et al., Oak Ridge National Laboratory, March 1987.

D. NUREG/CR-4715, "An Aging Assessment of Relays and Circuit Breakers and System Interactions," Franklin Research Center for Brookhaven National Laboratory, June 1987.

E. NUREG/CR-4461, "Human Factors in Annunciator Systems," Roscoe, B.J. and Weston, L.M., Battelle Pacific Northwest Laboratories, May 1986.

F. NUREG/CR-4227, “Human Engineering Guidelines for the Evaluation and Assessment of Visual Display Units,” Gilmore, W.E., EG&G Idaho, Inc., July 1985.

G. NUREG/CR-3808, “Aging-Seismic Correlation Study on Class lE Equipment,” NUTECH Engineers for Sandia National Laboratory, September 1984.

H. NUREG/CR-3453, “Electronic Isolators Used in Safety Systems of U.S. Nuclear Power Plants,” Nielsen, J.R., EG&G Idaho, Inc., March 1986.

I. NUREG/CR-2499, “Review of Emergency Instrumentation and Analysis Methods at NMSS-Licensed Sites,” Herrington, W.N. et al., Battelle Pacific Northwest Laboratories, August 1984.

J. Generic Letter 88-14, “Instrument Air Supply System Problems Affecting Safety-Related Equipment,” USNRC, August 1988.

5.2 NONSAFETY CLASS INSTRUMENTATION AND CONTROL SYSTEMS

This section lists regulatory design criteria and guidelines considered relevant to the design and maintenance of nonsafety class instrumentation and control (I&C) systems in nuclear facilities. Such facility I&C systems typically include process control systems and data acquisition and display systems not part of facility safety class I&C systems or protection systems. Where the operation or functional condition of a nonsafety class I&C system and/or component interfaces with or otherwise impacts the safety function of a safety class I&C system and/or component, the criteria identified in 5.1 must also be considered for design and maintenance activities.

5.2.1 Code of Federal Regulations

A. 10 CFR 60.131, “General Design Criteria for Geological Repository Operations Area.”

B. 10 CFR 70.23, “Requirements for the Approval of Applications.”

5.2.2 USNRC Regulatory Guides, SRP Branch Technical Positions and Appendices

A. Regulatory Guide 1.12, “Instrumentation for Earthquakes.”

B. Regulatory Guide 1.23, “Onsite Meteorological Programs.”

C. Regulatory Guide 1.75, “Physical Independence of Electric Systems.”

D. Regulatory Guide 3.12, “General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants.”

E. Regulatory Guide 3.16, “General Fire Protection Guide for Plutonium and Fuel Fabrication Plants.”

F. Regulatory Guide 3.32, “General Design Guide for Ventilation Systems for Fuel Reprocessing Plants.”

G. Regulatory Guide 3.38, “General Fire Protection Guide for Fuel Reprocessing Plants.”

5.2.3 Codes and Standards

A. “Standards and Practices for Instrumentation,” Instrument Society of America Publication, Tenth Edition, 1989, Volumes 1 and 2.

B. ANSI C2-1990, “National Electric Safety Code.”

C. ANSI/IEEE 384-1981, “IEEE Standard Criteria for Independence of Class lE Equipment and Circuits.”

D. ANSI/NEMA ICS-1-1988, “General Standards for Industrial Control and Systems.”

E. ANSI/NFPA 70-1990, “National Electric Code.”

F. ANSI/UL-508-1988, “Industrial Control Equipment.”

5.2.4 Supplementary Information

None.

CHAPTER 6

ELECTRIC POWER, UTILITY SERVICES, AND FIRE PROTECTION

This chapter identifies criteria for electric power, utilities such as water and sewer service, and fire protection.

6.1 ELECTRIC POWER

Criteria for providing normal power and emergency power for safety-related systems are-identified in this section.

6.1.1 Code of Federal Regulations

A. 10 CFR 50.55a, "Codes and Standards."

B. 10 CFR 60.131, "General Design Criteria for the Geologic Repository Operations Area."

C. 10 CFR 72.122, "Overall Requirements."

6.1.2 Regulatory Guides

A. Regulatory Guide 1.108, "Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants."

B. Regulatory Guide 3.14, "Seismic Design Classification for Plutonium Processing and Fuel Fabrication Plants."

C. Regulatory Guide 3.16, "General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants."

D. Regulatory Guide 3.38, "General Fire Protection Guide for Fuel Reprocessing Plants."

6.1.3 Codes and Standards

A. Safety Class Electric Power Systems.

1. ANSI/IEEE 308-1980, "IEEE Standard for Class lE Power Systems for Nuclear Power Generating Stations."

2. ANSI/IEEE 336-1985, "IEEE Standard for Installation, Inspection, and Testing Requirements for Power Instrumentation and Control Equipment at Nuclear Facilities."

3. ANSI/IEEE 338-1987, “IEEE Standard Criteria for the Periodic Testing of Nuclear Power Generating Station Class lE Power and Protection Systems.”

4. ANSI/IEEE 379-1988, “IEEE Standard for the Application of the Single Failure Criterion to Nuclear Power Generating Station Safety Systems.”

5. ANSI/IEEE 384-1981, “IEEE Standard Criteria for Independence of Class lE Equipment and Circuits.”

6. ANSI/IEEE 420-1982, “IEEE Standard for the Design and Qualification of Class lE Control Boards, Panels, and Racks Used in Nuclear Power Generating Stations.

7. ANSI/IEEE 450-1987, “IEEE Recommended Practice for Maintenance, Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Substations.”

8. ANSI/IEEE 484-1987, “IEEE Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations.

9. ANSI/IEEE 690-1984, “IEEE Standard for Design and Installation of Cable Systems for Class lE Circuits in Nuclear Power Generating Stations.”

10. ANSI/IEEE 741-1986, “IEEE Standard Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations.”

11. ANSI/IEEE 749-1983, “IEEE Standard for Periodic Testing of Diesel-Generator Units Applied as Standby Power Supplies at Nuclear Power Generating Stations.”

12. ANSI/IEEE 946-1985, “IEEE Standard for the Design of Safety-Related DC Auxiliary Power Systems for Nuclear Power Generating Stations.”

B. Nonsafety Class Electric Power Systems.

1. ANSI C2-1990, “National Electric Safety Code.”

2. ANSI/IEEE 141-1986, “IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (Red Book).”

3. ANSI/IEEE 142-1982, “IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book).”

4. ANSI/IEEE 241-1983, “IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book).”

5. ANSI/IEEE 242-1986, “IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).”

6. ANSI/IEEE 399-1980, “IEEE Recommended Practice for Power System Analysis (Brown Book).”

7. ANSI/IEEE 446-1987, “IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book).”

8. ANSI/IEEE 493-1980, “IEEE Recommended Practice for Design of Reliable Industrial and Commercial Power Systems (Gold Book).”

9. ANSI/NFPA 70-1990, “National Electric Code.”

6.1.4 Supplementary Information

A. Safety Class Electric Power Systems.

1. NUREG/CR-5051, “Detecting and Mitigating Battery Charger and Inverter Aging,” Gunther, W.E., Lewis, R., and Subudhi, M., Brookhaven National Laboratory, August 1988.

