CHAPTER 12

12.0 RADIATION PROTECTION

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12.1 Ensuring that Occupational Radiation Exposures are as Low as Reasonably Achievable (ALARA)

12.1.1 Policy Considerations

12.1.1.1 Corporate Health Physics Policy

It is the policy of the Duke Energy Progress, LLC to develop, implement, and maintain sound health physics programs at each Company facility where radiation-producing equipment and/or radioactive materials are used or stored. The health physics programs shall be structured to ensure that radiation doses to Company personnel, contractor personnel, and the general public are maintained at levels which are as low as reasonably achievable (ALARA) and consistent with the United States Nuclear Regulatory Commission Regulations in Title 10 of the United States Code of Federal Regulations and with applicable state regulations.

The line management at each of these Company facilities is responsible and accountable for implementing and enforcing the facility's health physics program. Radiation control personnel shall be assigned to these Company facilities to assist line management in carrying out their responsibility to protect workers and the general public. Radiation control personnel shall have sufficient independence from the line management which they assist to assure that proper health physics practices are not compromised by operational pressures. Furthermore, radiation control personnel shall have access to higher levels of management for the resolution of health physics concerns which cannot be resolved at a lower management level.

All Company and contractor employees working in a facility where exposure to radiation might occur are personally responsible for maintaining radiation doses and releases of radioactive materials to unrestricted areas as far below specified limits as reasonably achievable, to minimize the creation of radwaste, and to support the requirements of the health physics programs consistent with the proper discharge of their duties. Personnel who habitually or willfully disregard or violate health physics procedures and practices will be subject to disciplinary action.

A manual shall be developed and maintained as the controlling document for the Company's health physics programs and shall set forth policies and standards for the Company's health physics programs. The health physics programs at the Company's nuclear generating plants shall comply with the manual and meet the intent of the Institute of Nuclear Power Operations' "Guidelines for Radiological Protection at Nuclear Power Stations."

The goal of the Company is to maintain the annual integrated occupational dose at nuclear plants and dose to members of the public from Company activities among the lowest in the country. The design, maintenance, and operation of nuclear facilities shall be consistent with this goal. Modifications to existing nuclear facilities shall be designed and implemented in compliance with the health physics programs to meet the ALARA objective.

To support this goal and to allow management to conduct effective health physics programs, the Company will commit sufficient resources in the form of facilities, equipment, and personnel to the programs. Personnel involved in the conduct of the health physics programs, including general employees and contractors, shall be given adequate training and instruction to allow them to contribute to the programs.

Nuclear Oversight (NOS) evaluates the performance and effectiveness of the Company's health physics programs on a continuous basis to assure they are being carried out in an effective manner. These activities are to detect deficiencies in the desired levels of performance and quality, reporting these conditions to the Vice President - Robinson Nuclear Plant, and ensuring adequate action is taken to correct and eliminate these conditions.

12.1.1.2 Facility Management Policy

Duke Energy Progress, LLC is committed to a program of keeping occupational radiation exposure as low as reasonably achievable (ALARA). The Operating License, issued by the Nuclear Regulatory Commission, carries with it an obligation to both workers and the general public to maintain exposures as low as is reasonably achievable, considering costs and expected benefits. Duke Energy Progress, LLC follows the general guidance of Regulatory Guides 1.8., 8.8, 8.10, and publications which deal with ALARA concepts and practices, including Title 10, Code of Federal Regulations, Part 20. As discussed in Section 12.1.1.1, corporate management has formally committed itself to this concept by issuing and endorsing the Corporate Health Physics Policy, which ensures compliance with all state and federal regulations that pertain to the safe operation of nuclear power plants.

The implementation of the Corporate Health Physics Policy is accomplished through a number of mechanisms and procedures in all phases of plant operation. The Radiation Control and Protection Manual provides the direction necessary for implementing corporate policy.

The Radiation Control and Protection Manual sets forth the basic philosophy and general radiation protection standards and procedures that are essential to the safe operation of DEP's nuclear facilities. The Site Vice President of each nuclear facility is responsible for ensuring the requirements of this manual are included in the Radiation Control and Protection Program at that facility. Requirements of the Radiation Control and Protection Manual and/or applicable Nuclear Generation Group procedures.

The primary purpose of the Radiation Control and Protection Program is to provide personnel with a safe environment in which to work, to protect the general public and the off-site environs, and to establish procedures and a system of records to meet all the requirements of applicable regulations.

Effective control of radiation exposure involves the following major considerations:

1. Management commitment to, and support of, the Radiation Control and Protection Program

2. Careful design of facilities and equipment to minimize radiation exposure during operation and maintenance.

3. Good radiation protection practices, including good planning and the proper use of appropriate equipment by qualified, well-trained personnel.

   The management of DEP is firmly committed to performing all reasonable actions for ensuring that radiation exposures are maintained ALARA.

12.1.1.3 Facility Management Responsibilities

Management's commitment to the Corporate Health Physics Policy is reflected in the careful preparation of plant operating and maintenance procedures, the provision for review of these procedures and for review of equipment design to consider the results of operating experience, and most importantly, the establishment of an on-going training program. Training is provided for personnel, so that each individual will be capable of carrying out his responsibility for maintaining his own radiation exposure, as well as that of others, ALARA consistent with discharging his duties. The development of a proper attitude and an awareness of the potential problems in the area of health physics is accomplished through proper training of all plant personnel.

The responsibility for implementation of the ALARA program resides with the Site Vice President, with primary support from all facility Section and Unit heads. The Superintendent - Radiation Control reports to the General Manager - Robinson Plant and makes recommendations to plant management concerning the most effective radiation exposure reduction methods. He is assisted in this task by the Specialist - ALARA who includes, as a major portion of his assignment, an analysis of plant operations and maintenance with respect to maintaining an ALARA approach to personnel radiation exposure.

The success of the program depends upon cooperation between many plant operating groups. The Specialist - ALARA acts as liaison between the groups while maintaining a high degree of organizational freedom. An ALARA Committee, composed of all major plant operating groups and chaired by the Site Vice President - Robinson Plant or designee, ensures radiation exposure reduction initiatives are identified and implemented, ensures interface with various plant groups, and provides a mechanism for the review of outages and maintenance activities. Data and experience compiled from the operation of HBR 2 and similar nuclear plants are used as a basis for the review of plant operations, features, and proposed modifications.

The Superintendent - Radiation Control reports to the Plant General Manager, assuring an open line of communication with appropriate management. The overall effectiveness of the program is reviewed periodically by appropriate plant and corporate personnel. Formal guidance is provided in the Radiation Control and Protection Manual (discussed in Section 12.1.1.2) and a written ALARA program. Formal support for the plant's ALARA program may be requested from company resources, outside agencies or contact personnel, through the efforts of the Superintendent - Radiation Control, who is responsible for ensuring that the direction provided in the Radiation Control and Protection Manual is implemented and that the health physics programs comply with the Corporate Health Physics Policy.

12.1.1.4 Policy Implementation

The management's ALARA policy is implemented at HBR 2 by the Radiation Control Staff under the direction of the Superintendent - Radiation Control, Radiation Control Supervisors, and Specialist - ALARA. It is formalized by incorporating ALARA philosophy and considerations into permanent plant procedures which deal specifically with ALARA concerns. The operational ALARA considerations identified in Sections 12.1.3. and 12.5.3.2 have been implemented according to plant procedures.

A training program has been established to give appropriate plant personnel the knowledge necessary to understand why and how they should maintain their occupational radiation exposure ALARA.

12.1.1.5 ALARA Program Implementation Components

The Plant Management's responsibilities for implementation of corporate policy include:

1. Ensuring that an effective measurement system is established and used to determine the degree of success achieved by plant operations with regard to the ALARA goals and objectives.

2. Ensuring that the measurement system results are reviewed on a periodic basis, and that corrective action is taken when attainment of the specific objectives appears to be jeopardized.

3. Ensuring that the authority for providing procedures and practices, by which the specific goals and objectives are achieved, is delegated.

4. Ensuring that the resources needed to achieve ALARA goals and objectives are made available.

The health physics program is based on regulations and experience including or considering the following:

1. Detailed procedures have been prepared and approved for radiation protection and are a part of HBR's health physics program.

2. Radiological incidents are thoroughly investigated and documented in order to minimize the potential for recurrence. Reports are made to the NRC, in accordance with 10CFR20.2202 and 10CFR20.2203, 10CFR20.2204 and the ODCM.

