Met-Ed / GPU

Metropolitan Edison Company
Post Office Box 480
Middletown, Pennsylvania 17057

Writer's Direct Dial Number

December 22, 1981
LL2-81-0285

TMI Program Office
Attn: Mr. Lake H. Barrett, Deputy Program Director
U. S. Nuclear Regulatory Commission
c/o Three Mile Island Nuclear Station
Middletown, Pennsylvania 17057

Dear Sir:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
General Project Design Criteria

Attached is a copy of Revision 1 of our General Project Design Criteria (GPDC) for recovery facilities. This revision supercedes Revision 0 that was transmitted to you by our letter, LL2-81-0140, dated May 29, 1980. Your comments on Revision 0 transmitted to us via NRC/TMI-81-047 dated August 24, 1981 affected Table 4.3 of the Mechanical section. These comments were received at the same time this revision was being issued, and are not incorporated into this revision. The disposition of these comments have been sent to you in our letter, LL2-81-0245, dated November , 1981 and changes to be incorporated will be included in Revision 2. These general criteria will serve as a basis for developing the majority of system and facility specific design criteria that will be needed through the course of recovery. As we have previously discussed, we will be submitting system and facility specific design criteria to you for approval prior to developing more detailed designs.

The GPDC is provided to be used in conjunction with each facility design criteria when reviewing these documents. In that this document reflects our general design approach, your review and approval of the General Section (Design Criteria 13387-2-L01-100) is requested. This will preclude our having to address these general criteria repetitiously with each new submittal. You may also wish to review the remaining sections of the GPDC, and we will address any comments you have that may have generic applicability. Comments applicable only to any specific facility or system, however, should be handled as part of the NRC review and approval of that specific submittal.

Sincerely,

Aperture Card Dist

A001 5/1

J. J. Barton
Acting Director, TMI-2

JJB:JJB:djb
Attachment
cc: Dr. B. J. Snyder, Program Director, TMI Program Office

Design Criteria 13587-2-L01-100

GPU SERVICE CORPORATION

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

DESIGN CRITERIA DOCUMENTS

COVER SHEET

JOB NO: 13587 **DISCIPLINE:** General Section

1	7/21/81	Revised as Noted and Issued for Use Upon GPUSC Approval	ETS	WHH	RW	KD
0	12/12/80	Issued for Use Upon GPUSC Approval	ETS	WHH	RW	KD
REV. NO.	DATE	REVISION DESCRIPTION	ORIGINATOR	GROUP SUPV.	PROJECT ENG.	GPUSC
				APPROVAL		

GPU-1367 9/80

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SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.
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DESIGN CRITERIA DOCUMENTS
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1.0 GENERAL

1.1 INTRODUCTION

1.1.1 This design criteria is applicable only to those facilities and activities for which Bechtel has design responsibility.

1.1.2 This section of the General Project Design Criteria contains information common to all disciplines.

1.1.3 The General Project Design Criteria is applicable to facilities designed by Bechtel for the TMI-2 recovery effort. The criteria presented herein are not applicable to the rebuilding of the unit for power generation. The General Project Design Criteria is to be applied to each facility by reference in each facility's specific design criteria document. Any conflicts between the general and specific criteria must be identified in the specific design criteria document.

1.1.4 Existing plant systems interfacing recovery systems need not be upgraded to current codes and standards applicable to the recovery systems and associated tie-ins.

1.1.5 Recovery project designs pertaining to systems, structures, and components classified as safety related or important to safety shall incorporate pertinent requirements from applicable NRC Regulatory Guides listed in the Project Nuclear Quality Assurance Manual. Systems, structures, and components to which the Project Nuclear Quality Assurance Program applies are identified in the Project Q-List, document number 13587-2-G20-100, and the Project NSQ-List, document number 13587-2-G20-101.

1.2 PROJECT OBJECTIVES

1.2.1 There are four main objectives of the TMI-2 recovery. These objectives are:

1) Decontaminate the reactor building and equipment contained therein

2) Remove and store the reactor core

3) Decontaminate the Reactor Coolant System

4) Process radioactive waste

1.2.2 In order to achieve these objectives additional facilities and systems will be required. Some of these facilities will be permanent in nature; others will only be for the recovery of the unit and will be removed prior to the unit returning to service.

1.2.3 In addition to the facilities and systems to be provided, there will be plans developed for many of the activities required to achieve the project objectives.

1.3 PROJECT CONCERNS

1.3.1 There are two major concerns that directly influence the design of the facilities and the operations required for the cleanup of TMI-2. These concerns are:

1) Public health and safety

2) Occupational health and safety

2.0 DEFINITIONS

2.1 SAFE SHUTDOWN EARTHQUAKE (SSE)

The safe shutdown earthquake is that earthquake which is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is that earthquake which produces the maximum vibratory ground motion for which certain structures, systems, and components are designed to remain functional.

2.2 OPERATING BASIS EARTHQUAKE (OBE)

The operating basis earthquake is that earthquake which, considering the regional and local geology and seismology and specific characteristics of local subsurface material, could reasonably be expected to affect the plant site during the operating life of the plant; it is that earthquake which produces the vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public are designed to remain functional.

2.3 SEISMIC CATEGORY I/NON-SEISMIC CATEGORY I

Seismic Category I structures, systems, and components for seismic design purposes are defined as those structures, systems, and components important to safety that are designed to remain functional in the event of a safe shutdown earthquake. Structures, systems, and components important to safety and Seismic Category I are those necessary to ensure: 1

a. The integrity of the reactor coolant pressure boundary,

b. The capability to shut down the reactor and maintain it in a safe shutdown condition, or

c. The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of 10 CFR Part 100.

Non-Seismic Category I structures, systems, and components are those whose failure would not result in the release of radioactivity in excess of 10 CFR 100 limits nor prevent reactor safe shutdown.

2.4 DESIGN BASES

Design bases are postulated events/conditions or combinations of events/conditions which establish the function and structural requirements of a structure, system, or component.

2.5 SAFETY-RELATED FEATURES

Safety-related features are those plant features necessary to assure the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a safe shutdown condition, or the capability to prevent or mitigate the consequences of accidents which could result in offsite exposures comparable to the guideline exposures of 10 CFR Part 100.

2.6 IMPORTANT TO SAFETY

Features important to safety are those structures, systems, and components that are safety related plus those:

a. Which are employed for radioactive waste management (as defined in Regulatory Guide 1.143)

b. Which are required to prevent fires or mitigate the consequences of fires in areas which contain safety-related components or significant quantities of radioactive materials (Note 1)

c. Whose failure during a safe shutdown earthquake could reduce the functioning of a safety-related plant feature.

3.0 LICENSING

3.1 INTRODUCTION

Recovery operations, activities, and work tasks will be performed within the existing TMI-2 Technical Specifications and in accordance with applicable NRC Regulatory Guides. Specific design criteria shall identify | 1
applicable Technical Specifications and Regulatory Guide requirements.

3.2 BASIC CRITERIA

3.2.1 Facilities and systems constructed to support the recovery shall not be designed to requirements based on the hypothesis of accidents at power.

Note 1: Defined as the quantity of radioactive materials which, in case of fire in the facility, could cause an airborne release to the environment which could exceed the limits of 10 CFR Part 20, Appendix B, Table II, Column 1.

3.2.2 Facilities and systems constructed for the life of the plant shall be designed to the applicable requirements specified in Chapter 3 of the TMI-2 FSAR in addition to the requirements necessary for the recovery. The latest applicable codes and standards will be employed.

3.2.3 To the extent practicable, facilities and services constructed for the recovery effort will be separate from existing facilities and services.

Where it is not practicable to separate the facilities and services constructed for the recovery effort from existing facilities and services, design requirements will be imposed as necessary in order not to compromise the original design bases of the existing facilities and services. These requirements shall be identified in the specific design criteria for the facility and service to be provided. The following will serve as guidelines:

a. Where piping and cables to be left in place when the unit is returned to service are routed through buildings containing seismic Category I piping and cables, the failure of the non-seismic Category I components shall not result in the failure of the seismic Category I components as a result of a seismic event.

b. Where services to support recovery must tie into existing plant services, isolation provisions commensurate with the design requirements of the existing plant service shall be provided.

c. Where piping to be left in place when the unit is returned to service is routed through buildings containing safety-related equipment, the requirements for high energy line break and pipe whip specified in the TMI-2 FSAR shall be satisfied as applicable.

d. Where cables to be left in place when the unit is returned to service are routed through buildings containing safety-related equipment, the requirements for separation and fire protection specified in the TMI-2 FSAR and TMI-2 Fire Protection Reevaluation shall be satisfied as applicable.

3.2.4 Facilities constructed to support the recovery effort shall not have as part of their design basis the severe natural phenomena for which the plant was originally designed. Included under "severe natural phenomena" are:

a. Safe shutdown earthquake

b. Tornado and tornado missile

c. Maximum flood.

The facilities will be designed to ensure that there will be no loss of required function of existing adjacent safety-related structures, equipment, or systems should these events occur.

These facilities shall be designed for the more probable natural phenomena as called for by area building code requirements.

3.2.5 Facilities constructed to support the recovery shall not be designed for man-made events not resulting from recovery activities. Included under "man-made events not resulting from recovery activities" are:

a. Transportation accidents occurring offsite

b. Airplane crashes

c. Release of toxic chemicals.

The facilities will be designed to ensure that there will be no loss of required function of existing adjacent safety-related structures, equipment, or systems should these events occur.

3.2.6 For environmental analyses, the annual average value for meteorology specified in the TMI-2 FSAR of $X/Q = 6.7E - 6\ sec/m^3$ shall be used.

3.2.7 For environmental analyses, the river characteristics specified in Chapter 2 of the TMI-2 FSAR shall be used. River water quality data is that specified in the Plant Design and Mechanical Design Criteria, 13587-2-M01-100.

3.3 DESIGN CONDITIONS

This section defines the spectra of operating conditions to which the activities required for the recovery shall be designed. Also provided are the general design requirements for these operating conditions.

3.3.1 Condition I - Normal Operation

Condition I occurrences are those that can reasonably be expected to occur during the recovery activities. Examples of Condition I occurrences are:

a. Those that are normally expected to occur during the recovery including contamination/decontamination resulting from routine activities.

b. Operations with equipment out of service or undergoing tests within operational limitations.

Condition I occurrences shall be accommodated with only routine action required to prevent an unplanned release of radioactive materials in effluents to unrestricted areas.

3.3.2 Condition II - Incidents of Moderate Frequency

Condition II occurrences are those any one of which may reasonably be expected to occur during a calendar year and which could result in a release of radioactive material requiring additional support personnel and/or equipment to control. Examples of Condition II occurrences are:

a. Loss of electrical power

b. Minor leakage from systems installed to support the recovery

c. Inadvertent actuation of a single active component in a system installed to support the recovery

d. Single error by an operator engaged in a recovery activity

e. Single active failure of a component (taken as the initiating event) in a system installed to support the recovery

Condition II occurrences shall be accommodated with, at most, a cessation of activities with the capability of resuming the activities after corrective action. Any release of radioactive materials in effluents to unrestricted areas shall be in conformance with Paragraph 20.1 of 10 CFR Part 20, "Standards for Protection Against Radiation."

3.3.3 Condition III - Infrequent Incidents

Condition III occurrences are those which are not expected to occur but are assumed to occur during the lifetime of the recovery effort and could result in a significant release of radioactive material. Examples of Condition III occurrences are:

a. Rupture of any tank utilized for the recovery effort

b. Pipe break in a system installed to support the recovery

c. Fire in an area where recovery activities occur

d. An operating basis earthquake (OBE).

e. Fuel handling accident in the reactor building (Note 2).

Condition III occurrences may result in damage to recovery facilities sufficient to preclude resumption of recovery activities for a considerable time. The release of radioactive material in effluents to unrestricted areas may exceed the guidelines of 10 CFR Part 20, "Standards for Protection Against Radiation," but shall not be sufficient to interrupt or restrict public use of those areas beyond the exclusion radius.

Note 2: The source term for the postulated occurrence is based on assuming the assembly with the peak inventory of radioactive material in the TMI-2 core is intact. The burnup is based on exact power history. Credit is taken for a decay period of two years or more. 1

3.4 REGULATORY REQUIREMENTS

3.4.1 Code of Federal Regulations

The facilities and activities associated with the recovery shall satisfy the following:

a. 10 CFR Part 20, Paragraph 20.103, Exposure of Individuals to Concentrations of Radioactive Materials in Air in Restricted Areas

b. 10 CFR Part 20, Paragraph 20.105, Permissible Levels of Radiation in Unrestricted Areas

c. 10 CFR Part 20, Paragraph 20.106, Radioactivity in Effluents to Unrestricted Areas

d. 10 CFR Part 50, Paragraph 50.34a, Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents - Nuclear Power Reactors

e. 10 CFR Part 50, Paragraph 50.36a, Technical Specifications on Effluents from Nuclear Power Reactors

f. 10 CFR Part 50, Appendix A, General Design Criteria for Nuclear Power Plants

g. 10 CFR Part 50, Appendix I, Numerical Guides for Design Objectives and Limiting Conditions for Operations to Meet the Criterion "As Low As Is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents

h. 10 CFR Part 100, Reactor Site Criteria

i. 29 CFR Part 1910, Occupational Safety and Health Standards (Department of Labor Regulations)

j. 40 CFR Part 190, Uranium Fuel Cycle Standard (Environmental Protection Agency Regulations)

k. 49 CFR Part 173, Shippers-General Requirements for Shipments and Packagings (Department of Transportation Regulations)

l. 10 CFR Part 50, Appendix R, Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979 1

m. 40 CFR Parts 260 through 265, Hazardous Waste Regulations (Environmental Protection Agency Regulations)

3.4.2 Regulatory Guides

Table 1 lists many of the regulatory guides which may be applicable to individual facility or system design. This table and other regulatory guides shall be reviewed and any regulatory guides to be implemented shall be included as part of the specific design criteria for the associated facility or system.

3.4.3 Standard Review Plans (SRPs)

The following SRPs and Branch Technical Positions shall be reviewed and the guidance provided used as applicable in designing the facilities and activities to support the recovery.

a. SRP 11.2, Liquid Waste Management Systems, Rev. 1

b. SRP 11.3, Gaseous Waste Management Systems, Rev. 1

c. SRP 11.4, Solid Waste Management Systems, Rev. 1

d. SRP 15.7.3, Postulated Radioactive Releases Due to Liquid Containing Tank Failures, Rev. 1

e. Branch Technical Position ASB 9.5-1, Guidelines for Fire Protection for Nuclear Power Plants, Rev. 1

f. Branch Technical Position ETSB 11-3, Design Guidance for Solid Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Plants, Rev. 1

3.4.4 State Regulations

The facilities and activities associated with the recovery shall satisfy the following: 1

Title 25, Environmental Resources; Chapter 75, Solid Waste Management (Pennsylvania Department of Environmental Resources Regulations)

3.5 INDUSTRY CODES AND STANDARDS

Applicable industry codes and standards are identified in the individual discipline design criteria.

3.6 SAFETY ASSESSMENT

A safety assessment will be performed for each facility and activity to be provided. This assessment shall include a review of the final design to ensure that the safety criteria have been satisfied. When the assessment reveals that the final design does not satisfy the safety criteria, design changes shall be made or administrative controls imposed.

4.0 ALARA DESIGN CRITERIA AND CONSIDERATIONS

The items listed in Table 2 form the basis for the TMI-2 Recovery Project ALARA program. During the design process, the applicable items shall be considered and incorporated into the design as appropriate. 1

TABLE 1

REGULATORY GUIDES

1. Reg. Guide 1.21 - Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquids and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants (Rev. 1, June 1974)

Discussion

This guide is applicable to the design of radiation monitoring systems in liquid and gaseous effluent paths and in the design of means for determining the total curie quantity and radionuclide composition of solid wastes shipped offsite with the following clarification.

(1) (Ref: Appendix A, Paragraph C) To preclude unnecessary radiation exposure to personnel, the curie and radionuclide determinations for solid radioactive waste shipped offsite will be performed to the extent and level required by Department of Transportation Regulations and 10 CFR Part 71, "Packaging of Radioactive Material." Additional sampling and analysis is not required.

2. Reg. 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 (Rev. 0, March 1972)

Discussion

The assumptions of the guide may be used with the following exceptions or clarifications, in the analysis of the potential radiological consequences of a fuel handling accident.

(1) [Ref: Paragraph C.3.b(2)] Whole-body gamma doses and beta-skin doses are presented separately, as the dose from beta radiation of the whole body is negligible. The total dose to the skin is the sum of the beta-skin dose and the whole-body gamma dose.

(2) [Ref: Paragraph C.3.b(3)] Dose conversion factors are taken from Reg. Guide 1.109.

(3) (Ref: Paragraph C.1) The source term for the postulated fuel handling accident is based on assuming the assembly with the peak inventory of radiaoctive material in the TMI-2 core is intact. The burnup is based on exact power history. Credit is taken for a decay period of two years or more. 1

TABLE 1 (Continued)

3. <u>Reg. Guide 1.26</u> - Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants (Rev. 3, February 1976)

<u>Discussion</u>

Since the original design and construction of the Three Mile Island Plants was to different classification criteria than contained in this guide, TMI will comply with the regulatory position of this guide with the following clarifications:

a. For modifications to existing plant systems and for new construction, items will be classified by Technical Functions according to this guide providing such action will improve the safety of the system being modified or make a significant improvement in overall plant safety. Otherwise the items will be classified the same as the original design and construction.

b. Tie-ins to existing plant systems will be made to the same or more recent applicable code, standard, and technical requirements which were applicable to the system to which the tie-in is to be made.

4. <u>Reg. Guide 1.29</u> - Seismic Design Classification (Rev. 3, September 1978)

<u>Discussion</u>

Since the original design and construction of the Three Mile Island Plants was to different classification criteria than contained in this guide, TMI will comply with the regulatory position of this guide with the following clarifications:

a. For modifications to existing plant systems and for new construction, items will be classified by Technical Functions according to this guide providing such action will improve the safety of the system being modified or make a significant improvement in overall plant safety. Otherwise the items will be classified the same as the original design and construction.

b. Tie-ins to existing plant systems will be made to the same or more recent applicable code, standard, and technical requirements which were applicable to the system to which the tie-in is to be made.

TABLE 1 (Continued)

5. Reg. Guide 1.60 - Design Response Spectra for Seismic Design of Nuclear Power Plants (Rev. 1, December 1973)

Discussion

This guide is applicable to facilities housing radioactive waste management systems and subject to and as invoked by Reg. Guide 1.143.

6. Reg. Guide 1.61 - Damping Values for Seismic Design of Nuclear Power Plants (Rev. 0, October 1973)

Discussion

This guide is applicable to facilities housing radioactive waste management systems and subject to and as invoked by Reg. Guide 1.143.

7. Reg. Guide 1.63 - Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants (Rev. 2, July 1978)

Discussion

TMI will comply with the regulatory position of this guide with the following clarification:

> For modifications to existing structures and to new constructions, this guide will be utilized providing its use will improve the safety of the structure being modified or make a significant improvement in overall plant safety. Otherwise, the same or more recent applicable code, standard, and technical requirements applicable to the original design and construction will be utilized.

8. Reg. Guide 1.92 - Combining Modal Responses and Spatial Components in Seismic Response Analysis (Rev. 1, February 1976)

Discussion

This guide is applicable to facilities housing radioactive waste management systems and subject to and as invoked by Reg. Guide 1.143.

9. Reg. Guide 1.109 - Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I (Rev. 1, October 1977)

TABLE 1 (Continued)

Discussion

Subject to the exceptions indicated below, the assumptions of Regulatory Guide 1.109 are followed in the analysis of annual doses to man from routine releases.

(1) (Ref: Appendix C, Paragraph 3.a) Equation C-5 is modified to consider the different mechanisms for the transport of radionuclides to the edible parts of root-like vegetables (i.e., potatoes, carrots, peanuts, and sugarbeets). The concentrations of radioactive material in the edible parts of root-like vegetables result from uptake of activity deposited on the ground and from the translocation of activity from contaminated leaves. The translocation factor ranges from 0.05 to 0.25. Equation C-5 has been modified to include a factor to account for the fraction of activity on the leaves that translocates to the root.

(2) (Ref: Appendix A, Paragraph 2.d.1) Equation A-8 is modified to consider the effect that the method of irrigation has on the buildup of activity on vegetation. Equation A-8 includes one term for deposition directly on leaves and one term for uptake from the soil.

The two principal methods of irrigation are flooding and sprinkling. Since flooding will not result in a direct deposition on leaves, a factor has been added to Equation A-8 to account for the method of irrigation employed.

10. Reg. Guide 1.111 - Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors (Rev. 1, July 1977)

Discussion

The assumptions of this guide may be used in the analyses of atmospheric dispersion factors and deposition rates, with the following exception.

(1) (Ref: Paragraph C.3.b) The annual average value for meteorology specified in the TMI-2 FSAR of $X/Q = 6.7E - 6$ sec/m^3 shall be used.

11. Reg. Guide 1.112 - Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors (Rev. 0, April 1976)

Discussion

The applicable methods described in this guide may be used in calculating estimated releases from liquid waste processing systems.

TABLE 1 (Continued)

12. Reg. Guide 1.113 - Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I (Rev. 1, April 1977)

Discussion

The applicable methods described in this guide may be used in estimating aquatic dispersion of effluents.

13. Reg. Guide 1.132 - Site Investigations for Foundations of Nuclear Power Plants (Rev. 1, March 1979)

Discussion

Recognizing the site-sensitive aspects, the guidance provided by this guide may be used in the development of site investigation studies for foundations of facilities to be provided.

14. Reg. Guide 1.138 - Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants (Rev. 0, April 1976)

Discussion

Recognizing the site-sensitive aspects, the guidance provided by this guide may be used in the laboratory investigations of soils required by Reg. Guide 1.132.

15. Reg. Guide 1.140 - Design, Testing, and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants (Rev. 1, October 1979)

Discussion

The detailed project position is under development. However, this guide is applicable to atmosphere cleanup systems and, in general, the guidance provided may be followed.

16. Reg. Guide 1.143 - Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants (Rev. 1, October 1979)

Discussion

This guide is applicable to systems and facilities that are associated with the control and management of liquid, gaseous, and

TABLE 1 (Continued)

solid radioactive waste. (Note: radioactive waste means those liquids, gases, or solids containing radioactive materials that by design or operating practice will be processed prior to final disposition.)

The guidance provided is applicable subject to the following clarifications.

(1) (Ref: Paragraph C.6) The term "herein" in the phrase ". . . shall conform to the quality control provisions of the codes and standards specified herein . . ." is interpreted to refer to Reg. Guide 1.143 rather than ANSI N199-1976.

(2) (Ref: Paragraph C.6) The "referenced codes and standards" in the second sentence of Paragraph 4.2.3 are interpreted to mean the first tier of codes and standards identified in the Reg. Guide itself (example ACI-349), but <u>not</u> lower tier codes and standards referenced in the first tier documents (examples: ANSI N45.2.11, 2.9, 2.6).

17. <u>Reg. Guide 8.8</u> - Information Relevant to Ensuring That Occupational Radiation Exposure at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable (Rev. 3, June 1978)

<u>Discussion</u>

The design considerations, personnel qualifications, and plans and procedures for ensuring that occupational radiation exposures will be as low as is reasonably achievable are in accordance with Regulatory Guide 8.8 subject to the following clarifications or exceptions:

(1) (Ref: Paragraph C.2) The design features discussed in this paragraph are described in general terms which may permit several acceptable alternative designs for a particular application, e.g., different types or amounts of shielding.

(2) (Ref: Paragraph C.2.g) Airborne monitoring equipment will be provided in areas to which personnel normally have access and in which there is a potential for airborne radioactivity. In addition, area radiation monitors will be provided in areas to which personnel normally have access and where there is a potential for personnel unknowingly receiving high levels of radiation exposure (e.g., in excess of 10 CFR 20 limits) in a short period of time because of system failure or improper personnel action.

1

TABLE 2

ALARA ITEMS

Item No.	Description	Responsibilities	Note
Sec. A	FACILITY ARRANGEMENT		
1.0	Facility Layout		
1.1	Check that equipment with contact radiation levels of Zone III (see Table 4) or greater is separated from Zone II and lower areas by shielding or distance plus access barriers.	N	*
1.2	Check that major equipment which by design accumulates or concentrates radioactivity with Zone III or greater contact radiation levels is shielded or separated from adjacent active and passive equipment to meet the applicable radiation shielding criteria for adjacent areas.	N	*
1.3	Check that equipment compartments are arranged such that radiation zone differences between adjacent areas are minimized.	N	*
1.4	Check that personnel access control and traffic patterns are considered to minimize spread of contamination during all facility operating modes.	A, N, PO	*
1.5	Check that active components in clean (nonradioactive) services are not located in Radiation Zone III or greater.	N	*
1.6	Check that equipment subject to removal or replacement has adequate aisles or area access and built-in provisions (such as monorails, jib cranes, etc.) for removal.	PO	*
1.7	Check that access to components requiring frequent maintenance, in-service inspection, adjustment, etc. is from the lowest practicable radiation zone and not via a Zone V.	PO	*

TABLE 2 (Continued)

Item No.	Description	Responsibilities	Note
1.8	Check that adequate space and facilities are provided for clothing change stations outside contaminated areas.	A	
1.9	Check that all corridors and normal traffic areas are Zone I or II.	N, A	*
2.0	Equipment Location		
2.1	Check that adequate space is provided around equipment to allow ease of maintenance.	PO, CS	
2.2	Check that equipment maintenance envelopes include estimated size of rigging requirements and temporary shielding, if required.	PO	
2.3	Check that laydown area requirements for equipment are available.	PO	*
2.4	Check that equipment which requires routine maintenance, service, testing, or inspection, such as instruments, sample stations, or rotating components, are located to provide maximum direct access.	PO, CS	*
2.5	Check that the clear space for doorways is a minimum of 3 feet by 7 feet and that there is adequate access for personnel, tools, and component removal.	A, PO	*
2.6	Check that equipment manways are readily accessible.	PO	
2.7	Check that high radiation equipment is located such that interconnecting high radiation piping is minimized.	PO	
3.0	Specific Component Layout		
3.1	Filters		
	Check that adequate space is provided for semi-remote	PO	*

1

TABLE 2 (Continued)

Item No.	Description	Responsibilities	Note
	removal, cask loading, and transporting spent radioactive filter cartridges to the solid radwaste area.		
3.2	Pumps		
3.2.1	Check that small pumps are oriented in a manner that allows easy removal from the area.	PD	
3.2.2	Check that adequate access is provided for pump seal replacement.	PD	
3.3	Tanks		
3.3.1	Check that direct access and removal space is provided for motors of tank agitators.	PD	*
3.3.2	Check that direct access to active components or manways is provided into the upper levels of tank rooms as well as the lower elevations.	PD	*
3.3.3	Check that adequate space is provided for tank internals cleaning operations.	PD	
3.4	Evaporators		
3.4.1	Check that concentrates and distillate components are adequately separated.	PD	
3.4.2	Check that components which accumulate radioactivity or crud, such as heating tubes, are separated from active components such as valves.	PD, N	
3.4.3	Check that adequate space is provided to allow uncomplicated removal of heating tube bundles.	PD	
3.5	Sample Stations		
3.5.1	Check that sample stations for routine sampling of process fluids are separated by shielding or distance from other radioactive components to Zone II.	PD, N, CS	

TABLE 2 (Continued)

Item No.	Description	Responsibilities	Note
3.5.2	Check that local ventilation (e.g., a hood) is provided at sample stations containing radioactive materials.	PO, N, CS	
3.6	Ventilation System Components		
3.6.1	Check that ventilation fans and filters are provided with adequate access space to permit servicing.	PO	
3.6.2	Check that outside air supply and building exhaust system components are in areas no greater than Zone II.	PO	
3.6.3	Check that general ventilation flow is from areas of potential (or actual) low contamination to areas of potential (or actual) high contamination.	PO	
3.7	Instruments		
3.7.1	Check that instruments which require periodic attention are located in Zone II (or lower) areas whenever possible.	CS	
3.7.2	If instruments must be located in Zone III or greater, check that they are mounted so that they are readily accessible for maintenance and calibration and are easily removable to a lower radiation zone for extended servicing or calibration.	PO, CS	
3.7.3	If control valves must be located in Zone IV or greater, check that appurtenances such as E/P converters, airsets, and solenoid valves are not mounted on the control valve but are located in a lower radiation zone.	PO, CS	
3.8	Sumps		
	Check that sumps capable of accumulating radioactive wastes are located in zones compatible with radiation levels due to the contained activity.	PO	

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Table 2 (Continued)

Item No.	Description	Responsibilities	Note
Sec. B	SHIELDING		
1.0	Bulk Shielding		
1.1	Check that shielding or separation is provided between radiation zone areas to meet the radiation level criteria for adjacent areas.	N	*
1.2	Check that shielding design is based on conservative or measured radiation source term, component design, and plant layout assumptions.	N	
1.3	Check that poured concrete density specifications are consistent with shielding design basis minimum densities.	N, C	
1.4	Check that concrete block density specifications are consiste t with shielding design basis minimum densities.	N, A	
1.5	Check that concrete block wall designs meet or exceed the minimum shielding requirements.	N, A	
1.6	Check that removable or temporary shielding is designed consistent with applicable radiation shielding criteria for adjacent areas.	N	
2.0	Penetration and Discontinuity Shielding		
2.1	Check that penetrations, such as H&V ducts and piping, are either located with an offset between radiation sources and accessible areas or are appropriately shielded.	N, PO, E, CS	
2.2	Check that penetrations are located as far as possible above the accessible floor elevation.	N, PO, E, CS	
2.3	Check that penetration shielding is provided as necessary to meet the radiation shielding criteria in adjacent accessible areas.	N	

TABLE 2 (Continued)

Item No.	Description	Responsibilities	Note
2.4	Check that seismic gap shielding is provided to maintain radiation levels in adjacent accessible areas within radiation shielding criteria limits.	N, C	
3.0	Entryway Shielding		
3.1	Check that there is no direct or near direct shine out of shielded cells.	N	*
3.2	Check that adequately shielded labyrinths or hatches are provided to limit direct and scattered radiation out of shielded areas.	N	*
Sec. C	SYSTEM DESIGN		
1.0	Decontamination Provisions		
1.1	Check that radioactive systems with Zone V component radiation levels have provisions to flush the entire system. Flushing capability should be available even if the system pump is inoperable.	M, PD	
1.2	Check that major components of the primary coolant purification system where crud can collect up to Zone V radiation levels, such as filters, heat exchangers, etc. have provisions for chemical decontamination, including low point drains. Check that means are available to take the decon solution to chemical waste area.	M, PD	
1.3	Check that seal flush water is provided to pumps with chemical or slurry wastes.	M, PD	
1.4	Check that all serviceable components have isolating and draining capability.	M, PD, CS	
1.5	Check that provisions are available to flush potentially contaminated instrument lines.	M, PD, CS	

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TABLE 2 (Continued)

Item No.	Description	Responsibilities	Note
1.6	Check that flush connections are located downstream of the component isolation valve on the inlet line and upstream of the isolation valve on the outlet line, and as close as possible to the inlet and outlet connections of the component.	M, PD	
1.7	Check that isolation valves are provided on the flush connections and are located as close as possible to the main pipe.	M, PD	
1.8	Check that all flush connections are equipped with quick connect/disconnect fittings.	M, PD	
2.0	Remote Operation and Instrumentation		
2.1	Check that adequate process instrumentation and controls are available to allow system and component operation from a low radiation zone.	CS	
2.2	Check that filters which accumulate high radioactivity are designed with the means either to backflush the filter remotely or to perform cartridge replacement with semi-remote tools.	PD	
2.3	Check that probe type instruments are used on highly radioactive tanks containing two-phase materials.	CS	
3.0	Leakage Provisions		
3.1	Check that tank overflow lines are directed to the waste collection system.	PD	
3.2	Cneck that sludge tanks and air mixing tanks which contain radioactive materials are vented to the respective building ventilation system or the vent collection system.	PD	
3.3	Check that strainers are included in vent lines from tanks containing spent resins or sludge.	PD	

TABLE 2 (Continued)

Item No.	Description	Responsibilities	Note
4.0	Demineralizers		
4.1	Check that demineralizers in radioactive systems and associated piping are designed with provisions for being flushed with demineralized water.	PO	
4.2	Check that strainers are located immediately downstream of ion exchangers.	PO	
4.3	Check that drains and downstream strainers are designed for full system pressure drop.	M, PO	
4.4	Check that strainers are included in vent lines from the demineralizer vessel.	PO	
4.5	Check that flush connections are provided at all critical locations (such as elbows, ties, valves) to clear potential plugs.	PO	
4.6	Check that flow in piping is turbulent enough to maintain suspension of fines.	M	
5.0	Floor Drains		
5.1	Check that equipment drains are piped directly to a drainage collection system.	PO	
5.2	Check that provisions are made to remove plugging should it occur in drain lines.	PO	
5.3	Check that radioactive and potentially radioactive drains are separated from nonradioactive drains.	PO	
Sec. D	PIPING AND VALVE DESIGN		
1.0	Pipe Routing		
1.1	Check that piping containing radioactive materials is routed through suitably zoned, controlled access areas in accordance with piping	PO	