2. NUREG/CR-4659, “Seismic Fragility of Nuclear Power Plant Components (Phase II),” Brookhaven National Laboratory, February 1990.

3. NUREG/CR-4564, “Operating Experience and Aging - Seismic Assessment of Battery Chargers and Inverters,” Gunther, W.E., Subudhi, M., and Taylor, J.H., Brookhaven National Laboratory, June 1986.

4. NUREG/CR-4457 , “Aging of Class lE Batteries in Safety Systems of Nuclear Power Plants,” Edson, J.L. and Hardin, J.E., EG&G Idaho Inc., July 1987.

5. NUREG/CR-4156, “Operating Experience and Aging - Seismic Assessment of Electric Motors,” Subudhi, M., Burns, E.L., and Taylor, J.H., Brookhaven National Laboratory, June 1985.

6. NUREG/CR-4099, “Age-Related Degradation of Naturally-Aged Class 1E Battery Cells,” Bonzon, L.L., Janis, W.J., and Bellamy, G., Sandia National Laboratory, April 1986.

7. NUREG/CR-3808, “Aging-Seismic Correlation Study on Class lE Equipment,” NUTECH Engineers for Sandia National Laboratory, September 1984.

8. NUREG/CR-2927, “Nuclear Power Plant Electric Cable Damageability Experiments,” Sandia National Laboratories, November 1982.

9. NRC Information Notice No. 89-17, “Contamination and Degradation of Safety-Related Battery Cells,” USNRC.

B. Nonsafety Class Electric Power Systems.

None.

6.2 UTILITY SERVICES

Criteria for nonsafety-related services such as ventilation, compressed air, water and sewage systems are identified in this section.

6.2.1 Code of Federal Regulations

A. 10 CFR 60.131, “General Design Criteria for the Geologic Repository Operations Area.”

B. 10 CFR 72.122, “Overall Requirements.”

6.2.2 Regulatory Guides

A. Regulatory Guide 3.14, “Seismic Design Classification for Plutonium Processing and Fuel Fabrication Plants.”

B. Regulatory Guide 3.16, “General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants.”

C. Regulatory Guide 3.38, “General Fire Protection Guide for Fuel Reprocessing Plants.”

6.2.3 Codes and Standards

None.

6.2.4 Supplementary Information

None.

6.3 FIRE PROTECTION

Criteria for facility design features and characteristics that provide for fire protection as well as fire detection, alarm, and extinguishing systems are identified in this section.

6.3.1 Code of Federal Regulations

A. 10 CFR 60.131, "General Design Criteria for the Geologic Repository Operations Area.

B. 10 CFR 70.23, "Requirements for Approval of Application."

C. 10 CFR 72.122, "Overall Requirements."

6.3.2 Regulatory Guides

A. Regulatory Guide 3.7, "Monitoring of Combustible Gases and Vapors in Plutonium Processing and Fuel Fabrication Plants."

B. Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants.

C. Regulatory Guide 3.16, "General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants."

D. Regulatory Guide 3.18, "Confinement Barriers and Systems for Fuel Reprocessing Plants."

E. Regulatory Guide 3.31, "Emergency Water Supply Systems for Fuel Reprocessing Plants."

F. Regulatory Guide 3.32, "General Design Guide for Ventilation Systems for Fuel Reprocessing Plants."

G. Regulatory Guide 3.38, "General Fire Protection Guide for Fuel Reprocessing Plants."

6.3.3 Codes and Standards

A. NFPA, "National Fire Codes of the National Fire Protection Association."

B. ANSI Z49.1-1988, "Safety in Welding and Cutting."

C. ACI 216R-1981 (R1987), "Guide to Determining the Fire Endurance of Concrete Elements."

D. ACI Special Publication SP-80, “Fire Safety of Concrete Structures.”

E. ACI Special Publication SP-92, “Evaluation and Repair of Fire Damage to Concrete.”

F. ASTM Fire Test Standards, 2nd Edition.

G. ASTM Special Technical Publication STP-614, “Fire Standards and Safety.”

H. ASTM Special Technical Publication STP-685, “Design of Buildings for Fire Safety.”

I. ASTM Special Technical Publication STP 762, “Fire Risk Assessment.”

J. ASTM Special Technical Publication STP 816, “Behavior of Polymeric Materials in Fire.”

K. ASTM Special Technical Publication STP 882, “Fire Safety: Science and Engineering.”

L. ASTM Special Technical Publication STP 983, “Mathematical Modeling of Fire.”

6.3.4 Supplementary Information

A. TID-10620, “Report on Glove Boxes and Containment Enclosures,” USAEC.

B. TID-24236, “Glove Box Fire Safety,” USAEC.

C. NUREG/CR-4264 , “Investigation on High-Efficiency Particulate Air Filter Plugging by Combustion Aerosols,” Fenton, D.L. and Gregory, W.S., Los Alamos National Laboratory, May 1985.

D. NUREG/CR-2409, “Requirements for Establishing Detector Siting Criteria in Fires Involving Electrical Materials,” Boccio, J.L., Sandia National Laboratories, September 1982.

E. NUREG/CR-2431, “Burn Mode Analysis of Horizontal Cable Tray Fires,” Schmidt, W.H., Sandia National Laboratories, April 1982.

F. NUREG/CR-2321, “Investigation of Fire Stop Test Parameters - Final Report,” Przybyla, L., Sandia National Laboratories, November 1981.

G. NUREG/CR-1798, “Acceptance and Verification of Early Warning Fire Detection Systems,” Boccio, J.L. et al., Brookhaven National Laboratory, March 1981.

H. NUREG/CR-1552, “Development and Verification of Fire Tests for Cable Systems and System Components,” Underwriters Laboratories, September 1980.

I. IE Information Notice 87-14, “Actuation of Fire Suppression System Causing Inoperability of Safety-Related Ventilation Equipment,” USNRC.

J. NRC Information Notice 88-56, “Potential Problems With Silicone Foam Fire Barrier Penetration Seals,” USNRC.

K. NRC Information Notice 89-52, “Potential Fire Damper Operational Problems,” USNRC.

CHAPTER 7

RADIOACTIVE WASTE MANAGEMENT

This chapter identifies criteria for the control, collection, handling, processing, storage, and disposal of liquid, gaseous, and solid wastes that may contain radioactive materials, and the instrumentation used to monitor the release of radioactive materials. Also included are EPA regulations for hazardous and radioactive waste management pursuant to the Resource Conservation Recovery Act (RCRA) of 1976.

7.1 CODE OF FEDERAL REGULATIONS

A. 10 CFR 60.132, "Additional Design Criteria for Surface Facilities in the Geologic Repository Operations Area."

B. 10 CFR 70.59, "Effluent Monitoring Reporting Requirements."

C. 10 CFR 72.104, "Criteria for Radioactive Materials in Effluents and Direct Radiation from an ISFSI or MRS."

D. 10 CFR 72.128, "Criteria for Spent Fuel, High-Level Radioactive Waste, and Other Radioactive Waste Storage and Handling."