3. Periodic radiation, contamination, and airborne activity surveys are performed and recorded to document radiological conditions. Records of surveys are maintained in accordance with 10CFR20.2103.

4. Radiation areas, high radiation areas, and very high radiation areas are segregated and identified in accordance with 10CFR20.1003, 10CRF20.1501, 10CFR20.1601, 10CFR20.1602, 10CFR20.1901, 10CFR20.1902, and the Technical Specifications. Airborne radioactivity is determined and posted in accordance with 10CFR20.1003, 10CFR20.1501, 10CFR20.1901, and 10CFR20.1902.

12.1.2 DESIGN CONSIDERATIONS

HBR 2 was designed and constructed in accordance with the proposed General Design Criteria (proposed Appendix A to 10CFR50, published in July, 1967) and other appropriate design guidance, including experience with other plants, that was available at the time. The general design criteria are discussed in Section 3.1.

12.1.3 Operational Considerations

Operational considerations at HBR that promote the ALARA philosophy include the determination of the origins of radiation exposures, the proper training of personnel, the preparation of radiation protection procedures, the development of conditions for implementing these procedures, and the formation of a review system to assess the effectiveness of the ALARA philosophy.

Operational radiation protection objectives deal with access to radiation areas, exposure to personnel, and decontamination. Working at or near highly radioactive components requires planning, special methods, and criteria directed toward keeping occupational radiation exposure ALARA. Job training and debriefing following selected high exposure jobs contribute toward reduced exposures. Decontamination also helps to reduce exposure. Procedures and techniques are based upon operational criteria and experience that have worked to keep radiation exposure ALARA.

12.1.3.1 Plant Organization

As described in Section 12.5.1, the plant organization provides both the Radiation Control Supervisors and Superintendent - Radiation Control access to the Plant General Manager. This organization allows the Plant General Manager to be involved in the review and approval of specific ALARA goals and objectives as well as review of data and dissemination of information related to the ALARA program.

The organization also provides the Specialist - ALARA through the Superintendent - Radiation Control, who is normally free from routine health physics activities, to implement the plant's ALARA program. This individual is primarily responsible for coordination of plant ALARA activities and routinely interfaces with first line supervision in radiation work planning and post-job review.

12.1.3.2 Operating Experience

The Radiation Work Permit process described in Section 12.5.3 provides a mechanism for collection and evaluation of data relating to personnel radiation exposure. Information, collated by systems and/or components and job function, assists in evaluating design or procedure changes intended to minimize future radiation exposures.

The Radiation Control Supervisors and the Specialist - ALARA, are responsible for the review of radiation exposure records, investigating not only the individual exposures, but the exposures as classified by job description and job location.

12.1.3.3 Exposure Reduction

Specific radiation exposure reduction techniques that are used at HBR are described in Section 12.5.3. Procedures assure that: applicable plant activities are completed with adequate preparation and planning; work is performed with appropriate health physics recommendations and support; and, results of post-job data evaluation are applied to implement improvements.

In addition, the radiation control staff is, at all times, vigilant for ways to reduce radiation exposures by soliciting employee suggestions, evaluating origins of plant exposures, investigating unusual exposures, and assuring that adequate supplies and instrumentation are available.

12.2 RADIATION SOURCES

Radiation shielding for normal plant operation is designed for operation at the maximum licensed thermal power level, and for safe operation with one percent fuel element defects. Reactor coolant inventories of fission products are discussed in Chapter 11 and remain bounding for operation at 2339 MWt within the RCS activity limits contained in the Technical Specifications. .

12.3 RADIATION PROTECTION DESIGN FEATURES

12.3.1 SHIELDING

12.3.1.1 Design Basis

Radiation shielding is designed for operation at maximum calculated thermal power and to limit the normal operation levels at the site boundary to below those levels allowed for continuous non-occupational exposure. The plant is capable of safe operation with the RCS inventory of fission products discussed in Chapter 11.

In addition, the shielding provided ensures that in the event of a design basis accident the contained activity does not result in offsite radiation exposure in excess of 10 CFR 50.67.

The shielding is divided into five categories according to function. These functions include the primary shielding, the secondary shielding, the accident shielding, the fuel transfer shielding, and the auxiliary shielding.

12.3.1.2 Primary Shield

The primary shield is designed to:

a) Reduce the neutron fluxes incident on the reactor vessel to limit the radiation induced increase in transition temperature.

b) Attenuate the neutron flux sufficiently to prevent excessive activation of plant components.

c) Limit the gamma flux in the reactor vessel and the primary concrete shield to avoid excessive temperature gradients or dehydration of the primary shield.

d) Reduce the residual radiation from the core, reactor internals and reactor vessel to levels which will permit access to the region between the primary and secondary shields after plant shutdown.

e) Reduce the induced secondary radiation leakage to obtain optimum division of the shielding between the primary and secondary shields.

The primary shield consists of the core baffle, water annuli, barrel-thermal shield (all of which are within the reactor vessel), the reactor vessel wall, and a concrete structure surrounding the reactor vessel.

The primary shield immediately surrounding the reactor vessel consists of an annular reinforced concrete structure extending from the base of the containment to Elevation 275.0 ft. The lower portion of the shield is a minimum thickness of 6.5 ft of regular concrete (density of 2.3 g/cc) and is an integral part of the main structural concrete support for the reactor vessel; it extends upward to the operating floor, with vertical walls 6 ft thick, to form an integral portion of the refueling cavity. The primary shield has been designed for a uniform temperature of 50EF and for thermal gradients as shown on Figures 3.8.3-1 through 3.8.3-4. All thermal stress calculations assumed 70°F as a starting temperature.

The primary concrete shield is air cooled to prevent overheating and dehydration from the heat generated by radiation absorption in the concrete. Eight "windows" have been provided in the primary shield for insertion of the out-of-core nuclear instrumentation. Cooling for the primary shield concrete and the nuclear instrumentation is provided by 12,000 cfm cooling air.

The primary shield neutron fluxes and design parameters are listed in Table 12.3.1-1.

12.3.1.3 Secondary Shield

The main function of the secondary shielding is to attenuate the radiation originating in the reactor and the reactor coolant. The major source in the reactor coolant is the Nitrogen-16 activity, which is produced by neutron activation of oxygen during passage of the coolant through the core. The secondary shield will limit the full power dose rate outside the Containment Building to less than 1 mR/hr.

The secondary shield surrounds the reactor coolant loops and the primary shield. It consists of interior walls in the containment structure, the operating floor, and the reactor containment structure. The containment structure also serves as the accident shield.

The main portion of the secondary shield above grade consists of the 3 ft -6 in. cylindrical portion of the reactor containment, and a concrete crane wall, 3 ft thick, surrounding the reactor coolant loops. The secondary shield will attenuate the radiation levels in the primary loop compartment from a value of 25 rem/hr to a level of less than 1 mR/hr outside the Reactor Containment Building.

The crane wall has been designed for a uniform temperature of 50ºF and 120ºF.

The secondary shield design parameters are listed in Table 12.3.1-2.

12.3.1.4 Accident Shield

The accident shield ensures safe radiation levels outside the Containment Building following a maximum hypothetical accident.

The accident shield consists of the 3 ft -6 in. reinforced concrete cylinder capped by a hemispherical reinforced concrete dome 2 ft -6 in. thick. Supplemental shielding has been provided for containment penetrations. This includes a 3 ft -6 in. concrete shadow shield for the equipment access hatch, and a 2 ft concrete shield for the personnel lock.

Smaller penetrations associated with piping, cables, and ventilation are directed into pipe tunnels which are shielded with 24 in. of concrete. The Control Room is protected with concrete sidewalls 18 in. thick, and a concrete roof 22 in. thick.

The accident shield design parameters are listed in Table 12.3.1-3.

A design review of plant shielding was performed in response to NUREG-0737 Item II.B.2.2 to ensure adequate post accident access to vital areas.

12.3.1.5 Fuel Handling Shield

The fuel handling shield permits the safe removal and transfer of spent fuel assemblies and control rod clusters from the reactor vessel to the spent fuel pit. It is designed to attenuate radiation from spent fuel, control clusters, and reactor vessel internals to less than 2.5 mR/hr at the refueling cavity water surface and less than 1.0 mR/hr in the Fuel Handling Building.

The refueling cavity is irregularly shaped, formed by the upper portions of the primary shield concrete, and other sidewalls of varying thicknesses. A portion of the cavity is used for storing the upper and lower internals packages; these are shielded with concrete walls, 3 and 4-ft thick, respectively. The remaining walls are a minimum thickness of 6 ft of concrete, and provide the shielding required during transfer of spent fuel.