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TABLE 2 (Continued)

Item No.		Responsibilities	Note
	radiation classification as shown in Table 3.		
1.2	Check that equipment compartments contain radioactive piping associated only with equipment within the compartment or that nonassociated piping is adequately separated.	PO	
1.3	Check that where it is necessary for radioactive piping to be routed through corridors or other radiation zone areas, shielded pipeways are provided to meet area radiation level requirements.	PO, N	
1.4	Check that long runs of exposed radioactive piping are minimized, particularly in active component areas such as valve galleries or pump cells.	PO	
1.5	Check that radioactive piping is routed to take credit for shielding effects of equipment or structures.	N, PO	
2.0	<u>Valve Location</u>		
2.1	Check that valves are separated from components which accumulate or contain radioactivity by shielding or distance to meet the applicable radiation shielding criteria levels.	N, PO	
2.2	Check that valves are readily accessible from floors or permanent platforms.	PO, CS	
2.3	Check that sufficient space is provided to facilitate valve and valve operator maintenance, operations, and testing.	PO, CS	
2.4	Check that valves are not located in radioactive pipeways.	PO, CS	
2.5	Check that vent and drain isolation and instrument root isolation valves are located as close as practical to process piping or components.	PO, CS	

TABLE 2 (Continued)

Item No.		Responsibilities	Note
2.6	Check that process valves are not located at low points in piping.	PD	
2.7	Check that reach rods or remote manipulators are provided for manually operated valves that are required in potentially high radiation areas (Zone V or greater).	PD, N	
3.0	Pipe Design		
3.1	Check that branch lines having little or no flow during normal operation are connected above the horizontal midplane of the main pipe.	PD	
3.2	Check that thermal expansion loops in radioactive systems are raised rather than dropped.	PD	
3.3	Check that orifices are located on vertical piping runs if possible. If located in horizontal piping runs, use eccentric design of the orifice.	PD, CS	
3.4	Check that reducers are installed not to form a stagnant pocket, i.e., use eccentric design with bottom flat, except at pumps.	PD	
3.5	Check that bypass lines are laid out to allow draining and flushing the main line without disruption of system operation.	PD, CS	
3.6	Check that lengths of radioactive pipe runs and number of bends are minimized.	PD	
3.7	Check that low points and dead legs in radioactive piping are minimized and are capable of being flushed.	PD	
3.8	Check that instrument and sensing line connections are located in such a way as to avoid corrosion product and radioactive gas buildup.	PD, CS	

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TABLE 2 (Continued)

Item No.		Responsibilities	Note
3.9	Check that welded joints are used whenever possible to minimize crud traps in the mechanical joints.	PD, CS	
4.0	Valve and Valve Operator Selection		
4.1	Check that full ported valves are used in systems expected to handle spent resins or slurries with radiation levels of 25 mr/hr or greater at contact with the surface of the pipe. (See Table 3)	M, PD, CS	
4.2	Check that valves 2-½ inches and larger (except butterfly valves and plug valves) in lines carrying radioactive fluids with radiation levels of 25 mr/hr or greater (contact dose rate) are diaphragm, packless, or have a double set of packing with lantern ring.	M, PD, CS	
4.3	Check that all globe valves in drain lines (excluding instrument valves) 2 inches and smaller are Y-pattern globe valves to facilitate rodding if plugging should occur.	M, PD	
4.4	Check that remote operators or handwheels on reach rods are provided for all valves, which must be accessible during operation, in lines processing evaporator bottoms or spent resins.	M, PD, CS	
4.5	Check that pressure relief valves have flange connections to facilitate removal for set pressure verification and calibration.	M, PD	
4.6	Check that valve operators are properly selected and meet the criteria in Table 3.	M, PD	
4.7	Check that valve types are properly selected for their intended service and environment.	M, PD	

TABLE 2 (Continued)

Item No.		Responsibilities	Note
4.8	Check that plug valves or equal are used on systems transporting resins and sludge, and on radwaste systems.	M, PD	
5.0	Spent Resin and Sludge Piping		
5.1	Check that resin lines are continuously sloped in the direction of flow to avoid potential stagnant pockets.	PD	
5.2	Check that valves are located as close as possible to the spent resin tank room to minimize the length of the dead leg.	PD	
5.3	Check that flow control valves and orifices are not used in resin lines.	M, CS	
5.4	Check that long radius (1.5 times the pipe diameter or greater) bends and elbows are used at direction changes.	PD	
5.5	Check that directional changes in resin piping runs are minimized.	PD	
5.6	Check that fluid velocity is high enough to keep resins in suspension.	PD	
5.7	Check that system design permits flow to be continuous until resins are flushed from piping, or provision is made for flushing at a velocity high enough to pick up resins that have settled out during flow interruption.	PD	
Sec. E	COMPONENT DESIGN (For components containing radioactive fluids or located in high radiation areas)		
1.0	Specifications		
1.1	Check that material requisitions specify the radiation environmental requirements for the intended material application.	M, CS	
1.2	Check that equipment design features as presented in the remainder of this section are included in the appropriate equipment specification.	M, CS	

TABLE 2 (Continued)

Item No.		Responsibilities	Note
2.0	Heat Exchangers		
2.1	Check that corrosion-resistant tubes of stainless steel or other suitable material with welded tube-to-tube sheet joints are provided to minimize leakage.	M	
2.2	Check that impact baffles are provided with tube side and shell side velocities limited to minimize erosive effects.	M	
2.3	Check that drains are provided on the lowest portion to ensure removal of contaminated fluids.	M, PD	
2.4	Check that where practical the contaminated side of the heat exchanger operates at a lower pressure than the clean side.	M	
2.5	Check that the more radioactive stream is on the tube side.	M	
3.0	Evaporators		
	Check that chemical addition connections are provided to allow use of chemicals for descaling operations.	M	
4.0	Pumps (Small)		
4.1	Check that pump casings are provided with drain connections.	M	
4.2	Check that pumps in radiation areas (Zone III or higher) are purchased with mechanical seals to reduce seal servicing time and leakage.	M	
4.3	Check that pumps in radioactive systems are provided with flanged connections for ease in removal.	M	
4.4	Check that electrical quick disconnects are provided on pumps in high radiation zones (V or higher).	M, E	
4.5	Check that painted surfaces of the pump (if any) are painted with a radiation-resistant and decontaminable coating.	M, A	

TABLE 2 (Continued)

Item No.		Responsibilities	Note
4.6	Check that the pump has long-lived bearings and that lubrication is the permanent type.	M	
4.7	Check that the pump selection has considered the use of low RPM designs.	M	
5.0	Tanks		
5.1	Check that tanks in radioactive service are provided with sloped bottoms (min. 1 inch per foot of tank diameter) and bottom outlet connections. Conical or dished bottom tanks with bottom connections are acceptable.	M, C	
5.2	Check that adequate tank mixing is provided to prevent crud settling.	M	
5.3	Check that each tank requiring a manway is top fitted with one of at least a 2-foot diameter. (If a manway is located on the side of a tank, it should be clearly demonstrated that it is necessary.)	M, C	
5.4	Check that side manways have eccentrically hinged covers designed to easily clear fastening studs.	M, C	
5.5	Check that outlet pipes have backflushing capability into the tank to break up sediment. Backflush capability should include air.	M, PD	
5.6	Check that tank linings (if any) are suitable for the expected service. Epoxy paint should be avoided.	M, C, A	
5.7	Check that overflow lines are lower than vent lines to prevent fluid from contaminating vent lines.	M, PD, C	
5.8	Check that a permanent connection is provided for insertion of a hydrolaser unit for decontamination of tanks in Zone V areas.	M, PD, C	

TABLE 2 (Continued)

Item No.		Responsibilities	Note
5.9	Check that lap joints were not used in tank construction.	M, C	
5.10	Check that no backing strips were used on tank welds.	M, C	
5.11	Check that backing rings were not used on nozzle welds.	M, C	
5.12	Check that siphoning of liquid waste from tanks cannot occur.	PD	
5.13	Check that in-line filters with backflushing capability are provided for tanks with a sludge buildup potential.	PD	
5.14	Check to ensure that tanks with a potentially hazardous leakage consequence are located over catch pans or within curbs with drain lines leading to radioactive liquid waste storage tanks or to sumps capable of handling a potential spill.	M, PD	
6.0	<u>Instruments</u>		
6.1	Check that chemical seals are provided on sensing lines on process piping that may contain high amounts of solids.	CS	
6.2	Check that primary instruments which, for functional reasons, are located in high radiation zones (V and greater) are designed for easy removal to a radiation Zone II or lower for calibration.	CS	
6.3	Check that instruments are selected which contain minimal quantities of contaminated working fluids; e.g., pressure transducers rather than bellows-type pressure gauges.	CS	

TABLE 2 (Continued)

Item No.		Responsibilities	Note
Sec. F	MISCELLANEOUS FACILITY DESIGN		
1.0	Lighting		
1.1	Check that multiple electric lights are provided for each cell or room containing highly radioactive components (Zone V and greater) so that burnout of a single lamp will not require entry.	E	
1.2	Check that lighting in high radiation areas (Zone V and greater) is actuated from outside the area in the lowest practical radiation zone.	E	
1.3	Check that sufficient lighting is provided in areas that contain remote viewing devices to allow their efficient use.	E	
1.4	Check that plug-in, accessible, bracket hung, removable units are provided for easy removal and relamping outside high radiation areas. (Lightweight units are preferable for ease of handling.)	E	
1.5	Check that extension cord powered units stored on brackets and cord hangers outside the entrance are provided if permanent units are not practical, and the pre-placed brackets are provided within the high radiation area to facilitate installation.	E	
1.6	Check that long-life bulbs are provided in high radiation areas (Zone V).	E	
2.0	Contamination Control and Coatings		
2.1	Check the floor drains and properly sloped floors are provided for each room or cubicle containing serviceable components with radiation levels of a Zone III or higher.	M, PD, C	

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TABLE 2 (Continued)

Item No.		Responsibilities	Note
2.2	Check that local gas traps or porous seals are not used on floor drains from radiation areas.	M, PO	
2.3	Check that gas traps are provided at the common sump or collection tank.	M, PO	
2.4	Check that concrete surfaces in areas of potential contamination are covered with a smooth-surfaced coating for the floor and wainscot, which will allow easy decontamination.	N, A	
2.5	Check that threshold curbs, cofferdams, or other means are provided to control radioactive leakage or spills.	PO, A, C	
2.6	Check that protection from backflooding of floor drains is provided.	PO, C	
3.0	Access Platforms		
3.1	Cheak that equipment subject to routine maintenance (defined as at least once per year) has permanent access platforms.	PO, CS	
3.2	Check that direct access to active components is provided from any working platform.	PO, CS	
3.3	Check that ample space is provided on platforms for accommodating safe personnel movement during replacement of components (including the use of any necessary material handling equipment).	PO	
4.0	Remote Viewing Devices		
	Check that in high radiation areas (Zone V and greater) where routine visual surveillance inspections are required, remote viewing devices are provided.	M, PO, CS	
5.0	Temporary Shielding		
	Check that when shielding is required and permanent shielding is not feasible,	N, PO, C	

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TABLE 2 (Continued)

Item No.		Responsibilities	Note
	sufficient space and supports for portable shielding are provided and the structure is capable of accepting the additional loading.		
6.0	Insulation		
	Check that piping and components requiring frequent (once per year or greater) access for maintenance, inspection, etc. utilize quick removal insulation wherever practical.	PD	
7.0	Plant Services		
	Check that services such as electrical power, water, respirable air, and compressed air are available reasonably close to radiation work areas.	M, PD, E, N	

Legend

Symbol	Description
PD	Plant Design
CS	Control Systems
A	Architectural
E	Electrical
C	Civil
M	Mechanical
N	Nuclear/Licensing
*	Item to be completed prior to transmittal of general arrangement drawing to client for initial review.

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TABLE 3

TYPICAL RADIOACTIVE PIPING CLASSIFICATION AND ROUTING

Exposure Rate at Contact with Pipe Surface (mR/hr)	Radioactivity Description	Acceptable Radiation Zone Routing*
---	Nonradioactive	I, II, III, IV, V
0.5	Slightly radioactive	I, II, III, IV, V
2.5	Low radioactivity	II, III, IV, V
25	Low to moderately radioactive	III, IV, V
100	Moderately radioactive	IV, V
>100	Highly radioactive	V, VI, VII

* Routing of nonradioactive or low radioactivity piping in high radiation zones should be minimized.

TABLE 4

RADIATION ZONES

Zone	Design Dose Rate (mrem per hour)	Access Description
I	≤0.5*	Uncontrolled, unlimited access
II	0.5 to 2.5	Controlled, limited access 40 hours per week
III	2.5 to 25	Controlled, limited access 4 to 40 hours per week
IV	25 to 100	Controlled, limited access 1 to 4 hours per week
V	100 to 1000	Normally inaccessible access during emergency
VI	1000 to 3000	Normally inaccessible access during emergency Locked barrier to zone
VII	≥3000	Normally inaccessible access during emergency Locked barrier to zone

* Design dose rates in office spaces and other Zone I areas which are continuously occupied 8 hours per day, 5 days per week or more shall be less than 0.25 mrem/hr. Corridors and other Zone I areas of a transient occupancy nature shall be below 0.5 mrem/hr.

Design Criteria 13587-2-A01-100

GPU SERVICE CORPORATION
THREE MILE ISLAND - UNIT 2
RECOVERY FACILITIES

DESIGN CRITERIA DOCUMENTS

COVER SHEET

JOB NO: 13587

DISCIPLINE: ARCHITECTURAL

REV. NO.	DATE	REVISION DESCRIPTION	ORIGINATOR	APPROVAL: GROUP SUPV.	APPROVAL: PROJECT ENG.	APPROVAL: GPUSC
1	7/21/81	Revised as Noted and Issued for Use Upon GPUSC Approval	CL	JSW	AWJ	KED
0	12/22/80	Issued for Use Upon GPUSC Approval	CL	JSW	AWJ	KED

GPD-1367 9/80

SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.
1	0												
1	0												
2	0												
3	1												
4	1												
5	1												
6	1												
7	1												

BECHTEL

DESIGN CRITERIA DOCUMENTS
REVISION STATUS SHEET

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ARCHITECTURAL DESIGN CRITERIA

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1.0 INTRODUCTION

1.1 These criteria shall govern the Architectural design of the structures and facilities for the Three Mile Island - Unit 2 recovery services.

1.2 All significant deviations from these design criteria shall be approved by the Division Chief Architect.

2.0 GOVERNING CODES, REGULATIONS, AND REFERENCE DOCUMENTS

Unless specifically stated otherwise, the design of all structures and facilities shall be based on the latest issue (unless otherwise indicated) on the applicable portions of the following codes, specifications, industry standards, regulations and standards of the Bechtel Thermal Power Organization. When conflict occurs between criteria, the more restrictive shall apply. Compliance to these documents shall be discussed in the individual facility design criteria, and/or specifications.

2.1 FEDERAL CODES AND STANDARDS

NRC regulatory guides, branch technical positions and codes of federal regulations applicable to the recovery facilities and listed in the general section of the project design criteria.

2.2 GOVERNING CODES, REGULATIONS, AND INDUSTRY STANDARDS

2.2.1 Pennsylvania Code for Fire and Panic Regulations by Department of Labor and Industry, 1978

2.2.2 The BOCA Basic Building Code, 1978

2.2.3 The BOCA Plumbing Code, 1978

2.2.4 American Institute of Steel Construction (AISC)

Standards as applicable

2.2.5 American Iron and Steel Institute (AISI), "Specification for the Design of Cold-Formed Steel Structural Members"

Standards as applicable

2.2.6 American Welding Society (AWS),

"Structural Welding Code" (AWS D1.1-79)

2.2.7 American Concrete Institute (ACI)

Standards as applicable

2.2.8 American Society for Testing and Materials (ASTM)

Standards as applicable

2.2.9 American National Standards Institute (ANSI)

Standards as applicable

2.2.10 American Nuclear Insurance/Mutual Atomic Energy Reinsurance Pool (ANI/MAERP)

Basic Fire Protection for Nuclear Power Plant, 1977

2.2.11 National Fire Protection Association (NFPA)

Standards as applicable

2.2.12 National Concrete Masonry Association (NCMA)

2.2.13 Underwriters Laboratories Inc. (UL)

Fire Resistance Directory, 1980

Building Materials Directory, 1980

2.2.14 Factory Mutual Engineering Corporation (FM)

Standards as applicable

2.2.15 Steel Door Institute (SDI)

Standards as applicable

2.2.16 Steel Structures Painting Council (SSPC)

Number	Subject
SSPC SP 1	Solvent Cleaning
SSPC SP 2	Hand Tool Cleaning
SSPC SP 3	Power Tool Cleaning
SSPC SP 10	Near White Metal Blasting
SSPC PA 2	Dry Film Measurement Using Nondestructive Magnetic Gages
SSPC VIS 1	Pictorial Surface Preparation Standards for Painting Steel Surfaces

2.2.17 Tile Council of America

Standards as applicable

2.3 BECHTEL THERMAL POWER ORGANIZATION STANDARDS AND DESIGN GUIDES

2.3.1 Discipline Standard Specifications

2.3.2 Discipline Drawing Standard and Standard Detail

2.3.3 Discipline Design Standards and Guides

2.4 PROJECT STANDARDS AND DOCUMENTS

2.4.1 Project Engineering Procedures Manual

2.4.2 TMI-2 Final Safety Analysis Report and amendments

2.4.3 Fire Protection Program Reevaluation for TMI-2 1

2.5 MATERIAL SPECIFICATIONS

Nationally recognized industry standards are used whenever possible to describe material properties, testing procedures, fabrication, and construction methods.

3.0 MATERIAL DESCRIPTION

3.1 ROOFS

3.1.1 Roof construction in general will consist of gravel-surfaced composition roofing (with or without rigid insulation board) with or without vapor barrier. That insulation and vapor barrier, if provided, shall be attached by an approved method including perimeter fastening. The roofing will conform to UL Class A construction. Metal deck roof assemblies shall conform to Underwriters Laboratories listing as fire-acceptable, and Factory Mutual approval as Class I construction. 1

3.1.2 Metal decking will be galvanized steel of a standard section appropriate for the loads and span required.

3.2 WALLS

3.2.1 Walls enclosing plant mechanical and electrical equipment rooms, exit stairways, and storage areas will be constructed of concrete masonry unit, poured-in-place concrete, or precast concrete panel. 1

3.2.2 Partitions other than masonry or concrete will be metal studs covered with gypsum wallboard, or metal partition, as required.

3.2.3 Insulated and Uninsulated Metal Siding

Unless otherwise noted all exterior surfaces of insulated and uninsulated metal siding will be finished with PVF_2 KYNAR 500 or accepted equal. Wall insulation shall be noncombustible. Insulated metal panels shall be in approved fire rated assemblies.

All interior surfaces of insulated and uninsulated metal siding will receive the manufacturer's standard finish coat.

3.2.4 Metal flashing will match adjacent finish of exterior or interior panels.

3.2.5 Exterior walls will be reinforced concrete, metal siding, precast
concrete panel, brick, or concrete masonry unit.

3.3 CEILINGS

Ceilings in finished areas will be acoustical lay-in units in an exposed-
grid suspension system or suspended metal lath on furring channels and
cement plaster, as required. The type of ceiling will be determined by
the use of the particular area. Ceilings and their supports will be
made of noncombustible materials. Unless otherwise noted ceiling will
be exposed underside of metal roof deck and structural steel. 1

3.4 FLOORS

Unless otherwise noted concrete floors will be finished in accordance
with Paragraph 5.8. Ceramic tile floor will be manufactured and installed
in accordance with Tile Council of America, Inc. Resilient floor will
conform to Federal Specification No. SS-T-312A Type IV for tiles.

4.0 GENERAL STAIRS AND DOORS

4.1 STAIRS

All metal stairs shall have galvanized steel safety treads, platforms, 1
railings, and landings. Required fire exit stairs will have solid metal
risers and poured concrete treads.

4.2 DOORS AND FRAMES

All personnel doors including fire rated doors will be hollow metal
doors with pressed steel frames.

Doors and frames will be painted as described in Paragraph 5.9. Oversize
doors should be fire resistive construction with certification if 1
unlabeled.

4.3 SPECIAL DOORS

Special doors such as pressure type, airtight, equipment doors, etc.,
will be provided as required.

5.0 PAINTING AND COATING

Surfaces to be coated include concrete floors, ceilings and walls,
masonry walls, structural and miscellaneous steel, cranes, equipment,
tanks, and piping.

5.1 STRUCTURAL AND MISCELLANEOUS METAL

5.1.1 All structural and miscellaneous steel, except in the pre-engin-
eered buildings and steel joists, will receive shop-applied inorganic
zinc primer. Compatible finish coat will be applied in the field as
required. Structural steel requiring fireproofing material will receive
primer compatible with the fireproofing selected.

5.2 CARBON STEEL PIPING, PIPE HANGERS, AND SUPPORTS

5.2.1 All uninsulated piping and all hangers and supports exposed to chemical contaminants will be protected with shop-applied epoxy primer. Compatible finish coat will be applied in the field as required.

5.2.2 All uninsulated piping and all hangers and supports not exposed to chemical contaminants will receive manufacturer's standard alkyd primer, except at field weld joints. Field touchup will be performed 1
as required. No field finish coat will be applied.

5.2.3 All insulated piping will receive manufacturer's standard finish. No field touchup or finish coat will be applied.

5.3 VALVES, VALVE OPERATORS, AND VALVE MOTORS

5.3.1 All valves, valve operators, and valve motors exposed to chemical contaminants will be protected with shop-applied epoxy primer. Compatible finish coat will be applied in the field as required.

5.3.2 All valves, valve operators, and valve motors not exposed to chemical contaminants will receive a manufacturer's standard finish.

5.4 MECHANICAL EQUIPMENT AND SUPPORTS

5.4.1 All mechanical equipment and supports exposed to chemical contaminants will be protected with shop-applied epoxy primer. Compatible finish coat will be applied in the field as required.

5.4.2 All mechanical equipment and supports not exposed to chemical contaminants will receive manufacturer's standard finish.

5.5 ELECTRICAL AND INSTRUMENTATION EQUIPMENT

5.5.1 All electrical and instrumentation equipment will receive a manufacturer's standard finish.

5.5.2 All conduits, junction boxes, cable trays, hangers and supports, including unistrut required for the electrical and instrumentation, will be hot dipped galvanized or equal. 1

5.6 HVAC DUCTWORKS, HANGERS, AND SUPPORTS

All HVAC ductworks, hangers, and supports will be galvanized or painted carbon steel.

5.7 FERROUS AND NON-FERROUS METALS

5.7.1 Stainless steel and non-ferrous metals will not be shop or field coated.

5.7.2 All floor gratings, metal deck forms, and checkered plates will be galvanized.

5.8 CONCRETE WALLS, FLOORS, CEILINGS, AND MASONRY WALLS

5.8.1 Surfaces exposed to chemical contaminants will be protected with an epoxy surfacer and one coat of epoxy finish.

5.8.2 Concrete floors and walls in areas shown as sealed will be protected with a sealer or a hardener.

5.8.3 Surfaces except floors in areas other than those in Paragraphs 5.8.1 and 5.8.2 will be painted with conventional paint as required.

5.9 DOORS AND FRAMES

5.9.1 All doors and frames in areas which are not exposed to chemical contaminants will have manufacturer's standard shop-applied primer and will receive a field-applied finish coating as required.

5.9.2 All doors and frames exposed to chemical contaminants will receive manufacturer's standard primer and field-applied epoxy top coat.

5.10 SPECIAL DOORS

All special doors and frames will receive manufacturer's standard shop-applied primer and will receive a field-applied finish coating as required.

6.0 TOILET COMPARTMENTS AND LOCKERS

Toilet compartments will be of ceiling-hung, flush type metal, with baked-enamel factory finish. Lockers are steel, factory finished, and will be mounted on concrete curbs. Wood benches will receive a sealer.

7.0 ARCHITECTURAL ELEMENTS OF FIRE PROTECTION

7.1 BUILDING MATERIALS

7.1.1 Building materials, structural components, and interior finishes will be rated in accordance with ASTM E 84 and/or UL-723 Standard Test Methods for Classification of Building Materials. Materials shall have demonstrated flame spread classifications of 25 or less, fuel contribution of 25 or less by these tests. In addition, materials composed of or containing plastics and any floor coverings shall be separately approved for their planned utilization. 1

7.1.2 Fire resistive coatings will be applied to structural steel where necessary to obtain minimum hourly rating. 1

7.2 FIRE PROPAGATION CONTROL IN BUILDING DESIGN

7.2.1 Noncombustible fire barrier walls, floors, and ceilings will be provided in order to subdivide buildings into fire areas. The fire resistive rating and the delineation of fire barrier walls, floors, ceilings, and structural steel will be provided where required, based on: 1

7.2.1.1 Pennsylvania Code Fire and Panic Regulations by Department of Labor and Industry

7.2.1.2 NFPA codes and standards

7.2.1.3 ANI/MAERP Basic Fire Protection for Nuclear Power Plants

7.2.1.4 NRC Branch Technical Position ASB 9.5-1, Appendix A

7.2.2 The fire resistive integrity of fire barrier walls, floors, and
ceilings having through-penetrations will be maintained by sealing the 1
penetration openings with a tested material having an equivalent fire
resistive rating. Fire stop installations shall be approved by ANI.
The stops shall be tested in accordance with ASTM E 119 and shall meet 1
the requirements of 10 CFR 50, Appendix R, Section III.M.

7.2.3 Deleted 1

7.2 4 Floor drainage shall be provided and properly arranged to protect
against water damage and/or communication of fire. Floor penetrations
shall be curbed. Removable plugs shall be provided where needed to
prevent spread of fire due to flammable/combustible liquids that may 1
reach drains from spreading to another fire area.

7.2.5 An approved arrangement shall be provided to vent smoke and heat from fire from all levels of buildings, using either dedicated means, fixed or portable, or in combination with building features. Provisions will be made to monitor or sample smoke released from potentially radioactive areas.

7.3 EXIT FACILITIES REQUIREMENTS

Exit facilities will conform to the Pennsylvania Code for Fire and Panic Regulations by Department of Labor and Industry and OSHA requirements.

8.0 <u>SECURITY SYSTEM</u>

A security system will be provided and designed by GPU Services Corporation in accordance with their existing program.

BECHTEL

GPU SERVICE CORPORATION

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

DESIGN CRITERIA DOCUMENTS

COVER SHEET

JOB NO: 13587

DISCIPLINE: Civil-Structural

REV. NO.	DATE	REVISION DESCRIPTION	ORIGINATOR	APPROVAL: GROUP SUPV.	APPROVAL: PROJECT ENG.	APPROVAL: GPUSC
1	7/21/81	Revised as Noted and Issued for Use Upon GPUSC Approval				
0	12/22/80	Issued for Use Upon GPUSC Approval				

GPU-1.36 9/80

SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.
i	0												
ii	1												
1	0												
2	1												
3	1												
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App.A	0												
App.B	0												
App.C	1												
App.D	1												

DESIGN CRITERIA DOCUMENTS

REVISION STATUS SHEET

JOB NO. 13587

REV. 1

DISCIPLINE Civil-Structural

PAGE 1 of 1

CONTENTS

CONTENTS (Cont.)

1.0 INTRODUCTION

These criteria shall govern the design of structures and facilities of the Three Mile Island - Unit 2 recovery. The general Civil-Structural requirements for the design of structures and facilities are contained herein. Specific design requirements for major recovery facilities are contained in the specific design criteria for the facility. The design of recovery facilities shall be based on the general requirements contained herein and the additional specific requirements of the specific design criteria for the facility. In addition, the design of the facilities shall be based on consideration of such factors as the environment, specific site conditions, plant operation and maintenance, and public safety.

Revisions or additions to existing Unit 2 structures to accommodate recovery structures, systems, and components shall conform to the Unit 2 Final Safety Analysis Report (FSAR) and the criteria contained herein. The structural adequacy of the existing structures shall be evaluated for the new loads imposed by recovery facilities to assure conformance with the Unit 2 FSAR.

2.0 GOVERNING CODES, REGULATIONS, AND REFERENCE DOCUMENTS

Unless specifically stated otherwise, the design of all structures and facilities shall be based on applicable portions of the following codes, specifications, industry standards, regulations, topical reports and standards of the Bechtel Thermal Power Organization, and other reference documents. Where conflict occurs between criteria, the more restrictive shall apply. The date of issue (or revision) indicated shall apply.

2.1 GOVERNING CODES, SPECIFICATIONS, AND INDUSTRY STANDARDS

2.1.1 Building Officials and Code Administrators International, "The BOCA Basic Building Code," 1978.

2.1.2 American Institute of Steel Construction (AISC)

a. "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings," November 1, 1978

b. "Code of Standard Practice for Steel Buildings and Bridges," September 1, 1976

c. "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts," April 26, 1978.

2.1.3 American Iron and Steel Institute (AISI), "Specification for the Design of Cold-Formed Steel Structural Members," 1968 Edition, with Commentary dated 1970 and Supplement dated 1971.

2.1.4 American Welding Society (AWS)

a. "Structural Welding Code," (AWS D1.1-79)

b. "Reinforcing Steel Welding Code," (AWS D12.1-75).

2.1.5 American Concrete Institute (ACI)

a. "Building Code Requirements for Reinforced Concrete," (ACI 318-77)

b. "Manual of Standard Practice for Detailing Reinforced Concrete Structures," (ACI 315-74)

c. "Code Requirements for Nuclear Safety Related Concrete Structures," (ACI 349-76), revised 1978

d. "Building Code Requirements for Concrete Masonry Structures," (ACI 531-79). 1

2.1.6 American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, 1977, including all the approved addenda up to summer 1979, for the following sections:

Section II - Material Specifications, Part A - Ferrous

Section V - Nondestructive Examination

Section VIII - Pressure Vessels

Section IX - Welding and Brazing Qualifications

2.1.7 American National Standards Institute (ANSI), "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures," (ANSI A58.1-1972).

2.1.8 American Petroleum Institute (API)

a. "Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks," API Standard 620, Sixth Edition, Revision 2, December 31, 1978

b. "Welded Steel Tanks for Oil Storage," API Standard 650, Sixth Edition, Revision 1, May 15, 1978.

2.1.9 American Water Works Association (AWWA)

a. "Steel Pipe Design and Installation," AWWA Manual M11, 1964

b. "Standard for Reinforced Concrete Pressure Pipe, Noncylinder Type, for Water and Other Liquids," (AWWA C302-74).

2.1.10 American Society for Testing and Materials (ASTM)

Applicable ASTM standard specifications are referred to in the Project Civil-Structural specifications and Section 8 of these criteria.

2.1.11 American Association of State Highway and Transportation Officials (AASHTO)

a. "Standard Specifications for Highway Bridges," 1977

b. "Standard Specifications for Transportation Materials and Methods of Sampling and Testing," Parts I and II, 1978.

2.1.12 American Railway Engineering Association (AREA), "Manual for Railway Engineering," Volumes I and II, 1978.

2.1.13 Crane Manufacturers Association of America (CMAA), "Specifications for Electric Overhead Traveling Cranes," CMAA Specification No. 70, revised 1975. 1

2.2 REGULATIONS

2.2.1 United States Nuclear Regulatory Commission (USNRC) Regulations

USNRC regulations and regulatory guides applicable to the design of recovery facilities are listed in the General Section of the Project General Design Criteria.

2.2.2 OSHA Regulations

Occupational Safety and Health Administration (OSHA) regulations applicable to the design of recovery facilities are listed in the General Section of the Project General Design Criteria.

2.2.3 Regulations of the State of Pennsylvania as follows:

a. Pennsylvania Code for Fire and Panic Regulations by Department of Labor and Industry

b. Pennsylvania Department of Transportation Form 408 Specifications

2.3 BECHTEL THERMAL POWER ORGANIZATION'S TOPICAL REPORTS

Applicable Bechtel Thermal Power Organization's Topical Reports are listed in Appendix A of these design criteria.