E. 40 CFR 260, "Hazardous Waste Management System."

F. 40 CFR 261, "Identification and Listing of Hazardous Waste."

G. 40 CFR 262, "Standards Applicable to Generators of Hazardous Waste."

H. 40 CFR 263, "Standards Applicable to Transporters of Hazardous Waste."

I. 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities."

J. 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities."

7.2 REGULATORY GUIDES

A. Regulatory Guide 1.21, “Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants.”

B. Regulatory Guide 1.143, “Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants.”

C. Regulatory Guide 3.10, “Liquid Waste Treatment Design Guide for Plutonium Processing and Fuel Fabrication Plants.”

D. Regulatory Guide 3.13, “Guide for Acceptable Waste Storage Methods at UF_6 Production Plants.”

E. Regulatory Guide 3.20, “Process Offgas Systems for Fuel Reprocessing Plants.”

F. Regulatory Guide 3.49, “Design of an Independent Spent Fuel Storage Installation (Water-Basin Type).”

G. Regulatory Guide 3.60, “Design of an Independent Spent Fuel Storage Installation (Dry Storage).”

7.3 CODES AND STANDARDS

A. ANSI/ANS 40.35-1984, “Volume Reduction of Low-Level Waste.”

B. ANSI/ANS 57.7-1988, “Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type).”

C. ANSI/ANS 57.9-1984, “Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type).”

D. ANSI/ASME N510-1980, “Testing of Nuclear Air Cleaning Systems.”

E. ANSI N42.18-1980 (R1985), “Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents.”

F. ANSI N303-1978, “Guide for Control of Gasborne Radioactive Materials at Nuclear Fuel Reprocessing Facilities.”

G. ANSI N305-1975 (R1981), “Design Objectives for Highly Radioactive Solid Material Handling and Storage Facilities in a Reprocessing Plant.”

7.4 SUPPLEMENTARY INFORMATION

A. NUREG/CR-3973, "Alternative Containers for Low-Level Wastes Containing Large Amounts of Tritium," Gause, E.P. et al., Brookhaven National Laboratory, September 1985.

B. NUREG/CR-3087, "Incineration of a Typical LWR Combustible Waste and Analysis of the Resulting Ash," Treat, R.L. et al., Battelle Pacific Northwest Laboratories, May 1983.

C. NUREG/CR-2731, "An Evaluation of the Safety Aspects of the Design and Operation of Temporary Mobile Radioactive Waste Solidification Systems," McDonald, F.N. and McLure, L.W., Exxon Nuclear Co., August 1982.

D. NUREG/CR-2721, "Scoping Study of the Alternatives for Managing Waste Containing Chelating Decontamination Chemicals," Brookhaven National Laboratory, February 1984.

E. NUREG/CR-2206, "Volume Reduction Techniques in Low-Level Radioactive Waste Management," Tigilio, G., Teknekron, Inc., September 1981.

F. PNL-3109, "Spray Calcination/In-Can Melting: Effluent Characterization and Treatment," Hansom, M.S., Battelle Pacific Northwest Laboratories, March 1980.

G. PNL-3181, "Characterization of Gaseous and Particulate Effluents from the Nuclear Waste Vitrification Project," Goles, R.W. et al., Battelle Pacific Northwest Laboratories, October 1979.

H. PNL-2786, "Processing of Waste Solutions from Electrochemical Decontamination," Charlot, L.A., et al., Battelle Pacific Northwest Laboratories, September 1979.

I. MLM-2646, "Mound Cyclone Incinerator Preliminary Design Criteria - Batch Mode Operation," Klinger, L.M., et al., Mound Facility, September 1979.

J. DP-1521, "Design of an Experimental Incinerator for Alpha Waste," Warren, J.H., E.I. duPont Co., Savannah River Laboratory, August 1979.

K. Y/DA-8220, "Denitrification of Industrial Strength Nitrate Waste," Taylor, P.A., Oak Ridge Y-12 Plant, February 1979.

L. ICP-1177, "Vitrification of High-Level ICPP Calcined Wastes," Gombert, H.S. et al., Allied Chemical Corp., February 1979.

M. SAND-78-2270G, "Application of Inorganic Sorbent in Actinide Separation Process," Tallant, D.R., Sandia Laboratories, 1979.

N. MLM-2536 (OP), "Tritium Effluent Removal System," Lamberger, P.H. and Gibbs, G.E., Mound Facility, 1978.

O. UCRL-52404, "Determination of Acceptable Risk Criteria for Nuclear Waste Management," Cohen, J.J., Lawrence Livermore Laboratory, October 1977.

P. DP-MS-76-79, "Ion Exchange Decontamination of Alkaline Solutions of Nuclear Waste," Wiley, J.R., E.I. duPont Co., Savannah River Laboratory, 1977.

Q. HEDL-SA-856, "Technologies for Recovery of Transuranics and Immobilization of Non-High-Level Wastes," Richardson, G.L., Hanford Engineering Development Laboratory, June 1976.

R. RFP-2471, "Fluidized Bed Incineration of Radioactive Waste," Ziegler, D.L., Rocky Flats Plant, May 1976.

S. ARH-SA-239, "Glass Forms for Alpha Waste Management," Hobbick, C.W. and Mendel, J.E., Atlantic Richfield Hanford, July 1975.

T. ANL-7683, "Sand Bed Filtration of Aerosols: A Review of Published Information on Their Use in Industrial and Atomic Energy Facilities," Juvinall, R.A., Kessie, R.W., and Steindler, M.J., Argonne National Laboratory, June 1970.

U. IE Information Notice No. 87-03, "Segregation of Hazardous and Low-Level Radioactive Wastes," USNRC.

V. IE Information Notice No. 84-94, "Reconcentration of Radionuclides Involving Discharges into Sanitary Sewage Systems Permitted Under 10 CFR 20.303," USNRC.

CHAPTER 8

RADIATION PROTECTION

The criteria identified in this chapter are for the radiation protection of operating, construction, and maintenance personnel during normal and anticipated operational occurrences. The compilation includes criteria for facility equipment design and programs to minimize and monitor radiation exposure to meet the standards for protection against radiation of 10 CFR 20.

8.1 ASSURING THAT OCCUPATIONAL EXPOSURES ARE AS LOW AS REASONABLY ACHIEVABLE

8.1.1 Code of Federal Regulations

A. 10 CFR 19.12, "Instructions to Workers."

B. 10 CFR 20, "Standards for Protection Against Radiation."

C. 10 CFR 60.111, "Performance of the Geologic Repository Operations Area Through Permanent Closure."

D. 10 CFR 60.131, "General Design Criteria for the Geologic Repository Operations Area."

E. 10 CFR 61.12, "Specific Technical Information."

F. 10 CFR 61.41, "Protection of the General Population From Releases of Radioactivity."

G. 10 CFR 61.43, "Protection of Individuals During Operations."

H. 10 CFR 72.44, "License Conditions."

I. 10 CFR 72.104, "Criteria for Radioactive Materials in Effluents and Direct Radiation from an ISFSI or MRS."

J. 10 CFR 72.126, "Criteria for Radiological Protection."

8.1.2 Regulatory Guides

Note: Regulatory Guides listed in Chapter 1 (Subsection 1.3.2) all contain criteria for radiation protection.