The refueling cavity, which is flooded with borated water to between approximate elevations 274 ft and 273 ft (consistent with the normal SFP level of between 37 ft 5/8 in. and 36 ft 2 1/2 in.) during refueling operations, provides a temporary water shield above the components being withdrawn from the reactor vessel. The water height during refueling is approximately 25 ft above the reactor vessel flange. This height ensures that a minimum of 10 ft 6 in. of water will be above the active fuel of a withdrawn fuel assembly. Under these conditions, the dose rate is less than 2.5 mR/hr at the water surface.

The spent fuel assemblies and control rod clusters are remotely removed from the reactor containment through the horizontal spent fuel transfer tube and placed in the spent fuel pit. Concrete, 6 ft thick, shields the spent fuel transfer tube. This shielding is designed to protect personnel from radiation during the time a spent fuel assembly is passing through the main concrete support of the reactor containment and the transfer tube.

Radial shielding during fuel transfer is provided by the water and concrete walls of the fuel transfer pit. An equivalent of 6 ft of concrete is provided to ensure a maximum dose value of 1.0 mR/hr in the areas adjacent to the spent fuel pit.

Fuel is stored in the spent fuel pit of the Fuel Handling Building which is located adjacent to the Containment Building. Shielding for the spent fuel storage pit is provided by 6 ft thick concrete walls, and the pit is flooded to a level such that the normal water level is at least 21 ft above the stored spent assemblies. During spent fuel handling a minimum of 7 ft 6 in. is maintained above the fuel.

The refueling shield design parameters are listed in Table 12.3.1-4.

12.3.1.6 Auxiliary Shielding

The function of the auxiliary shielding is to protect personnel working near various system components in the Chemical and Volume Control System, the Residual Heat Removal System, the Waste Disposal System and the Sampling System. The shielding provided for the Auxiliary Building is designed to limit the dose rate to less than 1 mR/hr in normally occupied areas, and at or below 2.5 mR/hr in periodically-occupied areas.

The auxiliary shield consists of concrete walls around certain components and piping which process reactor coolant. In some cases, the concrete block walls are removable to allow personnel access to equipment during maintenance periods. Periodic access to the Auxiliary Building is allowed during reactor operation. Each equipment compartment is individually shielded so that compartments may be entered without having to shut down and, possibly, to decontaminate the adjacent system.

The shield material provided throughout the Auxiliary Building is concrete (density of 2.3 g/cc). The principal auxiliary shielding provided is tabulated in Table 12.3.1-5.

TABLE 12.3.1-1

PRIMARY SHIELD NEUTRON FLUXES AND DESIGN PARAMETERS
CALCULATED NEUTRON FLUXES

ENERGY GROUP	INCIDENT FLUXES *	LEAKAGE FLUXES *
	(n/cm^2 - sec)	(n/cm^2 - sec)
E > 1 Mev	1.2×10^{9}	1.4×10^{2}
5.3 kev < E $\leq$ 1 Mev	2.7×10^{10}	3.3×10^{2}
.625 ev $\leq$ E $\leq$ 5.3 kev	1.6×10^{10}	6.0×10^{2}
E < .625 ev	4.1×10^{9}	7.0×10^{4}

DESIGN PARAMETERS

Core thermal power	2300 MW *
Active core height	144 in.
Effective core diameter	119.7 in.
Baffle wall thickness	1.125 in.
Barrel wall thickness	2.03 in.
Thermal shield wall thickness	2.69 in.
Reactor vessel ID	155.5 in.
Reactor vessel wall thickness	9.31 in.
Reactor coolant cold leg temperature	555ºF
Reactor coolant hot leg temperature	611ºF
Maximum thermal neutron flux exiting primary concrete	7.0×10^{4} n/cm^2-sec *
Reactor shutdown dose exiting primary concrete	<15 mR/hr

* Although this analysis was performed for a power level of 2300 MWt, evaluations have shown that either the analysis remains bounding for operation at 2339 MWt or the impact on the analysis is negligible.

TABLE 12.3.1-2

SECONDARY SHIELD DESIGN PARAMETERS

Core power density	86.4 w/cc *
Reactor coolant liquid volume	9400 ft^3
Reactor coolant transit times:	
Core	0.9 sec
Core exit to steam generator inlet	2.0 sec
Steam generator inlet channel	0.6 sec
Steam generator tubes	3.2 sec
Steam generator tubes to vessel inlet	2.7 sec
Vessel inlet to core	2.1 sec
Total Out of Core	10.6 sec
Total power dose rate outside secondary shield	<1 mR/hr

* Although this analysis was performed for a power level of 2300 MWt, evaluations have shown that either the analysis remains bounding for operation at 2339 MWt or the impact on the analysis is negligible.

TABLE 12.3.1-3

ACCIDENT SHIELD DESIGN PARAMETERS

Core thermal power	2300 MW *
Minimum full power operating time	1000 days
Equivalent fraction of core melting	1.0
Fission product fractional releases:	
Noble gases	1.0
Halogens	0.5
Remaining fission product inventory	0.01
Clean-up rate following accident 0	
Maximum integrated dose (infinite exposure) in the Control Room	<2rem

* Although this analysis was performed for a power level of 2300 MWt, evaluations have shown that either the analysis remains bounding for operation at 2339 MWt or the impact on the analysis is negligible.

TABLE 12.3.1-4

REFUELING SHIELD DESIGN PARAMETERS

Total number of fuel assemblies	157
Minimum full power exposure	1000 days
Minimum time between shutdown and fuel handling	96 hr
Maximum dose rate adjacent to spent fuel pit	1.0 mR/hr
Maximum dose rate at water surface	2.5 mR/hr

TABLE 12.3.1-5

PRINCIPAL AUXILIARY SHIELDING

COMPONENT	CONCRETE SHIELD THICKNESS (ft - in.)
Demineralizers	4 - 0
Charging pumps	2 - 4
Liquid holdup tanks	2 - 6
Volume control tank	3 - 7
Reactor coolant filter	2 - 9
Gas stripper	2 - 6
Gas decay tanks	6 - 0
Gas compressor	2 - 8
Waste evaporator	2 - 0
Liquid waste holdup tank	2 - 0

Design parameters for the auxiliary shielding include:

Core thermal power	2300 Mwt *
Fraction of fuel rods containing small clad defects	0.01
Reactor coolant liquid volume	9400 ft^3
Letdown flow (normal purification)	60 gpm
Cesium purification flow (intermittent)	60 gpm
Cut-in concentration deborating demineralizer	160 ppm
Dose rate outside Auxiliary Building	<1 mR/hr
Dose rate in the building outside shield walls	<2.5 mR/hr

* Although this analysis was performed for a power level of 2300 MWt, evaluations have shown that either the analysis remains bounding for operation at 2339 MWt or the impact on the analysis is negligible.

12.3.2 VENTILATION

Ventilation is discussed in Section 9.4.

12.3.3 AREA RADIATION AND AIRBORNE RADIOACTIVITY MONITORING INSTRUMENTATION

The Radiation Monitoring System (RMS) consists of the following:

a) Area Radiation Monitoring System

b) Process and Effluent Radiological Monitoring and Sampling System

The Area Radiation Monitoring System is described below, while the Process and Effluent Monitoring and Sampling System (which includes Airborne Radiation Monitoring) is described in Section 11.5.

12.3.3.1 Area Radiation Monitoring System

12.3.3.1.1 Design Basis

The Radiation Monitoring System is designed to perform two basic functions:

a) Warn of any radiation health hazard which might develop

b) Give early warning of a plant malfunction which might lead to a health hazard or plant damage

Instruments are located at selected points in and around the plant to detect, compute, and record the radiation levels. In the event the radiation level should rise above a desired setpoint, an alarm is initiated in the Control Room. The automatic Radiation Monitoring System operates in conjunction with regular and special radiation surveys and with chemical and radiochemical analyses performed by the plant staff. Adequate information and warning are thereby provided for the continued safe operation of the plant and assurance that personnel exposure does not exceed 10CFR20 limits.

The only components of these systems which are located in the containment are the detectors for certain area monitoring channels. The low range channels would not be expected to operate following a major loss-of-coolant accident and are not designed for this purpose. Components of all other area monitoring channels are designed for post-accident operation. Area monitors are of a nonsaturating design so that they "peg" full scale if exposed to radiation levels above full scale indications. The Time-to-Count technique employed in the GM tube detectors eliminate the dead time and the saturation effects. The Ion chamber detector operates in ‘current mode’ such that increasing dose rate beyond full scale continues to increase or maintain current output of the detector tube.