2.4 BECHTEL THERMAL POWER ORGANIZATION'S STANDARDS

2.4.1 Civil/Structural Standard Details

2.4.2 Civil/Structural Design Standards and Guides listed in Appendix B

2.5 PROJECT'S STANDARDS AND DOCUMENTS

2.5.1 Project Engineering Procedures Manual

2.5.2 TMI Unit 2 Final Safety Analysis Report (FSAR) and amendments

2.5.3 Civil-Structural specifications

2.5.4 "Subsurface Investigation and Foundation Report, Three Mile Island Unit 2 Recovery Project," prepared by Bechtel Civil and Minerals, Inc., January 1981. 1

2.6 OTHER REFERENCE DOCUMENTS

2.6.1 American Institute of Timber Construction (AITC), "Timber Construction Manual," 1974.

2.6.2 American Concrete Institute (ACI), "Concrete Masonry Structures - Design and Construction," 1970.

2.6.3 Metal Building Manufacturers Association (MBMA), "Recommended Design Practices Manual," 1974.

3.0 SITE INFORMATION

The following site characteristics are included in FSAR Chapter 2.0:

a. Geography and Demography (FSAR Section 2.1)

b. Nearby Industrial, Transportation, and Military Facilities (FSAR Section 2.2)

c. Meteorology (FSAR Section 2.3)

d. Hydrologic Engineering (FSAR Section 2.4)

e. Geology and Seismology (FSAR Section 2.5).

The specific information to be used in civil-structural design is given in the following subsections:

3.1 SURVEYS AND DATUM

See the FSAR (Figure 1.2-2 and Section 2.5.1.2) for specific survey data and site location.

3.2 WATER LEVELS

Normal water level	277 ft
Maximum recorded high water level	302 ft
Design flood high water level	304 ft
Probable maximum flood high water level	311 ft
Design low water level	NA

3.3 PRECIPITATION

3.3.1 Rainfall

Average annual	36.5 in.
Daily maximum	12.6 in.
Design hourly maximum	5 in.

3.3.2 Snowfall

Average annual	36 in.
Daily maximum	21 in.
Monthly maximum	34 in.

3.4 GROUNDWATER TABLE

Average groundwater level is approximately at water level of the Susquehanna River. Groundwater levels around the Unit 2 powerblock range from 279 feet to 285 feet. 1

3.5 FROST PENETRATION

Depth below grade	3 ft, 4 in.

3.6 ICE

3.6.1 Damage due to the formation of ice on the Susquehanna River shall not be considered unless specifically noted in the specific design criteria for the facility.

3.6.2 Flooding due to the formation of an ice jam in the river is less severe than the maximum recorded high water level and need not be considered.

3.6.3 Structures within 500 feet of the Unit 2 cooling towers shall be designed for the load from 1 inch of ice uniformly distributed on its surface.

3.7 AIR TEMPERATURE

Record low	-8 F
Record high	107 F

3.8 DESIGN WINDS AND TORNADOES

3.8.1 Design Winds

Based on 100 year recurrence interval, the design wind velocity shall be 80 mph at 30 feet above grade.

3.8.2 Tornadoes

Site conditions:

Rotational wind velocity	290 mph
Translational wind velocity	70 mph
Combined wind velocity	360 mph

3.9 SEISMOLOGY

The site is located in Seismic Zone 1 as defined in the BOCA Basic Building Code. Seismic loads shall be considered in accordance with Subsection 6.9 of these criteria.

3.10 SOIL AND FOUNDATION CONDITIONS

Soil conditions and foundation recommendations for recovery facilities are contained in "Subsurface Investigation and Foundation Report, Three Mile Island Unit 2 Recovery Project." The allowable soil bearing 1
capacity for each facility is contained in the specific design criteria for the facility.

4.0 SEISMIC DESIGN CLASSIFICATION OF STRUCTURES

The plant structures, systems, and components are classified into two categories in accordance with NRC Regulatory Guide No. 1.29, "Seismic Design Classification." The two categories are Seismic Category I and non-Seismic Category I. For definitions of the two seismic design categories, see the General Section of the Project General Design Criteria. The specific design criteria for the facility will indicate the seismic design classification.

5.0 CIVIL WORK CRITERIA

5.1 EARTHWORK

5.1.1 Unless specified otherwise by the soils engineer, the following maximum slopes shall be used for excavation and embankment:

Evaporation ponds	3:1	(Horizontal:
Road excavation and embankments	2:1	Vertical)
Others	2:1	

5.1.2 The following values for compaction, expressed as percent of maximum dry density as determined by ASTM D 1557, shall be used:

Backfill for foundations, pipes, and electrical duct banks	95 percent
Embankments	95 percent
Roads	95 percent
Others	90 percent

5.2 ROADS

5.2.1 Grades shall be held to a maximum of 6 percent.

5.2.2 Minimum radius of curvature shall be as follows:

Access Road:	200 feet
Plant Road:	50 feet

5.2.3 Minimum width of lane shall be 12 feet. Shoulders are not required.

5.2.4 Design loading over culverts and pipes shall be in accordance with AASHTO-HS20-44, except for areas subject to special heavy transporting equipment.

5.3 RAILROADS

5.3.1 Grades shall be held to a maximum of 1 percent.

5.3.2 Curvature shall be held to a maximum of 14 degrees, with 10 degrees preferable.

5.3.3 A minimum of 4 inches of ballast under the ties shall be used.

5.3.4 No super-elevation will be required.

5.3.5 Construction and materials shall conform to the AREA Manual for Railway Engineering.

5.3.6 Design loading over culverts and pipes shall be Coopers E-80 plus 50 percent impact.

5.4 STORM DRAINAGE

5.4.1 Runoff, resulting from rainfall, shall be conveyed to drainage ditches by sloping the tributary surface area. Surface slopes shall be 1.0 percent minimum, but 0.5 percent minimum may be permitted in some instances, if approved by the Civil Group Supervisor.

5.4.2 Drainage ditch slopes shall be 0.5 percent minimum, but slopes as flat as 0.25 percent may be permitted in some instances, if approved by the Civil Group Supervisor.

5.4.3 Calculation of the flow shall be based on the Rational Method. The quantity of runoff shall be determined by the Rational Formula ($Q=CiA$) where:

Q = Design discharge
C = Runoff coefficient, ratio of runoff to rainfall
i = Rainfall intensity
A = Contributory area

5.4.4 Storm sewers shall be used near the locations of major structures. The maximum velocity shall be 8 fps and spacing between manholes shall not exceed 300 feet.

6.0 DESIGN LOADS

The following design loads shall be used for all structures and facilities unless noted otherwise in the specific design criteria for the facility.

6.1 DEAD LOADS (D)

6.1.1 The dead loads include the weight of framing, roofs, floors, walls, partitions, platforms, shielding, and all permanent equipment and materials. The vertical and lateral pressures of liquids shall also be treated as dead loads, as provided in Section 9.2.5 of ACI 318.

6.1.2 Floors shall be checked for the actual equipment loads (see the specific design criteria for major equipment weights). To provide for permanently attached small equipment, piping, conduits, and cable trays, a minimum of 50 psf shall be added where appropriate.

Pipe loads in areas with heavy piping concentrations and cable tray loads in areas of large concentrations of trays shall be carefully reviewed with the Project Plant Design Group and the Project Electrical Group, respectively, to determine the applicable design loads. These areas shall include, but are not limited to, those areas identified in the specific design criteria for the facility.

Where the piping is to be supported from platforms or walkway beams, actual loads shall be determined and used. The suitability of pipe hanger locations for main piping or unusual arrangements shall be coordinated with the Project Plant Design Group.

After pipe hanger locations and loads are fully established, all structural members shall be reviewed for structural adequacy and, if the members are overstressed, they shall be reinforced to withstand the established loads.

6.2 LIVE LOADS (L)

6.2.1 Live loads shall be as specified in Subsection 6.2.2, but in no case less than the minimum design live loads specified in Subsection 6.2.4 or the specific design criteria for the facility.

6.2.2 Live loads include floor area loads, laydown loads, equipment handling loads, lateral earth pressure, ice and snow, trucks, railroad vehicles, and similar items. The floor area live load shall be omitted from areas occupied by equipment whose weight is specifically included in dead load. Live load shall not be omitted where access under equipment is provided, for instance, an elevated tank on four legs. The floor design live loads shall be shown both in the calculations and on the design drawings.

6.2.3 Posting of Live Loads

The design live loads shall be marked on plates of approved design. Such plates shall be affixed at selected conspicuous places in each space to which they relate.

6.2.4 Minimum Design Live Loads

The following minimum live loads shall be used in the design. Live loads applicable to specific structures or facilities are listed separately in the specific design criteria for the facility.

a. General

Roofs	Snow loads (Subsection 6.4)
Offices	50 psf
Assembly and locker rooms	100 psf
Laboratories and laundry rooms	100 psf
Stairs, platforms, and walkways	100 psf or 1000 lbs.*
Railings (applied in any direction at top of railing)	50 plf or 200 lbs.*
Floors on grade	250 psf
Railroad support structures	Coopers E-80
Railroad surcharge	Per AREA Manual
Truck support structures	AASHTO HS20-44
Machine shop and warehouse floor	500 psf
All other elevated floors	200 psf

*Note: Concentrated loads should be so applied as to produce maximum moment or shear.

b. Live Load Reduction

1) No live load reduction shall be allowed for warehouses, storage areas, and tanks.

2) No live load reduction shall be allowed for the design of slabs, beams, joists, trusses, and girders for live loads greater than 100 psf.

3) For live loads greater than 100 psf, the following live load reduction shall apply for the design of columns, piers, walls, and foundations:

Supporting:	
Roof	0%
Roof and 1 floor	0%
Roof and 2 floors	10%
Roof and 3 or more floors	20%

4) For live loads of 100 psf or less the requirements of the BOCA Basic Building Code shall apply.

6.3 CONSTRUCTION LOADS

Displacements and stresses of major structural elements shall be checked for the following loads:

a. Metal decking for concrete slabs	Weight of the concrete plus 50 psf without increase in allowable stress, or weight of the concrete plus 100 psf with one-third increase in allowable stress, whichever governs.
b. Steel beams supporting concrete floors	Weight of the concrete plus 100 psf uniform load on the tributary floor area, or weight of the concrete plus 5 kips concentrated load so applied as to produce maximum moment or shear. One-third increase in allowable stress is permitted.
c. Precast floor panels supporting poured-in-place topping	Weight of the precast panel and topping plus 100 psf uniform load, or weight of the precast panel and topping plus 5 kips concentrated load so applied as to produce maximum moment or shear. Increase in allowable stress shall not be permitted. Camber shall be provided for long spans.

6.4 SNOW LOADS AND PONDING

The ground snow load is 30 psf based on 100-year mean recurrence interval. The minimum roof snow load shall be taken as 0.8 times the ground snow load. To account for roof geometry and drifting, the snow load distributions and related coefficients given in Appendix L of the BOCA Basic Building Code shall be utilized.

Unless a roof surface is provided with sufficient slope toward points of free drainage or adequate individual drains to prevent the accumulation of rainwater, the roof structure shall be designed to assure stability under ponding conditions. The provisions of Section 1.13.3 of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings shall be satisfied to assure stability.

6.5 CRANE LOADS

a. All cranes will be class B, per CMAA Specification No. 70, unless noted otherwise.

b. Crane and equipment supplier's information shall be used for wheel loads, equipment loads, and weights of moving parts. Construction loads shall be considered, where applicable.

c. Impact allowance for traveling crane supports and runway horizontal forces shall be in accordance with Paragraphs 1.3.3 and 1.3.4 of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

d. Maximum vertical deflection for crane and monorail girders shall not exceed 1/800 of the span length. Impact shall not be considered in determining deflection.

e. Crane lift loads need not be combined with wind loads.

f. The weight of the unloaded crane shall be considered simultaneously with the seismic loads. The horizontal inertia forces shall be obtained by the provisions of the BOCA Basic Building Code.

6.6 ELEVATOR LOADS

Impact allowance for the supports of elevators shall be 100 percent unless otherwise specified by the equipment suppliers.

6.7 DESIGN FLOOD PRESSURE

For structural and buoyancy calculations, Seismic Category I structures shall be designed to withstand the effect of the probable maximum flood high water level given in Subsection 3.2. Non-Seismic Category I structures shall be designed for the effect of the design flood high water level given in Subsection 3.2.

6.8 DESIGN WIND AND TORNADO LOADS

6.8.1 Design wind loads shall be determined in accordance with Topical Report BC-TOP-3-A and ANSI A58.1 for the design wind velocity given in Subsection 3.8.1. 1

6.8.2 Tornado Loads

a. The design basis tornado shall conform to Regulatory Guide 1.76, Region I, and shall have the following characteristics:

Maximum wind velocity	360 mph
Rotational velocity	290 mph
Maximum translational velocity	70 mph
Minimum translational velocity	5 mph
Radius of maximum rotational velocity	150 ft
Pressure drop	3.0 psi
Rate of pressure drop	2.0 psi/sec

The characteristics listed above and the techniques presented in Topical Report BC-TOP-3-A shall be utilized to determine tornado loads.

b. The postulated tornado missiles and the criteria for their design shall be given in the specific design criteria of the facility if applicable.

6.9 SEISMIC LOADS

Topical Report BC-TOP-4-A shall be the basic reference document for seismic analysis. Horizontal and vertical seismic accelerations shall be considered to act simultaneously. The horizontal response spectra and vertical response spectra given in BC-TOP-4-A Figures 2-11 and 2-15, respectively, shall be utilized by linearly scaling to the ground acceleration levels indicated below. The following seismic loads shall be considered based on the seismic design classification of the structure:

6.9.1 Seismic Category I

a. Safe Shutdown Earthquake Load

Seismic Category I structures and components shall be designed for no loss of function when subjected to the safe shutdown earthquake (SSE). The ground accelerations for the SSE shall be .12 g horizontal and .08 g vertical. Damping factors shall be as listed in Topical Report BC-TOP-4-A.

b. Operating Basis Earthquake Load

Seismic Category I structures and components shall also be designed to remain within appropriately defined allowable stress limits when subjected to operating basis earthquake (OBE). The ground accelerations for the OBE shall be .06 g horizontal and .04 g vertical. Damping factors shall be as listed in Topical Report BC-TOP-4-A.

6.9.2 Non-Seismic Category I

a. Non-Seismic Category I structures shall be designed for seismic loads determined in accordance with the BOCA Basic Building Code for Seismic Zone 1, except as noted below and in Subsection 7.5 of these design criteria.

b. Non-Seismic Category I structures whose collapse or excessive deformation could result in loss of required function of adjacent safety-related structures, equipment, or systems shall be designed in one of the following ways:

1) An inelastic analysis will be performed to assure that the non-Seismic Category I structure will not collapse or deform to the extent that loss of the required safety function of adjacent safety-related structures, equipment, or systems will result when subjected to the SSE.

2) An elastic analysis will be performed to assure that the non-Seismic Category I structure will not collapse or deform to the extent that loss of the required safety

function of adjacent safety-related structures, equipment, or systems will result when subjected to the SSE. Stresses shall be limited to 0.9 of yield or 0.9 of any failure mode.

6.10 SPECIAL CONSIDERATIONS FOR TEMPORARY LOADS

a. Temporary Conditions

For structures subjected to temporary loads, one-third increase in allowable stress is permitted. Liner plates, if used as forms, either shall be designed for the lateral pressure corresponding to the rate of concrete placement, or shall be provided with a suitable bracing system as noted on the drawings.

Design restrictions on shoring removal that are different from the normal practice recommended by ACI codes shall be shown on the specific design drawings.

b. Backfill Conditions

Generally structures may be backfilled with structural backfill when concrete compressive strength reaches 60 percent of the specified compressive strength (f'_c). Other backfill restrictions, if any, shall be shown on the specific design drawings.

7.0 DESIGN BASES

7.1 GENERAL

All steel structures shall be designed by the working stress or plastic design methods. All reinforced concrete structures shall be designed using strength design concepts. Soil bearing pressure shall be checked for the actual loads.

The following sections establish the design methods and load combinations for all structures based on the seismic design classification of the structure. In addition, seismic considerations; factors of safety for overturning, sliding, and flotation; and temperature limits and reductions are presented.

7.2 FACTORS OF SAFETY FOR OVERTURNING, SLIDING, AND FLOTATION

7.2.1 Factors of Safety for Seismic Category I Structures

All Seismic Category I structures shall be checked for overturning, sliding, and flotation using the load combinations and the minimum factors of safety indicated below.

Load Combination	Minimum Factor of Safety		
	Overturning	Sliding	Flotation
D + H + E	1.5	1.5	-

D + H + W	1.5	1.5	-
D + H + E´	1.1	1.1	-
D + H + W_t	1.1	1.1	-
D + F	-	-	1.1

H is the lateral earth pressure and F is the resultant bouyant force due to the probable maximum flood high water level. D, E, W, W_t, and E´ are defined in Section 7.4.1.

7.2.2 Factors of Safety for Non-Seismic Category I Structures

Non-Seismic Category I structures shall be checked for overturning, sliding, and flotation using the load combinations and the minimum factors of safety indicated below.

Load Combination	Minimum Factor of Safety		
	Overturning	Sliding	Flotation
D + H + E	1.5	1.5	-
D + H + W	1.5	1.5	-
D + F	-	-	1.1
D + H + E_{ss}	1.1	1.1	-

H is defined in the above section. D, E, W, and E_{ss} are defined for non-Seismic Category I structures in Section 7.5.1. F is the resultant bouyant force due to the design flood high water level.

The last load combination in the above table shall be checked for type A and type C non-Seismic Category I structures only. For definition of the different types of non-Seismic Category I structures, see Section 7.5.

7.3 SEISMIC CONSIDERATIONS

In the loading combinations where seismic forces are considered, the general criterion is to use dead and live loads most likely to exist during normal operation. Based on this criterion the loads as defined in Sections 6.1 and 6.2 shall be taken into account as follows:

a. Dead loads (D): The total dead load must be considered in seismic analysis and design.

b. Live Loads (L): The design live loads are based on maximum probable loads during normal operation or shutdown and maintenance conditions. The fraction of design live load which is likely to occur during normal operation (occupancy loads) is relatively small. Other loads contributing to the design live load (such as laydown, maintenance, temporary crane, etc.)

should not be included in the loading combinations involving seismic loads. Therefore, in seismic analysis and design only a fraction of the design live loads should be considered. The fraction of the live load to be used should be based on functional requirements of the particular structure, but in no case should be less than 25 percent of the design live load.

7.4 SEISMIC CATEGORY I STRUCTURES

In general, all Seismic Category I concrete structures shall be designed in accordance with ACI 349. All Seismic Category I steel structures shall be designed in accordance with the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. Certain modifications and supplements to suit conditions peculiar to nuclear power plants will be noted in the allowable stresses and load combinations given in the following subsections.

The design of masonry walls in Seismic Category I structures shall be in accordance with Appendix O.

When subjected to various combinations of gravity, thermal, and environmental loads, Seismic Category I structures shall be proportioned to maintain elastic behavior. Elastic behavior shall be considered as limited by the yield stress of structural steel materials or the ultimate capacity of reinforced concrete elements. Yield stress for steel (including reinforcing steel) is the guaranteed minimum value in the appropriate ASTM specification. Reinforcing steel stresses shall always control the design of reinforced concrete members.

The seismic analysis of Seismic Category I structures shall conform to Topical Report BC-TOP-4-A.

7.4.1 Definitions

The following nomenclature and definition of terms apply to the design of Seismic Category I structures.

a. Normal Loads

Normal loads are those loads encountered during normal plant operation and shutdown. They include the following:

D = Dead loads as defined in Section 6.1

L = Live loads as defined in Section 6.2

T_o = Thermal effects and loads during normal operating and shutdown conditions, based on the most critical transient or steady-state condition

R_o = Pipe reactions during normal operating or shutdown conditions, based on the most critical transient or steady-state condition

b. Severe Environmental Loads

Severe environmental loads are those loads that could infrequently be encountered during plant life. They include the following:

E = Loads generated by the operating basis earthquake (OBE) as defined in Section 6.9.1.b

W = Loads generated by the design wind as defined in Section 3.8.1

c. Extreme Environmental Loads

Extreme environmental loads are those loads which are credible but highly improbable. They include the following:

E' = Loads generated by the safe shutdown earthquake (SSE) as defined in Section 6.9.1.a

W_t = Loads generated by the design basis tornado as specified in Section 6.8.2. They include loads due to tornado wind pressure, tornado-created differential pressure, tornado-generated missiles, and collapse of adjacent non-Seismic Category I structure(s).

d. Other Definitions

S = For structural steel, S is the required section strength based on the elastic design methods and the allowable stresses defined in Part 1 of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

U = For concrete structures, U is the section strength required to resist design loads, based on the methods described in ACI 349.

Y = For structural steel, Y is the section strength required to resist design loads, based on plastic design methods described in Part 2 of AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

The one-third increase in allowable stresses for concrete and steel due to seismic or wind loadings is not permitted for Seismic Category I structures.

7.4.2 Load Combinations

Seismic Category I structures and components shall be designed to resist the load combinations given in the following subsections unless noted otherwise in the specific design criteria for the facility.

7.4.2.1 Seismic Category I Concrete Structures and Components

Seismic Category I concrete structures shall be designed to resist the following load combinations. The strength design method described in ACI 349 shall be used.

a. Load Combinations for Service Load Conditions

1. $U = 1.4\ D + 1.7\ L$
2. $U = 1.4\ D + 1.7\ L + 1.9\ E$
3. $U = 1.4\ D + 1.7\ L + 1.7\ W$
4. $U = 0.75\ (1.4\ D + 1.7\ L + 1.7\ T_o + 1.7\ R_o)$
5. $U = 0.75\ (1.4\ D + 1.7\ L + 1.9\ E_o + 1.7\ T_o + 1.7\ R_o)$
6. $U = 0.75\ (1.4\ D + 1.7\ L + 1.7\ W + 1.7\ T_o + 1.7\ R_o)$

The cases of L having its full value of being completely absent shall be checked for the above combinations. The following combinations shall also be satisfied:

7. $U = 1.2\ D + 1.9\ E$
8. $U = 1.2\ D + 1.7\ W$

Where lateral earth and liquid pressures are present, in addition to all the above combinations where they have been included in L and D, respectively, the requirements of Section 9.2.4 and 9.2.5 of ACI 318 shall also be satisfied.

b. Load Combinations for Factored Load Conditions

The following load combinations, which represent extreme environmental conditions, shall be satisfied. The cases of L having its full value or being completely absent shall be checked.

9. $U = D + L + T_o + R_o + E'$
10. $U = D + L + T_o + R_o + W_t$

7.4.2.2 Seismic Category I Steel Structures and Components

Seismic Category I steel structures shall be designed to resist the following load combinations. For all load combinations listed below, the cases of L having its full value or being completely absent shall be checked.

a. Load Combinations for Service Load Conditions

1. For elastic working stress design methods, the following load combinations shall be considered:

   1. $S = D + L$
   2. $S = D + L + E$
   3. $S = D + L + W$
   4. $1.5\ S = D + L + T_o + R_o$
   5. $1.5\ S = D + L + T_o + R_o + E$

6. $1.5\,S = D + L + T_o + R_o + W$

No increase in allowable stress is permitted for load combinations 1, 2, and 3.

2. If plastic design methods are used, the following load combinations shall be considered:

1. $Y = 1.7\,D + 1.7\,L$
2. $Y = 1.7\,D + 1.7\,L + 1.7\,E$
3. $Y = 1.7\,D + 1.7\,L + 1.7\,W$
4. $Y = 1.3\,(D + L + T_o + R_o)$
5. $Y = 1.3\,(D + L + E_o + T_o + R_o)$
6. $Y = 1.3\,(D + L + W + T_o + R_o)$

b. Load Combinations for Factored Load Conditions

1. For elastic working stress design methods, the following load combinations shall be satisfied:

7. $1.6\,S = D + L + T_o + R_o + E'$
8. $1.6\,S = D + L + T_o + R_o + W_t$

2. If plastic design methods are used, the following load combinations shall be considered:

7. $0.9\,Y = D + L + T_o + R_o + E'$
8. $0.9\,Y = D + L + T_o + R_o + W_t$

For load combinations 7 and 8, thermal loads may be neglected where it can be shown that they are secondary and self-limiting in nature and where the material is ductile.

7.4.2.3 Explanation of Load Combinations

a. Load Combinations for Service Load Conditions

These combinations include all loads which are expected to be applied during normal plant operation, including loads from the design wind and the OBE as well as loads from thermal effects and pipe reactions.

b. Load Combinations for Factored Load Conditions

These combinations include events and the resulting loads which are highly improbable, the safe shutdown earthquake and the design basis tornado.

7.5 NON-SEISMIC CATEGORY I STRUCTURES

All non-Seismic Category I concrete structures shall be designed in accordance with ACI 318. All non-Seismic Category I steel structures shall be designed in accordance with the AISC Specification for the

Design, Fabrication and Erection of Structural Steel for Buildings. In addition, any modifications or supplemental requirements given in the following subsections shall apply.

The design of masonry walls in non-Seismic Category I structures shall be in accordance with ACI 531. 1

Non-Seismic Category I structures are further classified as type A, B, C, or D as follows.

Type A: Structures which are located adjacent to safety-related systems, structures, and equipment are classified as type A. Type A structures shall be designed for seismic loads determined in accordance with the BOCA Basic Building Code. In addition, these structures shall be checked to assure that they will not collapse or experience excessive deformation to the extent that they will cause loss of the safety function of adjacent safety-related systems, structures, or equipment when subjected to the safe shutdown earthquake (SSE).

Type B: Structures which are not located adjacent to safety-related systems, structures, and equipment are classified as type B. Type B structures shall be designed for seismic loads determined in accordance with the BOCA Basic Building Code only.

Type C: Structures which house liquid and/or solid radwaste systems and are located adjacent to safety-related systems, structures, and equipment are classified as type C. Type C structures shall be designed for seismic loads due to the operating basis earthquake (OBE). In addition, these structures shall be checked to assure that they will not collapse or experience excessive deformation to the extent that they will cause loss of the safety function of adjacent safety-related systems, structures, or equipment when subjected to the SSE.

Type D: Structures which house liquid and/or solid radwaste systems but are not located adjacent to safety-related systems, structures, and equipment are classified as type D. Type D structures shall be designed for seismic loads due to the OBE.

The simplified "inelastic" analysis procedure given in Civil/Structural Design Guide C-2.33, "Simplified Inelastic Seismic Analysis of Non-Category I Structures," is an acceptable method to determine the loads due to the SSE for type A and type C structures.

Non-Seismic Category I structures located adjacent to safety-related structures shall not be designed to prevent collapse when subjected to the design basis tornado. The safety-related structure shall instead be checked to assure that it can withstand the collapse of the adjacent non-Seismic Category I structure(s) without loss of safety-related function.

7.5.1 Definitions

The following nomenclature and definition of terms apply to the design of non-Seismic Category I structures.

a. Normal Loads

Normal loads are those loads encountered during normal plant operation and shutdown. They include the following:

D = Dead loads as defined in Section 6.1

L = Live loads as defined in Section 6.2

b. Severe Environmental Loads

Severe environmental loads are those loads that could infrequently be encountered during plant life. They include the following:

E = Seismic loads as specified in the BOCA Basic Building Code for type A and type B structures or seismic loads due to the operating basic earthquake (OBE) for type C and type D structures

W = Loads generated by the design wind as defined in Section 3.8.1

c. Extreme Environmental Loads

Extreme environmental loads are those loads which are credible but highly improbable. They include the following:

E_{ss} = Loads generated by the safe shutdown earthquake, obtained using Design Guide C-2.33

Extreme environmental loads shall be considered in the design of type A and type C structures only.

d. Other Definitions

S = For structural steel, S is the required section strength based on the elastic design methods and the allowable stresses defined in Part 1 of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

U = For concrete structures, U is the section strength required, based on the methods described in ACI 318.

Y = For structural steel, Y is the section strength required, based on plastic design methods described in Part 2 of the AISC Specification.

7.5.2 Load Combinations

Non-Seismic Category I structures and components shall be designed to resist the load combinations given in the following subsections unless noted otherwise in the specific design criteria for the facility.

7.5.2.1 Non-Seismic Category I Concrete Structures and Components

Non-Seismic Category I concrete structures shall be designed to resist the following load combinations. The strength design method described in ACI 318 shall be used.

1. $U = 1.4\ D + 1.7\ L$
2. $U = 0.75\ (1.4\ D + 1.7\ L + 1.87\ E)$
3. $U = 0.75\ (1.4\ D + 1.7\ L + 1.7\ W)$

The cases of L having its full value or being completely absent shall be checked for the above equations and equation 6. The following combinations shall also be satisfied:

4. $U = 0.9\ D + 1.43\ E$
5. $U = 0.9\ D + 1.3\ W$

The following load combination shall be checked for type A and type C structures only:

6. $U = D + L + E_{ss}$

Where lateral earth and liquid pressures are present, in addition to all the above combinations where they have been included in L and D, respectively, the requirements of Section 9.2.4 and 9.2.5 of ACI 318 shall also be satisfied.

7.5.2.2 Non-Seismic Category I Steel Structures and Components

Non-Seismic Category I steel structures shall be designed to resist the following load combinations. For all load combinations listed below, the cases of L having its full value or being completely absent shall be checked.

a. For elastic working stress design methods, the following load combinations shall be considered:

   1. $S = D + L$
   2. $1.33\ S = D + L + E$
   3. $1.33\ S = D + L + W$

   The following load combination shall be checked for type A and type C structures only:

   4. $1.6\ S = D + L + E_{ss}$

b. If plastic design methods are used, the following load combinations shall be considered:

1. $Y = 1.7\ (D + L)$
2. $Y = 1.3\ (D + L + E)$
3. $Y = 1.3\ (D + L + W)$

The following load combination shall be checked for type A and type C structures only:

4. $0.9\ Y = D + L + E_{ss}$

7.5.2.3 Explanation of Load Combinations

Combinations 1 through 5 for concrete structures and 1 through 3 for steel structures are strictly in accordance with established criteria for the design of conventional structures. These five load combinations for concrete structures are in accordance with the ACI 318, and the three combinations for steel structures are in accordance with AISC Specification.

Combination 6 for concrete structures and 4 for steel structures involve the safe shutdown earthquake and are applicable to type A and type C structures only. These combinations include extreme environmental loads and should be checked only to assure that the structure will not collapse or deform to the extent that it will affect the integrity of adjacent safety-related systems, structures, and equipment. Consequently, only the main framing members which resist earthquake forces should be considered and sized to satisfy these combinations.

In addition to the loads listed in Section 7.5.1, the effects of differential settlement and temperature changes should be considered if these effects are significant.

7.5.3 Pre-engineered Metal Buildings

Pre-engineered metal buildings may be used for structures classified as type B non-Seismic Category I structures only.

Pre-engineered metal buildings shall conform to the requirements of this section in lieu of the requirements given in the preceding sections for non-Seismic Category I structures.

The design of pre-engineered metal buildings shall conform to the Metal Building Manufacturers Association (MBMA), "Recommended Design Practices Manual." The combinations of loads and allowable stresses to be considered in the design of all members of the structure shall be in accordance with Section 7 of the MBMA Manual.

The basic wind load shall be 20 psf applied and proportioned as horizontal and uplift forces in accordance with Section 4 of the MBMA manual.

Seismic loads determined in accordance with the BOCA Basic Building Code for Seismic Zone 1 shall be considered in the design of pre-engineered metal buildings.

7.6 TEMPERATURE LIMITS AND REDUCTIONS

7.6.1 Steel

For structural steel elements, the maximum temperatures are limited to 700 F and the allowable stress values shall be reduced by 5 percent for each 100 F increase in temperature, using 100 F as the base for the allowables.

7.6.2 Concrete

The limitations listed below are applicable only to concrete structural components:

a. The following temperature limitations are for normal operation or any other long-term period. The temperatures are not allowed to exceed 150 F, except for local areas which may be allowed increased temperatures not exceeding 200 F.

b. The following temperature limitations are for accident or any other short-term period. The temperatures are not allowed to exceed 350 F for the interior surface. However, local areas may be allowed to reach 650 F from steam and/or water jets in the event of a pipe failure.

c. Temperatures higher than given in items a. and b. may be allowed in concrete, if test data can be provided to evaluate the corresponding reduction in strength. Such a reduction shall be applied to the design allowable values. Also, evidence will be provided which verifies that the increased temperatures do not cause deterioration of concrete, either with or without load.

8.0 CONSTRUCTION MATERIALS

8.1 The principal construction materials for Seismic Category I and non-Seismic Category I structures are concrete, reinforcing steel, structural steel, masonry, and metal decking, as specified herein or in the specific design criteria for the facility.

8.2 Concrete design compressive strengths shall be as follows:

Item	f'_c (psi)
Precast concrete panels	5000
All other plant structures	3000 (minimum)
Lean concrete backfill and electrical duct encasement	2500

Compressive strength (f'_c) refers to compressive strength at 28 days.

8.3 Reinforcing steel shall be deformed billet steel, conforming to ASTM A 615, Grade 60.

8.4 Welded Steel Wire Fabric shall conform to ASTM A 185 (plain wire) or A 497 (deformed wire).

8.5 Structural steel shall conform to ASTM A 36, unless otherwise noted on drawings or within specifications.

8.6 Fasteners shall conform to ASTM A 307 unless high-strength bolts are specified. High-strength bolts shall conform to ASTM A 325 or A 490.