A. Regulatory Guide 3.6, “Content of Technical Specifications for Fuel Reprocessing Plants.”

B. Regulatory Guide 8.1, “Radiation Symbol.”

C. Regulatory Guide 8.2, “Administrative Practices in Radiation Monitoring.”

D. Regulatory Guide 8.10, “Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as is Reasonably Achievable.”

E. Regulatory Guide 8.24, “Health Physics Surveys During Enriched Uranium Processing and Fuel Fabrication.”

8.1.3 Codes and Standards

A. ANSI N2.1-1989, “Radiation Symbol.”

B. ANSI N12.1-1989, “Fissile Material Symbol.”

C. ANSI N13.2-1969 (R1982), “Guide for Administrative Practices in Radiation Monitoring.”

D. ANSI N43.2-1988 (R1989), “Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment.”

E. ANSI N43.3-1989, “General Safety Standard for Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies Up to 10 MeV.”

8.1.4 Supplementary Information

A. NCRP Report No. 8 (NBS Handbook 50), “Control and Removal of Radioactive Contamination in Laboratories,” National Council on Radiation Protection and Measurements.

B. NCRP Report No. 38, “Protection Against Neutron Radiation, ” National Council on Radiation Protection and Measurements.

C. NCRP Report NO. 39, “Basic Radiation Protection Criteria,” National Council on Radiation Protection and Measurements.

D. NCRP Report No. 59, “Operational Radiation Safety Program,” National Council on Radiation Protection and Measurements.

E. NCRP Report No. 65, “Management of Persons Accidentally Contaminated with Radionuclides,” National Council on Radiation Protection and Measurements.

F. NCRP Report No. 71, "Operational Radiation Safety Training," National Council on Radiation Protection and Measurements.

G. NUREG-0041, "Manual of Respiratory Protection Against Airborne Radioactive Materials," USNRC, October 1976.

H. NUREG-0914, "Radiological Containment Handbook," U.S. Nuclear Regulatory Commission, October 1982.

I. NUREG-1127, "Radiation Protection Training at Uranium Hexafluoride and Fuel Fabrication Plants," Brodsky, A. et al., U.S. Nuclear Regulatory Commission, May 1985.

J. NUREG/CR-3343, "Recommended Radiation Protection Practices for Low-Level Waste Disposal Sites," Hadlock, D.E. et al., Battelle Pacific Northwest Laboratories, December 1983.

K. NUREG/CR-3125, "Current Practices for Maintaining Occupational Exposures ALARA at Low-Level Waste Disposal Sites," Hadlock, D.E. et al., Battelle Pacific Northwest Laboratories, December 1983.

L. NUREG/CR-2272 and CR-2958, "Expedient Methods of Respiratory Protection," Cooper, D.W. et al., Sandia National Laboratories, November 1981, and Harvard University, October 1983.

M. LA-6671-M, "A Guide to Industrial Respiratory Protection," Prichard, J.A., Los Alamos National Laboratory, March 1977.

N. IE Information Notice No. 83-73, "Radiation Exposure from Gloves Contaminated with Uranium Daughter Products," USNRC.

O. NRC Information Notice No. 90-33, "Sources of Unexpected Occupational Radiation Exposures at Spent Fuel Storage Pools," USNRC.

P. NRC Information Notice No. 90-47, "Unplanned Radiation Exposures to Personnel Extremities Due to Improper Handling of Potentially Highly Radioactive Sources," USNRC.

8.2 RADIATION PROTECTION DESIGN FEATURES

8.2.1 Code of Federal Regulations

A. 10 CFR 20.1, "Purpose."

B. 10 CFR 20.101, “Radiation Dose Standards for Individuals in Restricted Areas.”

C. 10 CFR 20.103, “Exposure of Individuals to Concentrations of Radioactive Materials in Air in Restricted Areas.”

D. 10 CFR 20.104, “Exposure of Minors.”

E. 10 CFR 20.203, “Caution Signs, Labels, Signals, and Controls.”

F. 10 CFR 20.207, “Storage and Control of Licensed Materials in Unrestricted Areas.”

G. 10 CFR 60.131, “General Design Criteria for the Geologic Repository Operations Area.”

H. 10 CFR 60.132, “Additional Design Criteria for Surface Facilities in the Geologic Repository Operations Area.”

I. 10 CFR 61.12, “Specific Technical Information.”

J. 10 CFR 70.24, “Criticality Accident Requirements.”

K. 10 CFR 72.122, “Overall Requirements.”

L. 10 CFR 72.124, “Criteria for Nuclear Criticality Safety.”

M. 10 CFR 72.126, “Criteria for Radiological Protection.”

8.2.2 Regulatory Guides

A. Regulatory Guide 3.9, “Concrete Radiation Shields.”

B. Regulatory Guide 8.5, “Criticality and Other Interior Evacuation Signals.”

C. Regulatory Guide 8.12, “Criticality Accident Alarm Systems.”

8.2.3 Codes and Standards

A. ANSI/ACI 349-85, “Code Requirements for Nuclear Safety-Related Concrete Structures.”

B. ANSI/ACI 349R-85, “Commentary on Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-85).”

C. ANSI/ANS 6.1.2-1989, "Neutron and Gamma-Ray Cross Sections for Nuclear Radiation Protection Calculations for Nuclear Power Plants."

D. ANSI/ANS 6.4-1985, "Guidelines on the Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants."

E. ANSI/ANS 6.4.2-1985, "Specification for Radiation Shielding Materials."

F. ANSI/ANS 8.3-1986, "Criticality Accident Alarm System."

G. ANSI N2.3-1979, "Immediate Evacuation Signal for Use in Industrial Applications."

8.2.4 Supplementary Information

A. ERDA 76-21, "Nuclear Air Cleaning Handbook," Burchsted, C.A., Kahn, J.E., and Fuller, A.B., Oak Ridge National Laboratory, March 31, 1976.

B. NCRP Report No. 49, "Structural Shielding Design and Evaluation for Medical Use of X-Rays and Gamma-Rays of Energies up to 10 MeV," National Council on Radiation Protection and Measurements.

C. Schaffer, N.M., Ed., "Reactor Shielding for Nuclear Engineers," USAEC, 1973.

D. BNWL-SA-3139, "The Effects of Radiation Levels from Plutonium on Fuel Fabrication Process Design," Faust, L.G., Smith, R.C., and Van Tuyl, H.H., Battelle Pacific Northwest Laboratories, 1970.

8.3 RADIATION AND PERSONNEL EXPOSURE MONITORING/DOSE ASSESSMENT

8.3.1 Code of Federal Regulations

A. 10 CFR 20.102, "Determination of Prior Dose."

B. 10 CFR 20.202, "Personnel Monitoring."

C. 10 CFR 61.12, "Specific Technical Information."

D. 10 CFR 61.13, "Technical Analyses."

E. 10 CFR 72.106, "Controlled Area of an ISFSI or MRS."

F. 10 CFR 72.124, “Criteria for Nuclear Criticality Safety.”

G. 10 CFR 72.126, “Criteria for Radiological Protection.”

8.3.2 Regulatory Guides

A. Regulatory Guide 4.16, “Monitoring and Reporting Radioactivity in Releases of Radioactive Material in Liquid and Gaseous Effluents of Nuclear Fuel Processing and Fabrication Plants and Uranium Hexafluoride Production Plants.”