The components of the Radiation Monitoring System in the control room are designed according to the following normal environmental conditions:

a) Temperature - an ambient temperature range of 70º to 77ºF

b) Humidity - 20 to 80 percent relative humidity

c) Pressure - normal atmospheric pressure (components inside the containment are designed to withstand test pressure).

d) Radiation - Negligible

12.3.3.1.2 General system description

The Area Radiation Monitoring System consists of twelve channels which monitor radiation levels in various areas of the plant. These areas are as follows:

CHANNEL	AREA MONITOR
R-1	Control Room
R-2	Containment
R-3	Pass Panel Area
R-4	Charging Pump Room
R-5	Spent Fuel Building
R-6	Sampling Room
R-7	In-Core Instrumentation Cubicle
R-8	Drumming Station
R-9	Failed Fuel
R-32A	Containment
R-32B	Containment
R-33	Monitor Building

All of the Control Room system equipment is centralized in three cabinets. High reliability and ease of maintenance are emphasized in the design of this system. Sliding channel drawers are used for rapid replacement of units, assemblies, and entire channels. It is possible to completely remove the various chassis from the cabinet, after disconnecting the cables from the rear of these units.

A Multipoint strip chart recorder is provided in the Radiation Monitoring System cabinets in the Control Room. Each monitoring channel can be recorded.

Table 12.3.3-1 indicates the detector medium and temperature conditions during normal operation.

The relation of the radiation monitoring channels to the systems with which they are associated is given in the sections describing those systems. Routine test and recalibrations will ensure that the channels operate properly.

12.3.3.1.2.1 Channel R1, 2, 3, 4, 5, 6, 7, 8, 9 and 33

Each channel has a fixed position gamma sensitive GM tube detector (except for channel R-9, which has an Ion Chamber detector) assembly located remotely in the plant. Each detector contains a source check mechanism and signal processing electronics. Each detector is connected to a field located ratemeter which provides power to operate the detector and provides outputs to a ratemeter in the control room. The control room ratemeter provides outputs to the control room recorder, the local readout, the ERFIS computer, and upon alarm, to the RTGB annunciator panel. The field located ratemeter indicates alarm conditions and provides audible warning on a high radiation alarm. R-1 remote buzzer is disabled since the control room is manned all the time. R-1 also provides a signal to operate control room ventilation equipment on an alarm signal.

The pulse rate from each detector is averaged by the ratemeter, converted to a reading in Mr/hr and displayed digitally at the ratemeter. Local readouts are on digital ratemeters. The range of R-1 through R-8 is 0.1 mR/hr to 10,000 mR/hr. The range of R-9 and R-33 is 1.0 mR/hr to 100,000 mR/hr.

The control room ratemeter front panel consists of the following:

A vacuum fluorescent display where channel activity and error messages are displayed;

A three position key switch for selecting ratemeter operating mode;

A six button keypad for accessing and modifying ratemeter data, and performing ratemeter functions;

Four indicator lamps representing High Alarm, Alert Alarm (not used), Normal Operation, and Fail Alarm.

12.3.3.1.2.2 Channel 32A and 32B

The Post Accident Containment Radiation Monitoring System is designed to provide measurement of containment radiation exposure levels during an accident to help assess the severity of the accident.

The system consists of two, independent monitors with a measurement range of 1R/hr to 10^7R/hr. The monitors and associated equipment are qualified for continuous post-accident operation. The monitors are mounted on opposite sides of the containment building and are powered by independent vital power supplies. Readout and recording for each monitor are provided in the control room.

TABLE 12.3.3-1

AREA RADIATION MONITORING SYSTEM

DETECTING MEDIUM CONDITIONS

CHANNEL	MEDIUM	TEMPERATURE RANGE (ºC)
R-1	Air	10-50
R-2	Air	10-50
R-3	Air	10-50
R-4	Air	10-50
R-5	Air	10-50
R-6	Air	10-50
R-7	Air	10-50
R-8	Air	10-50
R-9	Air	10-50
R-32A	Air	0-177
R-32B	Air	0-177
R-33	Air	10-50

12.3.4 Criticality Monitors

H. B. Robinson Steam Electric Plant (HBRSEP), Unit No. 2 has chosen to comply with the provisions of 10 CFR 50.68(b) "Criticality accident requirements," in lieu of providing the criticality monitoring and alarm system required by 10 CFR 70.24. A discussion of the compliance with each of the criteria of 10 CFR 50.68(b) is provided below.

12.3.4.1 Criterion 1

"Plant procedures shall prohibit the handling and storage at any one time of more fuel assemblies than have been determined to be safely subcritical under the most adverse conditions feasible by unborated water."

Response:

Fuel handling procedures are written to instruct the operators to move one fuel assembly from the shipping cask, allow for fuel inspection, and insert the fuel assembly into the new fuel storage rack, before moving a subsequent assembly. Additionally, HBRSEP possesses only one new fuel crane; therefore, handling of more than one new fuel assembly at a time in accordance with procedural controls is prevented by this material limitation. Criticality analyses which incorporate administrative controls show that subcriticality will be maintained with k_{eff} less than 0.95 for unborated water and less than 0.98 in an optimum moderation condition in the new fuel storage areas.

Fuel handling activities in other areas are procedurally controlled to preclude accidental criticality. In the spent fuel pool during the storage and handling of the fuel, analysis requires a minimum boron concentration of 800 ppm to be safely subcritical for an assumed mishandling event. Technical Specifications 3.7.13 mandates a minimum boron concentration of 1500 ppm to protect against a dilution event. This provides adequate boron concentration to meet the mishandling event requirements.

In the cavity, the analysis requires a minimum boron concentration during refueling operations which involve fuel handling, and is bounded by Technical Specifications 3.9.1 and the Core Operating Limits Report. Use of refueling equipment and movement of fuel assemblies is governed by plant procedures. The design of the fuel handling equipment does not allow for handling of more than one fuel assembly in a local vicinity. For example, there can be one assembly in the new fuel elevator, but at the same time an assembly could be in transition via the spent fuel tool to its final location in the spent fuel pool.

Criticality may be possible under certain circumstances described in the Carolina Power & Light (CP&L) Company letter to the NRC dated May 10, 1999, that requested an interpretation of the criteria of 10 CFR 50.68(b). However, the NRC response to the May 10, 1999, letter dated May 19, 1999, stated that there is no need for an interpretation and "that the staff concludes that H. B. Robinson 2 meets 10 CFR 50.68." In light of this correspondence from the NRC, criticality considerations are adequately considered in the reactor vessel and in the spent fuel pool by existing analyses and by the administrative controls in place to control fuel movement and storage in these areas.

12.3.4.2 Criterion 2

"The estimated ratio of neutron production to neutron absorption and leakage (k_{eff}) of the fresh fuel in the fresh fuel storage racks shall be calculated assuming the racks are loaded with fuel of the maximum fuel assembly reactivity and flooded with unborated water and must not exceed 0.95, at a 95 percent probability, 95 percent confidence level. This evaluation need not be performed if administrative controls and/or design features prevent such flooding or if fresh fuel storage racks are not used."

Response:

The current criticality analysis of record for HBRSEP is documented in EMF-94-113, "H. B. Robinson New and Spent Fuel Criticality Analysis." This document was submitted to the NRC by CP&L letter dated July 28, 1994, in support of a request for a license amendment to increase the allowable fuel enrichment to 4.95 + 0.05 (nominal 4.95) weight percent of U-235. The amendment was approved by the NRC by letter dated January 5, 1995.

Documentation that the k_{eff} of the fresh fuel storage racks filled with fuel of the maximum permissible U-235 enrichment and flooded with unborated water does not exceed 0.95, at a 95% probability, 95% confidence level, is provided in EMF-94-113, section 5.1. The successful conclusions of this analysis assume that certain new fuel rack locations are "locked out" and unavailable for storage of fuel. The locking out is accomplished by the installation of chains and locks on designated fuel rack cells that prohibit the insertion of a new fuel assembly.

CP&L letter dated May 10, 1999, requested an interpretation regarding whether the phrase "racks are. . .loaded with fuel," requires that rack cells that are "locked out" by administrative controls be assumed to contain fuel for the purposes of the analysis required by 10 CFR 50.68(b)(2). The "locking out" and administrative controls are described in fuel handling procedures. The NRC response to the May 10, 1999, letter dated May 19, 1999, stated that there is no need for an interpretation and "that the staff concludes that H. B. Robinson 2 meets 10 CFR 50.68."