8.7 Anchor bolts shall conform to ASTM A 36, A 307, or A 449.

8.8 Masonry for all structures shall conform to Project Architectural Specification 13587-2-A-016 and Material Requisition 13587-2-A-016/1.

8.9 Unless otherwise required by special conditions, metal decking shall be used and considered in design for forming concrete slabs.

8.10 The Civil-Structural specifications specify all the construction materials for Seismic Category I and non-Seismic Category I structures.

9.0 DESIGN CONTROL

9.1 DOCUMENT SUBMITTALS

In accordance with the Division Chief Civil Engineer's design control procedures, design documents listed in the Project Civil-Structural Design Control Check List (DCCL) shall be submitted to the Division Chief Civil Engineer for review and approval.

9.2 DESIGN SUMMARY

A design summary shall be prepared for each major recovery structure as listed in the Project Civil-Structural DCCL. The design summary shall be in the form of a calculation and limited to the following information:

a. Reference to the appropriate specific design criteria for that structure

b. Methods of analysis and design

c. Summary of results, showing the margin of safety under design loads for typical sections in the building.

APPENDIX A

LIST OF

BECHTEL THERMAL POWER ORGANIZATION'S

TOPICAL REPORTS

FOR

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

TOPICAL REPORT NUMBER, REVISION, DATE	TITLE
BC-TOP-3-A, Rev. 3, 8-74	Tornado and Extreme Wind Design Criteria for Nuclear Power Plants
BC-TOP-4-A, Rev. 3, 11-74	Seismic Analyses of Structures and Equipment for Nuclear Power Plants

APPENDIX B

LIST OF

BECHTEL THERMAL POWER ORGANIZATION'S

CIVIL/STRUCTURAL DESIGN STANDARDS AND GUIDES

FOR

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

DESIGN STANDARDS AND GUIDES		REV.	DATE
C-2.5	Caissons	0	09/74
C-2.14	Structural Design of Pile Foundations	0	09/74
C-2.16	Structural Welding	1	04/75
C-2.17	Structural Design of Diaphragms	0	10/73
C-2.22	Yard Utilities	1	05/76
C-2.23	Earthwork	1	05/77
C-2.25	Structural Review of Heavy-Lift Rigging	0	06/74
C-2.26	Rotating Equipment Foundations	0	10/74
C-2.27	Sanitary Facilities	0	03/74
C-2.28	Design Criteria for Nuclear Power Plant Category I Structures	0	02/75
C-2.29	Beam End Connections Steel Beam to Concrete 45 Kips or Less	0	04/74
C-2.30	Waterproofing and Waterstops	1	10/75
C-2.31	Instructions for Using Computer Programs	0	10/73
C-2.32	Strength Criteria for Structural Steel for Category I Structures	0	03/74
C-2.33	Simplified Inelastic Seismic Analysis of Non-Category I Structures	0	06/75
C-2.34	Anchor Bolt	1	04/75
C-2.36	Modular Embed Systems and Insert Plates	3	04/79
C-2.37	Painting and Coating Exposed Surfaces of Power Plants	0	12/76
C-2.38	Thermal Effects Combined With Real Loads	0	02/77
C-2.40	Concrete Expansion Anchors	0	08/77
C-2.42	Multi-Discipline Design Guide for Embedded Conduit & Piping	0	06/78

APPENDIX C

(deleted) 1

APPENDIX D

DESIGN REQUIREMENTS OF MASONRY WALLS IN SEISMIC CATEGORY I STRUCTURES 1

FOR

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

(later)

BECHTEL

Design Criteria 13587-2-C01-100

GPU SERVICE CORPORATION

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

DESIGN CRITERIA DOCUMENTS

COVER SHEET

JOB NO: 13587

DISCIPLINE: Civil-Structural

0	12/22/80	Issued for Use Upon GPUSC Approval	EJS		RW	
REV. NO.	DATE	REVISION DESCRIPTION	ORIGINATOR	GROUP SUPV.	PROJECT ENG	GPUSC
				APPROVAL		

GPU-1.80 Rev. 9/80

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BECHTEL

DESIGN CRITERIA DOCUMENTS
REVISION STATUS SHEET

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CONTENTS

CONTENTS (Cont.)

1.0 INTRODUCTION

These criteria shall govern the design of structures and facilities of the Three Mile Island - Unit 2 recovery. The general Civil-Structural requirements for the design of structures and facilities are contained herein. Specific design requirements for major recovery facilities are contained in the specific design criteria for the facility. The design of recovery facilities shall be based on the general requirements contained herein and the additional specific requirements of the specific design criteria for the facility. In addition, the design of the facilities shall be based on consideration of such factors as the environment, specific site conditions, plant operation and maintenance, and public safety.

Revisions or additions to existing Unit 2 structures to accommodate recovery structures, systems, and components shall conform to the Unit 2 Final Safety Analysis Report (FSAR) and the criteria contained herein. The structural adequacy of the existing structures shall be evaluated for the new loads imposed by recovery facilities to assure conformance with the Unit 2 FSAR.

2.0 GOVERNING CODES, REGULATIONS, AND REFERENCE DOCUMENTS

Unless specifically stated otherwise, the design of all structures and facilities shall be based on applicable portions of the following codes, specifications, industry standards, regulations, topical reports and standards of the Bechtel Thermal Power Organization, and other reference documents. Where conflict occurs between criteria, the more restrictive shall apply. The date of issue (or revision) indicated shall apply.

2.1 GOVERNING CODES, SPECIFICATIONS, AND INDUSTRY STANDARDS

2.1.1 Building Officials and Code Administrators International, "The BOCA Basic Building Code," 1978.

2.1.2 American Institute of Steel Construction (AISC)

a. "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings," November 1, 1978

b. "Code of Standard Practice for Steel Buildings and Bridges," September 1, 1976

c. "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts," April 26, 1978.

2.1.3 American Iron and Steel Institute (AISI), "Specification for the Design of Cold-Formed Steel Structural Members," 1968 Edition, with Commentary dated 1970 and Supplement dated 1971.

2.1.4 American Welding Society (AWS)

a. "Structural Welding Code," (AWS D1.1-79)

b. "Reinforcing Steel Welding Code," (AWS D12.1-75).

2.1.5 American Concrete Institute (ACI)

a. "Building Code Requirements for Reinforced Concrete," (ACI 318-77)

b. "Manual of Standard Practice for Detailing Reinforced Concrete Structures," (ACI 315-74)

c. "Code Requirements for Nuclear Safety Related Concrete Structures," (ACI 349-76), revised 1978.

2.1.6 American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, 1977, including all the approved addenda up to summer 1979, for the following sections:

Section II - Material Specifications, Part A - Ferrous

Section V - Nondestructive Examination

Section VIII - Pressure Vessels

Section IX - Welding and Brazing Qualifications

2.1.7 American National Standards Institute (ANSI), "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures," (ANSI A58.1-1972).

2.1.8 American Petroleum Institute (API)

a. "Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks," API Standard 620, Sixth Edition, Revision 2, December 31, 1978

b. "Welded Steel Tanks for Oil Storage," API Standard 650, Sixth Edition, Revision 1, May 15, 1978.

2.1.9 American Water Works Association (AWWA)

a. "Steel Pipe Design and Installation," AWWA Manual M11, 1964

b. "Standard for Reinforced Concrete Pressure Pipe, Noncylinder Type, for Water and Other Liquids," (AWWA C302-74).

2.1.10 American Society for Testing and Materials (ASTM)

Applicable ASTM standard specifications are referred to in the Project Civil-Structural specifications and Section 8 of these criteria.

2.1.11 American Association of State Highway and Transportation Officials (AASHTO)

a. "Standard Specifications for Highway Bridges," 1977

b. "Standard Specifications for Transportation Materials and Methods of Sampling and Testing," Parts I and II, 1978.

2.1.12 American Railway Engineering Association (AREA), "Manual for Railway Engineering," Volumes I and II, 1978.

2.1.13 Crane Manufacturers Association of America (CMAA), "Specifications for Electric Overhead Traveling Cranes," CMAA Specification No. 70, revised 1975.

2.1.14 National Concrete Masonry Association (NCMA), "Specification for the Design and Construction of Load-Bearing Concrete Masonry," August, 1972.

2.2 REGULATIONS

2.2.1 United States Nuclear Regulatory Commission (USNRC) Regulations

USNRC regulations and regulatory guides applicable to the design of recovery facilities are listed in the General Section of the Project General Design Criteria.

2.2.2 OSHA Regulations

Occupational Safety and Health Administration (OSHA) regulations applicable to the design of recovery facilities are listed in the General Section of the Project General Design Criteria.

2.2.3 Regulations of the State of Pennsylvania as follows:

a. Pennsylvania Code for Fire and Panic Regulations by Department of Labor and Industry

b. Pennsylvania Department of Transportation Form 408 Specifications

2.3 BECHTEL THERMAL POWER ORGANIZATION'S TOPICAL REPORTS

Applicable Bechtel Thermal Power Organization's Topical Reports are listed in Appendix A of these design criteria.

2.4 BECHTEL THERMAL POWER ORGANIZATION'S STANDARDS

2.4.1 Civil/Structural Standard Details

2.4.2 Civil/Structural Design Standards and Guides listed in Appendix B

2.5 PROJECT'S STANDARDS AND DOCUMENTS

2.5.1 Project Engineering Procedures Manual

2.5.2 TMI Unit 2 Final Safety Analysis Report (FSAR) and amendments

2.5.3 Civil-Structural specifications

2.6 OTHER REFERENCE DOCUMENTS

2.6.1 American Institute of Timber Construction (AITC), "Timber Construction Manual," 1974.

2.6.2 American Concrete Institute (ACI), "Concrete Masonry Structures - Design and Construction," 1970.

2.6.3 Metal Building Manufacturers Association (MBMA), "Recommended Design Practices Manual," 1974.

3.0 SITE INFORMATION

The following site characteristics are included in FSAR Chapter 2.0:

a. Geography and Demography (FSAR Section 2.1)

b. Nearby Industrial, Transportation, and Military Facilities (FSAR Section 2.2)

c. Meteorology (FSAR Section 2.3)

d. Hydrologic Engineering (FSAR Section 2.4)

e. Geology and Seismology (FSAR Section 2.5).

The specific information to be used in civil-structural design is given in the following subsections:

3.1 SURVEYS AND DATUM

See the FSAR (Figure 1.2-2 and Section 2.5.1.2) for specific survey data and site location.

3.2 WATER LEVELS

Normal water level	277 ft
Maximum recorded high water level	302 ft
Design flood high water level	304 ft
Probable maximum flood high water level	311 ft
Design low water level	NA

3.3 PRECIPITATION

3.3.1 Rainfall

Average annual	36.5 in.
Daily maximum	12.6 in.
Design hourly maximum	5 in.

3.3.2 Snowfall

Average annual	36 in.
Daily maximum	21 in.
Monthly maximum	34 in.

3.4 GROUNDWATER TABLE

Average groundwater level is approximately at water level of the Susquehanna River. The normal water level of the river is at Elevation 277 ft.

3.5 FROST PENETRATION

Depth below grade	3 ft, 4 in.

3.6 ICE

3.6.1 Damage due to the formation of ice on the Susquehanna River shall not be considered unless specifically noted in the specific design criteria for the facility.

3.6.2 Flooding due to the formation of an ice jam in the river is less severe than the maximum recorded high water level and need not be considered.

3.6.3 Structures within 500 feet of the Unit 2 cooling towers shall be designed for the load from 1 inch of ice uniformly distributed on its surface.

3.7 AIR TEMPERATURE

Record low	-8 F
Record high	107 F

3.8 DESIGN WINDS AND TORNADOES

3.8.1 Design Winds

Based on 100 year recurrence interval, the design wind velocity shall be 80 mph at 30 feet above grade.

3.8.2 Tornadoes

Site conditions:

Rotational wind velocity	290 mph
Translational wind velocity	70 mph
Combined wind velocity	360 mph

3.9 SEISMOLOGY

The site is located in Seismic Zone 1 as defined in the BOCA Basic Building Code. Seismic loads shall be considered in accordance with Subsection 6.9 of these criteria.

3.10 SOIL AND FOUNDATION CONDITIONS

Soil and foundation conditions are given in Appendix C.

4.0 SEISMIC DESIGN CLASSIFICATION OF STRUCTURES

The plant structures, systems, and components are classified into two categories in accordance with NRC Regulatory Guide No. 1.29, "Seismic Design Classification." The two categories are Seismic Category I and non-Seismic Category I. For definitions of the two seismic design categories, see the General Section of the Project General Design Criteria. The specific design criteria for the facility will indicate the seismic design classification.

5.0 CIVIL WORK CRITERIA

5.1 EARTHWORK

5.1.1 Unless specified otherwise by the soils engineer, the following maximum slopes shall be used for excavation and embankment:

Evaporation ponds	3:1	(Horizontal:
Road excavation and embankments	2:1	Vertical)
Others	2:1	

5.1.2 The following values for compaction, expressed as percent of maximum dry density as determined by ASTM D 1557, shall be used:

Backfill for foundations, pipes, and electrical duct banks	95 percent
Embankments	95 percent
Roads	95 percent
Others	90 percent

5.2 ROADS

5.2.1 Grades shall be held to a maximum of 6 percent.

5.2.2 Minimum radius of curvature shall be as follows:

Access Road: 200 feet
Plant Road: 50 feet

5.2.3 Minimum width of lane shall be 12 feet. Shoulders are not required.

5.2.4 Design loading over culverts and pipes shall be in accordance with AASHTO-HS20-44, except for areas subject to special heavy transporting equipment.

5.3 RAILROADS

5.3.1 Grades shall be held to a maximum of 1 percent.

5.3.2 Curvature shall be held to a maximum of 14 degrees, with 10 degrees preferable.

5.3.3 A minimum of 4 inches of ballast under the ties shall be used.

5.3.4 No super-elevation will be required.

5.3.5 Construction and materials shall conform to the AREA Manual for Railway Engineering.

5.3.6 Design loading over culverts and pipes shall be Coopers E-80 plus 50 percent impact.

5.4 STORM DRAINAGE

5.4.1 Runoff, resulting from rainfall, shall be conveyed to drainage ditches by sloping the tributary surface area. Surface slopes shall be 1.0 percent minimum, but 0.5 percent minimum may be permitted in some instances, if approved by the Civil Group Supervisor.

5.4.2 Drainage ditch slopes shall be 0.5 percent minimum, but slopes as flat as 0.25 percent may be permitted in some instances, if approved by the Civil Group Supervisor.

5.4.3 Calculation of the flow shall be based on the Rational Method. The quantity of runoff shall be determined by the Rational Formula (Q=CiA) where:

Q = Design discharge
C = Runoff coefficient, ratio of runoff to rainfall
i = Rainfall intensity
A = Contributory area

5.4.4 Storm sewers shall be used near the locations of major structures. The maximum velocity shall be 8 fps and spacing between manholes shall not exceed 300 feet.

6.0 DESIGN LOADS

The following design loads shall be used for all structures and facilities unless noted otherwise in the specific design criteria for the facility.

6.1 DEAD LOADS (D)

6.1.1 The dead loads include the weight of framing, roofs, floors, walls, partitions, platforms, shielding, and all permanent equipment and materials. The vertical and lateral pressures of liquids shall also be treated as dead loads, as provided in Section 9.2.5 of ACI 318.

6.1.2 Floors shall be checked for the actual equipment loads (see the specific design criteria for major equipment weights). To provide for permanently attached small equipment, piping, conduits, and cable trays, a minimum of 50 psf shall be added where appropriate.

Pipe loads in areas with heavy piping concentrations and cable tray loads in areas of large concentrations of trays shall be carefully reviewed with the Project Plant Design Group and the Project Electrical Group, respectively, to determine the applicable design loads. These areas shall include, but are not limited to, those areas identified in the specific design criteria for the facility.

Where the piping is to be supported from platforms or walkway beams, actual loads shall be determined and used. The suitability of pipe hanger locations for main piping or unusual arrangements shall be coordinated with the Project Plant Design Group.

After pipe hanger locations and loads are fully established, all structural members shall be reviewed for structural adequacy and, if the members are overstressed, they shall be reinforced to withstand the established loads.

6.2 LIVE LOADS (L)

6.2.1 Live loads shall be as specified in Subsection 6.2.2, but in no case less than the minimum design live loads specified in Subsection 6.2.4 or the specific design criteria for the facility.

6.2.2 Live loads include floor area loads, laydown loads, equipment handling loads, lateral earth pressure, ice and snow, trucks, railroad vehicles, and similar items. The floor area live load shall be omitted from areas occupied by equipment whose weight is specifically included in dead load. Live load shall not be omitted where access under equipment is provided, for instance, an elevated tank on four legs. The floor design live loads shall be shown both in the calculations and on the design drawings.

6.2.3 Posting of Live Loads

The design live loads shall be marked on plates of approved design. Such plates shall be affixed at selected conspicuous places in each space to which they relate.

6.2.4 Minimum Design Live Loads

The following minimum live loads shall be used in the design. Live loads applicable to specific structures or facilities are listed separately in the specific design criteria for the facility.

a. General

Roofs	Snow loads (Subsection 6.4)
Offices	50 psf
Assembly and locker rooms	100 psf
Laboratories and laundry rooms	100 psf
Stairs, platforms, and walkways	100 psf or 1000 lbs.*
Railings (applied in any direction at top of railing)	50 plf or 200 lbs.*
Floors on grade	250 psf
Railroad support structures	Coopers E-80
Railroad surcharge	Per AREA Manual
Truck support structures	AASHTO HS20-44
Machine shop and warehouse floor	500 psf
All other elevated floors	200 psf

*Note: Concentrated loads should be so applied as to produce maximum moment or shear.

b. Live Load Reduction

1) No live load reduction shall be allowed for warehouses, storage areas, and tanks.

2) No live load reduction shall be allowed for the design of slabs, beams, joists, trusses, and girders for live loads greater than 100 psf.

3) For live loads greater than 100 psf, the following live load reduction shall apply for the design of columns, piers, walls, and foundations:

Supporting:	
Roof	0%
Roof and 1 floor	0%
Roof and 2 floors	10%
Roof and 3 or more floors	20%

4) For live loads of 100 psf or less the requirements of the BOCA Basic Building Code shall apply.

6.3 CONSTRUCTION LOADS

Displacements and stresses of major structural elements shall be checked for the following loads:

a. Metal decking for concrete slabs — Weight of the concrete plus 50 psf without increase in allowable stress, or weight of the concrete plus 100 psf with one-third increase in allowable stress, whichever governs.

b. Steel beams supporting concrete floors — Weight of the concrete plus 100 psf uniform load on the tributary floor area, or weight of the concrete plus 5 kips concentrated load so applied as to produce maximum moment or shear. One-third increase in allowable stress is permitted.

c. Precast floor panels supporting poured-in-place topping — Weight of the precast panel and topping plus 100 psf uniform load, or weight of the precast panel and topping plus 5 kips concentrated load so applied as to produce maximum moment or shear. Increase in allowable stress shall not be permitted. Camber shall be provided for long spans.

6.4 SNOW LOADS AND PONDING

The ground snow load is 30 psf based on 100-year mean recurrence interval. The minimum roof snow load shall be taken as 0.8 times the ground snow load. To account for roof geometry and drifting, the snow load distributions and related coefficients given in Appendix L of the BOCA Basic Building Code shall be utilized.

Unless a roof surface is provided with sufficient slope toward points of free drainage or adequate individual drains to prevent the accumulation of rainwater, the roof structure shall be designed to assure stability under ponding conditions. The provisions of Section 1.13.3 of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings shall be satisfied to assure stability.

6.5 CRANE LOADS

a. All cranes will be class B, per CMAA Specification No. 70, unless noted otherwise.

b. Crane and equipment supplier's information shall be used for wheel loads, equipment loads, and weights of moving parts. Construction loads shall be considered, where applicable.

c. Impact allowance for traveling crane supports and runway horizontal forces shall be in accordance with Paragraphs 1.3.3 and 1.3.4 of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

d. Maximum vertical deflection for crane and monorail girders shall not exceed 1/800 of the span length. Impact shall not be considered in determining deflection.

e. Crane lift loads need not be combined with wind loads.

f. The weight of the unloaded crane shall be considered simultaneously with the seismic loads. The horizontal inertia forces shall be obtained by the provisions of the BOCA Basic Building Code.

6.6 ELEVATOR LOADS

Impact allowance for the supports of elevators shall be 100 percent unless otherwise specified by the equipment suppliers.

6.7 DESIGN FLOOD PRESSURE

For structural and buoyancy calculations, Seismic Category I structures shall be designed to withstand the effect of the probable maximum flood high water level given in Subsection 3.2. Non-Seismic Category I structures shall be designed for the effect of the design flood high water level given in Subsection 3.2.

6.8 DESIGN WIND AND TORNADO LOADS

6.8.1 Design wind loads shall be determined in accordance with Topical Report BC-TOP-3-A and ANSI 58.1 for the design wind velocity given in Subsection 3.8.1.

6.8.2 Tornado Loads

a. The design basis tornado shall conform to Regulatory Guide 1.76, Region I, and shall have the following characteristics:

Maximum wind velocity	360 mph
Rotational velocity	290 mph
Maximum translational velocity	70 mph
Minimum translational velocity	5 mph
Radius of maximum rotational velocity	150 ft
Pressure drop	3.0 psi
Rate of pressure drop	2.0 psi/sec

The characteristics listed above and the techniques presented in Topical Report BC-TOP-3-A shall be utilized to determine tornado loads.

b. The postulated tornado missiles and the criteria for their design shall be given in the specific design criteria of the facility if applicable.

6.9 SEISMIC LOADS

Topical Report BC-TOP-4-A shall be the basic reference document for seismic analysis. Horizontal and vertical seismic accelerations shall be considered to act simultaneously. The horizontal response spectra and vertical response spectra given in BC-TOP-4-A Figures 2-11 and 2-15, respectively, shall be utilized by linearly scaling to the ground acceleration levels indicated below. The following seismic loads shall be considered based on the seismic design classification of the structure:

6.9.1 Seismic Category I

a. Safe Shutdown Earthquake Load

Seismic Category I structures and components shall be designed for no loss of function when subjected to the safe shutdown earthquake (SSE). The ground accelerations for the SSE shall be .12 g horizontal and .08 g vertical. Damping factors shall be as listed in Topical Report BC-TOP-4-A.

b. Operating Basis Earthquake Load

Seismic Category I structures and components shall also be designed to remain within appropriately defined allowable stress limits when subjected to operating basis earthquake (OBE). The ground accelerations for the OBE shall be .06 g horizontal and .04 g vertical. Damping factors shall be as listed in Topical Report BC-TOP-4-A.

6.9.2 Non-Seismic Category I

a. Non-Seismic Category I structures shall be designed for seismic loads determined in accordance with the BOCA Basic Building Code for Seismic Zone 1, except as noted below and in Subsection 7.5 of these design criteria.

b. Non-Seismic Category I structures whose collapse or excessive deformation could result in loss of required function of adjacent safety-related structures, equipment, or systems shall be designed in one of the following ways:

1) An inelastic analysis will be performed to assure that the non-Seismic Category I structure will not collapse or deform to the extent that loss of the required safety function of adjacent safety-related structures, equipment, or systems will result when subjected to the SSE.

2) An elastic analysis will be performed to assure that the non-Seismic Category I structure will not collapse or deform to the extent that loss of the required safety

function of adjacent safety-related structures, equipment, or systems will result when subjected to the SSE. Stresses shall be limited to 0.9 of yield or 0.9 of any failure mode.

6.10 SPECIAL CONSIDERATIONS FOR TEMPORARY LOADS

a. Temporary Conditions

For structures subjected to temporary loads, one-third increase in allowable stress is permitted. Liner plates, if used as forms, either shall be designed for the lateral pressure corresponding to the rate of concrete placement, or shall be provided with a suitable bracing system as noted on the drawings.

Design restrictions on shoring removal that are different from the normal practice recommended by ACI codes shall be shown on the specific design drawings.

b. Backfill Conditions

Generally structures may be backfilled with structural backfill when concrete compressive strength reaches 60 percent of the specified compressive strength (f'_c). Other backfill restrictions, if any, shall be shown on the specific design drawings.

7.0 DESIGN BASES

7.1 GENERAL

All steel structures shall be designed by the working stress or plastic design methods. All reinforced concrete structures shall be designed using strength design concepts. Soil bearing pressure shall be checked for the actual loads.

The following sections establish the design methods and load combinations for all structures based on the seismic design classification of the structure. In addition, seismic considerations; factors of safety for overturning, sliding, and flotation; and temperature limits and reductions are presented.

7.2 FACTORS OF SAFETY FOR OVERTURNING, SLIDING, AND FLOTATION

7.2.1 Factors of Safety for Seismic Category I Structures

All Seismic Category I structures shall be checked for overturning, sliding, and flotation using the load combinations and the minimum factors of safety indicated below.

Load Combination	Minimum Factor of Safety		
	Overturning	Sliding	Flotation
D + H + E	1.5	1.5	-

D + H + W	1.5	1.5	-
D + H + E´	1.1	1.1	-
D + H + W_t	1.1	1.1	-
D + F	-	-	1.1

H is the lateral earth pressure and F is the resultant bouyant force due to the probable maximum flood high water level. D, E, W, W_t, and E´ are defined in Section 7.4.1.

7.2.2 Factors of Safety for Non-Seismic Category I Structures

Non-Seismic Category I structures shall be checked for overturning, sliding, and flotation using the load combinations and the minimum factors of safety indicated below.

Load Combination	Minimum Factor of Safety		
	Overturning	Sliding	Flotation
D + H + E	1.5	1.5	-
D + H + W	1.5	1.5	-
D + F	-	-	1.1
D + H + E_{ss}	1.1	1.1	-

H is defined in the above section. D, E, W, and E_{ss} are defined for non-Seismic Category I structures in Section 7.5.1. F is the resultant bouyant force due to the design flood high water level.

The last load combination in the above table shall be checked for type A and type C non-Seismic Category I structures only. For definition of the different types of non-Seismic Category I structures, see Section 7.5.

7.3 SEISMIC CONSIDERATIONS

In the loading combinations where seismic forces are considered, the general criterion is to use dead and live loads most likely to exist during normal operation. Based on this criterion the loads as defined in Sections 6.1 and 6.2 shall be taken into account as follows:

a. Dead loads (D): The total dead load must be considered in seismic analysis and design.

b. Live Loads (L): The design live loads are based on maximum probable loads during normal operation or shutdown and maintenance conditions. The fraction of design live load which is likely to occur during normal operation (occupancy loads) is relatively small. Other loads contributing to the design live load (such as laydown, maintenance, temporary crane, etc.)

should not be included in the loading combinations involving seismic loads. Therefore, in seismic analysis and design only a fraction of the design live loads should be considered. The fraction of the live load to be used should be based on functional requirements of the particular structure, but in no case should be less than 25 percent of the design live load.

7.4 SEISMIC CATEGORY I STRUCTURES

In general, all Seismic Category I concrete structures shall be designed in accordance with ACI 349. All Seismic Category I steel structures shall be designed in accordance with the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. Certain modifications and supplements to suit conditions peculiar to nuclear power plants will be noted in the allowable stresses and load combinations given in the following subsections.

The design of masonry walls in Seismic Category I structures shall be in accordance with Appendix D.

When subjected to various combinations of gravity, thermal, and environmental loads, Seismic Category I structures shall be proportioned to maintain elastic behavior. Elastic behavior shall be considered as limited by the yield stress of structural steel materials or the ultimate capacity of reinforced concrete elements. Yield stress for steel (including reinforcing steel) is the guaranteed minimum value in the appropriate ASTM specification. Reinforcing steel stresses shall always control the design of reinforced concrete members.

The seismic analysis of Seismic Category I structures shall conform to Topical Report BC-TOP-4-A.

7.4.1 Definitions

The following nomenclature and definition of terms apply to the design of Seismic Category I structures.

a. Normal Loads

Normal loads are those loads encountered during normal plant operation and shutdown. They include the following:

D = Dead loads as defined in Section 6.1

L = Live loads as defined in Section 6.2

T_o = Thermal effects and loads during normal operating and shutdown conditions, based on the most critical transient or steady-state condition

R_o = Pipe reactions during normal operating or shutdown conditions, based on the most critical transient or steady-state condition

b. Severe Environmental Loads

Severe environmental loads are those loads that could infrequently be encountered during plant life. They include the following:

E = Loads generated by the operating basis earthquake (OBE) as defined in Section 6.9.1.b

W = Loads generated by the design wind as defined in Section 3.8.1

c. Extreme Environmental Loads

Extreme environmental loads are those loads which are credible but highly improbable. They include the following:

E' = Loads generated by the safe shutdown earthquake (SSE) as defined in Section 6.9.1.a

W_t = Loads generated by the design basis tornado as specified in Section 6.8.2. They include loads due to tornado wind pressure, tornado-created differential pressure, tornado-generated missiles, and collapse of adjacent non-Seismic Category I structure(s).

d. Other Definitions

S = For structural steel, S is the required section strength based on the elastic design methods and the allowable stresses defined in Part 1 of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

U = For concrete structures, U is the section strength required to resist design loads, based on the methods described in ACI 349.

Y = For structural steel, Y is the section strength required to resist design loads, based on plastic design methods described in Part 2 of AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

The one-third increase in allowable stresses for concrete and steel due to seismic or wind loadings is not permitted for Seismic Category I structures.

7.4.2 Load Combinations

Seismic Category I structures and components shall be designed to resist the load combinations given in the following subsections unless noted otherwise in the specific design criteria for the facility.

7.4.2.1 Seismic Category I Concrete Structures and Components

Seismic Category I concrete structures shall be designed to resist the following load combinations. The strength design method described in ACI 349 shall be used.

a. Load Combinations for Service Load Conditions

1. $U = 1.4\ D + 1.7\ L$
2. $U = 1.4\ D + 1.7\ L + 1.9\ E$
3. $U = 1.4\ D + 1.7\ L + 1.7\ W$
4. $U = 0.75\ (1.4\ D + 1.7\ L + 1.7\ T_o + 1.7\ R_o)$
5. $U = 0.75\ (1.4\ D + 1.7\ L + 1.9\ E + 1.7\ T_o + 1.7\ R_o)$
6. $U = 0.75\ (1.4\ D + 1.7\ L + 1.7\ W + 1.7\ T_o + 1.7\ R_o)$

The cases of L having its full value of being completely absent shall be checked for the above combinations. The following combinations shall also be satisfied:

7. $U = 1.2\ D + 1.9\ E$
8. $U = 1.2\ D + 1.7\ W$

Where lateral earth and liquid pressures are present, in addition to all the above combinations where they have been included in L and D, respectively, the requirements of Section 9.2.4 and 9.2.5 of ACI 318 shall also be satisfied.

b. Load Combinations for Factored Load Conditions

The following load combinations, which represent extreme environmental conditions, shall be satisfied. The cases of L having its full value or being completely absent shall be checked.

9. $U = D + L + T_o + R_o + E'$
10. $U = D + L + T_o + R_o + W_t$

7.4.2.2 Seismic Category I Steel Structures and Components

Seismic Category I steel structures shall be designed to resist the following load combinations. For all load combinations listed below, the cases of L having its full value or being completely absent shall be checked.

a. Load Combinations for Service Load Conditions

1. For elastic working stress design methods, the following load combinations shall be considered:

    1. $S = D + L$
    2. $S = D + L + E$
    3. $S = D + L + W$
    4. $1.5\ S = D + L + T_o + R_o$
    5. $1.5\ S = D + L + T_o + R_o + E$

6. $1.5\ S = D + L + T_o + R_o + W$

No increase in allowable stress is permitted for load combinations 1, 2, and 3.

2. If plastic design methods are used, the following load combinations shall be considered:

1. $Y = 1.7\ D + 1.7\ L$
2. $Y = 1.7\ D + 1.7\ L + 1.7\ E$
3. $Y = 1.7\ D + 1.7\ L + 1.7\ W$
4. $Y = 1.3\ (D + L + T_o + R_o)$
5. $Y = 1.3\ (D + L + E_o + T_o + R_o)$
6. $Y = 1.3\ (D + L + W + T_o + R_o)$

b. Load Combinations for Factored Load Conditions

1. For elastic working stress design methods, the following load combinations shall be satisfied:

7. $1.6\ S = D + L + T_o + R_o + E'$
8. $1.6\ S = D + L + T_o + R_o + W_t$

2. If plastic design methods are used, the following load combinations shall be considered:

7. $0.9\ Y = D + L + T_o + R_o + E'$
8. $0.9\ Y = D + L + T_o + R_o + W_t$

For load combinations 7 and 8, thermal loads may be neglected where it can be shown that they are secondary and self-limiting in nature and where the material is ductile.