B. Regulatory Guide 8.2, “Guide for Administrative Practices in Radiation Monitoring.”

C. Regulatory Guide 8.3, “Film Badge Performance Criteria.”

D. Regulatory Guide 8.4, “Direct Reading and Indirect Reading Pocket Dosimeters.”

E. Regulatory Guide 8.5, “Criticality and other Interior Evacuation Signals.”

F. Regulatory Guide 8.9, “Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program.”

G. Regulatory Guide 8.11, “Applications of Bioassay for Uranium.”

H. Regulatory Guide 8.12, “Criticality Accident Alarm Systems.”

I. Regulatory Guide 8.13, “Instruction Concerning Prenatal Radiation Exposure.”

J. Regulatory Guide 8.14, “Personnel Neutron Dosimeters.”

K. Regulatory Guide 8.20, “Applications of Bioassay for I-125 and I-131.”

L. Regulatory Guide 8.21, “Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants.”

M. Regulatory Guide 8.24, “Health Physics Surveys During Enriched U-235 Processing and Fuel Fabrication.”

N. Regulatory Guide 8.26, “Applications of Bioassay for Fission and Activation Products.”

O. Regulatory Guide 8.28, “Audible Alarm Dosimeters.”

P. Regulatory Guide 8.32, “Criteria for Establishing a Tritium Bioassay Program.”

8.3.3 Codes and Standards

A. ANSI N13.1-1969 (R1982), “Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.”

B. ANSI N13.2-1969 (R1982), “A Guide for Administrative Practices in Radiation Monitoring.”

C. ANSI N13.3-1969 (R1982), “Dosimetry for Criticality Accidents.”

D. ANSI N13.4-1971 (R1983), “Specification for Portable X- or Gamma Radiation Survey Instruments.”

E. ANSI N13.5-1972 (R1989), “Performance Specifications for Direct-Reading and Indirect-Reading Pocket Dosimeters for X-Ray and Gamma Radiation.”

F. ANSI N13.7-1983 (R1989), “Criteria for Photographic Film Dosimeter Performance.”

G. ANSI N13.11-1983, “Criteria for Testing Personnel Dosimetry Performance.”

H. ANSI N13.15-1985, “Performance of Personnel Thermoluminescence Dosimetry Systems.”

I. ANSI N13.27-1981, “Performance Requirements for Pocket-Sized Alarm Dosimeters and Alarm Ratemeters.”

J. ANSI N42.12-1980 (R1985), “Calibration and Usage of Sodium Iodide Detector Systems.”

K. ANSI N42.13-1986, “Calibration and Usage of Dose Calibrator Ionization Chambers for the Assay of Radionuclides.”

L. ANSI N42.14-1978 (R1985), “Calibration and Usage of Germanium Detectors for Measurements of Gamma-Ray Emission of Radionuclides.”

M. ANSI N42.15-1990, “Performance Verification of Liquid-Scintillation Counting Systems.”

N. ANSI N42.16-1986, “Specification for Sealed Radioactive Check Sources Used in Liquid Scintillation Counters.”

O. ANSI N42.18-1980 (R1985), “Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents.”

P. ANSI N317-1980 (R1985), “Performance Criteria for Instrumentation Used for Inplant Plutonium Monitoring.”

Q. ANSI N319-1976 (R1984), “Personnel Neutron Dosimeters (Neutron Energies Less Than 20 MeV).”

R. ANSI N322-1977 (R1983), “Inspection and Test Specifications for Direct and Indirect Reading Quartz Fiber Pocket Dosimeters.”

S. ANSI N323-1978 (R1983), “Radiation Protection Instrumentation Test and Calibration.”

T. ANSI N343-1978 (R1984), “Internal Dosimetry for Mixed Fission and Activation Products.”

U. ANSI N545-1975 (R1982), “Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry (Environmental Applications).”

V. ANSI/ASTM C998-83, “Sampling Surface Soil for Radionuclides.”

W. ASTM D2476-81, “Test Method for Tritium in Water.”

X. ASTM D3442-75, “Test Method for Tritium Content in Air.”

Y. ANSI/ASTM E666-78 (R1984), “Standard Practice for Calculating Absorbed Dose from Gamma or X Radiation.”

8.3.4 Supplementary Information

A. NUREG-0938, “Information for Establishing Bioassay Measurements and Evaluations of Tritium Exposure,” Brodsky, A., USNRC, June 1983.

B. NUREG/CR-l045, “Acute Effects of Inhalation Exposure to Uranium Hexafluoride and Patterns of Deposition,” University of Rochester, August 1980.

C. NUREG/CR-3332, “Radiological Assessment - A Textbook on Environmental Dose Analysis,” Till, J.E. and Meyer, H.R., Oak Ridge National Laboratory, September 1983.

D. NUREG/CR-3535, "Age-Dependent Dose Conversion Factors for Selected Bone-Seeking Radionuclides," Cristy, M. et al., Oak Ridge National Laboratory, May 1984.

E. NUREG/CR-3454, "Bioassays Using Resonance Ionization Spectroscopy," Parks, J.E., Atom Sciences, Inc., November 1983.

F. NUREG/CR-3166, "Recommended Procedures for Measuring Radon Fluxes From Disposal Sites of Residual Radioactive Materials," Young, J.A. et al., Battelle Pacific Northwest Laboratories, March 1983.

G. NUREG/CR-3164, "Subsurface Monitoring Programs at Sites for Disposal of Low-Level Radioactive Waste," Litton, R.J. et al., Army Engineer Waterways Experiment Station, April 1983.

H. NUREG/CR-3004, "Evaluation of Experiences in Long-Term Radon and Radon Daughter Measurements," Young, J.A. et al., Battelle Pacific Northwest Laboratories, December 1982.

I. NUREG/CR-2644, "An Assessment of Offsite Real-Time Dose Measurement Systems for Emergency Situations," Maeck, M.J. et al. , Exxon Nuclear Co., April 1982.

J. NUREG/CR-2123, "An Identification of Processes and Parameters of Importance to Estimation of Uncertainties in Long-Term Collective Dose and Health Effects Resulting from Geologic Disposal of High-Level Radiaoctive Waste," Triegel, E.K. and Kocher, D.C., Oak Ridge National Laboratory, October 1981.

K. NUREG/CR-0494, "Dose-Rate Conversion Factors for External Exposure to Photon and Electron Radiation from Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle," Kocher, D.C., Oak Ridge National Laboratory, February 1979.

L. ICRP Publication No. 35 (Annals of the ICRP Vol. 9, No. 4), "General Principles of Monitoring for Radiation Protection of Workers."

M. ICRP Report No. 20, "Radiation Protection Instrumentation and its Application."

N. NCRP Report No. 47, "Tritium Measurement Techniques," National Council on Radiation Protection and Measurements.

O. NCRP Report No. 50, "Environmental Radiation Measurements," National Council on Radiation Protection and Measurements.

P. NCRP Report No. 57, "Instrumentation and Monitoring Methods for Radiation Protection," National Council on Radiation Protection and Measurements.

Q. NCRP Report No. 58, "A Handbook of Radioactivity Measurements Procedures," National Council on Radiation Protection and Measurements.

R. PNL-SA-12411, "Environmental Monitoring Techniques Under Accident Conditions," Martin, J.B. et al., Battelle Pacific Northwest Laboratories, January 1985.