12.3.4.3 Criterion 3

"If optimum moderation of fresh fuel in the fresh fuel storage racks occurs when the racks are assumed to be loaded with fuel of the maximum fuel assembly reactivity and filled with low-density hydrogenous fluid, the k_{eff} corresponding to this optimum moderation must not exceed 0.98, at a 95 percent probability, 95 percent confidence level. This evaluation need not be performed if administrative controls and/or design features prevent such moderation or if fresh fuel storage racks are not used."

Response:

The optimum moderation condition occurs at about 5% interspersed water volume. Documentation that the k_{eff} corresponding to this optimum moderation does not exceed 0.98, at a 95% probability, 95% confidence level, is provided in EMF-94-113, section 5.1. The successful conclusions of this analysis assume that certain new fuel rack locations are "locked out" and unavailable for storage of fuel. Administrative controls are adequate to assure that "locked out" fuel storage locations do not need to be included in the assumed fuel storage locations for the criticality analyses.

12.3.4.4 Criterion 4

"If no credit for soluble boron is taken, the k_{eff} of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with unborated water. If credit is taken for soluble boron, the k_{eff} of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with borated water, and the k_{eff} must remain below 1.0 (subcritical), at a 95 percent probability, 95 percent confidence level, if flooded with unborated water."

Response:

The HBRSEP, Unit No. 2 analysis for the low density spent fuel racks does not take credit for soluble boron. Documentation that the k_{eff} of low density spent fuel storage racks filled with fuel of the maximum permissible U-235 enrichment, and flooded with pure water, is less than or equal to 0.95, at a 95% probability, 95% confidence level, is provided in EMF-94-113, section 5.2. The analysis assumes fuel with an enrichment of 5.0 weight percent of U-235.

The HBRSEP, Unit No. 2 analysis for the high density spent fuel racks does take credit for soluble boron. Documentation that the k_{eff} of high density spent fuel racks filled with fuel of the maximum permissible U-235 enrichment, and flooded with pure water, remains less than 1.0 at a 95% probability, 95% confidence level, is provided in report HI-992350. The analysis assumes fuel with an enrichment of 5.0 weight percent of U-235. If flooded with borated water (minimum 200 ppm soluble boron concentration), the k_{eff} will remain less than or equal to 0.95, at a 95% probability, 95% confidence level.

12.3.4.5 Criterion 5

"The quantity of SNM, other than nuclear fuel stored onsite, is less than the quantity necessary for a critical mass."

Response:

The quantity of SNM other than nuclear fuel stored on site is less than the quantity necessary for a critical mass. Procedures will contain a precaution that non-fuel quantities of SNM on site shall be limited to less than the amounts necessary for a critical mass.

12.3.4.6 Criterion 6

"Radiation monitors are provided in storage and associated handling areas when fuel is present to detect excessive radiation levels and to initiate appropriate safety actions."

Response:

The spent fuel pool area has an existing monitor, R-5, that will meet the criterion. This monitor provides an audible alarm.

Monitoring of fuel in the reactor vessel during fuel handling will be accomplished by the source range monitors which are required by Technical Specifications section 3.9.2. The audible count rate which can be heard in containment will warn personnel with an increased count rate. High rate alarms are provided in the control room and operators will dictate appropriate safety actions if unexpected readings are noted.

A portable (temporary) radiation monitor will be provided in the new fuel storage and handling areas when fuel is in storage or being handled in those areas.

Monitors will not be provided in areas where fuel is contained in shipping containers including the IF-300 cask, since these activities are performed in accordance with 10 CFR 71 or 10 CFR 72 and are, therefore, outside the scope of 10 CFR 50.68.

12.3.4.7 Criterion 7

"The maximum nominal U-235 enrichment of the fresh fuel assemblies is limited to five (5.0) percent by weight."

Response:

The limitation of U-235 enrichment in fresh fuel is provided in Technical Specifications Section 4.3.1.2, which states: "The new fuel storage racks are designed and shall be maintained with:

a. Fuel assemblies having a maximum U-235 enrichment of 5.0 weight percent."

12.4 DOSE ASSESSMENT

Historic data on annual man-rem doses resulting from operation and maintenance of HBR 2 is maintained by Duke Energy Progress, LLC.

12.5 Health Physics Program

12.5.1 Organization

12.5.1.1 Introduction

The HBR health physics program has been established to provide an effective means of radiation protection for plant personnel, visitors, and the general public. To provide this radiation protection, the health physics program incorporates a dedicated philosophy from management, qualified personnel to direct and to implement the health physics program, the appropriate equipment and facilities, and written procedures based upon acceptable radiation protection practices and guidance.

The health physics program at HBR is developed and implemented to evaluate and document plant radiological conditions and to ensure that every reasonable effort is made to maintain occupational radiation exposure (ORE) as low as reasonably achievable (ALARA). The organization of the health physics program provides a flexible, responsive, and comprehensive structure for attaining these goals. The qualifications of all plant personnel are provided in Sections 13.1.3 and 1.8.

12.5.1.2 Responsibilities

The Radiation Control Supervisors are under the supervision of the Superintendent - Radiation Control, and are responsible for providing the information necessary to establish compliance with regulations pertaining to radiation safety, for uniformly enforcing plant health physics requirements, and for ensuring every reasonable effort to minimize personnel exposures. In addition, they are responsible for ensuring that the staff members who implement the health physics program are trained and retrained in operational health physics principles. They are assisted by a staff which includes a number of RC Technicians. The ALARA program is implemented and evaluated under the technical direction of an Specialist - ALARA and the management direction of an RC Supervisor who reports to the Superintendent - Radiation Control. The Specialist - ALARA may report to an RC Supervisor that provides the management direction for the ALARA Program, if deemed necessary by the Superintendent - Radiation Control. The Specialist - ALARA provides technical direction and expertise to the RC subunit and ensures compliance with the corporate commitment to ALARA expressed in the Corporate Health Physics Policy.

The RC unit coordinates with the operations, maintenance, and engineering units and provides health physics coverage for all activities that involve radiation or radioactive material. In addition, RC provides various other services, including the following:

1. Preparing health physics procedures for routine and non-routine activities that may be encountered in operating, maintaining, inspecting, and testing the plant.

2. Ensuring that the provisions and standards of 10CFR20 for permissible dose limits and potential release levels are not exceeded.

3. Providing a personnel radiation dosimetry program and maintaining dosimetry records

4. Providing radiation surveys of plant areas and maintaining survey records

5. Assisting in plant training programs by consulting with the plant training organization

6. Providing and calibrating radiation detection instruments and equipment for assessing the radiation environment at HBR

7. Providing, maintaining, and issuing protective clothing and equipment

8. Assisting in the shipping and receiving of all radioactive material to ensure compliance with regulatory requirements

9. Preparing, maintaining, and issuing reports of the required regulatory, plant, and personnel records that involve radiological aspects at HBR

10. Assisting in the decontamination of personnel, equipment, and facilities at HBR

11. Administration of the HBR respiratory protection program

The responsibilities of the Radiation Control Supervisors are to provide the day-to-day execution of the health physics program through supervision of the routine and special surveys and the programs required by applicable regulations and procedures. The Radiation Control Technicians implement the health physics program by performing routine and special surveys and by providing health physics surveillance in accordance with plant health physics procedures.

It is the responsibility of each individual to obey all radiation control procedures and to report to either the Radiation Control Supervisors, or Superintendent-Radiation Control or their designees any circumstances where procedures may be incorrect or unsafe activities may be occurring.

The Supervisor - Radiological Services is available to provide technical direction, guidance, support, and assistance for all radiation control programs and related activities. The Supervisor-Radiological Services reports to the Manager Material Services. The Manager Material Services has the organizational freedom to communicate directly with the Chief Executive Office to resolve any concern in the area of health physics should the concern not be resolved satisfactorily at a lower management level.

Nuclear Oversight (NOS) evaluates the performance and effectiveness of the Company's health physics programs on a continuous basis to assure they are being carried out in an effective manner. These assessments are to detect deficiencies in the desired levels of performance and quality, reporting these conditions to the Vice President - Robinson Nuclear Plant, and ensuring adequate action is taken to correct and eliminate these conditions.