7.4.2.3 Explanation of Load Combinations

a. Load Combinations for Service Load Conditions

These combinations include all loads which are expected to be applied during normal plant operation, including loads from the design wind and the OBE as well as loads from thermal effects and pipe reactions.

b. Load Combinations for Factored Load Conditions

These combinations include events and the resulting loads which are highly improbable, the safe shutdown earthquake and the design basis tornado.

7.5 NON-SEISMIC CATEGORY I STRUCTURES

All non-Seismic Category I concrete structures shall be designed in accordance with ACI 318. All non-Seismic Category I steel structures shall be designed in accordance with the AISC Specification for the

Design, Fabrication and Erection of Structural Steel for Buildings. In addition, any modifications or supplemental requirements given in the following subsections shall apply.

The design of masonry walls in non-Seismic Category I structures shall be in accordance with Appendix D.

Non-Seismic Category I structures are further classified as type A, B, C, or D as follows.

Type A: Structures which are located adjacent to safety-related systems, structures, and equipment are classified as type A. Type A structures shall be designed for seismic loads determined in accordance with the BOCA Basic Building Code. In addition, these structures shall be checked to assure that they will not collapse or experience excessive deformation to the extent that they will cause loss of the safety function of adjacent safety-related systems, structures, or equipment when subjected to the safe shutdown earthquake (SSE).

Type B: Structures which are not located adjacent to safety-related systems, structures, and equipment are classified as type B. Type B structures shall be designed for seismic loads determined in accordance with the BOCA Basic Building Code only.

Type C: Structures which house liquid and/or solid radwaste systems and are located adjacent to safety-related systems, structures, and equipment are classified as type C. Type C structures shall be designed for seismic loads due to the operating basis earthquake (OBE). In addition, these structures shall be checked to assure that they will not collapse or experience excessive deformation to the extent that they will cause loss of the safety function of adjacent safety-related systems, structures, or equipment when subjected to the SSE.

Type D: Structures which house liquid and/or solid radwaste systems but are not located adjacent to safety-related systems, structures, and equipment are classified as type D. Type D structures shall be designed for seismic loads due to the OBE.

The simplified "inelastic" analysis procedure given in Civil/Structural Design Guide C-2.33, "Simplified Inelastic Seismic Analysis of Non-Category I Structures," is an acceptable method to determine the loads due to the SSE for type A and type C structures.

Non-Seismic Category I structures located adjacent to safety-related structures shall not be designed to prevent collapse when subjected to the design basis tornado. The safety-related structure shall instead be checked to assure that it can withstand the collapse of the adjacent non-Seismic Category I structure(s) without loss of safety-related function.

7.5.1 Definitions

The following nomenclature and definition of terms apply to the design of non-Seismic Category I structures.

a. Normal Loads

Normal loads are those loads encountered during normal plant operation and shutdown.. They include the following:

D = Dead loads as defined in Section 6.1

L = Live loads as defined in Section 6.2

b. Severe Environmental Loads

Severe environmental loads are those loads that could infrequently be encountered during plant life. They include the following:

E = Seismic loads as specified in the BOCA Basic Building Code for type A and type B structures or seismic loads due to the operating basic earthquake (OBE) for type C and type D structures

W = Loads generated by the design wind as defined in Section 3.8.1

c. Extreme Environmental Loads

Extreme environmental loads are those loads which are credible but highly improbable. They include the following:

E_{ss} = Loads generated by the safe shutdown earthquake, obtained using Design Guide C-2.33

Extreme environmental loads shall be considered in the design of type A and type C structures only.

d. Other Definitions

S = For structural steel, S is the required section strength based on the elastic design methods and the allowable stresses defined in Part 1 of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

U = For concrete structures, U is the section strength required, based on the methods described in ACI 318.

Y = For structural steel, Y is the section strength required, based on plastic design methods described in Part 2 of the AISC Specification.

7.5.2 Load Combinations

Non-Seismic Category I structures and components shall be designed to resist the load combinations given in the following subsections unless noted otherwise in the specific design criteria for the facility.

7.5.2.1 Non-Seismic Category I Concrete Structures and Components

Non-Seismic Category I concrete structures shall be designed to resist the following load combinations. The strength design method described in ACI 318 shall be used.

1. $U = 1.4\ D + 1.7\ L$
2. $U = 0.75\ (1.4\ D + 1.7\ L + 1.87\ E)$
3. $U = 0.75\ (1.4\ D + 1.7\ L + 1.7\ W)$

The cases of L having its full value or being completely absent shall be checked for the above equations and equation 6. The following combinations shall also be satisfied:

4. $U = 0.9\ D + 1.43\ E$
5. $U = 0.9\ D + 1.3\ W$

The following load combination shall be checked for type A and type C structures only:

6. $U = D + L + E_{ss}$

Where lateral earth and liquid pressures are present, in addition to all the above combinations where they have been included in L and D, respectively, the requirements of Section 9.2.4 and 9.2.5 of ACI 318 shall also be satisfied.

7.5.2.2 Non-Seismic Category I Steel Structures and Components

Non-Seismic Category I steel structures shall be designed to resist the following load combinations. For all load combinations listed below, the cases of L having its full value or being completely absent shall be checked.

a. For elastic working stress design methods, the following load combinations shall be considered:

   1. $S = D + L$
   2. $1.33\ S = D + L + E$
   3. $1.33\ S = D + L + W$

   The following load combination shall be checked for type A and type C structures only:

   4. $1.6\ S = D + L + E_{ss}$

b. If plastic design methods are used, the following load combinations shall be considered:

1. $Y = 1.7 (D + L)$
2. $Y = 1.3 (D + L + E)$
3. $Y = 1.3 (D + L + W)$

The following load combination shall be checked for type A and type C structures only:

4. $0.9 Y = D + L + E_{ss}$

7.5.2.3 Explanation of Load Combinations

Combinations 1 through 5 for concrete structures and 1 through 3 for steel structures are strictly in accordance with established criteria for the design of conventional structures. These five load combinations for concrete structures are in accordance with the ACI 318, and the three combinations for steel structures are in accordance with AISC Specification.

Combination 6 for concrete structures and 4 for steel structures involve the safe shutdown earthquake and are applicable to type A and type C structures only. These combinations include extreme environmental loads and should be checked only to assure that the structure will not collapse or deform to the extent that it will affect the integrity of adjacent safety-related systems, structures, and equipment. Consequently, only the main framing members which resist earthquake forces should be considered and sized to satisfy these combinations.

In addition to the loads listed in Section 7.5.1, the effects of differential settlement and temperature changes should be considered if these effects are significant.

7.5.3 Pre-engineered Metal Buildings

Pre-engineered metal buildings may be used for structures classified as type B non-Seismic Category I structures only.

Pre-engineered metal buildings shall conform to the requirements of this section in lieu of the requirements given in the preceding sections for non-Seismic Category I structures.

The design of pre-engineered metal buildings shall conform to the Metal Building Manufacturers Association (MBMA), "Recommended Design Practices Manual." The combinations of loads and allowable stresses to be considered in the design of all members of the structure shall be in accordance with Section 7 of the MBMA Manual.

The basic wind load shall be 20 psf applied and proportioned as horizontal and uplift forces in accordance with Section 4 of the MBMA manual.

Seismic loads determined in accordance with the BOCA Basic Building Code for Seismic Zone 1 shall be considered in the design of pre-engineered metal buildings.

7.6 TEMPERATURE LIMITS AND REDUCTIONS

7.6.1 Steel

For structural steel elements, the maximum temperatures are limited to 700 F and the allowable stress values shall be reduced by 5 percent for each 100 F increase in temperature, using 100 F as the base for the allowables.

7.6.2 Concrete

The limitations listed below are applicable only to concrete structural components:

a. The following temperature limitations are for normal operation or any other long-term period. The temperatures are not allowed to exceed 150 F, except for local areas which may be allowed increased temperatures not exceeding 200 F.

b. The following temperature limitations are for accident or any other short-term period. The temperatures are not allowed to exceed 350 F for the interior surface. However, local areas may be allowed to reach 650 F from steam and/or water jets in the event of a pipe failure.

c. Temperatures higher than given in items a. and b. may be allowed in concrete, if test data can be provided to evaluate the corresponding reduction in strength. Such a reduction shall be applied to the design allowable values. Also, evidence will be provided which verifies that the increased temperatures do not cause deterioration of concrete, either with or without load.

8.0 CONSTRUCTION MATERIALS

8.1 The principal construction materials for Seismic Category I and non-Seismic Category I structures are concrete, reinforcing steel, structural steel, masonry, and metal decking, as specified herein or in the specific design criteria for the facility.

8.2 Concrete design compressive strengths shall be as follows:

Item	f'_c (psi)
Precast concrete panels	5000
All other plant structures	3000 (minimum)
Lean concrete backfill and electrical duct encasement	2500

Compressive strength (f'_c) refers to compressive strength at 28 days.

8.3 Reinforcing steel shall be deformed billet steel, conforming to ASTM A 615, Grade 60.

8.4 Welded Steel Wire Fabric shall conform to ASTM A 185 (plain wire) or A 497 (deformed wire).

8.5 Structural steel shall conform to ASTM A 36, unless otherwise noted on drawings or within specifications.

8.6 Fasteners shall conform to ASTM A 307 unless high-strength bolts are specified. High-strength bolts shall conform to ASTM A 325 or A 490.

8.7 Anchor bolts shall conform to ASTM A 36, A 307, or A 449.

8.8 Masonry for all structures shall conform to Project Architectural Specification 13587-2-A-016 and Material Requisition 13587-2-A-016/1.

8.9 Unless otherwise required by special conditions, metal decking shall be used and considered in design for forming concrete slabs.

8.10 The Civil-Structural specifications specify all the construction materials for Seismic Category I and non-Seismic Category I structures.

9.0 DESIGN CONTROL

9.1 DOCUMENT SUBMITTALS

In accordance with the Division Chief Civil Engineer's design control procedures, design documents listed in the Project Civil-Structural Design Control Check List (DCCL) shall be submitted to the Division Chief Civil Engineer for review and approval.

9.2 DESIGN SUMMARY

A design summary shall be prepared for each major recovery structure as listed in the Project Civil-Structural DCCL. The design summary shall be in the form of a calculation and limited to the following information:

a. Reference to the appropriate specific design criteria for that structure

b. Methods of analysis and design

c. Summary of results, showing the margin of safety under design loads for typical sections in the building.

APPENDIX A

LIST OF

BECHTEL THERMAL POWER ORGANIZATION'S

TOPICAL REPORTS

FOR

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

TOPICAL REPORT NUMBER, REVISION, DATE	TITLE
BC-TOP-3-A, Rev. 3, 8-74	Tornado and Extreme Wind Design Criteria for Nuclear Power Plants
BC-TOP-4-A, Rev. 3, 11-74	Seismic Analyses of Structures and Equipment for Nuclear Power Plants

APPENDIX B

LIST OF

BECHTEL THERMAL POWER ORGANIZATION'S

CIVIL/STRUCTURAL DESIGN STANDARDS AND GUIDES

FOR

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

DESIGN STANDARDS AND GUIDES		REV.	DATE
C-2.5	Caissons	0	09/74
C-2.14	Structural Design of Pile Foundations	0	09/74
C-2.16	Structural Welding	1	04/75
C-2.17	Structural Design of Diaphragms	0	10/73
C-2.22	Yard Utilities	1	05/76
C-2.23	Earthwork	1	05/77
C-2.25	Structural Review of Heavy-Lift Rigging	0	06/74
C-2.26	Rotating Equipment Foundations	0	10/74
C-2.27	Sanitary Facilities	0	03/74
C-2.28	Design Criteria for Nuclear Power Plant Category I Structures	0	02/75
C-2.29	Beam End Connections Steel Beam to Concrete 45 Kips or Less	0	04/74
C-2.30	Waterproofing and Waterstops	1	10/75
C-2.31	Instructions for Using Computer Programs	0	10/73
C-2.32	Strength Criteria for Structural Steel for Category I Structures	0	03/74
C-2.33	Simplified Inelastic Seismic Analysis of Non-Category I Structures	0	06/75
C-2.34	Anchor Bolt	1	04/75
C-2.36	Modular Embed Systems and Insert Plates	3	04/79
C-2.37	Painting and Coating Exposed Surfaces of Power Plants	0	12/76
C-2.38	Thermal Effects Combined With Real Loads	0	02/77
C-2.40	Concrete Expansion Anchors	0	08/77
C-2.42	Multi-Discipline Design Guide for Embedded Conduit & Piping	0	06/78

APPENDIX C

SUBSURFACE INVESTIGATION REPORT

FOR

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

(later)

APPENDIX D

DESIGN REQUIREMENTS OF MASONRY STRUCTURES

FOR

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

(later)

BECHTEL

GPU SERVICE CORPORATION

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

DESIGN CRITERIA DOCUMENTS

COVER SHEET

JOB NO: 13587

DISCIPLINE: Control Systems

REV. NO.	DATE	REVISION DESCRIPTION	ORIGINATOR	GROUP SUPV.	PROJECT ENG.	GPUSC
1	7/21/81	Revised as Noted and Issued for Use Upon GPUSC Approval				
0	12/22/80	Issued for Use Upon GPUSC Approval				

APPROVAL

GPD-13879 1/80

SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.
i	0												
ii	0												
1	0												
2	0												
3	1												
4	1												
5	1												
6	0												
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8	0												
9	0												
10	1												
11	1												
12	1												
13	0												
14	0												
15	0												

BECHTEL

DESIGN CRITERIA DOCUMENTS

REVISION STATUS SHEET

JOB NO. 13587	REV.
DISCIPLINE CONTROL SYSTEMS	1
PAGE 1 of 1	

GPD-27049-A 5/79

CONTROL SYSTEMS DESIGN CRITERIA

FOR

THREE MILE ISLAND--UNIT 2

TABLE OF CONTENTS

1.0 INTRODUCTION

This document delineates the control systems design criteria for the recovery activities at Three Mile Island - Unit 2. It does not address modifications to existing plant systems for reconstruction. Included are general design requirements as well as codes and standards which shall be used as the basis for system design.

2.0 CODES AND STANDARDS

The design of control systems and equipment shall conform to all applicable portions of the latest issue (unless otherwise indicated) of the following codes and standards including addenda where applicable. NRC Regulatory Guides, Branch Technical Positions, and Code of Federal Regulations are listed in the General section of the Project Design Criteria. Compliance to these documents shall be discussed in the individual facility or system design criteria.

2.1 American National Standards Institute (ANSI)

B2.1 Pipe Threads (except dryseal)

B16.5 Steel Pipe Flanges and Flanged Fittings

B16.10 Face-to-Face and End-to End Dimensions of Ferrous Valves

B16.11 Forged Steel Fittings, Socket Welding and Threading

B16.25 Butt-Welding Ends

B16.34 Steel Valves - Flanged and Butt Welding Ends

B16.104 American National Standard for Control Valve Seat Leakage

B31.1 Power Piping

N13.1 Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities

N13.10 Specification and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents

2.2 American Society of Mechanical Engineers (ASME)

Boiler and Pressure Vessel Code

Section II Material Specifications

Section IX Welding and Brazing Qualifications

Fluid Meters

2.3 American Society for Testing and Materials (ASTM)

Standards as applicable

2.4 American Welding Society (AWS)

D1.1 Structural Welding Code

2.5 Bechtel Thermal Power Organization (TPO)

Control Systems Design Standards and Guides

Control Systems Drawing Standards and Standard Details

2.6 Instrument Society of America (ISA)

Standards as applicable

2.7 Insulated Cable Engineers Association (ICEA)

S-19-81 Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

2.8 Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)

SP-25 Marking System for Valves, Fittings, Flanges and Unions

SP-55 Quality Standard for Steel Castings - Visual Method

SP-61 Pressure Testing of Steel Valves

SP-72 Ball Valves with Flanged or Butt-Welding Ends for General Service

SP-84 Steel Valves - Socket Welding and Threaded Ends

2.9 National Electrical Manufacturers Association (NEMA)

ICS 6 Enclosures for Industrial Controls and Systems

2.10 Project Standards and Documents

Project Engineering Procedures Manual

TMI-2 Final Safety Analysis Report and Amendments

3.0 DEFINITIONS

The definitions of terms which are frequently used in the Design Criteria are provided in the general section of the Project Design Criteria.

4.0 CENTRALIZED CONTROL

4.1 COMMAND CENTER (see Personnel Access Facility Design Criteria 13587-2-GD1-102)

4.2 LOCAL CONTROL PANELS

4.2.1 Local control panels shall be provided with sufficient alarms, status lights, controls, and indications to permit local startup and operation of the systems provided for the cleanup effort.

4.2.2 Local control panels shall be NEMA Type 12 control panels located away from the process equipment. These panels shall be rigidly braced, provided with lifting eyes, if required, and designed for bolting to the wall or floor. Floor-mounted panels shall be provided with 120 V ac lighting and convenience outlets.

4.2.3 Panels shall be as completely wired and assembled as practicable with all devices installed so that the entire assembly is an operating unit ready for installation.

4.2.4 Panels shall be furnished with a copper ground bus extending the full length of the cabinet. A ground lug shall be furnished at each end of the ground bus for connection of a 4/0 AWG bare copper station ground cable.

4.2.5 Panels shall be designed to accept top or bottom entry of conduit sized large enough to carry the required external cables. 1

4.2.6 <u>Mimic Diagrams</u>

Panels shall utilize mimic diagrams to assist the operator in working with systems having complex interconnections.

4.2.7 <u>Wiring</u>

4.2.7.1 Panel wiring shall be Class B stranded copper, No. 14 AWG minimum with insulation rated for 90 C conductor temperature and meet the requirements of ICEA S-19-81. Polyvinyl chloride (PVC) type insulation shall not be used. Class C stranding shall be used for applications
subject to excessive flexing. No. 16 AWG or larger shielded and twisted 1
pairs shall be used for all low level signal wiring to prevent noise interference. Shields shall be continuous and grounded at one point only.

4.2.7.2 Wire terminations shall utilize terminal blocks with sliding links to the maximum extent possible.

4.2.7.3 Wires shall not be spliced between terminal connections. Wire nuts shall not be used for any connections.

4.2.7.4 Each conductor shall be identified with its wire number at each end by a permanent marker. 1

4.2.7.5 Wiring connections other than low-level wiring soldered connections shall be made with crimp-type ring-tongue terminals with insulated ferrules.

4.2.8 In addition to the information displayed on the local control panels, certain key parameters may also be displayed in the plant main control room, e.g., systems designed to comply with Regulatory Guide 1.143 shall have a high level alarm both locally and in the plant control room for tanks containing liquid.

5.0 ANNUNCIATION SYSTEM

5.1 If required, annunciator displays shall be provided on the top section of the control panels. Design shall be solid-state. The annunciation system shall be supplemented by process indication and status lights. All annunciator windows shall be 3 inches wide by 3 inches high with engraved 1/4-inch characters. Alarm circuits should be normally closed, and open to alarm. Relays should be normally energized and de-energized to alarm. An auxiliary relay shall be provided for each window which shall de-energize when the window is in an alarm state.

5.2 The number of annunciation points shall be minimized, and nuisance alarms on equipment starting and shutdown shall be suppressed.

6.0 CONTROL AND INSTRUMENTATION EQUIPMENT

6.1 GENERAL REQUIREMENTS

6.1.1 Signal Levels

6.1.1.1 Instrumentation system analog signal transmission, except for RTD and TC signals, shall utilize 4 to 20 ma dc levels, wherever possible, for both inputs and outputs. Pneumatic signal transmission shall utilize 3 to 15 psig signal levels.

6.1.1.2 All control circuits shall be 120 V ac or 125 V or less dc. | 1

6.1.2 The minimum accuracy of instruments in percentage of full-scale value shall generally be as indicated below:

a. Transmitters and recorders: 1/2 percent

b. Temperature indicators and pressure gauges: 1 percent

c. Process electronic indicators: 2 percent.

6.1.3 Electronic field transmitters shall be non-indicating.

6.1.4 Pneumatic transmitters can either be indicating or non-indicating. The non-indicating type shall utilize an output pressure gauge as a local indicator.

6.1.5 A sealed bellow or diaphragm shall be used to separate the process fluid from the pressure, flow, or level sensor when the process fluid is highly radioactive. 1

6.1.6 Process control and alarm shall not depend upon a common device. These functions shall be derived from separate instruments.

6.1.7 Indicating Light Colors

The colors of the indicating lights shall be as follows:

Color	Function	
Red	Pump:	running
	Valve:	open
	Breaker:	closed
	Heater:	on
Green	Pump:	stopped
	Valve:	closed
	Breaker:	tripped
	Heater:	off
Orange	Lock-out	
Blue	Status	
Amber	Specials where designated	

6.1.8 Nameplates and Identification Tags

6.1.8.1 Nameplates shall be mounted to panels, racks, or mounting brackets to identify the function and the specific controlled device identification tag number rather than the specific device. Devices shall have engraved metallic identification tags which shall provide permanent device identification.

6.1.8.2 Nameplates shall be white lamacoid with black letters.

6.1.9 In the event of an electrical or pneumatic failure or any undesirable deviation from normal operation, the system shall trip into a shutdown condition which provides protection for the equipment and ensures the safety of operating personnel.

6.2 EQUIPMENT ENCLOSURES

6.2.1 Instrument housings located outside of the plant main control room and command center shall be NEMA Type 4 except where other enclosure classes are advisable for specific applications.

6.2.2 Plant main control room and command center equipment enclosures shall be NEMA Type 12.

6.3 RECORDERS AND INDICATORS

6.3.1 Process recorders shall generally be 3x6 inch or 6x6 inch type with 4-inch nominal chart width.

6.3.2 Indications shall be provided for normal and safe operating areas on indicators.

6.3.3 Legends for process variables shall be provided for all indicators and recorders.

6.3.4 Key process parameters may be displayed on 4 1/2-inch or larger square switchboard indicators (250-degree scale) to provide extra emphasis or long distance visibility.

6.3.5 Indicators shall match the calibrated span of the transmitted variable.

6.4 PRESSURE INSTRUMENTS

6.4.1 Pressure gauges shall be 4 1/2-inch diameter, phenolic case with white face. Larger gauges shall be provided as required for readability.

6.4.2 Pressure devices on pulsating services shall be equipped with pulsation dampeners.

6.4.3 Pressure elements shall be a type suitable for the process variables and of material with the required corrosion resistance.

6.5 FLOW INSTRUMENTS

6.5.1 Concentric orifice plates using flange taps with beta ratio from 0.20 to 0.75 shall be the preferred metering method.

6.5.2 Orifice plates should be installed in horizontal lines where possible. If installed in vertical lines, the flow shall be downward for gas and steam, and upward for liquid.

6.5.3 Flowmeter straight piping run requirements and installation techniques shall be in accordance with ASME Fluid Meters, 6th Edition, 1971.

6.5.4 Linear scales generally shall be used for flow indication and recording.

6.5.5 In-line paddle flow switches shall not be used in service where a detached paddle could cause a hazard to equipment.

6.5.6 Flow instruments in general shall have scales with flow units as follows:

a. Steam - lb/hr

b. Liquids - gpm

c. Gases - scfh or scfm

6.5.7 To measure flow in lines 3/4-inch and smaller, rotameters shall be used where possible.

6.5.8 Orifice plate thickness for 10-inch pipe and less shall be 1/8-inch unless subjected to high stress which would require a greater thickness.

6.5.9 The differential should be 50 or 100 inches of water for liquid service, and for gas or steam, the differential in inches of water should not exceed the line static pressure in PSIA.

6.6 LEVEL INSTRUMENTS

6.6.1 Gauge glasses used in conjunction with level instruments shall cover a range in excess of that covered by the instrument.

6.6.2 Tubular gauges shall be avoided wherever possible and used only on services near atmospheric pressure and where breakage would produce no hazard. Tubular gauges shall not be used on corrosives, flammable liquids, or radioactive services.

6.6.3 Displacement-type level instruments shall generally be used for low range (less than 20-inch) measurement and control.

6.6.4 Differential pressure-type level instruments shall generally be used when the measured range exceeds 60 inches.

6.6.5 Differential pressure-type instruments shall be used on large outdoor tanks.

6.6.6 Level scales shall generally be in gallons.

6.6.7 Permanently installed level indication shall be included on all vessels containing liquid.

6.7 TEMPERATURE INSTRUMENTS

6.7.1 Dial thermometers shall generally have 5-inch diameter dials, white face, and be of the adjustable angle type, bimetal actuated.

6.7.2 RTDs shall be 100-ohm platinum type, 3- or 4-wire circuit, as required, ungrounded.

6.7.3 Thermocouples shall be iron constantan, ISA Type J, ungrounded.

6.7.4 Temperature sensing elements shall be spring-loaded wherever possible.

6.7.5 All temperature elements, including switches, with the exception of HVAC and surface measurement applications shall be installed using thermowells.

6.7.6 The resonant frequency of all thermowells as installed in the process fluid shall be greater than 1.25 times the flow-induced forcing frequency.

6.7.7 Minimum thermowell insertion length shall be 3 inches.

6.8 PROCESS SWITCHES

6.8.1 Switches shall be applied so that the actuation point is within the center one-third of the instrument range wherever possible.

6.8.2 Temperature switches shall be gas- or vapor-actuated with stainless steel capillary armor.

6.8.3 Bistable units on the output of pressure and temperature transmitters shall be considered in lieu of process-actuated switches if extreme accuracy is required.

6.8.4 Switches with external adjustments shall be avoided.

6.8.5 Switches shall be of the snap action type.

6.8.6 Field contacts in process switches shall be rated 5 amperes at 120 V ac and 0.5 ampere, inductive, at 125 V dc.

6.9 MATERIALS PROHIBITED IN NUCLEAR SERVICE

The use of mercury and polyvinyl chloride (PVC) shall be eliminated as far as practicable for any instrumentation application. Teflon shall not be used if the predicted accumulated dose exceeds 10^4 rads.

6.10 SEISMIC DESIGN CRITERIA

All equipment and installations covered by this criteria are classified as non-seismic Category I.

7.0 INSTRUMENT APPLICATION AND INSTALLATION

7.1 GENERAL

7.1.1 The use of racks, panels, or mounts for mounting field transmitters and process switches shall be minimized.

7.1.2 All instrument tubing shall be firmly supported and secured against vibration. Tubing runs shall be routed to preclude air pockets or liquid traps as applicable.

7.1.3 Instruments used for air or gas service shall be mounted above line with the process tap off the top of the process pipe.

7.1.4 Instruments used for liquid or steam service shall be mounted below line with the process tap off the side of the process pipe.

7.1.5 Field sensing lines shall be installed with a minimum slope of 1/4-inch per foot. The direction of slope shall be determined by the requirements of the process system, i.e., steam, air, or water.

7.1.6 In-line flow devices which are subject to periodic maintenance, e.g., rotameters, shall be provided with isolation and bypass valves.

7.2 PROCESS CONNECTION STANDARD

7.2.1 The following process connection sizes should be used for instrumentation connections:

a. Pressure - 3/4 inch

b. Temperature - 1 inch

c. Level - 1 inch (except displacer type use 1-1/2 inch)

7.2.2 Process connection bosses or flanges shall be installed in the line pipe at the pipe fabricator's shop. Field installation work, if possible, shall not include burning or drilling into shop-fabricated piping.

7.3 FIELD SENSING LINE

Field sensing lines and sample lines generally shall utilize 3/8-inch OD, 0.065-inch wall thickness tubing and compression fittings. Socket weld fittings shall be used where tubing is joined by welding. Tubing and fitting material shall be 300 series stainless steel.

7.4 PROCESS INDICATION

7.4.1 Process indications which are required on a day-to-day basis for equipment operating guidance, or are needed for determination of equipment status, or for maintenance guidance, shall be displayed on a local indicator visible from the operating location.

7.4.2 Differential pressure indicators shall be permanently installed across filter units, screens, strainers, and demineralizers when the process equipment is part of a major process system.

7.4.3 Instruments, excepting temperature detectors, shall not be installed on equipment or piping subject to vibration.

7.5 SINGLE ROOT VALVES

Single root valves shall be provided for instrument line shutoff. In the case of an instrument line penetrating a shield wall, an additional root valve shall be added outside the shield wall.

1

7.6 INSTRUMENT VALVES AND MANIFOLDS

Instrument valves or manifolds shall be installed at each instrument.

7.7 ACCESSIBILITY

7.7.1 Instruments shall generally be located so that they are readily accessible from permanent structures, such as operating floors, platforms, and caged ladders on tanks.

7.7.2 Instrument Location

7.7.2.1 Instrumentation displays required on a continuous basis shall not be located in zones where radioactivity exceeds 2.5 mrem/hr. Instrumentation displays that are required infrequently (i.e., less than 1 hour per 8-hour shift) may be located in zones less than 25 mrem/hr.

7.7.2.2 No process indicators shall be provided in zones where radioactivity exceeds 25 mrem/hr.

7.7.3 Transmitters and other signal processing equipment shall be accessible for maintenance, test, servicing, and calibration during operation. Functional integrity of such systems shall not be compromised, however, to achieve such accessibility.

7.7.4 Primary instrument devices, located in high-radiation areas, shall be designed for easy removal to lower radiation zones for calibration, or facilities for in situ calibration shall be provided. If possible, all process instrumentation, except flow elements and temperature detectors, should be located in low-radiation areas.

7.8 NON-SEISMIC CATEGORY I EQUIPMENT IN A SEISMIC CATEGORY I STRUCTURE

Non-seismic Category I equipment in a seismic Category I structure shall be located such that its failure or collapse will not compromise seismic Category I equipment.

8.0 CONTROL VALVES

8.1 Control valve minimum body size shall be one inch nominal with reduced trim as applicable.

8.2 Control valves shall not be provided with bypass or isolation valves except where specific operating or maintenance circumstances demonstrate the need for such valving.

8.3 Control valves shall be provided with handwheels.

8.4 Flanged connections shall be used for control valves for maintenance, except where piping specifications for hazardous or other special conditions preclude flanged connections.

8.5 Control valves shall have ribbon grafoil packing with a leakoff connection (pipe nipple socket welded into bonnet) at the lantern ring if required.

8.6 Generally, control valve body size shall be no more than one standard nominal size smaller than line size.

8.7 Cast iron valve bodies shall not be used.

8.8 Valve body material shall be the same as the attached piping unless 1
a need for a different material can be demonstrated.

8.9 Control valves used in modulating service shall be sized using the manufacturer's capacity rating at 85 percent of lift to equal or exceed the maximum required design flow capacity. Exceptions to this criterion may be considered on a case basis.

8.10 Solenoid coils shall be rated 120 V ac or 125 V dc. Coil insulation shall be Class H, suitable for ambient temperatures of 200 F. Lugged connectors shall be installed on the solenoid leads and covered with heat shrink tubing to allow easy replacement.

8.11 Limit switches shall be provided at both open and closed positions.

9.0 INSTRUMENT AIR SYSTEM

Individual air reducing stations shall be provided, rather than group devices on a low-pressure header, except that low-pressure headers may be used inside cabinets and on racks.

10.0 SAMPLING AND ANALYSIS SYSTEMS

10.1 For process points which require continuous sampling or sampling at a frequency of more than once a week, the sample should be routed to a centralized sampling station. (Exception: No sample lines shall be routed to the hot chemistry laboratory.)

10.2 Local grab samples, rather than permanently installed sample lines to a centralized station, shall be provided for those process points which require sampling at a frequency of less than once a week, or require heat tracing. Except for heat-traced sample lines, these local sample stations shall be located in zones where radiation is less than 25 mrem/hr to the extent practicable.

10.3 Sample lines carrying radioactive substances shall be fabricated using techniques that minimize "crud" traps. Where practicable, sampling shall be accomplished through the use of in-line connections which return flushed samples to process lines, in order to minimize radwaste processing. To facilitate the sampling of radioactive fluids, quick-connector type connections shall be utilized.

10.4 High energy process samples shall be conditioned and reduced below 30 psig and 140 F for safety of operators.

10.5 Fume hood, sink, and flushing water facilities shall be provided as necessary.

10.6 For samples which are withdrawn from radioactive lines, two valves shall be provided: one at the process connection and one outside the shield wall.

10.7 Shielding shall be provided at the local sample stations to maintain radiation zoning in proximate areas and minimize personnel exposure during sampling.

10.8 Effluent sampling provisions shall be provided to demonstrate compliance with all applicable effluent regulations. 1

11.0 RADIATION MONITORING

11.1 GENERAL

Radiation monitoring shall be provided to monitor normal and abnormal radiation levels in areas where radioactive material may be present, stored, handled, or inadvertently introduced and to monitor selected process lines including HVAC ductwork for radiation in excess of acceptable limits.

11.2 CHARACTERISTICS

11.2.1 Area radiation monitors, including constant air monitors and/or radiation area monitors, with local audible and visual alarms and a ratemeter shall be provided for the protection of personnel in those areas which require accessibility.

