GPU SERVICE CORPORATION

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

DESIGN CRITERIA DOCUMENTS

COVER SHEET

JOB NO: 13587 **DISCIPLINE:** Nuclear

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SHIELDING DESIGN AND ACCESS CONTROL

DESIGN CRITERIA

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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 formulations 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 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. | 1

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 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. | 1

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.