12.5.1.3 Authority

The plant General Manager, who is ultimately responsible for all plant activities including radiation safety, receives direct reports from the Superintendent - Radiation Control concerning the status of the health physics program. To ensure uniform enforcement of health physics requirements, the Plant General Manager delegates his authority to the Superintendent-Radiation Control and the Radiation Control Supervisors. The Superintendent-Radiation Control and the Radiation Control Supervisors have the authority to cease any work activity when, in their judgment, worker safety is jeopardized, or in the event of unnecessary personnel radiation exposures.

The Radiation Control Supervisors delegate authority to responsible RC Technicians to cease any work activity which is not being performed in accordance with health physics requirements. The Radiation Control Technicians have the authority to ensure that jobs are conducted in accordance with health physics requirements.

In the absence of Radiation Control supervision, the authority associated with the above positions may be delegated, in accordance with the plant's health physics procedures, to the most senior health physics individual on shift.

12.5.1.4 Experience and Qualification

The radiation control staff, which is responsible for the health physics program at HBR, meet minimum experience and qualification requirements as described in Section 1.8. Each Radiation Control Technician must be qualified in the use and application of radiation protection control procedures.

12.5.2 Equipment, Instrumentation, and Facilities

12.5.2.1 Personnel Protective Equipment

Personnel entering the Radiation Control Area may be required to wear protective clothing. The nature of the work to be done is the governing factor in the selection of protective clothing to be worn by individuals. Some of the protective apparel available are shoe covers, head covers, gloves, coveralls, etc. Additional items of specialized apparel such as plastic or rubber suits, and respirators are available for operations involving wet surfaces or airborne radioactivity. In all cases, health physics-trained personnel shall evaluate the radiological conditions and specify the required items of protective clothing to be worn.

Respiratory protective devices may be required in situations arising from plant operations in which an airborne radioactive area exists or is expected. Airborne concentrations are monitored by health physics personnel and the necessary personnel protective devices are specified according to the concentration and type of airborne contaminants present while maintaining the total effective dose equivalent ALARA.

Respiratory devices which may be available for use include:

1. Full-face air purifying respirator

2. Air supplied full-face respirators or hoods

3. Self-contained breathing apparatus.

Respirators are maintained by checking for mechanical defects, contamination, and cleanliness by qualified personnel.

12.5.2.2 Radiation Instrumentation

Facilities are provided for the Environmental & Chemistry and Radiation Control Group. These facilities include both laboratory and health physics work areas. These facilities are equipped to analyze routine air samples and contamination smear surveys. These facilities also serve as a central location for portable radiation survey instruments, respiratory protection equipment, and contamination control supplies.

Survey instruments are calibrated periodically.

12.5.2.3 Personnel Monitoring

All individuals, except casual visitors, who enter the Radiation Control Area are monitored for external whole body radiation exposure using an appropriate individual monitoring device. Individual monitoring devices used at HBR include (but are not limited to) thermoluminescent dosimeters (TLDs), electronic pocket dosimeters, and self-reading pocket ionization chambers.

Individuals subject to monitoring for occupational radiation exposure are issued individual monitoring devices and are required to wear them at all times while in the Radiation Control Area.

Special or additional individual monitoring devices are issued as may be required at the discretion of health physics personnel.

Individual monitoring devices capable of measuring neutron dose equivalent are issued as required. The neutron dose equivalent may be determined initially by using survey data and stay times to calculate exposure.

Casual visitors are not subject to monitoring, recordkeeping, and reporting requirements of 10 CFR 19 and 10 CFR 20. However, they are issued a self-reading dosimeter (e.g., pocket ionization chamber or electronic pocket dosimeter) for verification purposes.

12.5.2.4 Facilities and Access Provisions

The plant site is divided into two categories, the Clean Area and the Radiation Control Area for radiation protection purposes as shown on Figures 12.5.2-1 and 12.5.2-2.

Normal entry to and exit from the primary Radiation Control Area is through a single access control point. Additional access control points may be established to support plant operations. Numerous locations for emergency Radiation Control Area entry/exit are available.

Satellite Radiation Control Areas exist in other areas on plant site and access to these areas is administratively controlled by the Environmental and Radiation Control Organization.

Radiation Control Areas are surveyed, classified, and conspicuously posted in accordance with 10 CFR 20 regulations.

The general arrangement of the service facilities is designed to provide personnel decontamination and change areas (see Figure 12.5.2-1). Clean locker rooms in the RCA Access Facility are used to store individuals' clothing when they must dress out to perform work in the Radiation Control Area. A dress out area is provided in the Radiation Control Area. A supply of clean protective clothing for personnel is maintained in this area. Appropriate personnel contamination survey devices are located at the exit point of the Radiation Control Area so that personnel can survey themselves upon leaving the Radiation Control Area. A decontamination shower and washroom is located in the Radiation Control Area.

Decontamination areas are also provided in the Radwaste Building for the decontamination of hand tools and small equipment. Decontamination areas are established or removed in other plant areas based on plant configuration or need. In addition, satellite decontamination areas may be established for special conditions or projects.

Administrative and physical security measures are employed to prevent unauthorized entry of personnel to any High Radiation Area. These measures include the following:

1. Any areas accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 100 mRem in any one hour at 30 centimeters from the radiation source or from the surface the radiation penetrates, are barricaded and conspicuously posted as "High Radiation Areas".

2. Locations where the above value exceeds 1 Rem in any one hour at 30 centimeters from the radiation source or from any surface the radiation penetrates are conspicuously posted and, in addition, locked doors are provided to prevent unauthorized entry.

3. Areas, accessible to personnel, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads in any one hour at one meter from a radiation source or from any surface that radiation penetrates, are designated as Very High Radiation Areas. Accesses to these areas are administratively controlled. Entry into Very High Radiation Areas is forbidden unless there is a sound operational or safety reason for entering.

4. Any individual or group of individuals entering "high radiation areas" is provided with or accompanied by one or more of the following:

a. A radiation monitoring device which continuously monitors the radiation dose in the area.

b. A radiation monitoring device provided for each individual which continuously integrates the radiation dose rate in the area and alarms when a preset integrated dose is received. Entry into such areas with this monitoring device may be made after the dose rate levels in the area have been established and personnel have been made knowledgeable of them.

c. An individual qualified in radiation protection procedures who is equipped with a radiation dose rate monitoring device. This individual shall be responsible for providing positive control over the activities within the area and shall perform periodic radiation surveillance at frequency specified by the Radiation Control Supervisor in the Radiation Work Permit.

12.5.3 Procedures

The health physics procedures developed for HBR are an integral part of the ALARA policy, as discussed in Section 12.1. These procedures, developed through careful planning and preparation and utilized by well-trained and qualified personnel, contribute significantly to the overall reduction of the occupational radiation exposures. The health physics procedures cover the appropriate administrative, operating, and ALARA-related operations and conditions at HBR. As indicated in Section 12.1, ALARA considerations have been embodied in applicable procedures. In addition, procedures for personnel radiation protection shall be prepared consistent with the requirements of 10CFR20 and shall be approved, maintained and adhered to for all operations involving personnel radiation exposure.

12.5.3.1 Control of Access and Stay Time in Radiation Areas

As specified in Section 12.1, physical and administrative controls are instituted at HBR to ensure that the philosophy of maintaining personnel exposures as low as reasonably achievable (ALARA) is implemented.

12.5.3.1.1 Physical controls

12.5.3.1.1.1 Security check point and access control

The plant's security checkpoints are continuously manned. TLD badges issued to individuals will remain the custody of the individual. All personnel will maintain their TLD with their security badge. Each individual will be responsible for bringing their security badge to work each day and ensuring the TLD is available to be exchanged during TLD changeout period. A restricted area access list is maintained at the security entrance. Any individual not authorized access must be accompanied by a person who is an authorized escort for restricted areas. The training, retraining, and testing requirements for unescorted access are described in the HBR Plant Access Training Procedures.

12.5.3.1.1.2 Door and area posting and locking

Physical control is provided by the posting and locking, as appropriate, of Radiation Areas, High Radiation Areas, and very High Radiation Areas. These areas, as defined in 10CFR20.1003, are posted in accordance with 10CFR20.1902. Plant areas that are routinely accessible are surveyed in accordance with plant procedures to determine radiation and contamination levels. The surveys are performed on a frequency that is appropriate with the potential hazard present. In addition to recording the results of these surveys in accordance with 10CFR20.2103, the radiological postings are updated to reflect operating conditions.