11.2.2 All area radiation monitors shall be indicated and recorded in the command center. Indication and alarms may be provided in other areas, such as the control room, to provide adequate control and alarm response. 1

11.2.3 Process radiation monitors shall be provided for certain process systems, ventilation systems, and all unit effluent streams to ensure compliance with the Code of Federal Regulations; Title 10, parts 20 and 50, Regulatory Guide 1.21 and GOC-64. The ventilation system radiation monitors shall also provide protection to personnel from airborne radioactivity.

11.2.4 Indication shall be provided in the command center for all process monitors. Indication and alarms may be provided in other areas, such as the control room, to provide adequate control and alarm response. 1

11.2.5 All effluent monitors and the corresponding flowrate shall be recorded in the command center.

11.2.6 The ventilation system airborne samples shall be extracted in accordance with the requirements of ANSI N13.1.

11.2.7 Process and ventilation radiation monitor sample lines shall be sized and routed to minimize sample plate-out.

11.3 RANGE

11.3.1 Area radiation monitors shall have a calibrated range dictated by the area in which they are located.

11.3.2 Process monitors shall have ranges established in accordance with the requirements of a particular application.

11.4 ALARMS

Loss of power, alert, and high radiation alarms shall be provided in the command center.

11.5 OPERABILITY

Process and area radiation monitors shall be provided with a check source of a known intensity to verify operability.

12.0 CLOSED CIRCUIT TELEVISION SYSTEM

12.1 GENERAL

A closed circuit television (CCTV) system shall be provided to monitor equipment and/or selected work activities. The degree to which CCTV shall be utilized shall be discussed in the specific design criteria.

12.2 CAMERAS

12.2.1 Conventional

12.2.1.1 These cameras shall provide general surveillance of areas where work activities are being performed.

12.2.1.2 Each camera shall be provided with controls located at the monitoring station(s) which permit remote pan, tilt, focus, and zoom.

12.2.1.3 These cameras should be designed consistent with their operating environment.

12.2.2 Underwater

12.2.2.1 Submersible cameras shall be provided to cover the activities associated with defueling of the reactor vessel.

12.2.2.2 Controls for remote operation shall be located at the monitoring station(s).

12.2.2.3 Lighting for the cameras should be self-contained or attached, as required for the particular operation.

12.2.2.4 These cameras shall be constructed of radiation resistant materials. The actual design parameters will be detailed in the Technical Specification.

12.3 MONITORS

12.3.1 Monitoring stations shall be provided at selected locations for the remote viewing of the outputs of all cameras.

12.3.2 Monitors with the capability of monitoring the output of any camera should be provided for visitor or management briefings.

12.3.3 A monitor with the capability of monitoring the output of any camera should be provided for the purpose of permitting the workers to familiarize themselves with the in-containment work areas and activities prior to entry.

12.4 RECORDING

Video cassette recorders (VCR) shall be provided to record the outputs of all cameras in the system to provide a permanent record of all activities associated with the cleanup effort and to provide a tool that could be used for training of the work crews.

12.5 TRAINING

A system comprising a color video cassette recorder, a color monitor, and a portable color camera shall be provided for preparing training tapes, playback of offsite produced training tapes, and recording special onsite events.

13.0 RADIO COMMUNICATIONS

13.1 GENERAL

A radio communications system shall be provided which permits audio communications between personnel located in the command center and work crews located in the containment, containment air control envelope (CACE) in the containment recovery service building (CRSB) and the fuel handling building.

13.2 BASIC SYSTEM

13.2.1 A duplex system should be utilized for communications between the command center and the portable radios (walkie-talkies).

13.2.2 The portable radios should be provided with a talk-around feature that would permit communications between the work crews in containment without going through the command center.

13.2.3 The portable radios shall be compact and self-contained. They shall be provided with a rechargeable battery good for at least eight hours of continuous service.

13.2.4 The headsets shall be an integral earphone and microphone unit which can be worn comfortably beneatn anti-contamination headdress and air masks. Activation of the portable radios shall be accomplished without deliberate use of the hands.

13.2.5 An antenna shall be provided in the containment which permits communications from any location.

13.2.6 The central control unit shall be positioned in close proximity to a CCTV monitoring station so that audio and video communications can be coordinated.

13.2.7 The central control unit shall be provided with a telephone patch to permit communications with offsite personnel.

BECHTEL

GPU SERVICE CORPORATION

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

DESIGN CRITERIA DOCUMENTS

COVER SHEET

JOB NO: 13587

DISCIPLINE: ELECTRICAL

REV. NO.	DATE	REVISION DESCRIPTION	ORIGINATOR	GROUP SUPV.	PROJECT ENG.	GPUSC
1	7/21/81	Revised as Noted and Issued for Use Upon GPUSC Approval	GAP	[illegible]	RWJ	SEO
0	12/22/80	Issued for Use Upon GPUSC Approval	[illegible]	GAP	RWJ	SEO

APPROVAL

GPD-13 9/80

SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.
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DESIGN CRITERIA DOCUMENTS
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ELECTRICAL DESIGN CRITERIA

TABLE OF CONTENTS

TITLE

1.0 SCOPE

This document delineates the electrical design criteria for general support facilities for the non-safety-related recovery activities at Three Mile Island - Unit 2. Included are general design requirements as well as codes and standards which shall be used as the basis for system design.

2.0 CODES AND STANDARDS

2.1 The codes and standards of the following organizations shall be used as guidelines in the design of electrical systems and equipment and, where required by law, such systems and equipment shall conform to applicable codes and standards.

Anti-Friction Bearing Manufacturers Association (AFBMA)

AFBMA 9	Load Ratings and Fatigue Life for Ball Bearings
AFBMA 11	Load Ratings and Fatigue Life for Roller Bearings

American National Standards Institute (ANSI)

ANSI C33	Electrical Devices and Materials
ANSI C37	Power Switchgear
ANSI C50	Rotating Machines
ANSI C57	Transformers, Regulators and Reactors
ANSI C80	Conduits
ANSI C89.2	Dry Type Transformers for General Applications
ANSI Z55.1	Gray Finishes for Industrial Apparatus and Equipment

American Society for Testing and Materials (ASTM)

ASTM A 307	Carbon Steel Externally and Internally Threaded Fasteners
ASTM A 366	Sheet Steel, Carbon, Cold-Rolled, Commercial Quality
ASTM A 386	Specifications for Zinc Coating (Hot-Dip) on Assembled Steel Products
ASTM A 525	Specification for Zinc Coated (Galvanized Iron or Steel Sheets) Coils and Cut Lengths

ASTM B 3	Standard Specification for Soft or Annealed Copper Wire
ASTM B 8	Concentric - Lay Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 33	Standard Specification for Soft or Annealed Copper Tinned Wire for Electrical Purposes
ASTM D 635	Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 2671	Heat Shrinkable Tubing Testing

Insulated Cable Engineers Association (ICEA)

ICEA P-46-426	Power Cable Ampacities, Volume 1 - Copper conductors, and Cumulative Errata Sheets
ICEA P-54-440	Ampacities-Cables in Open-top Cable Trays
ICEA S-19-81	Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
ICEA S-61-402	Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
Interim Standard No. 1 to ICEA S-68-516	Cables rated 0-35,000 volts and having Ozone-Resistant Ethylene-Propylene Rubber Insulation
ICEA S-66-524	Cross-Linked Thermosetting-Polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

Institute of Electrical and Electronics Engineers (IEEE)

IEEE-112A	Test Procedure for Polyphase Induction Motors and Generators
IEEE-142	Recommended Practice for Grounding of Industrial and Commercial Power Systems
IEEE-281	Service Conditions for Power System Communications Apparatus
IEEE-288	Guide for Induction Motor Protection
IEEE-383	Guide for Type Test of Class IE Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations (flame tests only)

Illuminating Engineering Society (IES)
-Recommended Practices

National Electrical Code (NEC)

National Electrical Manufacturers Association (NEMA)

NEMA AB-1	Molded Case Circuit Breakers
NEMA ICS (Excluding Part 3)	Industrial Controls and Systems Standards for Industrial Controls
NEMA MG-1	Motors and Generators
NEMA MG-2	Safety Standard for Construction and Guide for Selection, Installation, and Use of Fractional and Integral HP Motors and Generators
NEMA PB-1	Panelboards
NEMA ST-20	Dry Type Transformers for General Applications
NEMA TR-1	Transformers, Regulators, and Reactors
NEMA TR-27	Distribution Transformers, Dry type - Commercial, Institutional and Industrial
NEMA VE-1	Cable Trays, Ventilated
NEMA WC-21	Nonreturnable Reels
NEMA WC-25	Protective Covering for Wire and Cable Reels

Occupational Safety and Health Administration (OSHA)

Occupational Safety and Health Standards

Underwriters' Laboratories, Inc (UL)

UL 1	Flexible Metal Electrical Conduit
UL 6	Rigid Metal Electrical Conduit
UL 44	Rubber Insulated Wire and Cables
UL 50	Electrical Cabinets and Boxes
UL 67	Electric Panelboards
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508	Industrial Control Equipment (MCCs)

UL 514	Electrical Outlet Boxes and Fittings
UL 651	Rigid Nonmetallic Electrical Conduit
UL 797	Electrical Metallic Tubing
UL 845	Motor Control Centers
UL 886	Electrical Outlet Boxes and Fittings for Use in Hazardous Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G.

2.2 Existing plant documents will be used as a basis for new system designs to the greatest extent practicable.

3.0 SYSTEMS DESIGN

3.1 GENERAL

3.1.1 Each of the recovery facilities shall derive its respective power source from existing switchgear located in the generating station or from extensions of the existing 13.2 kV overhead lines located at the northeast and southwest areas of the site. A dedicated substation may or may not be required for each facility, depending upon such factors as the electrical loads within the building, availability of suitably rated distribution switchgear present in the existing system, and physical orientations of the facilities with respect to their anticipated sources.

3.1.2 Depending upon the facility served, 480 volt, 60 Hz loads shall be supplied from unit substations, motor control centers, distribution panelboards, or all of these. The 120/208 volt, 60 Hz loads shall be supplied from distribution and lighting panelboards.

3.1.3 Motor control centers shall be energized directly from 480 volt substations. The 480/277 volt lighting panels shall be energized via 480 to 277/480 volt transformers from substations or motor control centers. The 120/208 volt lighting and distribution panels shall be fed from motor control centers or distribution panelboards via step-down transformers. Branch circuits shall be supplied through individual circuit breakers within the panelboards.

3.1.4 Voltage sensitive loads requiring a regulated and/or isolated power source shall be supplied from line voltage regulators which furnish 120 and 240 volt, 60 Hz, single phase power regulated to within 1 percent of rated voltage, with less than 5 percent total harmonic distortion.

3.1.5 A 125 volt DC service will be provided for control power for unit substations required by new facility loads. This service will be supplied by existing plant DC power panels.

3.1.6 For those locations where hazardous materials are utilized, electrical equipment installations shall conform to appropriate sections of Chapter 5 of the National Electrical Code.

3.1.7 Distribution equipment ratings shall generally be selected so that 25 percent spare capacity is available when the equipment is purchased, in order to ensure adequate margin for system growth. This margin will be reduced however, for those facilities whose permanently installed loads will be modified to operate at a lower capacity for post-recovery periods.

3.1.8 Insofar as practicable, plant loads shall be energized from diverse power sources if available in order to maximize system reliability and availability.

3.1.9 Any permanent modifications made to the existing plant in order to accommodate the additional loads necessitated by the recovery effort shall be effected so that the final design (i.e., on-line operation of TMI-2) is within acceptable limits for system loading, short circuit capacity and voltage regulation. Where any such modifications are made on a temporary basis only, that fact and any resulting precautions to be followed shall be explicitly noted in the design documentation.

3.1.10 Waterproof cabinets or drip shields shall be used to protect electrical switchgear and motor control centers in areas which will be 1
sprinklered.

3.1.11 In general, the electrical equipment and design philosophy in- 1
cluded in the scope of this document shall be reviewed against and, wherever practicable, integrated with the existing plant design. Existing equipment specifications will be used where feasible for timely procurement of new equipment.

3.2 COMMUNICATIONS

Permanently installed communications facilities shall be provided as follows:

3.2.1 For operational purposes, a public address system consisting of six separate and independent communications channels shall be provided. These channels include one page and five party lines. Communications between parties within the plant are established by using the page channel, with a party line channel being used after the page is completed. As many as five party lines may communicate simultaneously. The system is also used to broadcast multitone alarms for reactor building evacuation, site evacuation, and fire. Capability shall be provided to merge this system with the existing public address equipment of Units 1 and 2. System components include wall mount and desk-type handset stations, amplifiers, and loudspeakers.

3.2.2 For communications between control consoles and equipment being maintained, calibrated, or tested, a multi-channel maintenance jack system consisting of a permanently interconnected series of jack stations shall be provided. The system provides two-way communication between multiple stations on a preselected channel by means of plug-in headsets.

3.2.3 A raceway system only for a leased, automatic dial-type commercial telephone system with extensions for intra- and inter-plant use interconnecting all buildings shall be provided.

3.3 FREEZE PROTECTION

3.3.1 Freeze protection shall be provided for outdoor water lines and instrumentation taps as required. This may consist of heater tape or electrically heated enclosures which are energized/deenergized by a locally mounted ambient air thermostat. Temperature monitors shall be provided in order to alarm a low temperature condition on the piping or enclosure served.

3.3.2 Outdoor water storage tanks shall be provided with either thermostatically controlled strap-on type heaters or immersion-type heaters. Temperature monitors shall also be provided.

3.3.3 All alarms shall be annunciated in the command center.

3.4 LIGHTING

3.4.1 Normal Lighting System

3.4.1.1 This system shall provide adequate illumination levels and convenience power for operating and service conditions. In addition, it serves as a distribution system of 120/208 VAC power to serve miscellaneous small load requirements. This system consists of a complete distribution network of cables, raceways, transformers, lighting panels, lighting fixtures, receptacles, and switches.

3.4.1.2 Lighting shall be served from diverse sources to preclude complete loss of illumination in an area in the event of equipment malfunction.

3.4.1.3 Lighting levels shall be as recommended by the Illuminating Engineering Society.

3.4.1.4 The raceway system shall be steel conduit, rigid, IMC or EMT. No EMT shall be used within the existing plant buildings. Where EMT is used, its application shall be restricted to preclude personnel walking and/or climbing on it.

3.4.1.5 The receptacles shall be 20 ampere or larger, 120 volt, NEMA configured, 3-wire grounding, duplex type. GFI circuit breakers shall be used for receptacle circuits in laboratories and shops. Switches shall be 20 ampere 120 or 277 volt bakelite base, single-pole, double-pole, three-way and four-way, as required. Where building construction permits, receptacles and switches shall be flush mounted; otherwise they shall be surface mounted. In outdoor areas, switches and receptacles shall be in weatherproof enclosures with raintight covers. Lighting fixtures may be fluorescent, incandescent, or high intensity discharge depending on environment and application. No mercury-bearing fixtures or switches shall be used in the containment or fuel storage areas. 1

3.4.2 Emergency Lighting System

3.4.2.1 This system shall provide emergency lighting for egress routes in all areas.

3.4.2.2 This system shall consist of individual, self-contained, 8-hour rated, sealed-beam battery units connected to the normal lighting AC source to maintain battery charge and which automatically transfer to their internal batteries upon loss of AC.

3.4.2.3 Illumination levels shall match existing plant design or where required shall be in accordance with the Pennsylvania Department of Labor and Industry Fire and Panic Regulations.

3.4.3 Exterior Lighting System

3.4.3.1 Exterior lighting shall be limited to fixtures mounted on perimeter building structures for entrance areas and where required for security illumination of areas adjacent to structures.

3.4.3.2 Exterior lighting levels shall be in accordance with existing site surveillance requirements.

3.5 RACEWAY

3.5.1 A complete system of raceways shall be provided to furnish protection and support for all wire and cable systems.

3.5.2 These raceway systems shall include separation of voltage classes such as 5 kV power cables, large 600 volt power cables requiring maintained spacing, 600 volt power, control and digital signal cables and analog instrumentation cables.

3.5.3 The systems shall be installed according to the applicable portions of the NEC and applicable NEMA standards except as noted in paragraph 3.5.5.

3.5.4 Materials shall be UL approved unless specifically approved otherwise on the drawings or specifications.

3.5.5 Where raceways are to be routed through existing plant areas, these raceways shall comply with the existing Unit 2 Burns & Roe Specification 2555-70 Section 16 Z, paragraphs 6.1.2.4 and 6.1.2.5 regarding separation and seismic II over I criteria which deal with seismic-generated collapse of non-seismic II equipment located above seismic I equipment.

3.5.6 Exposed raceways may consist of steel ladder-type cable tray, rigid steel, IMC or EMT conduit up to 4-inch sizes and rigid steel above 4 inch. For new conduit within the existing plant, EMT shall not be used for any applications. Flexible steel conduit shall be used at the connection to all equipment and devices subject to removal or vibration. Liquid-tight, flexible, metal conduit shall be used for these applications outdoors and in wet areas indoors. No setscrew conduit fittings shall be used. Threaded fittings shall be used for rigid steel conduit, clamp or compression type for EMT and flexible conduit. Where EMT is used its application shall be restricted to preclude personnel walking and/or climbing on it.

3.5.7 Underground or embedded raceways shall be rigid steel conduit, heavy wall PVC conduit, or steel floor raceways. PVC shall be used primarily in outdoor or underground locations and for specific nonmagnetic applications. Where standard 90-degree bends are to be used at the end of an underground duct run, the 90-degree bends shall be rigid steel conduit.

3.5.8 Where raceways are brought to an interface point, provisions shall be made for extension of connections.

3.5.9 Penetrations for electrical cable trays or multiple conduits penetrating a fire-rated wall or ceiling shall be sealed with fire stop materials to an extent commensurate with the wall or ceiling rating. Individual conduits or raceways embedded or concealed in walls or ceilings for direct feeds to lighting fixtures or receptacles will not be sealed. In addition, openings for electrical raceways passing through partition walls or drop ceilings which are not fire rated shall not be sealed.

3.6 GROUNDING SYSTEM

3.6.1 All new structures, electrical equipment, and metal components shall be grounded by direct or indirect connection to the existing site grounding system.

3.6.2 Buildings shall have a 4/0 AWG bare copper or larger ground cable run beneath or embedded in grade-level floor slabs at the building perimeter and connected to the site ground grid at a minimum of two places with the same size conductor. Steel building structures shall be connected to these perimeter cables by riser cables at a minimum of two locations on small structures and every other column on large structures.

3.6.3 Large electrical equipment, i.e., switchgear, unit substations, motor control centers, and large transformers, shall have direct connections to the grounding system in at least two places.

3.6.4 All electrical equipment mounted on concrete shall be connected to the nearest point of the grounding system.

3.6.5 All concrete buildings which may house electrical equipment shall have a minimum 4/0 AWG copper cable embedded in walls and/or floors and be connected to a minimum of two surface-embedded ground pads per room.

3.6.6 In addition to equipment grounds, all electrical apparatus operating above 240 volts shall be provided with a ground fault return conductor which is to be run as close as practicable to the power conductors. Metallic conduit and/or cable tray (if NEC approved) may serve as the ground fault return conductor if the conduit and/or tray (if NEC approved) is electrically continuous and has the required conductivity to pass sufficient current to ensure the operation of the overcurrent device.

3.6.7 At least one end of all steel conduit extensions to nonmetallic conduit shall be connected to the grounding system.

3.6.8 Cable tray installations, unless specifically certified to National Electrical Code requirements as a ground fault conductor, shall have a bare 4/0 AWG copper conductor installed and attached to each section of all trays carrying power cables. This cable shall be connected to the ground bus of the power source. Where conduits are used as the ground fault conductor, the conduits shall be connected to this ground cable on or in the cable tray and the conductor for this connection shall be sized in accordance with Table 250-95 of the National Electrical Code. Where flexible conduit is attached to rigid steel conduit that is being used as a ground fault conductor, the flexible conduit shall be jumpered with a bare copper cable.

3.7 CABLE DERATING AND CABLE SIZE SELECTION

3.7.1 Ampacity rating and group derating factors of cables shall be in accordance with ICEA P-46-426 for cables in conduit, ducts, and trays with maintained spacing. ICEA P-54-440 shall be used for cables in random filled tray.

3.7.2 In determining cable sizes for various services, the following load factors shall be used:

a. Transformer feeders	-	125 percent of transformer full load current
b. Motors feeders	-	125 percent of motor full load current
c. MCC feeders	-	100 percent of the bus rating plus 25 percent of the full load current rating of the largest motor which can be connected to the bus or where the actual loads are a small percentage of the main bus rating the cables shall be sized for the actual load plus 25 percent of the full load rating of the largest motor plus 25 percent for load growth.
d. Distribution panel branch circuits	-	100 percent of the maximum load to be served and/or 100% of the protective device setting. Where the ampacity of the conductor does not correspond with the standard fuse or breaker size, the next higher device rating may be used.

3.7.3 For those facilities to which the NEC applies, cable sizing will be in accordance with NEC recommendations in lieu of the above. (Applicability is defined in specific facility criteria.)

3.8 TEMPORARY LIGHTING AND POWER SYSTEM FOR CONTAINMENT RECOVERY

3.8.1 This system shall provide adequate lighting and power for the entry and decontamination phases of the recovery effort.

3.8.2 This system shall be served from the existing electrical system in Unit 2 via the containment recovery service building electrical system. Services at 480 volt, 3-phase and 120/208 volt, 3-phase, four wire will be sufficient for all temporary electrical requirements.

3.8.3 Temporary power outlets shall be provided for lighting, CCTV, heaters, steam jennies, power tools, radiation monitors, and welding machines.

3.8.4 Lighting levels shall be consistent with specific work tasks and with the requirements of the CCTV system.

3.8.5 Emergency lighting shall be provided to ensure egress lighting throughout the containment upon loss of normal power.

3.8.6 To ensure personnel safety, all electrical equipment shall be effectively grounded. In addition, ground fault circuit protection will be provided.

3.8.7 Existing electrical systems within containment, where operable, shall supplement the systems described in 3.8.1 through 3.8.6.

4.0 MAJOR EQUIPMENT DESIGN

4.1 SWITCHGEAR

In the event that the recovery facilities' loads necessitate the addition of 4160-volt switchgear, the additional equipment shall, insofar as possible, duplicate the existing switchgear in order to maintain standardization of large electrical apparatus within the general plant areas. All such switchgear shall be controlled from the main control room.

4.2 LIGHTING AND DISTRIBUTION PANELBOARDS

4.2.1 Lighting panelboards for 277/480 volt, 3 phase 4 wire service shall be equipped with molded case single pole circuit breakers. Interrupting ratings at 277 volts shall be a minimum of 10,000 amperes symmetrical. Power distribution panelboards for 480-volt, 3-phase, 3-wire service shall be equipped with 3-pole molded case circuit breakers rated 22,000 amperes symmetrical.

4.2.2 Panelboards for 120/208 volt, 3 phase service shall be equipped with molded case circuit breakers having 1 or 2 poles, as required. Interrupting ratings at 120 and 208 volts shall be a minimum of 10,000 amperes asymmetrical.

4.2.3 Circuit breakers for all panelboards shall be the indicating type. Multipole breakers shall have common trips. Circuit breakers shall be of the bolt on, quick make, quick break type, having thermal-magnetic overcurrent and short circuit trip elements, and shall be trip-free on overload and short circuits.

4.2.4 Panelboards shall have NEMA 12 enclosures, be surface mounted in general plant areas, and flush mounted in office areas.

4.3 MOTOR CONTROL CENTERS

4.3.1 Motor control centers shall consist of vertical sections joined together to form a rigid, free-standing enclosure. Each section shall be compartmentalized into combination starters and feeder tap breakers. MCC units shall be removable and interchangeable.

4.3.2 Generally, the motor control centers will supply motors rated 460V and 200 HP or less.

4.3.3 The MCC bus system shall be braced to withstand a short circuit current of 42,000 amps symmetrical (50,000 amps asymmetrical) amperes. The main bus shall be rated 600 amperes continuous. The vertical and ground busses shall be rated 300 amperes continuous.

4.3.4 Short circuit protection of combination motor starters shall be provided by circuit breakers equipped with adjustable instantaneous magnetic trip elements. Running protection of the motors shall be provided by ambient compensated overload elements in each phase of the motor starters. The overload elements shall have long-time-trip characteristics which approximate the heating curves of the motors. Protection of feeder tap units shall be provided by circuit breakers equipped with inverse time thermal overload protection and instantaneous magnetic short circuit protection on each phase. Breaker rated symmetrical interrupting capacity shall be greater than or equal to the total available symmetrical current at the point of application, as determined by the procedures of NEMA AB-1.

4.3.5 Ground fault protection shall be provided on an individual basis to ensure coordination with the incoming MCC feeder breakers. In general, this is provided for combination starters feeding loads exceeding 25 HP, and for feeder tap breakers with ratings exceeding 15A.

4.4 DRY TYPE TRANSFORMERS

4.4.1 Transformers shall be dry type, having a 480 volt, 3 phase delta primary and 120/208 volt, 3 phase, 4 wire wye secondary (or a 277/480 volt, 3 phase, 4 wire wye secondary for one-to-one transformers used as discussed in paragraph 3.1.3), or 480 volt, one phase primary and 120/240 volt, one phase, three wire secondary.

4.4.2 Transformer insulation shall be Class F or Class H. When fully loaded at rated voltage, the transformers shall have a maximum allowable temperature rise, as measured by resistance, of 115 degrees centigrade over an ambient of 40 degrees centigrade for Class F, or 150 degrees centigrade over 40 degrees centigrade for Class H insulations.

4.4.3 Transformers shall be furnished with four 2-1/2 percent full capacity taps, two above and two below nominal primary voltage.

4.4.4 Transformers shall have maximum noise levels of 45 decibels above a standard 24-decibel noise level of an anechoic test chamber as determined by NEMA standards.

4.5 MEDIUM VOLTAGE TRANSFORMERS

4.5.1 Transformers shall be provided for the facilities served by the 13.2 kV overhead lines to step down distribution voltage to a utilization voltage suitable for the building electrical loads.

4.5.2 The transformers shall be suitably rated 13.2 kV - 480 volt, 60 Hz, 95 kV BIL.

4.5.3 The primary winding configuration shall be delta capable of accepting a 3-wire, 13.2 kV feed from an overhead distribution line fused disconnect. The secondary winding configuration shall be a wye, with solidly grounded neutral for 480 volt feeds to the facilities.

4.5.4 The transformer shall be equipped with four 2½-percent taps, two above and two below nominal primary voltage.

4.5.5 The transformer shall be liquid immersed, padmount type suitable for outdoor application. Polychlorinated biphenals (PCBs) shall not be used in insulating fluids.

4.5.6 The transformer shall be provided with lightning protection.

4.6 UNIT SUBSTATIONS

4.6.1 Unit substations shall be provided to distribute power to large electrical loads as required for the various permanent facilities which must be served from the existing 4160 volt distribution system. These substations shall consist of a primary incoming cubicle, a power transformer, and 480 volt switchgear section, complete with all necessary accessory equipment. The substations shall be rated for operation from a 4,160 volt, 3 phase, 60 Hz primary system with a resistance grounded neutral.

4.6.2 The primary equipment shall have copper bus work insulated for 5 kV and be suitably braced to withstand a momentary short circuit current of 80,000 amperes.

4.6.3 A disconnect switch, rated 5 kV, shall be provided with an external operating handle and an external position indicator which shall positively indicate whether the switch is in the open or closed position. The disconnect switch shall be kirk-key interlocked with the 480 volt secondary main circuit breaker.

4.6.4 Power transformers shall be of the open, dry, ventilated type, with 4160 volt primaries and 480 volt, 3-wire solidly grounded secondaries. The transformers shall be provided with four 2½-percent full capacity, no-load rated taps in the primary winding, none above and four below rated primary voltage. The transformers shall have Class H insulation, with a basic insulation level of 25 kV.

4.6.5 Circuit breakers shall be equipped with solid state, direct acting series overcurrent devices providing adjustable long- and short-time overcurrent and short circuit protection and shall have trip-free operating mechanisms.

4.6.6 Ground fault protection relays shall be furnished for each substation.

4.7 MOTORS

4.7.1 In general, motors shall be energy efficient, squirrel cage induction type suitable for operation in a 40-degree centrigrade environment. All motors shall be capable of full voltage starting, and shall be able to accelerate their loads to rated speed with only 80 percent of rated nameplate voltage applied to their terminals. Motors shall be capable of delivering their rated output in continuous operation within the range of plus or minus ten percent of their rated voltage.

4.7.2 In sizing motors, no portion of a motor's service factor above 1.0 shall be used in continuous operation throughout the operating range of the load. Motors shall have a service factor of 1.15.

4.7.3 Unless specified otherwise, motors shall be of the self-ventilated type, with open drip-proof enclosures with screened openings.

4.7.4 Motors shall have windings with Class B insulation.

4.7.5 Motors sized smaller than 1/2 horsepower shall be rated 115 volt, 60 Hz, single phase and shall be used on a 120 volt, 60 Hz solidly grounded system.

4.7.6 Motors sized from 1/2 to 200 horsepower shall be rated 460 volt, 60 Hz, three phase and shall be used on a 480 volt, 60 Hz solidly grounded system.

4.7.7 All motors larger than 5 horsepower which are located in a high humidity environment shall be provided with space heaters suitable for operation on a 120 volt single phase supply. Space heaters shall be rated at twice the operating voltage to prolong heater life.

4.7.8 All motors shall be provided with terminal boxes one size larger than specified in NEMA MG-1. Separate boxes shall be provided for power terminals and space heaters.

4.7.9 All valve electric motor operators shall be suitable for use on a 480 volt, three phase supply. Motor insulation shall be Class B. Each motor operator shall be furnished with self-locking gears and two-train geared limit switches and torque switches which operate in the closing and opening mode. All operators anticipated for use in a high humidity environment shall be provided with a 120 volt space heater. All components shall be housed in a NEMA IV enclosure.

4.8 WIRE AND CABLE

4.8.1 The following voltage classes of cables will be used:

a) 5 kV and 15 kV power cable

b) 600 V power cable

c) 600 V control cable

d) instrument and special cables

4.8.2 Power cables supplying facilities from 13.2 kV overhead lines shall be 15 kV, shielded and suitable for grounded service. Power cables for the 4.16 kV feeders supplying the unit substations shall be unshielded and rated 5 kV ungrounded. The 600-volt power and control cable shall be single conductor or multiple conductor, as required. Power and control cables shall have Class B stranded copper conductors with 90 C insulation, which meets IEEE 383 flame resistance tests.

4.8.3 Instrument cables for low level signals shall be shielded and twisted to reduce noise pickup. Conductors shall be copper with insulation rated 90 C and which meets IEEE 383 flame resistance tests.

4.8.4 Single phase branch circuit wiring for receptacle and lighting runs shall be copper with insulation rated for 90 C, 12 AWG minimum gauge. Insulation shall be 600 volt, type THW moisture and heat resistant thermoplastic. Lighting fixture wire shall be Class B stranded, tinned copper with insulation rated for 200 C, 14 AWG minimum gauge. Insulation shall be 600 volt, type SF-2 silicone rubber, or other suitable code approved type.

4.8.5 Polyvinylchloride (PVC) insulation shall not be used in any cable construction with the exception of lighting, receptacle and communications wiring which will be totally enclosed in conduit. For new installations within the existing plant, PVC shall be totally precluded. All lighting and receptacle wiring shall carry Underwriters' Laboratories approval.

BECHTEL

Design Criteria 13587-2-M01-100

GPU SERVICE CORPORATION

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

DESIGN CRITERIA DOCUMENTS

COVER SHEET

JOB NO: 13587 **DISCIPLINE:** Plant Design and Mechanical

1	7/21/81	Revised as Noted and Issued for Use Upon GPUSC Approval	RCM	TAH	RW	KO
0	12/22/80	Issued for Use Upon GPUSC Approval	JBB	RCM	RW	KO
REV. NO.	DATE	REVISION DESCRIPTION	ORIGINATOR	GROUP SUPV.	PROJECT ENG.	GPUSC
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GPD-13678 9/80

SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.
i	1												
ii	0												
1	0												
2	0												
3	1												
4	0												
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17	0												
18	1												
19	1												
20	0												
A-1	0												
8-1	0												
B-2	0												

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PLANT DESIGN AND MECHANICAL
DESIGN CRITERIA

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PLANT DESIGN AND MECHANICAL

DESIGN CRITERIA

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The Plant Design and Mechanical Design Criteria for the project applies to the systems for which Bechtel has design responsibility. The design criteria form the technical basis for the system design and equipment selection. This is based on specific client and site conditions, code requirements, environmental and licensing requirements, and existing power plant design experiences and technology.

This document pertains only to structures and systems designed for the cleanup of the containment and subsequent defueling following the March 28, 1979 accident at Three Mile Island Unit 2. It does not address the tasks of reconstruction and requalification of the plant. The purpose of this document is to provide a basis for design of new systems or modifications to existing systems which may be required to support containment entry and decontamination with the objective of placing the containment in a configuration where reactor vessel head removal can begin and fuel may be removed from the reactor and either shipped or stored.

