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12.0 RADIATION PROTECTION

The protection of plant personnel from radiation emanating from process equipment, radioactive materials present on equipment externals in work areas, airborne radioactive material particles, and gases is accomplished by combinations of measures such as design of shielding structures, selection and use of appropriate radiation monitoring instrumentation, and development and implementation of control standards and procedures. The following subsections provide a brief summary of these radiation protection techniques for Quad Cities Station.

Shielding design is described in Section 12.3. The area radiation monitoring system is also addressed in Section 12.3. Process radiation monitoring instrumentation is addressed in Section 11.5. The high radiation sampling system (HRSS) is described in Section 9.3 and the containment atmosphere monitoring (CAM) system is described in Section 6.2. The radiation sources generated in the reactor core and transported by the reactor coolant system are addressed in Section 11.1. Radiation sources from components of the radioactive waste management systems are described in Sections 11.2, 11.3, and 11.4. The Health Physics Program and its implementation of as low as reasonably achievable (ALARA) radiation exposure control are addressed in Section 12.5.

12.1 Ensuring That Occupational Exposures Are As Low As Reasonably Achievable

This subsection addresses the management policy and organizational structure related to implementation of the policy ensuring that occupational radiation exposures for operating personnel and contractor personnel are maintained ALARA.

12.1.1 Policy Considerations

12.1.1.1 Management Policies

It is the policy of ComEd to maintain occupational dose equivalents to the individual and the sum of dose equivalents received by all exposed workers to levels that are as low as reasonably achievable (ALARA). This ALARA philosophy is implemented in a manner consistent with station operating, maintenance, and modification requirements, taking into account the state of technology, the economics of improvements in relation to the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

It is the policy of ComEd to have all levels of management strongly committed to radiation protection and, specifically, to maintain occupational radiation exposures ALARA. Also, it is recognized that each worker must take personal responsibility for actions necessary to implement successful dose reduction measures.

ComEd's commitment to this policy is reflected in the ongoing station design, in the careful preparation and review of station operating and maintenance procedures, and in the review of equipment design to incorporate the results of operating experience.

12.1.1.2 Management Responsibilities and Organization

12.1.1.2.1 Corporate ALARA Management Responsibilities and Organization

This section has been deleted.

12.1.1.2.2 Station ALARA Management Responsibilities and Organization

Commonwealth Edison Company has authorized the creation of a Nuclear Station ALARA Committee which guides station ALARA activities. The Nuclear Station ALARA Committee approves ALARA decisions and evaluations at the station.

12.1.1.3 Policy Implementation

The management ALARA policy is implemented at the Quad Cities Station by the RPM and subordinates. The policy implementation is actualized via incorporation of ALARA policy considerations into the controlled station procedures.

12.1.2 Design Considerations

This subsection discusses the methods and features by which the policy considerations of Subsection 12.1.1 are applied to ongoing station design.

Quad Cities Station radiation protection design objectives establish a direction for maintaining radiation exposure ALARA. The maintenance of ALARA considerations is accomplished by identifying problems and concerns associated with the plant and equipment, implementing desired modifications, and applying design objectives to effect improvements where appropriate.

The Quad Cities Station radiation protection design objectives utilized in the specification of facility design objectives (Subsection 12.1.2.2) and equipment design objectives (Subsection 12.1.2.3) to incorporate ALARA policy philosophy can be generally stated as:

A. Minimizing the amount of time personnel spend in radiation areas; and

B. Minimizing radiation levels in routinely occupied plant areas and in the vicinity of plant equipment requiring attention.

These radiation protection design objectives are implemented in order to maintain exposures ALARA during normal plant conditions, maintenance and repair activities, calibrations, refueling and waste handling operations, and other events of moderate frequency.