12.5.3.1.1.3 Health physics surveillance

When appropriate, health physics surveillance of work activities is provided to assure a positive control of access and stay time in radiation areas. Surveillance may also be provided for tasks in areas where conditions may warrant timely instructions to workers (e.g., on jobs where the radiological conditions can fluctuate greatly).

12.5.3.1.2 Administrative controls

12.5.3.1.2.1 Training

As specified in Section 12.5.3.7, personnel allowed unescorted restricted area access receive health physics and related training in accordance with 10CFR19.12.

12.5.3.1.2.2 Radiation Work Permits

The Radiation Work Permit (RWP) system described in Section 12.5.3.2 is implemented to administratively control access and personnel dose in radiation areas. For personnel or groups who must enter these areas as a necessary part of work duties, a Radiation Work Permit (RWP) will be issued in accordance with plant procedures.

12.5.3.2 Assuring Occupational Radiation Exposures are ALARA

To effectively implement the corporate ALARA commitment as discussed in Section 12.1.1, an ALARA program is utilized at HBR to assure that activities are performed with ALARA personnel exposure. Progress Energy considers it necessary to apply the basic concepts of ALARA to both internal and external exposure to assure proper emphasis on both modes of potential radiation exposure. Procedures employed to implement the program described are subject to review and revision to ensure that the ALARA program is responsive to plant needs and conditions.

12.5.3.2.1 ALARA procedures common to external and internal exposure

12.5.3.2.1.1 Training

Individuals allowed unescorted restricted area access receive health physics training as described in Section 12.5.3.7. The individual's responsibility to avoid unnecessary exposure is emphasized during health physics training sessions.

As appropriate, individuals involved in potentially high occupational radiation exposure jobs receive pre-job instruction in exposure reduction techniques and controls applicable to the specific job. Post-job reviews are held, as appropriate, to provide a positive feedback on improved job performance.

12.5.3.2.1.2 Radiation Work Permit (RWP)

For entry into the Radiation Control Area (RCA), an RWP is initiated and approved prior to commencement of scheduled work. Plant procedures specify that an RWP will be completed for work that is performed involving the following situations:

1. Entry into any area where whole body radiation levels are in excess of 100 mrem/hr.

2. Any maintenance work which involves opening of any system which contains, or could potentially contain, radioactive material in excess of limits established by plant procedures

3. Any maintenance of contaminated or potentially contaminated equipment using methods involving abrasion, cutting, machining, or welding

Radiation control personnel evaluate the radiological conditions associated with the work to be performed and specify appropriate protective clothing/devices, respiratory protective equipment, dosimetry, special samples, surveys, and precautions to be taken.

The RWP is evaluated to ensure that the work will be performed utilizing good health physics practices and an ALARA approach.

The RWP is approved by a Radiation Control Supervisor or designee. The RWP implementation process is detailed in plant procedures.

12.5.3.2.1.3 Work scheduling

Use of the work management system establishes a data base from which supervisory staff are able to efficiently schedule workers.

12.5.3.2.1.4 Job pre-planning and exposure goals

Preparing an RWP is a form of job pre-planning. The responsible supervisor ensures that individuals selected to perform the task are familiar with the appropriate procedures to be employed.

On major dose accumulating job functions, total person-rem (also called man-rem) exposure goals are established prior to commencement of scheduled work. Significant deviations above established goals are investigated by ALARA staff. Methods to improve performance on future jobs will be investigated and implemented, if appropriate.

12.5.3.2.1.5 ALARA program reviews

In an effort to continually improve the ALARA program, the Specialist – ALARA and radiation protection personnel utilize benchmarking, operational experience, self-assessment, and the corrective action program to identify deficiencies and improvement opportunities in the ALARA program. Results of these efforts are documented and reported to the appropriate levels of plant management.

12.5.3.2.2 External ALARA

12.5.3.2.2.1 Administrative limits

Administrative limits are implemented by plant procedures to maintain personnel exposures ALARA with respect to federal regulations. Plant radiation exposure limits may be exceeded only after approval of plant management. Unapproved radiation exposures exceeding plant limits are investigated by radiation control personnel to identify causes and establish methods to prevent recurrence.

12.5.3.2.2.2 Temporary shielding and special tools

During the planning phase of RWP work, qualified radiation control personnel and the ALARA staff evaluate the use of temporary shielding. Care is taken to ensure that installation and removal of shielding does not cause larger man-rem total exposures than expected without its use.

Every reasonable effort is expended to ensure that any necessary, special, or modified tools are available for specific tasks.

12.5.3.2.3 Internal ALARA

To minimize potential intake of radioactive material in excess of federal limits, plant limits are established. Airborne radioactivity concentrations in excess of these limits may require work restriction, engineering controls, use of respiratory protection, and/or special in-vivo or bioassay studies.

When work orders indicate that work is required in areas containing potential airborne radioactive material, appropriate air samples are taken. These data samples are normally of short-term, low-volume nature in order to obtain representative of normal breathing rates. Any area that is posted as an airborne radioactivity area is sampled and analyzed prior to commencement of scheduled work.

12.5.3.2.3.1 Control of absorption

When work is scheduled on equipment or systems that contained or may contain radioactive liquids, every reasonable effort to prevent skin contact with radioactive solutions is made.

12.5.3.2.3.2 Control of area and equipment contamination levels

Contaminated areas and equipment are decontaminated to as low a level as reasonably achievable in accordance with plant procedures.

12.5.3.2.3.3 Airborne exposure evaluation

Exposure to airborne radioactive material is evaluated in accordance with 10CFR20.1201(d) and Subpart H - Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas to aid in work planning and to demonstrate the effectiveness of the internal ALARA program.

12.5.3.3 Radiation Surveys

The health physics program utilizes a comprehensive system of radiation surveys to document plant radiological conditions and identify sources of radiation that contribute to occupational radiation exposure. Radiation control personnel normally perform radiation and contamination surveys of all accessible areas in the plant. The surveys are performed on an appropriate frequency, depending on the probability of radiation and contamination levels changing, and the frequency with which the areas are visited. Surveys related to specific operations and maintenance activities may be performed prior to, during, and/or after the activity, based on information required to keep radiation exposures ALARA.

Radiation level surveys may be performed for alpha, gamma, beta, and/or neutron exposure rates. Contamination surveys are normally performed to establish gross beta-gamma contamination level, but may be processed for specific types of radiation (beta-alpha-gamma) or specific radionuclides (via gamma spectroscopy). Availability of current survey information aids in keeping exposures ALARA.

The radiation survey program is subject to evaluation by radiation control supervision to ensure that necessary data are collected while exposures to surveyors are ALARA.

12.5.3.4 Contamination Survey Procedures

A system of periodic contamination evaluations is utilized to minimize the spread of radioactive material. Evaluation of personnel, equipment and surface contamination is also made to demonstrate the effectiveness of engineering and procedural controls. In addition, the contamination survey programs are evaluated to assure that survey personnel exposures are ALARA.

12.5.3.4.1 Personnel contamination surveys

Evaluation of exposures due to personnel contamination is conducted in accordance with Section 12.5.3.6.

Instrumentation designed for contamination monitoring is strategically located within the Restricted Area. Every effort is made to locate these instruments in as low a radiation background area as possible in order to maximize sensitivity. Personnel are trained in the use of the instruments and interpretation of the readings.

Personnel contamination causing an alarm requires notification of radiation control personnel. Radiation control personnel take appropriate actions to minimize further spread of contamination, and direct appropriate decontamination of affected areas and personnel.

12.5.3.4.2 Equipment contamination surveys

Movement of equipment from the Radiation Control Area requires the assistance of RC personnel. Fixed and removable contamination levels are evaluated as appropriate and a clearance for removal is issued in accordance with plant procedures.

Reusable protective clothing and shoe covers used in contamination zones are collected in receptacles at access areas and sent for laundering/decontamination.

Change-out procedures require that individuals leaving the Radiation Control Area have to perform surveys of personal items that may have become contaminated during work.

Radioactive material is shipped in accordance with U. S. Department of Transportation and NRC Regulations. Plant procedures implement the applicable regulations with regard to proper packaging and labeling requirements. Appropriate removable contamination and dose rate surveys are taken, records completed, and shipment labeled accordingly.

12.5.3.4.3 Surface contamination surveys

A smear survey program is utilized to assure that a representative number of routinely accessible surface areas within the Radiation Control Area are checked for removable contamination. Emphasis is placed on survey of the clean side of established contamination area access areas.