S. RHO-HS-SA-14P, "Methodology for Making Environmental As Low As Reasonably Achievable (ALARA) Determinations," Brown, R.C. et al., Rockwell Hanford Operations, 1982.

T. BNWL-1723, "Environmental Surveillance for Fuel Fabrication Plants," Corley, J.P., Waite, D.A., Battelle Pacific Northwest Laboratories, May 1973.

U. IE Information Notice No. 86-22, "Underresponse of Radiation Survey Instrument to High Radiation Fields," USNRC.

V. NRC Information Notice No. 90-44, "Dose-Rate Instruments Underresponding to the True Radiation Fields," USNRC.

W. NRC Information Notice No. 91-30, "Inadequate Calibration of Thermoluminescent Dosimeters Utilized to Monitor Extremity Dose at Uranium Processing and Fabrication Facilities," USNRC.

CHAPTER 9

CONDUCT OF OPERATIONS

The criteria identified in this chapter address training, emergency planning, plant procedures, and the maintenance of records and reporting.

9.1 TRAINING

9.1.1 Code of Federal Regulations

A. 10 CFR 60.160, "General Requirements."

B. 10 CFR 60.161, "Training and Certification Program."

C. 10 CFR 60.162, "Physical Requirements."

D. 10 CFR 72.190, "Operator Requirements."

E. 10 CFR 72.192, "Operator Training and Certification Program."

F. 10 CFR 72.194, "Physical Requirements."

9.1.2 Regulatory Guides

A. Regulatory Guide 3.28, "Welder Qualification for Welding in Areas of Limited Accessibility in Fuel Reprocessing Plants and in Plutonium Processing and Fuel Fabrication Plants."

B. Regulatory Guide 3.42, "Emergency Planning for Fuel Cycle Facilities and Plants Licensed Under 10 CFR Parts 50 and 70.

9.1.3 Codes and Standards

A. ANSI/ASME B&PV Code Section IX, "Welding and Brazing Qualifications."

B. ANSI/ASTM C986-1983, "Standard Guide for Developing Training Programs in the Nuclear Fuel Cycle."

C. ANSI/ASTM E1168-1987, "Standard Guide for Radiological Protection Training for Nuclear Facility Workers."

D. NCRP Report No. 71, “Operational Radiation Safety Training.”

9.1.4 Supplementary Information

A. NUREG/CR-2712, “Analysis of Training and Certification of Operations Technicians and Independent Spent Fuel Storage Installations,” Hottman, S.B. et al., Sandia National Laboratories, August 1982.

9.2 EMERGENCY PLANNING

9.2.1 Code of Federal Regulations

A. 10 CFR 50.47, “Emergency Plans.”

B. 10 CFR 50, Appendix E, “Emergency Planning and Preparedness for Production and Utilization.”

C. 10 CFR 72.32, “Emergency Plan.”

9.2.2 Regulatory Guides

A. Regulatory Guide 3.42, “Emergency Planning for Fuel Cycle Facilities and Plants Licensed Under 10 CFR Parts 50 and 70.”

9.2.3 Codes and Standards

None.

9.2.4 Supplementary Information

A. NUREG-0762, “Standard Format and Content for Radiological Contingency Plan for Fuel Cycle and Materials Facilities,” November 1987.

B. NUREG-75/111, “Guide and Checklist for Development and Evaluation of State and Local Government Radiological Emergency Response Plans for Fixed Nuclear Facilities,” and Supplement No. 1 to NUREG-75/111, March 15, 1977.

9.3 OPERATING AND EMERGENCY PROCEDURES

9.3.1 Code of Federal Regulations

A. 10 CFR 70.23, “Requirements for the Approval of Applications.”

B. 10 CFR 70.57, “Measurement Control Program for Special Nuclear Materials Control and Accounting.”

C. 10 CFR 70.58, “Fundamental Nuclear Material Controls.”

D. 29 CFR 1910, “Occupational Safety and Health Standards.”

E. 29 CFR 1926, “Safety and Health Regulations for Construction.”

9.3.2 Regulatory Guides

A. Regulatory Guide 3.16, “General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants.”

B. Regulatory Guide 3.42, “Emergency Planning for Fuel Cycle Facilities and Plants Licensed Under 10 CFR Parts 50 and 70.”

C. Regulatory Guide 3.53, “Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Facility.”

9.3.3 Codes and Standards

None.

9.3.4 Supplementary Information

A. NUREG/CR-4271, “Recommended Safety, Reliability, Quality Assurance, and Management Aerospace Techniques With Possible Application by the DOE to the High-Level Radioactive Waste Repository Program,” Bland, W.M., GeeB’s Inc., June 1985.

B. DP-1467, “Experience With Processing Irradiated Fuel at the Savannah River Plant (1954-1976),” Sheldon, E.B., Savannah River Plant, September 1977.

C. ORO-651, Rev. 1, “Uranium Hexafluoride Handling Procedures and Container Criteria,” USAEC, 1967.

D. NRC Information Notice No. 90-47, “Unplanned Radiation Exposures to Personnel Extremities Due to Improper Handling of Potentially Highly Radioactive Sources,” USNRC.

E. IE Information Notice No. 85-87, “Hazards of Inerting Atmospheres,” USNRC.

9.4 REPORTS AND MAINTENANCE OF RECORDS

9.4.1 Code of Federal Regulations

A. 10 CFR 50.71, “Maintenance of Records, Making of Reports.”

B. 10 CFR 50.59, “Changes, Tests, and Experiments.”

C. 10 CFR 60.44, “Changes, Test, and Experiments.”

D. 10 CFR 60.71, “Records and Reports.”

E. 10 CFR 60.72, “Construction Records.”

F. 10 CFR 60.73, “Reports on Deficiencies.”

G. 10 CFR 60.74, “Tests.”

H 10 CFR 61.25, “Changes.”

I. 10 CFR 61.80, “Maintenance of Records, Reports, and Transfers.”

J. 10 CFR 70.51, “Material Balance, Inventory, and Records Requirements.”

K. 10 CFR 70.52, “Reports of Accidental Criticality or Loss or Theft or Attempted Theft of Special Nuclear Material.”

L. 10 CFR 70.53, “Material Status Reports.”

M. 10 CFR 70.54, “Nuclear Material Transfer Reports.”

N. 10 CFR 70.59, “Effluent Monitoring Reporting Requirements.”

O. 10 CFR 72.48, “Changes, Tests, and Experiments.”

P. 10 CFR 72.70, “Safety Analysis Report Updating.”

Q. 10 CFR 72.72, “Material Balance, Inventory, and Records Requirements for Stored Materials.”

R. 10 CFR 72.74, Reports of Accidental Criticality or Loss of Special Nuclear Material.”

S. 10 CFR 72.76, “Material Status Report.”

T. 10 CFR 72.78, Nuclear Material Transfer Reports.”

U. 10 CFR 72.80, “Other Records and Reports.”

9.4.2 Regulatory Guides

A. Regulatory Guide 1.21, “Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants.”

B. Regulatory Guide 3.19, “Reporting Operating Information for Fuel Reprocessing Plants.”

C. Regulatory Guide 3.50, “Standard Format and Content for a License Application to Store Spent Fuel and High-Level Radioactive Waste.”