The project's Plant Design and Mechanical engineering work is governed by several project design reference documents listed in Appendix A. Of these, the Plant Design and Mechanical Design Criteria shall be the basic design document, and any deviation from it, with the exception of those criteria specifically identified as guidelines, shall be registered with the project's Plant Design/Mechanical Group Supervisor before proceeding with the work.

2.0 CODES, STANDARDS, AND GUIDES

2.1 QUALIFYING STATEMENT

The latest issue of the governing codes and standards in effect at the time of issue of the purchase order shall be used for all specifications. Design work shall use the latest issue in effect at the time a drawing or document is issued for construction.

2.2 STATE AND LOCAL CODES AND STANDARDS

a. The Pennsylvania State Code, Fire and Panic Regulations by Department of Labor and Industry

b. "Clean Stream Laws," Commonwealth of Pennsylvania.

2.3 ALL OTHER CODES, STANDARDS, AND GUIDES

a. ASME Boiler and Pressure Vessel Code

1) Section II, Material Specifications

2) Section III, Nuclear Power Plant Components, Div. 1

3) Section V, Non-destructive Examination

4) Section VIII, Unfired Pressure Vessels, Div. 1

5) Section IX, Welding and Brazing Qualifications

6) Section X, Fiberglass-Reinforced Plastic Pressure Vessels

7) Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components

b. ASME Power Test Codes

c. Associated Air Balance Council

National Standard for Field Measurement and Instrumentation Total System Balance, Vol. 2, No. 12173

d. Air Conditioning and Refrigeration Institute

1) Standard 430 for Central Station Air Handling Units

2) Standard 550 for Centrifugal Water - Chilling Packages

3) Standard 280 for Central Forced Air Electrical Heating Equipment

4) Standard 210 for Unitary Air Conditioning Equipment

e. Anti-Friction Bearing Manufacturers Association (AFBMA) 1

Standards as applicable

f. American Gear Manufacturers Association (AGMA)

Standards as applicable

g. Air Movement and Control Association (AMCA) 1

1) Standard 210, Test Code for Air Moving Devices

2) Standard 211, Certified Rating for Air Moving Devices

3) Standard 500, Test Method for Louvers, Dampers, and Shutters

h. American Concrete Institute (ACI)

ACI 318 Building Code Requirements for Reinforced Concrete (Note: ACI code applies only as a supplemental code for embedded pipe)

i. American Institute of Steel Construction (AISC)

Manual of Steel Construction, 7th Edition

j. American National Standards Institute (ANSI)

1) B2.1, Pipe Threads

2) B16.1, Cast Iron Pipe Flanges and Flanged Fittings, 25, 125, 250 and 800 LB.

3) B16.5, Steel Pipe Flanges and Flanged Fittings

4) B16.9, Wrought Steel Butt Welding Fittings

5) B16.10, Face-to-Face and End-to-End Dimensions of Ferrous Valves

6) B16.11, Forged Steel Fittings, Socket-Welding, and Threaded

7) B16.25, Butt Welding Ends

8) B16.34, Steel Valves

9) B30.2.0, Safety Code for Overhead and Gantry Cranes

10) B30.10, Hooks

11) B31.1, Power Piping

12) 836.10 Wrought Steel and Wrought Iron Pipe

13) 836.19, Stainless Steel Pipe

14) N45.2.2, Packing, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants

15) N509, Nuclear Power Plant Air Cleaning Units and Components

16) N510, Testing of Nuclear Air-Cleaning Systems

17) S1.13, Methods for the Measurement of Sound Pressure Levels

18) S5.1, CAGI-PNEUROP, Test Code for the Measurement of Sound from Pneumatic Equipment

19) Z86.1, Commodity Specification for Air

k. American Petroleum Institute (API)

1) Standard 605 Large Diameter Carbon Steel Flanges

2) Standard 620 Design and Construction of Large, Welded, Low-pressure Storage Tanks

l. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)

Standards as applicable

m. American Society of Mechanical Engineers (ASME)

Standards as applicable

n. American Society of Non-destructive Testing (ASNT)

SNT-TC-1A, Recommended Practice for Non-destructive Testing, Personnel Qualification and Certification

o. American Society for Testing Materials (ASTM)

Standards as applicable

p. American Welding Society (AWS)

Standards as applicable

q. American Water Works Association (AWWA)

1) D-100, Standard for Welded Steel Elevated Tanks, Standpipes, and Reservoirs for Water Storage

2) C203 Coal-Tar Enamel Protective Coatings for Steel Water Pipe

3) C209 Cold-Applied Tape Coatings for Special Sections, Connections and Fittings for Steel Water Pipe

r. Building Officials and Code Administrators International (BOCA)

1) Basic Building Code

2) Basic Mechanical Code

3) Basic Plumbing Code

s. Compressed Gas Association (CGA)

1) G-1 Acetylene

2) G-1.3 Acetylene Transmission for Chemical Synthesis

3) G-7 Compressed Air for Human Respiration

4) G-7.1 Commodity Specification for Air

t. Crane Manufacturers Association of America (CMAA)

CMAA70, Electric Overhead Traveling Cranes

u. Canadian Standards Association (CSA)

Z180.1, Compressed Breathing Air

v. Heat Exchange Institute (HEI)

Standards as applicable

w. Hydraulic Institute (HI)

Standards of the Hydraulic Institute

x. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

1) MSS-SP-25, Standard Marking System for Valves, Fittings, Flanges, and Unions

2) MSS-SP-43, Wrought Stainless Steel Butt-Welded Fittings

3) MSS-SP-44, Steel Pipe Line Flanges

4) MSS-SP-55, Quality Standard for Steel Castings - Visual Method

5) MSS-SP-58, Pipe Hanger and Supports - Materials, Design, Manufacture

6) MSS-SP-61, Hydrostatic Testing of Steel Valves

7) MSS-SP-66 Pressure-Temperature Ratings for Steel Butt-Welding End Valves

8) MSS-SP-67, Butterfly Valves

9) MSS-SP-69, Pipe Hangers and Supports - Selection and Application

10) MSS-SP-72, Ball Valves with Flanged or Butt Welding Ends for General Service

11) MSS-SP-73, Silver Brazing Joints for Solder Joint Fittings

12) MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves

13) MSS-SP-84, Steel Valves--Socket-Welding and Threaded

14) MSS-SP-89 Pipe Hangers and Supports - Fabrication and Installation Practices

y. National Fire Protection Association (NFPA)

1) NFPA-10, Portable Fire Extinguishers

2) NFPA-12A Halon 1301 Systems

3) NFPA-13, Sprinkler Systems, Installation

4) NFPA-14, Standpipe and Hose Systems

5) NFPA-15 Water Spray Fixed Systems

6) NFPA-20 Centrifugal Fire Pumps

7) NFPA-24, Outside Protection

8) NFPA-26 Supervision of Valves

9) NFPA-45, Fire Protection for Laboratories Using Chemicals

10) NFPA-72D Proprietary Signaling Systems

11) NFPA-72E Automatic Fire Detectors

12) NFPA-80 Fire Doors and Windows

13) NFPA-90A Air Conditioning and Ventilating Systems

14) NFPA-90B Warm Air Heating and Air Conditioning

15) NFPA-194 Fire Hose Connections

16) NFPA-196 Fire Hose

17) NFPA-30 Flammable and Combustible Liquids Code 1

z. Pipe Fabrication Institute (PFI)

1) PFI-ES-3, Fabrication Tolerances

2) PFI-ES-5, Cleaning Fabricated Piping

3) PFI-ES-24, Pipe Bending Tolerances

4) PFI-ES-26, Welded Load Bearing Attachments to Pressure Retaining Piping Materials

aa. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1) High Pressure Duct Construction Standards

2) Low Pressure Duct Construction Standards

bb. Tubular Exchanger Manufacturers Association (TEMA)

Standards of Tubular Exchanger Manufacturers Association

cc. Bechtel Power Corporation, Procedures, Standards, and Guides

dd. Steel Structures Painting Council (SSPC)

1) SP-6, Commercial Blast Cleaning

2) SP-10, Near White Blast Cleaning

3) PA-1, Shop, Field, and Maintenance Painting

2.4 INSPECTIONS

Inspections performed on Section III, VIII, and X stamped components, by authorized Code inspectors not registered in the State of Pennsylvania, will require inspection by the state upon receipt of the component on site.

3.0 MAJOR PLANT PARAMETERS

3.1 NUCLEAR STEAM SUPPLY SYSTEM

Nuclear Steam Supply System data is given in the TMI-2 FSAR.

3.2 PLANT EXTERNAL FACILITIES

Water Source

The plant makeup water is from the Unit 1 water treatment system which draws from the Susquehanna River.

Spent Fuel Removal

The spent fuel is removed by over-the-road truck.

Radioactive Solid Waste Removal

Solid radioactive wastes that will be generated during the recovery operations will be packaged in approved containers for offsite disposal. An interim solid waste staging facility (ISWSF) will be provided as a temporary storage area for these wastes (approximately six months' storage capacity for both units will be provided). Later permanent low-level and high/medium-level storage facilities will be provided for storage of recovery and normal operations-related wastes prior to off-site disposal.

4.0 GENERAL PLANT CRITERIA FOR DESIGN

4.1 AIR QUALITY (Plant Discharge Air)

The plant shall employ the following design features or practices in furtherance of this requirement:

> New plant modifications shall be designed and constructed in accordance with federally-promulgated New Source Performance Standards and the Department of Environmental Quality Rules of Pennsylvania in effect at the time of the change.

4.2 RIVER WATER QUALITIES

The water quality design values of the Susquehanna River are as shown in Table 4-1.

4.3 REACTOR COOLANT ANALYSIS

The post-accident reactor coolant quality for design will be as shown in the latest issue of B&W Compilation of Chemistry Results for TMI-2 Reactor Coolant System.

4.4 QUALITY AND CONCENTRATIONS OF PRINCIPAL NUCLIDES CONTAINED IN REACTOR BUILDING SUMP WATER

Data taken in August 1979 is presented in Table 4-2. The data may be subject to change, depending on the system conditions encountered as the recovery effort proceeds.

4.5 MINIMUM WATER CHEMISTRY SPECIFICATIONS DURING THE PRE-DEFUELING PERIOD

Table 4-3 lists the Babcock & Wilcox Company's required and recommended "minimum water quality requirements" for the TMI-2 Recovery Effort. The time period of the document is designed to be in effect from the time issued to the initial core defueling. The specifications listed may be subject to change depending on the system conditions encountered as the recovery effort proceeds.

4.6 AMBIENT DESIGN CONDITIONS

Table 4-4 lists inside design temperatures and humidities for existing areas. Inside design conditions for new facilities will be addressed in the specific design criteria for each facility. HVAC systems will be designed for the following outside conditions:

Summer	94 F DB, 75 F W.B.
Winter	7 F DB

Data from ASHRAE Handbook of Fundamentals, 1977 edition, 1 percent values for Harrisburg, Pennsylvania airport.

4.7 WASTE WATER QUANTITY

New liquid processing systems containing radioactive material shall be designed to produce an effluent which conforms to 10 CFR 50, Appendix I guidelines, as interpreted by the TMI-2 technical specifications. Tankage shall be designed to retain the processed liquid such that although it is suitable for release from the plant site, releases need not be made.

4.8 LIQUID RADWASTE SYSTEMS RELEASE

Should it be necessary to discharge potentially radioactive liquid wastes to the environment, such wastes shall be sampled and analyzed prior to release and shall contain radionuclide concentrations that are in accordance with the Plant Technical Specifications.

4.9 NOISE CONTROL

In order to provide the means for evaluating new equipment liable to emit noise which would result in levels in excess of 90dBA, procurement documents shall require proposed and final sound pressure levels for the equipment proposed. Specific noise levels shall not be specified in the procurement document.

4.10 VALVE CRITERIA

4.10.1 All process piping vents shall be 3/4 inch in diameter and have 3/4 inch (min.) globe valves, and all process piping drains shall be 1 inch in diameter and have 1 inch (min.) wye pattern globe valves except air/gas systems which shall use ball or plug valves. All vents and drains will have screwed caps.

4.10.2 Double valving shall be used on vents and drains on piping based on the following criteria:

a. Nuclear and safeguard systems above 250 F and/or 200 psig

b. All balance of plant systems other than item a above 250 F and/or 500 psig; this will prevent leakage due to seat damage from throttling of the first valve, since the second valve is used for shutoff only, not throttling.

c. All sampling connections, since frequent usage would result in seat wear.

d. Systems containing radioactive fluid where leakage would be hazardous to personnel.

e. Caps or flanges after a single valve, in lieu of a second valve, are not to be used. Removal of a cap or blind flange, if there has been leakage, could result in personnel injury due to release of pressure buildup.

f. All radioactive tank drains.

4.10.3 Systems which contain, collect, store, or transport radioactive material will use valves which minimize radiation exposure to operating personnel (both direct due to internal crud buildup and inhalation due to external leakage).

Straight-through valve configurations or weir type diaphragm valves are preferred to those containing crevices and discontinuities. Diaphragm valves will have radiation-resistant diaphragms.

Valves 2-1/2 inches and larger will have double packing and lantern ring leakoffs, where specified.

4.10.4 Top trim material for boric acid system valves shall be austenitic stainless steel to prevent corrosion due to stem leakage.

4.10.5 To prevent liquid entrapment, double-seated valves (split wedge, flexible wedge, or multiple disc parallel seat) mounted in a horizontal run of pipe will be installed with stem in a vertical position.

4.10.6 Safety and relief valves and cast iron or bronze valves will be flanged. All other valves 2-1/2 inches and larger in a steel piping system will have butt-welding ends. Valves 2 inches and smaller will have socket welding ends except where temperature transients exceed one degree F per minute, buttweld ends are required.

4.10.7 Threaded bonnets for steel gate and globe valves will be seal welded.

4.10.8 Butterfly valves will only be used in lines 6 inches or greater. Application of butterfly valves is limited to low temperature-pressure and negligible radioactivity services. Flangeless valves will not be used where adjacent pipe or components may be removed while part of the system is in operation.

4.10.9 <u>Torque and Limit Switch Functions for Electric Motor Operated Valves</u>

a. All electric motor-actuated valves and gear-actuated valves, 10-inch and larger, 150 lb. and 8-inch and larger, 300 lb., shall be provided with power wrench operation for intermediate fast travel between seated and full open positions.

b. Gate, Globe, and Stop Check Valves:

Open: Valve travel to the fully open and backseated position will be controlled by a limit switch. Adjustment will be accomplished by cutting off power to the motor before final backseating. Moving inertia through the gear train will then effect final backseating.

The torque switch will provide protection if mechanical obstruction prevents opening of the valve, or if the opening limit switch fails to operate.

Close: Valve travel to fully close the valve will be controlled by the torque switch preset to the required torque to assure valve closure, without damage to the valve or actuator parts.

c. Butterfly and Ball Valves

Open and Close: Valve travel to the fully open and fully closed positions will be controlled by the limit switch. Adjustments will be accomplished by cutting off power to the motor before final seating. Moving inertia through the gear train will then effect final seating.

The torque switch will provide protection if mechanical obstruction prevents the valve from opening or closing, or if the limit switch fails to operate.

4.11 PIPING CRITERIA

4.11.1 The standard pipe sizes shall be 1/8, 1/4, 3/8, 1/2, 3/4, 1, 1-1/2, 2, 2-1/2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, and 24 inches. Deviations from these standards will be only for special fabricated piping.

4.11.2 Seal water, lube water, and miscellaneous oil piping around equipment will be installed with flanges or unions for normal maintenance.

4.11.3 A stress analysis in accordance with ASME Section III or ANSI B31.1 will be performed on all seismic Category I piping 2-1/2 inches and larger. Non-seismic piping systems containing fluid at 150 F or higher will also be analyzed for thermal expansion. However, a rigorous stress analysis will be performed as the situation may require. Seismic II/I will be analyzed as required by the General Section, 13587-2-L01-100.

4.11.4 Piping line specification change will normally be shown to change at the valve ends on the Piping and Instrument Diagrams and isometrics (piping plans). However, the more stringent stress analysis requirement will hold to the first anchor beyond the valve.

4.11.5 In general, welded piping joints will be used throughout the plant. Process lines 2-1/2-inch nominal pipe size or above will be butt welded (no backing rings will be used on resin or evaporator bottoms lines). Process lines two inches or smaller will be socket welded except where temperature transients exceed 1 F per minute, stress, or other conditions require butt welds. Instrumentation lines (downstream of the first root valve) are not considered process lines, and screwed connections may be used.

Flanges will be used with the following:

a. Rubber-seated butterfly valves

b. Cast-iron pumps

c. Control valves (3 inches and larger)

d. Safety and relief valves

e. Equipment normally provided with flanges for the temperature and pressure at which it operates and does not create a hazard to plant personnel

f. Startup strainers, orifice plates, drainage systems, etc.

4.11.6 Schedule 40 or 40S pipe will be used for 2-inch and smaller lines requiring volumetric inservice inspection rather than Schedule 10 or 10S.

4.11.7 All stainless steel pipe used for safety-related piping will be Type "L" (low carbon), as recommended by Regulatory Guide 1.44. In addition non-safety-related stainless steel piping will also be Type "L", unless otherwise noted.

4.11.8 Appendix B indicates the acceptable guideline velocity limits for various fluids and pipe sizes.

4.12 PIPE SUPPORT DESIGN CRITERIA

4.12.1 General

4.12.1.1 Structural Steel Supports shall be designed in accordance with the rules of ASME Section III, Appendix XVII, Design of Linear Type Supports by Linear Elastic and Plastic Analysis.

4.12.1.2 The supports will be adequate to restrain any additional loads due to various test conditions unless provisions are made for temporary support during the testing period.

4.12.1.3 Pipe supports will not be welded to elbows, tees, or other fittings unless approved by the Project Stress Group.

4.12.1.4 Temperatures used to calculate thermal movements (if any) shall be the temperatures of all normal operating modes. Spring supports will be selected so that there is sufficient overtravel to accommodate seismic piping displacement (OBE and SSE) without causing the spring to bottom/top out.

4.12.1.5 All supports will have a means of vertical adjustment in the vicinity of equipment and will have removable parts, if required, to avoid interference during maintenance.

4.12.2 Materials

4.12.2.1 All materials used in the construction of pipe supports will be in accordance with the referenced codes and standards. All welded piping attachments shall be the same material as the piping to which they are attached. Other materials shall not be used unless approved by the project engineer.

4.12.2.2 Commercially available component standard supports will be utilized to the fullest extent possible provided they conform with the specification.

4.12.2.3 Component standard supports shall be MSS-SP-69 or approved equal.

4.12.3 Design

4.12.3.1 Support Spacing

Support spacing will be as determined by a formal thermal and weight analysis. Where a formal stress analysis is not performed, the code recommended spacing shall be used unless justified by calculations.

4.12.3.2 Loading Conditions

The most severe conditions of coincident pressure, weight, temperature and any other fluid dynamic events shall be considered in the design of pipe supports. In addition to the above loading conditions, piping routed outside the power block shall be designed for wind and snow loads when applicable.

4.12.3.3 Riser Supports

Rigid riser supports on critical piping systems shall be designed for 75% of the total hydro load of the entire riser. All rigid riser supports will be designed so that the total piping load can be carried by one side of the clamp and one rod in the event of a load shift.

4.12.3.4 Minimum Material Yield Strength shall be as specified in the appropriate table in ASME Section III Appendix I and reduced proportionately consistent with the normal operating temperature of the structure.

4.12.3.5 All local stresses in structural steel members shall meet the requirements of ASME Section III Appendix XVII.

4.12.3.6 All welds shall be proportioned in accordance with ASME Section III, Appendix XVII, Paragraph 2452 and Table XVII-2452.1-1. Piping attachments shall be in accordance with PFI-ES-26.

4.12.3.7 All bolted connections and baseplates shall be designed in accordance with Gaithersburg Power Division Hanger Engineering Standards. Concrete anchor bolts will be wedge-type only and designed with a minimum safety factor of 4 and shall be proportioned to satisfy shear-tension interaction equation:

$$\frac{VT}{VA} + \frac{PT}{PA} \leq 1.0$$

Locking devices shall be used on right-hand threaded or bolted parts to prevent loosening or disengagement from vibration.

4.12.3.8 Friction Force

A friction force of .3 times the normal operating load shall be applied to all sliding supports which do not use devices which minimize friction.

4.13 FIRE PROTECTION CRITERIA

The selection of detection and extinguishment systems will be determined from a fire hazards analysis. Protection will be provided in accordance with NFPA Codes listed in Section 2.3.y of this document, and the Pennsylvania State Code, Fire and Panic Regulations.

TABLE 4-1

RIVER WATER QUALITIES

Item	Units	Value
Turbidity	JTU	3.3-24
Total hardness	ppm	60-242
Suspended solids	ppm	2-416
TDS	ppm	70-301
pH	---	7.4-8.8
Sulphates	ppm	25-126
Chlorides	ppm	7-32
Nitrates	ppm	3-13
Minimum daily flow	CFS	1,700
Average annual discharge	CFS	34,000

The above data is obtained from an ecological study of Susquehanna River near TMI, annual report 1979, compiled by Ichthyological Associates, Inc. |1

TABLE 4-2

QUALITY AND CONCENTRATIONS OF PRINCIPAL NUCLIDES CONTAINED IN REACTOR BUILDING SUMP WATER[a]

Radionuclide Content μCi/ml	Reactor Containment Building Top	Middle	Bottom
^{137}Cs	176	179	174
^{134}Cs	40	40	40
^{90}Sr	3	3	3
^{89}Sr	43	41	42
^{131}I	0.01	0.01	0.01
^{129}I μg/ml	0.08	0.08	0.08
$^{140}Ba/^{140}La$	0.09	0.08	0.14
^{3}H	1.0	1.1	1.0
Gross α dpm/ml	3.4 ± 1.6	1.2 ± 1.3	5.4 ± 2.0
Element ppm	**Top**	**Middle**	**Bottom**
B	1950	2200	1900
Cl	10	15	8
Na	1080	1200	1200
pH	8.1	8.1	8.1

a) Data taken from Oak Ridge National Laboratory analysis performed August 28, 1979.

TABLE 4-3

MINIMUM WATER CHEMISTRY SPECIFICATIONS DURING THE PRE-DEFUELING PERIOD

System	pH	Conductivity µmho/cm	Cat. Cond. µmho/cm	Cl ppm	F ppm	Diss. O_2 ppm	B ppm	Na ppm	N_2H_4 ppm	NH_3 ppm	H_2 cc/kg	Total Fe ppm	Susp. Solids ppm	Dis. Solids ppm	Morpholine ppm
I. Primary Water															
A. RCS - MU	(1)			1.0	1.0	0.1	3000-4500(11)	(1)	(7)						
B. RCS - Flush	6-8	2.5		1.0	1.0								1.0		
C. RCBHT - Flush	6-8	2.5		1.0	1.0								1.0		
D. BWST - MU				1.0	1.0		3000-4500(11)						1.0		
E. SFP				1.0	1.0		3000-4500(11)						1.0		
F. RCS/DHR	≥7.5			(6)	(6)	(6)	3000-4500(11)				5-15				
II. Pres. - Volume Control															
A. BWBT							7000 (nom)	2900 (nom)							
B. CWST (2)	(1)			1.0	1.0	0.1	3000-4000	(1)	(7)						
C. Surge Tks. (2)	(1)			1.0	1.0	0.1	3000-4000	(1)	(7)						
III. Secondary Water															
A. FW - Steaming	9.3-10.5		1.0			0.1			0.1 (Min)						
B. OTSG - Steaming	9.5-10.5		10	1.0		0.1		2.0							
C. FW - Layup	9.5-10.5		(8)	1.0					50-200	2-20					
D. OTSG - Layup	9.5-10.5		10	1.0				2.0	50-200	2-20					
E. Heater Shells Layup	9.5-10.5		(8)	1.0					50-200	2-20					
F. CST (3)	6-8		1.0									0.1			
G. Heater Tubes - Layup	9.5-10.5		(8)	1.0					50-200	2-20					
Misc.															
A. RB Cleanup & Flush H_2O (9)	5.5-8.0	25		10	5.0										
B. RB Deionized Water Flush	5.5-8.0	2.5		1.0	1.0										
C. Processed H_2O Stor. Tk. (10)															
D. ICW (5)	8.5-9.5			1.0	1.0	0.1			10-15(5)					25	2-6

TABLE 4-3 FOOTNOTES AND KEY

FOOTNOTES

(1) Sufficient to keep RCS/OHR pH ≥ 7.5 ≤ 9.5; using NaOH.

(2) Assumed to be for RCS/OHR makeup.

(3) Assumed to be non-treated makeup for OTSG, steam, or pre-boiler cycle.

(4) Deleted

(5) If water for CRO supply, Cu limited to <0.1 ppm.

(6) Specification based on makeup water requirements.

(7) 3 times Stoichiometric requirements to react with O_2.

(8) Recommended that cation conductivity not exceed 10 µmho/cm.

(9) Water quality prior to addition of alkaline additive chemicals. Unless other alkaline chemicals are used, the water should be treated with 5-15 ppm sodium phosphates with a molar ratio of 2.6:1.

(10) Must meet specifications for intended use, e.g., if for RCS-MU, must meet I-A specs.

(11) Limits specified in Interim Recovery Technical Specifications. | 1

KEY

MU = Quality for water used to makeup to the system.
Flush = Quality for water used to flush systems.
System w/o MU or flush notation = Quality of water in system.
Numbers = Maximum spec unless otherwise identified or range if latter given.

TABLE 4-4

INSIDE AMBIENT DESIGN CONDITIONS FOR EXISTING AREAS

Name of Building, Area, or Room	Normal Operating Temperature Max/Min (F)
Reactor Building	130 (Permanent Modifications)/ 104 max (Temporary Modifications)
Auxiliary Building	110
Turbine Building	107/50
Control Building Area	104/60
Fuel Handling Building	104
Service Building	75/70
Control Room	75/70

APPENDIX A

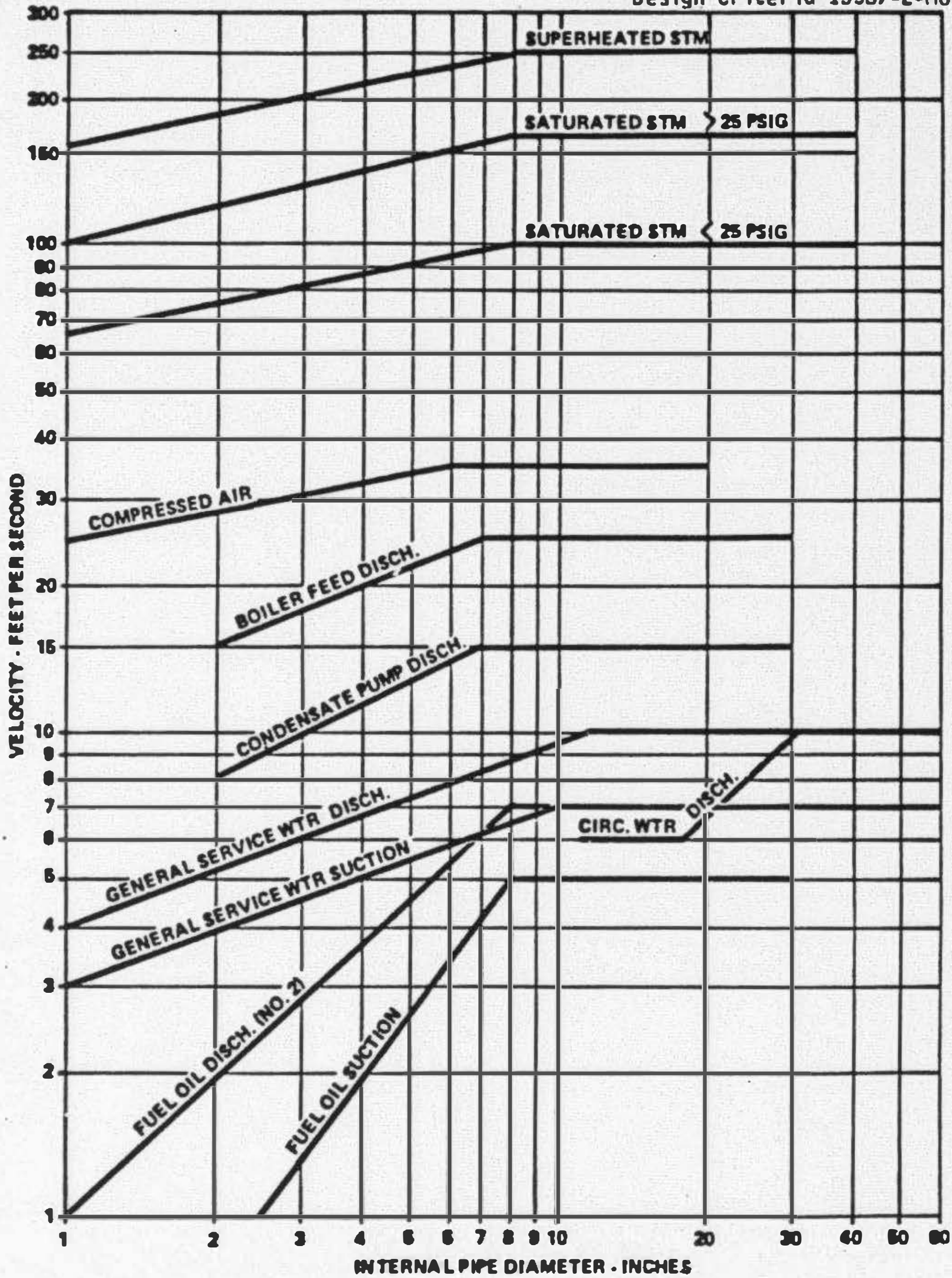
DESIGN REFERENCES

1. GPUSC Procedure ES-005 for System Descriptions, latest revision
2. Burns and Roe Criteria Documents, TMI Unit 2, latest revision
3. Oak Ridge National Laboratory Analysis of TMI-2 Sump Water, latest revision
4. Babcock and Wilcox TMI-2 Water Chemistry Manual, latest revision
5. Burns and Roe Flow Diagrams for Three Mile Island Unit 2, latest revision per B & R Drawing Log
6. Burns and Roe System Descriptions for Three Mile Island Unit 2, latest revision per B & R System Description Log
7. Burns and Roe Specifications for Three Mile Island Unit 2, latest revision per B & R Specification Log

APPENDIX B

Velocity Versus Pipe Diameter

The following graph presents guidelines for the selection of pipe sizes based on the velocity of the process fluid.



NOTES:

1. THESE CURVES REPRESENT A GUIDELINE FOR THE SELECTION OF PIPE SIZES AND ARE BASED ON ENGINEERING JUDGEMENT AND CURRENT PRACTICES. OTHER CRITERIA, SUCH AS ALLOWABLE LINE PRESSURE DROP, ECONOMICAL EVALUATION AND "FLASHING" CONSIDERATION, SHOULD BE CONSIDERED WHEN SIZING LINE.
2. SUCTION PIPE SIZES FOR SATURATED WATER SHOULD BE SIZED BASED ON THE PUMP'S NPSH REQUIREMENT, WITH 3 TO 5 FPS CONSIDERED TYPICAL.

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RECOVERY FACILITIES

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1	7/21/81	Revised as Noted and Issued for Use Upon GPUSC Approval	RPM	WHH	RW	JEO
0	12/22/80	Issued for Use Upon GPUSC Approval	RPM	WHH	RW	JEO
REV. NO.	DATE	REVISION DESCRIPTION	ORIGINATOR	GROUP SUPV.	PROJECT ENG.	GPUSC
				APPROVAL		

GPD-136 9/80

SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.	SHEET	LATEST REV.
i	1												
1	0												
2	0												
3	0.												
4	0												
5	1												
6	1												
7	1												

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SHIELDING DESIGN AND ACCESS CONTROL

DESIGN CRITERIA

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|1

1.0 GENERAL

1.1 The primary objective of the shielding design and access control will be to protect operating personnel and the general public from potential radiation sources in the reactor, power conversion system, radwaste system, and other auxiliary systems, including associated equipment and piping. Shielding will be designed to perform the following functions:

a. Limit the dose to plant personnel, construction workers, vendors, and visitors during cleanup, recovery, and inspection to within the requirements of 10 CFR Part 20 and to meet the intent of Regulatory Guide 8.8.

b. Limit the dose to unit personnel to within the requirements of 10 CFR Part 50, Appendix A, Criterion 61, Fuel Storage and Handling and Radioactivity Control.

c. Limit the dose rate to certain components in high-radiation areas within specified radiation tolerances.

d. Limit dose to persons at the boundary of the restricted area, due to direct radiation during normal operation, to a value no greater than 10 CFR Part 20 limits.

e. Limit dose to persons at the site boundary due to direct radiation during normal operation to a value less than 40 CFR Part 190 limits.