Occupied plant areas outside the Radiation Control Area are surveyed to assure that a representative number of floor surfaces are checked for removable contamination. The exit areas from the Radiation Control Area receive emphasis to minimize the spread of contamination.

Lunch room facilities and vending machine areas frequented by Radiation Control Area workers are checked for removable contamination. Stoves, benches, table tops, and floor surfaces are representatively smeared to assure minimal contamination in eating areas.

12.5.3.5 Airborne Radioactive Material

Accessible areas containing concentrations of airborne radioactive materials as specified in 10CFR20.1003 are posted in accordance with 10CFR20.1902(d) and applicable plant procedures.

12.5.3.5.1 Airborne concentration sampling

Routine sampling in selected areas of potential airborne radioactivity is accomplished with air monitors. Special air samples are taken, as required. The majority of special air samples are taken as a result of RWP requests and pertinent results are recorded thereon.

12.5.3.5.2 Respiratory protection

The respiratory protection program assures that personnel intake of radioactive material is minimized. The respiratory protection program is not used in place of practical engineering controls and prudent radiation control practices. Every reasonable effort is made to prevent potential, and minimize existing, airborne concentrations. When controls are not practicable, or conditions unpredictable, respiratory protective devices may be utilized to minimize potential intake of airborne radioactive material.

The RNPD Respiratory Protection Program ensures that the following minimum criteria are met: written standard operating procedures; proper selection of equipment, based on the hazard; proper training and instruction of users; proper fitting, use, cleaning, storage, inspection, quality assurance, and maintenance of equipment; appropriate surveillance of work area conditions; consideration of the degree of employee exposure to stress; regular inspection and evaluation to determine the continued program effectiveness; program responsibility vested in one qualified individual and an adequate medical surveillance program for respirator users.

12.5.3.5.3 Handling of radioactive material

Recognized methods for the safe handling of radioactive materials are incorporated into procedures to ensure proper usage. Procedures specify handling techniques, storage, and other safety considerations, as listed below:

1. Minimizing distances that large radioactive sources are transported
2. Use of shielded transporters
3. Storage of sources in appropriately shielded containers
4. Proper labeling of radioactive material containers in accordance with 10CFR20
5. Inventorying of all radioactive sources in accordance with plant procedures
6. Leak testing of sources at six-month intervals in accordance with license conditions
7. Monitoring of all packages received containing radioactive material in accordance with 10CFR20.1906.
8. Radioactive material is stored outside the primary radiological control area. These storage locations are typically plant components being stored and under a radiological surveillance program. In addition, HBR operates 2 ISFSIs; 7P ISFSI under a site specific license and a 24P ISFSI under a general license. The ISFSIs are used to store 15 x 15 used fuel assemblies. These locations are:

   a) Inside Protected Area

      Dose rates are established and maintained at less than or equal to 1 mrem/hr on the building exterior.
      - Building 458: Reactor Head Storage
      - Building 385: Steam Generator Storage
      - Building 457: Reactor Services ISFSI

      Dose rates are established and maintained at less than or equal to 2 mrem/hr at the building RCA fence line.
      - Building 380: Reactor Services Building 7P ISFSI
      - 24P ISFSI

   b) Outside Protected Area

      Dose rates are established and maintained at less than or equal to 0.05 mrem/hr on the building exterior.
      - Building 425: Spare Reactor Coolant Pump Motor

12.5.3.6 <u>Personnel Monitoring</u>

12.5.3.6.1 External radiation exposure assessment

Individual monitoring devices are used at HBR to evaluate external occupational exposure to radiation sources. The appropriate individual monitoring devices are issued in accordance with plant procedures implementing 10CFR20.1502(a).

Individuals who are issued individual monitoring devices are instructed in the purpose and use of the devices, plant administrative exposure limits, and interpretation of the self-reading monitoring device data.

Administrative exposure limits are established and implemented by health physics procedures to ensure the limits of 10CFR20.1201 are not exceeded and personnel occupational exposures are maintained ALARA.

12.5.3.6.2 Internal radiation exposure assessment

To demonstrate the effectiveness of engineering controls and the respiratory protection program, personnel are periodically monitored for internal radioactivity. The following methods for assessing internal exposure are used to ensure compliance with occupational dose equivalent limits:

1. Air sampling to determine the concentrations of airborne radioactive materials in the work area; or

2. Whole body counting techniques to determine the quantities of radioactive material in the body; or
3. Bioassay techniques to determine the quantities of radioactive material excreted from the body; or
4. Any combination of the above listed methods.

12.5.3.6.3 Methods of recording and reporting

Updates of exposure totals are compiled from self-reading pocket dosimeter readings. Unapproved exposures exceeding plant limits will be reported to the Plant General Manager and appropriate supervision, and investigated by radiation control personnel to identify causes and establish methods to prevent recurrence.

Occupational radiation exposure received during previous employment is used in preparation of individuals' Forms NRC-4, or equivalent in accordance with 10CFR20.2104. Records used in preparing Form NRC-4, or equivalent, are retained and preserved until the NRC authorizes disposition.

Records of the radiation exposure of personnel who are issued individual monitoring devices in accordance with 10CFR20.1502 are maintained on Form NRC-5, or equivalent. Records of radiation exposures of individuals receiving exposure under the provisions of 10CFR20.1206 are documented in accordance with 10CFR20.2105 and maintained on Form NRC-5 or equivalent.

Reports of exposure to radiation or radioactive materials are made to individuals as specified in 10CFR19.13. When reports of individual exposure to radiation or radioactive material are made to the NRC, the individual concerned is also notified. This notice is forwarded to the individual at a time no later than the transmittal to the NRC and complies with 10CFR19.13.

Reports of individual monitoring are submitted in accordance with 10CFR20.2206 on or before April 30 of each calendar year. As part of a routine annual operating report, personnel exposure information is submitted within the first quarter of each calendar year. It includes a tabulation of the number of plant, utility, and other personnel (including contractors) for whom monitoring was required or provided, the exposures then received, and associated man-rem exposure according to work and job functions.

Reports of overexposures at HBR are submitted to the NRC and the individual(s) involved in accordance with 10CFR19.13 and 10CFR20.2203. Reports are also forwarded to appropriate committees for review and recommendation for follow-up action

12.5.3.7 Health Physics Training Programs

Health physics training programs assure that personnel, who have unescorted access to the restricted area, possess an adequate understanding of radiation protection to maintain occupational radiation exposures ALARA. Special training/retraining is administered upon recommendation of the Training Supervisor or Radiation Control Supervisor. Record-keeping and training scheduling is performed by the Manager - Training or designated alternate. This program covers the following:

1. General employee health physics
2. General employee respiratory protection
3. Contractor health physics
4. Contractor respiratory protection
5. General employee retraining
6. Radiation control technician training
7. Radiation control technician retraining

12.5.3.7.1 Health physics training

Persons allowed unescorted access to Radiologically Controlled areas must demonstrate proficiency in the following areas as evidenced by passing a computer based or written examination:

1. Requirements of 10 CFR 19.12
2. Radiation/Contamination (examples and control)
3. ALARA (Corporate commitments, meaning, and individual responsibility)
4. Personnel Monitoring and Self-Survey Requirements
5. Radiological Control Signs and Posting Requirements

6. Radiation Exposure Control and Limits

7. Radiation Emergency Plan and Applicable Procedures

8. Prenatal Radiation Exposure

Training is administered to provide radiation workers with an adequate knowledge to effectively cope with job situations while maintaining radiation exposures as low as reasonably achievable.

To assure individual proficiency in radiation protection practices, retraining/retesting should be performed annually 25% (maximum 15 months). Scheduling, records and test results are maintained by the Manager - Training or designated alternate. Individuals changing job classification receive training of the level required by their new job classification.

12.5.3.7.2 Respiratory protection training program

Individuals requiring access to areas where respiratory protection is utilized are required to complete the Respiratory Protection Training Program. The instructor is a qualified individual with a thorough knowledge regarding the application and use of respiratory protective equipment and the hazards associated with radioactive airborne contaminants.

Training may include lectures, computer based training (CBT), demonstrations, discussions of pertinent plant procedures, and actual wearing of respirators to become familiar with the various devices utilized at HBR.

Security Related Information
Figure Withheld Under 10 CFR 2.390

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UNIT 2
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RADIATION CONTROL AREA SITE

FIGURE 12.5.2-1

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RADIATION CONTROL AREA
REACTOR AUXILIARY BUILDING

FIGURE 12.5.2 - 2

Security Related Information
Figure Withheld Under 10 CFR 2.390