9.4.3 Codes and Standards

A. ANSI/ASTM E1034-1985, “Specifications for Nuclear Facility Transient Worker Records.”

B. ANSI N13.6-1966 (R1989), “Practice for Occupational Radiation Exposure Records Systems.”

9.4.4 Supplementary Information

None.

CHAPTER 10

ACCIDENT ANALYSIS

The criteria in this chapter are for initiating events that result in a criticality accident.

10.1 Code of Federal Regulations

A. 10 CFR 50.34, “Contents of Applications: Technical Information.”

B. 10 CFR 60.21, “Content of Application.”

C. 10 CFR 61.13, “Technical Analyses.”

D. 10 CFR 70.22, “Content of Applications.”

E. 10 CFR 70.23, “Requirements for the Approval of Applications.”

F. 10 CFR 72.24, “Contents of Application: Technical Information.”

G. 10 CFR 100.11, “Determination of Exclusion Area, Low Population Zone, and Population Center Distance.”

10.2 REGULATORY GUIDES

A. Regulatory Guide 1.25, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel-Handling Accident in the Fuel-Handling and Storage Facility for Boiling and Pressurized Water Reactors.” (The method of calculating X/Q values in this guide is superseded by the method presented in Regulatory Guide 1.145, “Atmosphere Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants.”)

B. Regulatory Guide 1.91, “Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants.”

C. Regulatory Guide 1.113, “Estimated Aquatic Dispersion of Effluents from Accidental and Routine Releases for the Purpose of Implementing Appendix I.”

D. Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants."

E. Regulatory Guide 3.33, "Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Fuel Reprocessing Plant."

F. Regulatory Guide 3.34, "Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Uranium Fuel Fabrication Plant."

G. Regulatory Guide 3.35, "Assumptions Used for Evaluating the Potential Radiological Consequences of accidental Nuclear Criticality in a Plutonium Processing and Fuel Fabrication Plant."

10.3 CODES AND STANDARDS

A. ANSI/ANS 2.17-1980, "Evaluation of Radionuclide Transport in Ground Water for Nuclear Power Sites."

10.4 SUPPLEMENTARY INFORMATION

A. NUREG-1320, "Nuclear Fuel Cycle Facility Accident Analysis Handbook," USNRC, May 1988.

B. NUREG-1179, "Rupture of Model 48Y UF_6 Cylinder and Release of Uranium Hexafluoride," USNRC, February 1986.

C. NUREG-0772, "The Effects of Natural Phenomena on the Exxon Nuclear Company Mixed-Oxide Fabrication Plant at Richland Washington," USNRC, September 1980.

D. NUREG/CR-4303, "High-Level Waste Preclosure Systems Safety Analysis," GA Technologies, Inc., September 1985.

E. NUREG/CR-3682, "Nuclear Fuel Cycle Risk Assessment-Review and Evaluation of Existing Methods," Pelto, P.J. et al., Battelle Pacific Northwest Laboratories, May 1984.

F. NUREG/CR-3210, "Low-Level Waste Risk Methodology Development," Cox, N.D. et al., EG&G Inc., May 1983.

G. NUREG/CR-3139, "Scenarios and Analytical Methods for UF_6 Releases at NRC-Licensed Fuel Cycle Facilities," Siman-Tov, M. et al., Oak Ridge National Laboratory, July 1984.

H. NUREG/CR-2933, "Nuclear Fuel Cycle Risk Assessment: Survey and Computer Compilation of Risk-Related Literature," Yates, K.R. et al., Battelle Pacific Northwest Laboratories, October 1982.

I. NUREG/CR-2429, "Data Base for Radiation Events in the Commercial Nuclear Fuel Cycle, 1950-1978," Bodeau, D.J. et al., Argonne National Laboratory, March 1982.

J. NUREG/CR-2402, "Risk Analysis Methodology for Spent Fuel Repositories in Bedded Salt," Pepping, R.E. et al., Sandia National Laboratories, July 1983.

K. NUREG/CR-2260, "Technical Basis for Regulatory Guide 1.145 Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Snell, W.G., et al., NUS Corp., October 1981.

L. NUREG/CR-1604, "Methodology Development for Risk Assessment of Fuel Processing," Buckner, J.T., E.I. DuPont de Nemours & Co., July 1980.

M. NUREG/CR-1397, "Risk Methodology for Geologic Disposal of Radioactive Waste: Small Sample Sensitivity Analysis Technologies for Computer Models, With an Application to Risk Assessment," Sandia National Laboratories, May 1980.

N. NUREG/CR-0649, "Spent Fuel Heatup Following Loss of Water During Storage," Benjamin, A.S. et al., Sandia National Laboratories, March 1979.

O. LA-10294-MS, "A Guide to Radiological Accident Considerations for Siting and Design of DOE Nonreactor Nuclear Facilities," Elder, J.C., et al., Los Alamos National Laboratory, January 1986.

P. SAND-85-1230C, "Analysis Methods for Hazardous Materials Accidents," Bennett, D.E., Sandia National Laboratories, 1985.

Q. SAND-84-1851C, "Analysis Methods for Offsite Transport Hazards," Bennett, D.E., Sandia National Laboratories, 1985.

R. KSC-1006-1, "Risk Analysis of Spent Fuel Receiving and Storage Facility Using the GO Methodology," Wood, D.E. and Becar, N.J., Kaman Sciences Corp., March 1979.

S. DP-1449, "The Safety of UO_3 Production at the A-Line at the Savannah River Plant," Perkins, W.C. et al., E.I. DuPont de Nemours & Co., March 1977.

T. HEDL-TME-76-98, "Procedures for Hazards Analysis of Plutonium Glove Boxes Used in Analytical Chemistry Operations," Delvin, W.L., Hanford Engineering Development Laboratory, June 1977.

U. BNWL-1697, Rev. 1, "Considerations in the Assessment of the Consequences of Effluents from Mixed Oxide Fuel Fabrication Plants," Selby, J.M. et al., June 1975.

V. BNWL-SA-5588, "Calculated Doses from Inhaled Transuranium Radionuclides and Potential Risk Equivalent to Whole-Body Radiation," Strom, P.O. and Watson, E.C., Battelle Northwest Laboratories, 1975.

CHAPTER 11

TECHNICAL SPECIFICATIONS OR OPERATING CONTROLS AND LIMITS

This chapter identifies criteria for establishing controls and limits on operating conditions, and requirements imposed on facility operation in technical specifications or operational safety requirements.

11.1 CODE OF FEDERAL REGULATIONS

A. 10 CFR 50.36, "Technical Specifications."

B. 10 CFR 60.21, "Content of Application."

C. 10 CFR 70.22, "Contents of Applications."

D. 10 CFR 72.24, "Contents of Application: Technical Information."

E. 10 CFR 72.26, "Contents of Application: Technical Specifications."

E. 10 CFR 72.44, "License Conditions."

11.2 REGULATORY GUIDES

Note: Regulatory Guides 3.15, 3.25, 3.26, 3.39, 3.44, 3.48 and 3.52 listed in Chapter 1 each contain criteria for facility technical specifications or operating controls and limits.