12.1.2.1 Radiation Protection Design Considerations

Quad Cities Station radiation protection design objectives are directed to meet ALARA policy objectives and to ensure compliance with the standards for radiation protection specified in 10 CFR 20. Typical ALARA design considerations include the following:

A. Establish design dose rates for general access areas based upon ComEd experience and 10 CFR 20 requirements;

B. Determine the most severe mode of operation for equipment and piping;

C. Determine the equipment or piping source (see Sections 11.1, 11.2, 11.3, and 11.4 for further discussion of source terms);

D. Determine shielding required to maintain design dose rates (see Section 12.3 for further description of radiation shielding);

E. Determine advantages and disadvantages of equipment location, orientation, and segregation;

F. Use predetermined guidelines and criteria for locating piping and penetrations;

G. Revise design as appropriate to maintain exposures ALARA.

12.1.2.2 Facility Design Considerations

Quad Cities Station radiation protection design goals are translated into facility design objectives consistent with the ALARA policy. Attainment of these objectives typically requires that station design take into consideration direct radiation and airborne radiation.

The design objectives are coupled with operating experience to obtain an improved station design relative to ALARA policy objectives.

12.1.2.2.1 Station Layout

The Quad Cities Station is arranged and designed with the following considerations to meet ALARA policy objectives:

A. A sufficient quantity of access paths (general access areas) are furnished to allow personnel attendance to equipment.

B. The radiation levels in general access areas are maintained ALARA.

C. Sufficient shielding is provided to control the amount of direct radiation present in a general access area.

D. Radiation areas are classified into zones according to expected (maximum) radiation levels.

E. Segregation of radiation zones is employed when possible.

F. Shielding is utilized to accommodate equipment removal and maintenance.

G. The radiation protection design is based upon the design criteria given in Section 12.3.

12.1.2.2.2 Ventilation

The station ventilation systems aid in heat removal and control of airborne radioactive material. Ventilation systems are designed to direct potentially airborne radioactive material away from occupied areas and (except for the reactor building vents) are normally discharged to the 310-foot chimney. Ventilation systems are described in greater detail in Section 9.4. Other heating, ventilation and air conditioning systems have special functions, e.g., containment inerting (Section 6.2), and the standby gas treatment system (Section 6.5). The radiation protection aspects of these systems are discussed in Section 12.3.

12.1.2.2.3 Access Control

Access to radioactive equipment is designed so that properly trained radiation protection personnel can maintain radiation exposure to station workers ALARA during station operation. Access to radiation areas is strictly controlled.

12.1.2.2.4 Control of Radioactive Fluids and Effluents

Radioactive fluids (liquids and gases) are contained and controlled to keep the release of radioactive materials to general access areas and the environment ALARA. This consideration applies to drain liquids, airborne radioactivity, and process liquids and gases (i.e., reactor water, fuel pool water, radwaste water, drywell purge, off-gas, and turbine seal). The number of release paths are minimized in order to simplify control.

The process liquids and gases are stored and/or processed within defined boundaries. Systems which operate at positive or negative gauge pressures have closed boundaries. During normal operation, fluids from such systems escape their boundary only through pressure control equipment and by leakage. Some systems which operate at atmospheric pressure may have openings in their boundary (vents).

The resulting airborne contaminants are directed away from plant high occupancy areas and through particulate filters to the elevated release point. The ventilation systems are discussed in Section 9.4. The resulting liquid contaminants are directed from rooms or areas where the leakage occurs to liquid radwaste storage tanks.

The equipment drain system is connected to the liquid collection points attached to most equipment. The collected liquid is directed to sump pumps which discharge to the liquid radwaste system.

The floor drain system is designed to handle large volumes of liquid. Curbs are provided in component areas as required to prevent radioactive liquid that reaches the floor from contaminating low radiation areas, i.e., operating areas, general access areas, and corridors. Liquid radwaste tanks are located in cubicles/rooms which are provided with sufficient drainage and isolation from other plant areas, thus ensuring that tank failure will not result in an unacceptable radiation release.

12.1.2.3 Equipment Design Considerations

Radiation protection equipment design considerations involve shielding, equipment access, and segregation of radioactive equipment.