2.0 GUIDELINES FOR GENERAL ARRANGEMENT AND SHIELDING

2.1 The following guidelines will be used for equipment layout and shielding of the plant.

These guidelines will be used as the design basis for initial shielding design, such as determination of shield wall thickness, materials, and locations. As the detailed facility design develops, an ALARA review of the facility will be made. This review may result in the inclusion of additional permanent or temporary shielding in excess of that indicated by the design criteria in order to achieve a fully acceptable design from an ALARA standpoint.

All systems containing radioactivity will be identified and shielded, based on the access requirements of the area. All areas within the Owner-controlled area will be divided into zones, with dose rate levels and anticipated access as shown in the following table based on source terms for normal operation.

TABLE 1

RADIATION ZONES

ZONE	DESIGN DOSE RATE (MREM PER HR)	ACCESS DESCRIPTION
I	≤0.5 (Note 1)	Uncontrolled, Unlimited Access
II	0.5-2.5	Controlled, Limited Access 40 Hrs Per Week
III	2.5-25	Controlled, Limited Access 4 to 40 Hrs/Week
IV	25-100	Controlled, Limited Access 1 to 4 Hrs/Week
V	100-1000	Normally Inaccessible Access During Emergency
VI	1000-3000	Normally Inaccessible Access During Emergency Locked Barrier to Zone
VII	≥3000	Normally Inaccessible Access During Emergency Locked Barrier to Zone

NOTE 1: Design dose rates in office spaces and other Zone I areas which are continuously occupied eight hours per day, five days a week or more, shall be less than 0.25 mrem/hr. Corridors and other Zone I areas of a transient occupancy nature shall be below 0.5 mrem/hr.

3.0 SOURCE TERMS

3.1 During the initial containment decontamination effort, solid, liquid, and airborne activities will have to be monitored. Direct radiation sources will be from contamination plateout on all such surfaces, the reactor coolant system, fuel, and equipment. The sources involving different isotopes will be divided into six energy bins corresponding to the next highest gamma energies of 0.4, 0.8, 1.3, 1.7, 2.2, and 2.8 Mev. The contribution from individual sources will be calculated based on the model described below. The total dose to the receptor will be taken as the sum of the doses from each source.

3.2 The geometric model assumed for shielding evaluation of tanks, heat exchangers, filters, demineralizers, and evaporators will be a finite cylinder source and for piping, an infinite shielded cylinder. Corrosion products deposited on the surfaces such as pipe will be treated as a cylinder surface source. The mathematical models will be based on the for ulations in:

a. Reactor Shielding Design Manual, edited by Th. Rockwell III, first edition, Van Nostrand, New York, 1956.

b. Engineering Compendium on Radiation Shielding, edited by R. G. Jaeger, E. P. Blizard, A. B. Chilton, M. Grothenhuis, A. Honig, T. A. Jaeger, and H. H. Eisenlohr, Springer-Verlag, New York, 1968.

c. Various technical papers on buildup factors.

4.0 ACCESS CONTROL AND RADIATION ZONING

4.1 Access to areas inside the plant structures and plant yards is regulated and controlled by radiation zoning and access control. Each radiation zone defines the radiation level range to which the aggregate of all contributing sources must be attenuated by shielding.

4.2 All plant areas are categorized into radiation zones according to expected radiation levels and anticipated personnel occupancy with consideration given to maintaining personnel exposures as low as reasonably achievable and within the standards of 10 CFR 20. Each room, corridor, and pipeway of every plant building is evaluated for potential radiation sources during clean-up operations for maintenance occupancy requirements; for general access requirements; and for material exposure limits to determine appropriate zoning. Radiation zone categories employed and their descriptions are given in Table 1. All frequently accessed areas, e.g., corridors, are shielded for Zone I or Zone II access.

The control of ingress or egress of plant operating personnel to controlled access areas and procedures is employed to assure that radiation levels and allowable working times are within the limits prescribed by 10 CFR 20.

Whenever practicable, the measured radiation level and the location of the source are posted at the entry to any radiation or high radiation area.

4.3 The access zones for each area will be determined based upon the radioactive sources, process equipment to be shielded, adjacent zone requirements, and maintenance requirements. Efforts will be made to locate processing systems in such a manner as to minimize exposure to plant personnel. Plastic tents and ventilation hoods will be required over all decontamination tanks to minimize the dispersion of airborne contaminants. Concrete shield walls will be provided around the decontamination and storage areas.

4.4 In the design of the cleanup and recovery facilities, permanent and temporary shielding will be incorporated. Concrete walls and labyrinths are used to shield general access areas from high radiation storage or waste processing rooms. Outside perimeter facility walls will be built based upon shielding calculations. Steel or lead plate may be substituted where necessary in the design of these structures.

4.5 The use of temporary shielding will be required on a case-by-case basis. This will especially be necessary when extremely contaminated equipment is to be prepared for further decontamination. Where possible, transport of equipment within the facility will be done via shielded forklift trucks and monorails. As equipment is removed from the containment, lead blankets or bricks may be arranged around the transfer cart to minimize exposure to working personnel and to minimize the area radiation level. Concrete block can also be used for temporary shielding along permanent shield walls in case more shielding is required from time to time. The block can be stacked up around open hatches or doorways where "shadow" shielding may be necessary. Another temporary shielding method is the use of lead shot bags placed over equipment or "hot" pipes where adequate support structures exist.

Entire systems, both old and new, will have to be reviewed to determine whether permanent or temporary shielding is required for maintaining low radiation levels in general work areas. The new facility shield design will be based upon estimation of the maximum radiation sources to be located in the building. A thorough review of waste activities and quantities to be processed in each building will be conducted. Wastes such as spent resins, demineralizer beds, compacted trash, and evaporator bottoms have to be considered. The main facilities to be reviewed are the waste staging area, equipment decontamination building, containment recovery service building, and any new solidification systems.

Upon reentry into the containment, major areas of interest will be surveyed to establish allowable working periods. The initial dose rates are expected to range from 1.0R/hr. to 10.0R/hr. depending on the location inside the containment vessel (excluding the reactor cavity). Areas such as the floor hatch at the 305' level, air coolers, and the top of the steam generator compartments may have to be temporarily shielded. As decontamination proceeds and the general area radiation levels decrease, relative "hot spots" will be identified and be either removed or shielded by lead blankets, concrete block, or other shielding techniques.

The shielding criteria and design in the auxiliary building is based on the shielding of processing equipment, resin tanks and the transfer of spent resins and solidified waste. Because of the high initial radioactive levels of the liquid to be processed, additional shielding may be required. Also the radiation zone designations may have to be re-evaluated during processing of these high level wastes. The traffic paths for the removal of the spent resins and filter cartridges may have to be roped off during transfer to the solidification processing area.

Waste staging facilities will be provided. Very high activity drums may 1
require some temporary shielding. The building walls will be of sufficient thickness so that neither the site boundary nor the protected fence radiation limits will be violated.

5.0 AREA RADIATION AND AIRBORNE RADIOACTIVITY MONITORING

5.1 Area radiation monitoring is provided to supplement the personnel and area surveying capabilities to ensure compliance with the personnel radiation protection guidelines of 10 CFR 20, 10 CFR 50, 10 CFR 70, and Regulatory Guides 8.2, 8.8, and 8.12. Gamma radiation detectors will be 1
located throughout the plant. These monitors will be permanently mounted in general occupancy areas such as Zones I and II. Portable monitors will be used where the task requires plant personnel to be in areas of mid to high radiation zones. Airborne particulate activity can be a significant problem during gross decontamination efforts.

5.2 Consistent with this purpose, the area radiation monitors function to:

a. Immediately alert plant personnel entering or working in non-radiation or low-radiation areas of increasing or abnormally high radiation levels which, if unnoticed, could possibly result in inadvertent overexposures.

b. Inform the control room operator of the occurrence and approximate location of abnormal radiation increase in non-radiation or low-radiation areas.

c. Comply with the requirements of 10 CFR 50 Appendix A, General Design Criterion 63 for monitoring fuel and waste storage and handling areas.

d. Certain monitors located near the spent fuel pool act as criticality alarm monitors and conform to the requirements of 10 CFR 70 and Regulatory Guide 8.12.

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d. Check that plug-in, accessible bracket-hung, removable units are provided for easy removal and relamping outside high radiation areas. (Lightweight units are preferable for ease of handling.)

e. Check that extension cord powered units stored on brackets and cord hangers outside the entrance are provided if permanent units are not practical, and that pre-placed brackets are provided with the high radiation area to facilitate installation.

6.6.2 Contamination Control and Coatings

a. Check that floor drains and properly sloped floors are provided for each room or cubicle containing serviceable components with radiation levels of a Zone III or higher.

b. Check that local gas traps or porous seals are not used on floor drains from radiation areas.

c. Check that gas traps are provided at the common sump or collection tank.

d. Check that concrete surfaces in areas of potential contamination are covered with a smooth-surfaced coating for the floor and wainscot which will allow easy decontamination.

e. Check that threshold curbs, cofferdams, or other means are provided to control radioactive leakage or spills.

f. Check that protection from back flooding of floor drains is provided.

6.6.3 Access Platforms

a. Check that equipment subject to routine maintenance (defined as at least once per year) have permanent access platforms.

b. Check that direct access to active components is provided from any working platform.

c. Check that ample space is provided on platforms for accommodating safe personnel movement during replacement of components (including the use of any necessary material handling equipment).

6.6.4 Remote Viewing Devices

Check that in high radiation areas (Zone V and greater) where routine visual surveillance inspections are required remote, viewing devices are provided.

6.6.5 Temporary Shielding

Check that when shielding is required and permanent shielding is not feasible sufficient space and supports for portable shielding are provided and the structure is capable of accepting the additional loading.

6.6.6 Insulation

Check that piping and components requiring frequent (once per year or greater) access for maintenance, inspection, etc. utilize quick removal insulation wherever practical.

6.6.7 Plant Services

Check that services such as electrical power, water, respirable air, and compressed air are available reasonably close to radiation work areas.

TABLE 2

TYPICAL RADIOACTIVE PIPING CLASSIFICATION AND ROUTING

Exposure Rate at Contact with Pipe Surface (mr/hr)	Radioactivity Description	Acceptable[1] Radiation Zone Routing
-	Non-radioactive	I, II, III, IV, V
≤0.5	Slightly radioactive	I, II, III, IV, V
≤2.5	Low radioactivity	II, III, IV, V
≤25	Low to moderately radioactive	III, IV, V
≤100	Moderately radioactive	IV, V
≥100	Highly radioactive	V only[2]

(1) The routing of non-radioactive or low radioactivity piping in high radiation zones should be minimized.

(2) Piping from other Zones should be minimized in Zones VI and VII.

Design Criteria 13587-2-N01-100

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REV. NO.		REVISION DESCRIPTION	ORIGINATOR	GROUP SUPV. (APPROVAL)	PROJECT ENG (APPROVAL)	GPUSC (APPROVAL)
0	12/22/80	Issued for Use Upon GPUSC Approval	RPM	WHH	[illegible]	[illegible]

GPD-1367A Rev. 9/80

8112300096 811222
PDR ADOCK 05000320
P PDR

SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV
1	0												
1	0												
2	0												
3	0.												
4	0												
5	0												
6	0												
7	0												
8	0												
9	0												
10	0												
11	0												
12	0												
13	0												
14	0												
15	0												
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SHIELDING DESIGN AND ACCESS CONTROL DESIGN CRITERIA

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1.0 GENERAL

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a. Limit the dose to plant personnel, construction workers, vendors, and visitors during cleanup, recovery, and inspection to within the requirements of 10 CFR Part 20 and to meet the intent of Regulatory Guide 8.8.

b. Limit the dose to unit personnel to within the requirements of 10 CFR Part 50, Appendix A, Criterion 61, Fuel Storage and Handling and Radioactivity Control.

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VII	≥3000	Normally Inaccessible Access During Emergency Locked Barrier to Zone

NOTE 1: Design dose rates in office spaces and other Zone I areas which are continuously occupied eight hours per day, five days a week or more, shall be less than 0.25 mrem/hr. Corridors and other Zone I areas of a transient occupancy nature shall be below 0.5 mrem/hr.

3.0 SOURCE TERMS

3.1 During the initial containment decontamination effort, solid, liquid, and airborne activities will have to be monitored. Direct radiation sources will be from contamination plateout on all such surfaces, the reactor coolant system, fuel, and equipment. The sources involving different isotopes will be divided into six energy bins corresponding to the next highest gamma energies of 0.4, 0.8, 1.3, 1.7, 2.2, and 2.8 Mev. The contribution from individual sources will be calculated based on the model described below. The total dose to the receptor will be taken as the sum of the doses from each source.

3.2 The geometric model assumed for shielding evaluation of tanks, heat exchangers, filters, demineralizers, and evaporators will be a finite cylinder source and for piping, an infinite shielded cylinder. Corrosion products deposited on the surfaces such as pipe will be treated as a cylinder surface source. The mathematical models will be based on the formulations in:

a. Reactor Shielding Design Manual, edited by Th. Rockwell III, first edition, Van Nostrand, New York, 1956.

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c. Various technical papers on buildup factors.

4.0 ACCESS CONTROL AND RADIATION ZONING

4.1 Access to areas inside the plant structures and plant yards is regulated and controlled by radiation zoning and access control. Each radiation zone defines the radiation level range to which the aggregate of all contributing sources must be attenuated by shielding.

4.2 All plant areas are categorized into radiation zones according to expected radiation levels and anticipated personnel occupancy with consideration given to maintaining personnel exposures as low as reasonably achievable and within the standards of 10 CFR 20. Each room, corridor, and pipeway of every plant building is evaluated for potential radiation sources during clean-up operations for maintenance occupancy requirements; for general access requirements; and for material exposure limits to determine appropriate zoning. Radiation zone categories employed and their descriptions are given in Table 1. All frequently accessed areas, e.g., corridors, are shielded for Zone I or Zone II access.

The control of ingress or egress of plant operating personnel to controlled access areas and procedures is employed to assure that radiation levels and allowable working times are within the limits prescribed by 10 CFR 20.

Whenever practicable, the measured radiation level and the location of the source are posted at the entry to any radiation or high radiation area.

4.3 The access zones for each area will be determined based upon the radioactive sources, process equipment to be shielded, adjacent zone requirements, and maintenance requirements. Efforts will be made to locate processing systems in such a manner as to minimize exposure to plant personnel. Plastic tents and ventilation hoods will be required over all decontamination tanks to minimize the dispersion of airborne contaminants. Concrete shield walls will be provided around the decontamination and storage areas.

4.4 In the design of the cleanup and recovery facilities, permanent and temporary shielding will be incorporated. Concrete walls and labyrinths are used to shield general access areas from high radiation storage or waste processing rooms. Outside perimeter facility walls will be built based upon shielding calculations. Steel or lead plate may be substituted where necessary in the design of these structures.

4.5 The use of temporary shielding will be required on a case-by-case basis. This will especially be necessary when extremely contaminated equipment is to be prepared for further decontamination. Where possible, transport of equipment within the facility will be done via shielded forklift trucks and monorails. As equipment is removed from the containment, lead blankets or bricks may be arranged around the transfer cart to minimize exposure to working personnel and to minimize the area radiation level. Concrete block can also be used for temporary shielding along permanent shield walls in case more shielding is required from time to time. The block can be stacked up around open hatches or doorways where "shadow" shielding may be necessary. Another temporary shielding method is the use of lead shot bags placed over equipment or "hot" pioes where adequate support structures exist.

Entire systems, both old and new, will have to be reviewed to determine whether permanent or temporary shielding is required for maintaining low radiation levels in general work areas. The new facility shield design will be based upon estimation of the maximum radiation sources to be located in the building. A thorough review of waste activities and quantities to be processed in each building will be conducted. Wastes such as spent resins, demineralizer beds, compacted trash, and evaporator bottoms have to be considered. The main facilities to be reviewed are the waste staging area, equipment decontamination building, containment recovery service building, and any new solidification systems.

Upon reentry into the containment, major areas of interest will be surveyed to establish allowable working periods. The initial dose rates are expected to range from 1.0R/hr. to 10.0R/hr. depending on the location inside the containment vessel (excluding the reactor cavity). Areas such as the floor hatch at the 305' level, air coolers, and the top of the steam generator compartments may have to be temporarily shielded. As decontamination proceeds and the general area radiation levels decrease, relative "hot spots" will be identified and be either removed or shielded by lead blankets, concrete block, or other shielding techniques.

The shielding criteria and design in the auxiliary building is based on the shielding of processing equipment, resin tanks and the transfer of spent resins and solidified waste. Because of the high initial radioactive levels of the liquid to be processed, additional shielding may be required. Also the radiation zone designations may have to be re-evaluated during processing of these high level wastes. The traffic paths for the removal of the spent resins and filter cartridges may have to be roped off during transfer to the solidification processing area.

The two permanent waste staging facilities will be provided with a decontamination section and a truck loading bay. Containers will be separated by low, medium, and high activity. Very high activity drums may require some temporary shielding. The building walls will be of sufficient thickness so that neither the site boundary nor the protected fence radiation limits will be violated.

5.0 AREA RADIATION AND AIRBORNE RADIOACTIVITY MONITORING

5.1 Area radiation monitoring is provided to supplement the personnel and area surveying capabilities to ensure compliance with the personnel radiation protection guidelines of 10 CFR 20, 10 CFR 50, 10 CFR 70, and Regulatory Guides 8.2, 8.8, and 8.12. Both gamma and beta radiation detectors will be located throughout the plant. These monitors will be permanently mounted in general occupancy areas such as Zones I and II. Portable monitors will be used where the task requires plant personnel to be in areas of mid to high radiation zones. Airborne particulate activity can be a significant problem during gross decontamination efforts.

5.2 Consistent with this purpose, the area radiation monitors function to:

a. Immediately alert plant personnel entering or working in non-radiation or low-radiation areas of increasing or abnormally high radiation levels which, if unnoticed, could possibly result in inadvertent overexposures.

b. Inform the control room operator of the occurrence and approximate location of abnormal radiation increase in non-radiation or low-radiation areas.

c. Comply with the requirements of 10 CFR 50 Appendix A, General Design Criterion 63 for monitoring fuel and waste storage and handling areas.

d. Certain monitors located near the spent fuel pool act as criticality alarm monitors and conform to the requirements of 10 CFR 70 and Regulatory Guide 8.12.

e. A monitor is provided for use in assuring that solidified radwaste containers meet the requirements of 10 CFR 71 and 49 CFR 173 with respect to the radiation level on contact with the container and at certain distances from the container. This monitor will warn personnel when containers need additional shielding.

6.0 ALARA DESIGN CRITERIA AND CONSIDERATIONS

The following items form the basis for the TMI-2 Recovery Project ALARA program. During the design process, the applicable items shall be considered and incorporated into the design as appropriate.

6.1 FACILITY ARRANGEMENT

6.1.1 Facility Layout

a. Check that equipment with contact radiation levels of Zone III or greater are separated from Zone II and lower areas by shielding or distance plus access barriers.

b. Check that major equipment which by design accumulates or concentrates radioactivity with Zone III or greater contact radiation levels is shielded or separated from adjacent active and passive equipment to meet the applicable radiation shielding criteria for adjacent areas.

c. Check that equipment compartments are arranged so that radiation zone differences between adjacent areas are minimized.

d. Check that personnel access control and traffic patterns are considered to minimize spread of contamination during all facility operating modes.

e. Check that active components in clean (non-radioactive) services are not located in Radiation Zones III or greater.

f. Check that equipment subject to removal or replacement has adequate aisles or area access and built-in provisions (such as monorails, jib cranes, etc.) for removal.

g. Check that access to components requiring frequent maintenance, inservice inspection, adjustment, etc., is from the lowest practicable radiation zone and not via a Zone V.

h. Check that adequate space and facilities are provided for clothing change stations outside contaminated areas.

i. Check that all corridors and normal traffic area are Zone I or II.

6.1.2 Equipment Location

a. Check that adequate space is provided around equipment to allow ease of maintenance.

b. Check that equipment maintenance envelopes include estimated size of rigging requirements and temporary shielding, if required.

c. Check that laydown area requirements for equipment are available.

d. Check that equipment which requires routine maintenance, service, testing, or inspection such as instruments, sample stations, or rotating components is located to provide maximum direct access.

e. Check that the clear space for doorways is minimum 3 feet by 7 feet and that there is adequate access for personnel, tools, and component removal.

f. Check that equipment manways are readily accessible.

6.1.3 Specific Component Layout

a. Filters

Check that adequate space is provided for semi-remote removal, cask loading, and transporting spent radioactive filter cartridges to the solid radwaste area.

b. Pumps

1) Check that small pumps are oriented in a manner which allows easy removal from the area.

2) Check that adequate access is provided for pump seal replacement.

c. Tanks

1) Check that direct access and removal space is provided for motors of tank agitators.

2) Check that direct access to active components or manways is provided into the upper levels of tank rooms as well as the lower elevations.

3) Check that adequate space is provided for tank internals cleaning operations.

d. Evaporators

1) Check that concentrates and distillate components are adequately separated.

2) Check that components which accumulate radioactivity or crud such as heating tubes are separated from active components such as valves.

3) Check that adequate space is provided to allow uncomplicated removal of heating tube bundles.

e. Sample Stations

1) Check that sample stations for routine sampling of process fluids are separated by shielding or distance from other radioactive components to Zone II levels.

2) Check that local ventilation (e.g., a hood) is provided at sample stations containing radioactive materials.

f. Ventilation System Components

1) Check that ventilation fans and filters are provided with adequate access space to permit servicing.

2) Check that outside air supply and building exhaust system components are enclosed by a ventilation barrier and are in areas no greater than Zone II.

3) Check that general ventilation flow is from areas of potential (or actual) low contamination to areas of potential (or actual) high contamination.

g. Instruments

1) Check that instruments which require periodic attention are located in Zone II (or lower) areas whenever possible.

2) Check that, if instruments must be located in Zone III or greater, they are mounted so that they are readily accessible for maintenance and calibration and are easily removable to a lower radiation zone for extended servicing or calibration.

3) Check that, if control valves must be located in Zone IV or greater, appurtenances such as E/P converters, airsets, and solenoid valves are not mounted on the control valve but are located in a lower radiation zone.

6.2 SHIELDING

6.2.1 Bulk Shielding

a. Check that shielding or separation is provided between radiation zone areas to meet the radiation level criteria for adjacent areas.

b. Check that shielding design is based on conservative or measured radiation source term, component design, and plant layout assumptions.

c. Check that poured concrete density specifications are consistent with shielding design basis minimum densities.

d. Check that concrete block density specifications are consistent with shielding design basis minimum densities.

e. Check that concrete block wall designs meet or exceed the minimum shielding requirements.

f. Check that removable or temporary shielding is designed consistent with applicable radiation shielding criteria for adjacent areas.

6.2.2 Penetration and Discontinuity Shielding

a. Check that penetrations, such as H&V ducts and piping, are either located with an offset between radiation sources and accessible areas or are appropriately shielded.

b. Check that penetrations are located as far as possible above the accessible floor elevation.

c. Check that penetration shielding is provided as necessary to meet the radiation shielding criteria in adjacent accessible areas.

d. Check that seismic gap shielding is provided to maintain radiation levels in adjacent accessible areas within radiation shielding criteria limits.

6.2.3 Entryway Shielding

Check that adequately shielded labyrinths or hatches are provided to limit direct and scattered radiation out of shielded areas.

6.3 SYSTEM DESIGN

6.3.1 Decontamination Provisions

a. Check that radioactive systems with Zone V component radiation levels have provisions to flush the entire system. Flushing capability should be available even if the system pump is inoperable.

b. Check that major components of the primary coolant purification system where crud can collect up to Zone V radiation levels such as filters, heat exchangers, etc. have provisions for chemical decontamination including low point drains. Check that means are available to take the decon solution to chemical waste area.

c. Check that seal flush water is provided to pumps with chemical or slurry wastes.

d. Check that all serviceable components have isolating and draining capability.

e. Check that provisions are available to flush potentially contaminated instrument lines.

f. Check that flush connections are located downstream of the component isolation valve at the high point or low point of the inlet line and upstream of the isolation valve at the low point or high point of the outlet line and as close as possible to the inlet and outlet connections of the component.

g. Check that isolation valves are provided on the flush connections and are located as close as possible to the main pipe.

h. Check that all flush connections are equipped with quick connect/disconnect fittings.

6.3.2 Remote Operation and Instrumentation

a. Check that adequate process instrumentation and controls are available to allow system and component operation from a low radiation zone.

b. Check that filters which accumulate high radioactivity are designed with the means either to backflush the filter remotely or to perform cartridge replacement with semi-remote tools.

c. Check that probe type instruments are used on highly radioactive tanks containing two-phase materials.

6.3.3 Leakage Provisions

a. Check that tank overflow lines are directed to the waste collection system.

b. Check that sludge tanks and air mixing tanks which contain radioactive materials are vented to the respective building ventilation system or the vent collection system.

c. Check that strainers are included in vent lines from tanks containing spent resins or sludge.

6.3.4 Demineralizers

a. Check that demineralizers in radioactive systems and associated piping are designed with provisions for being flushed with demineralized water.

b. Check that strainers are located immediately downstream of ion exchangers.

c. Check that drains and downstream strainers are designed for full system pressure drop.

d. Check that strainers are included in vent lines from the demineralizer vessel.

e. Check that flush connections are provided at all critical locations (such as elbows, ties, valves) to clear potential plugs.

f. Check that flow in piping is turbulent enough to maintain suspension of fines.

6.3.5 Floor Drains

a. Check that equipment drains are piped directly to a drainage collection system.

b. Check that provisions are made to remove plugging should it occur in drain lines.

c. Check that radioactive and potentially radioactive drains are separated from non-radioactive drains.

6.4 PIPING AND VALVE DESIGN

6.4.1 Pipe Routing

a. Check that piping containing radioactive materials is routed through suitably zoned, controlled access areas in accordance with piping radiation classification as shown in Table 2.

b. Check that equipment compartments contain radioactive piping associated only with equipment within the compartment or that non-associated piping is adequately separated.

c. Check that where it is necessary for radioactive piping to be routed through corridors or other radiation zone areas, shielded pipeways are provided to meet area radiation level requirements.

d. Check that long runs of exposed radioactive piping are minimized, particularly in active component areas such as valve galleries or pump cells.

e. Check that radioactive piping is routed to take credit for shielding effects of equipment or structures.

6.4.2 Valve Location

a. Check that valves are separated from components which accumulate or contain radioactivity by shielding or distance to meet the applicable radiation shielding criteria levels.

b. Check that valves are readily accessible from floors or permanent platforms.

c. Check that sufficient space is provided to facilitate valve and valve operator maintenance, operations and testing.

d. Check that valves are not located in radioactive pipeways.

e. Check that vent and drain isolation and instrument root isolation valves are located close to process piping or components.

f. Check that process valves are not located at low points in piping.

g. Check that reach rods or remote manipulators are provided for manually operated valves in potentially high radiation areas.

6.4.3 Pipe Design

a. Check that branch lines having little or no flow during normal operation are connected above the horizontal midplane of the main pipe.

b. Check that thermal expansion loops in radioactive systems are raised, rather than dropped.

c. Check that orifices are located on vertical piping runs if possible. If located in horizontal piping runs, use eccentric design of the orifice.

d. Check that reducers are installed not to form a stagnant pocket, i.e., use eccentric design with bottom flat, except at pumps.

e. Check that bypass lines are laid out to allow draining and flushing the main line without disruption of system operation.

f. Check that lengths of radioactive pipe runs and number of bends are minimized.

g. Check that low points and dead legs in radioactive piping are minimized and are capable of being flushed.

h. Check that instrument and sensing line connections are located in such a way as to avoid corrosion product and radioactive gas buildup.

i. Check that welded joints are used whenever possible to minimize crud traps in the mechanical joints.

6.4.4 Valve and Valve Operator Selection

a. Check that full ported valves are used in systems expected to handle spent resins or slurries with radiation levels of 25 mr/hr or greater at contact with the surface of the pipe. (See Table 2)

b. Check that valves 2-1/2" and larger (except butterfly valves and plug valves) in lines carrying radioactive fluids with radiation levels of 25 mr/hr or greater (contact dose rate) are diaphragm, packless, or have a double set of packing with lantern ring.

c. Check that all globe valves (excluding instrument valves) 2" and smaller are Y-pattern globe valves to facilitate rodding if plugging should occur.

d. Check that plug valves or equal are used on systems transporting resins and sludge and radwaste systems.

e. Check that remote operators are provided for all valves in lines processing evaporator bottoms or spent resins.

f. Check that minimum volume valves are provided for vents and drains to minimize the internal surface area for deposition.

g. Check that pressure relief valves have flange connections to facilitate removal for set pressure verification and calibration.

6.4.5 Spent Resin and Sludge Piping

a. Check that resin lines are continuously sloped in direction of flow to avoid potential stagnant pockets.

b. Check that valves are located as close as possible to the spent resin tank room to minimize the length of the dead leg.

c. Check that flow control valves and orifices are not used in resin lines.

d. Check that long radius (greater than 1.5 times the pipe diameter) bends and elbows are used at direction changes.

e. Check that directional changes and resin piping runs are minimized.

6.5 COMPONENT DESIGN FOR COMPONENTS CONTAINING RADIOACTIVE FLUIDS OR LOCATED IN HIGH RADIATION AREAS

6.5.1 Specifications

a. Check that material requisitions specify the radiation environmental requirements for the intended material application.

b. Check that equipment design features as presented in the remainder of this Section are included in the appropriate equipment specification.

6.5.2 Heat Exchangers

a. Check that corrosion resistant tubes of stainless steel or other suitable material with tube-to-tube sheet joints welded are provided to minimize leakage.

b. Check that impact baffles are provided with tube-side and shell-side velocities limited to minimize erosive effects.

c. Check that drains are provided on the lowest portion to ensure removal of contaminated fluids.

d. Check that where practical the contaminated side of the heat exchanger operates at a lower pressure than the clean side.

6.5.3 Evaporators

Check that chemical addition connections are provided to allow use of chemicals for descaling operations.

6.5.4 Pumps (Small)

a. Check that pump casings are provided with drain connections.

b. Check that pumps in radiation areas (Zone III or higher) are purchased with mechanical seals to reduce seal servicing time.

c. Check that pumps in radioactive systems are provided with flanged connections for ease in removal.

d. Check that electrical quick disconnects are provided on pumps in high radiation zones (V or higher).

e. Check that painted surfaces of the pump (if any) are painted with a radiation resistant and decontaminable coating.

f. Check that the pump has long-lived bearings and that lubrication is permanent type.

g. Check that the pump selection has considered the use of low RPM designs.

6.5.5 Tanks

a. Check that tanks in radioactive service are provided with sloped bottoms (min. 1" per foot of tank diameter) and bottom outlet connections. Conical or dished bottom tanks with bottom connections are acceptable.

b. Check that adequate tank mixing is provided to prevent crud settling.

c. Check that each tank requiring a manway is top fitted with one of at least 2 feet in diameter. (If a manway is located on the side of a tank, it should be clearly demonstrated that it is necessary.)

d. Check that side manways have eccentrically hinged covers designed to easily clear fastening studs.

e. Check that outlet pipes have backflush capability into the tank to break up sediment. Backflush capability should include air.

f. Check that tank linings (if any) are suitable for the expected service. Epoxy paint should be avoided.

g. Check that overflow lines are lower than vent lines to prevent fluid from contaminating vent lines.

h. Check that a permanent connection is provided for insertion of a hydrolaser unit for decontamination of tanks in Zone V areas.

i. Check that lap joints were not used in tank construction.

j. Check that no backing strips were used on tank welds.

k. Check that backing rings were not used on nozzle welds.

l. Check that siphoning of liquid waste from tanks cannot occur.

m. Check that in-line filters with back flushing capability are provided for tanks with a sludge build-up potential.

n. Check to assure that tanks with a potentially hazardous leakage consequence are located over catch pans or within curbs with drain lines leading to radioactive liquid waste storage tanks or to sumps capable of handling a potential spill.

6.5.6 Instruments

a. Check that chemical seals are provided on sensing lines on process piping which may contain high amounts of solids.

b. Check that primary instruments which, for functional reasons, are located in high radiation zones (V and greater) are designed for easy removal to a radiation zone II, or lower, for calibration.

c. Check that instruments are selected which contain minimal quantities of contaminated working fluids; e.g., pressure transducers rather than bellows-type pressure gauges.

6.6 MISCELLANEOUS FACILITY DESIGN

6.6.1 Lighting

a. Check that multiple electric lights are provided for each cell or room containing highly radioactive components (Zone V and greater) so that burnout of a single lamp will not require entry.

b. Check that lighting in high radiation areas (Zone V and greater) is actuated from outside the area in the lowest practicable radiation zone.

c. Check that sufficient lighting is provided in areas that contain remote viewing devices to allow their efficient use.