A. Regulatory Guide 3.6, "Content of Technical Specifications for Fuel Reprocessing Plants."

11.3 CODES AND STANDARDS

A. ANSI/ANS 15.1-1982, "The Development of Technical Specifications for Research Reactors."

11.4 SUPPLEMENTARY INFORMATION

A. MSA Bulletin 1513-4, "Typical Technical Specifications for Air Filtration Systems Used in Nuclear Power Applications," Mine Safety Appliances, Co.

B. CONF-840247 (Vol. 1), DE 84012130, “Operational Safety Requirements at the Oak Ridge Gaseous Diffusion Plant,” McRae, N.G., Proceedings of the 1984 DOE Nuclear Reactor and Facility Conference.

CHAPTER 12

QUALITY ASSURANCE

12.1 QUALITY ASSURANCE DURING DESIGN, CONSTRUCTION, AND OPERATION

12.1.1 Code of Federal Regulations

A. 10 CFR 50.4, "Written Communications."

B. 10 CFR 50.55, "Conditions of Construction Permits."

C. 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

D. 10 CFR 60.31, "Construction Authorization."

E. 10 CFR 60 Subpart G, "Quality Assurance."

F. 10 CFR 61.12, "Specific Technical Information."

G. 10 CFR 72.40, "Issuance of License."

H. 10 CFR 72 Subpart G, "Quality Assurance."

12.1.2 Regulatory Guides

Note: Regulatory Guides 3.25, 3.26, 3.39, 3.44, 3.48, 3.50, 3.61 and 3.62 listed in Chapter 1 each contain quality assurance criteria applicable to NNFs.

A. Regulatory Guide 1.30, "Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment."

B. Regulatory Guide 2.3, "Quality Verification for Plate-Type Uranium-Aluminum Fuel Elements for Use in Research Reactors."

C. Regulatory Guide 3.3, "Quality Assurance Program Requirements for Fuel Reprocessing Plants and for Plutonium Processing and Fuel Fabrication Plants."

D. Regulatory Guide 3.10, "Liquid Waste Treatment System Design Guide for Plutonium Processing and Fuel Fabrication Plants.

E. Regulatory Guide 3.12, "General Design Guide for Ventilation Systems or Plutonium Processing and Fuel Fabrication Plants."

F. Regulatory Guide 3.16, “General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants.”

G. Regulatory Guide 3.20, “Process Offgas Systems for Fuel Reprocessing Plants.”

H. Regulatory Guide 3.21, “Quality Assurance Requirements for Protective Coatings Applied to Fuel Reprocessing and to Plutonium Processing and Fuel Fabrication Plants.”

I. Regulatory Guide 3.27, “Nondestructive Examination of Welds in the Liners of Concrete Barriers in Fuel Reprocessing Plants.”

J. Regulatory Guide 3.29, “Preheat and Interpass Temperature Control for the Welding of Low-Alloy Steel for Use in Fuel Reprocessing Plants and in Plutonium Processing and Fuel Fabrication Plants.”

K. Regulatory Guide 3.30, “Selection, Application, and Inspection of Protective Coatings (Paints) for Fuel Reprocessing Plants.”

L. Regulatory Guide 3.32, “General Design Guide for Ventilation Systems for Fuel Reprocessing Plants.”

M. Regulatory Guide 3.38, “General Fire Protection Guide for Fuel Reprocessing Plants.”

N. Regulatory Guide 3.49, “Design of an Independent Spent Fuel Storage Installation (Water Basin Type).

O. Regulatory Guide 3.53, “Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation.”

P. Regulatory Guide 3.60, “Design of an Independent Spent Fuel Storage Installation (Dry Storage).

Q. Regulatory Guide 4.15, “Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment.”

12.1.3 Codes and Standards

A. ANSI/ANS 15.2-1990, “Quality Control of Plate-Type Uranium-Aluminum Fuel Elements.”

B. ANSI N15.38-1982, “Generic Standard for Auditing Nuclear Material Safeguard Systems.”

C. ANSI/ANS 57.7-1988, “Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type).”

D. ANSI/ANS 57.9-1984, “Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type).”

E. ANSI/ASME NQA-1-1989, “Quality Assurance Program Requirements for Nuclear Facilities.”

F. ANSI/ASME NQA-2-1989, “Quality Assurance Requirements for Nuclear Facility Applications.”

G. ANSI/ASME NQA-3-1989, “Quality Assurance Program Requirements for the Collection of Scientific and Technical Information for Site Characterization of High-Level Nuclear Waste Repositories.”

H. ANSI/ASME N626-1990, “Qualifications and Duties for Authorized Nuclear Inspection Agencies and Personnel.”

I. ANSI/ASQC Bl, B2, B3-1985, “Guide for Quality Control Charts, Method of Analyzing Data, and Controlling Quality During Production.”

J. ANSI/ASQC C1-1985, “General Requirements for a Quality Program.”

K. ANSI/ASTM C934-85, “Standard Guide for Design and Quality Assurance Practices for Nuclear Fuel Rods.”

L. ANSI/ASTM C1009-84, “Guide for Establishing a Quality Assurance Program for Analytical Chemistry Laboratories Within the Nuclear Industry.”

M. ANSI/AWS B1.10-86, “Guide for the Nondestructive Inspection of Welds.”

N. ASTM DO1.43, “Manual of Coating Work for Light Water Nuclear Power Plant Primary Containment and Other Safety-Related Facilities,” First Edition, 1979.

O. ANSI/AWS QC1-1988, “Standard for Qualification and Certification of Welding Inspectors.”

P. ANSI/IEEE 336-1985, “Installation, Inspection, and Testing Requirements for Power, Instrumentation and Control Equipment at Nuclear Facilities.”

Q. ANSI/IEEE 498-1991, “IEEE Standard Requirements for the Calibration and Control of Measuring and Test Equipment Used in Nuclear Facilities.”

R. ANSI/IEEE 730.1-1989, "IEEE Standard for Software Quality Assurance Plans."

S. ASME Boiler and Pressure Vessel Code, Section III, Subsection NCA 4000, "Quality Assurance."

T. ASME Boiler and Pressure Vessel Code, Section V, "Nondestructive Examination."

U. NE F3-43, "Quality Assurance Testing of HEPA Filters," USDOE, October 1988.

V. NE F3-44, "DOE Filter Test Facilities Quality Program Plan," USDOE, July 1986.

W. SNT-TC-lA-1988, "Nondestructive Testing Personnel Qualification and Certification," American Society for Nondestructive Testing.

12.1.4 Supplementary Information

A. ASTM Publication STP 616, "Quality Systems in the Nuclear Industry," American Society for Testing and Materials.

B. NUREG-1055, "Improving Quality and the Assurance of Quality in the Design and Construction of Commercial Nuclear Power Plants: A Report to Congress," U.S. Nuclear Regulatory Commission, May 1984.

C. NUREG-1297, "Peer Review for High-Level Nuclear Waste Repositories: Generic Technical Position," USNRC, February 1988.

D. NUREG-1298, "Qualification of Existing Data for High-Level Nuclear Waste Repositories - Generic Technical Position," USNRC, February 1988.

E. NUREG/CR-3110, "Reliability of Nondestructive Examination," Bush, S.H., Battelle Pacific Northwest Laboratories, October 1983.

F. "Matrix of Nuclear Quality Assurance Program Requirements," American Society for Quality Control, April 1973.