These considerations are incorporated into ongoing station equipment design whenever it is reasonable to do so:

A. Locate equipment in accessible parts of cubicles;

B. Keep equipment that operates infrequently in accessible areas, i.e., radwaste pumps;

C. Provide galleries, gratings, and hatches to enhance accessibility to equipment located high above a floor;

D. Provide access for easy removal of equipment requiring frequent changing;

E. Provide localized shielding or space and adequate structure for localized shielding as part of the shielding design;

F. Locate equipment which processes low radioactivity material in separate cubicles from equipment which processes high radioactivity material;

G. Separate high from low radioactivity lines that connect to a single component;

H. Use removable block walls to minimize the radiation exposure in gaining access to highly radioactive components when removal is required; and

I. Provide cranes or lifting lugs to aid in equipment servicing, maintenance, and removal.

12.1.2.4 Equipment Selection

The selection of equipment to handle and process radioactive materials is based upon system requirements and radiation protection requirements such as minimizing leakage or spillage. Materials and coatings are selected for ease of decontamination as well as durability. Some components which may become contaminated are designed with provisions for flushing or cleaning. Reduced occupational radiation exposure is attained by utilizing operating experience, and where practical, providing prudent equipment selections.

12.1.2.5 Equipment Maintenance

In the operation of the station and its equipment, provisions are incorporated to assure that occupational radiation exposure is maintained ALARA. Facility improvements and equipment selection are aimed toward reducing personnel radiation exposure from equipment maintenance. Facility improvements utilize experience that is accumulated from other operating BWR and PWR plants to aid operating personnel in reducing maintenance time when servicing and removing radioactive equipment. This reduced maintenance time supports the ALARA policy objective of reduced occupational radiation exposure.

12.1.2.6 Servicing of Equipment and Instruments

The servicing of equipment that handles, or is associated with radioactive fluids, is considered in the Quad Cities Station ongoing plant design. The types of servicing considered include maintenance, sampling, inservice inspection, equipment decontamination, instrument calibration, radiation surveys, and manual operation of equipment.

12.1.3 Operational Considerations

This subsection discusses the methods and features by which the ALARA policy considerations of Subsection 12.1.1 are applied to station operational activities.

To assure that individual dose equivalents are kept within the limits of 10 CFR 20 and that occupational radiation exposures are maintained ALARA during the operation of the Quad Cities Station, specific activities are implemented and governed by station procedures which incorporate operational ALARA considerations.

12.1.3.1 Operational Procedure Considerations

The ALARA procedures incorporate ALARA policy considerations via the following:

A. Detailed procedures are prepared and approved for radiation protection during reactor plant operations. These procedures are a part of the station Health Physics Program and are reviewed to ensure incorporation of current ALARA policy.

B. All incoming and outgoing shipments which may contain radioactive material are surveyed to assure compliance with 10 CFR 20, 10 CFR 70, and 10 CFR 71.

C. Any radiological incidents are thoroughly investigated and documented in order to minimize the potential for recurrence. Reports are made to the NRC in accordance with 10 CFR 20.

D. Periodic radiation, contamination, and airborne activity surveys are performed and recorded to document radiological conditions. Records of the surveys are maintained in accordance with 10 CFR 20.

E. Records of occupational radiation exposure are maintained and reports are made to the NRC as required by 10 CFR 20, and to individuals as required by 10 CFR 19.

F. Radiation and high radiation areas are determined, segregated, and identified in accordance with 10 CFR 20. Airborne activity is determined and posted in accordance with 10 CFR 20. Positive control is exercised for each individual entry into high radiation areas. Posted radiological signs and labels meet the requirements of 49 CFR 173 and 10 CFR 20.

G. Personnel are provided with personal radiation monitoring equipment in accordance with 10 CFR 20 to measure their external radiation exposure (see Section 12.5).

H. Process radiation, area radiation, portable radiation, and airborne activity monitoring instrumentation is periodically calibrated as required (see Section 11.5).

I. Access control points are established to separate potentially contaminated areas from uncontaminated areas of the station.

J. Protective equipment and clothing (i.e., respirators, masks, etc.) are used to help prevent personnel contamination and the spread of contamination from one area to another.

K. All tools and equipment used in controlled areas are surveyed for contamination before removal from a controlled area. Tools and equipment removed from a contaminated area are normally packaged to prevent the spread of contamination to other areas.

L. Radiation work permits or equivalent document are issued for certain jobs in accordance with the station radiation protection procedures. Jobs involving significant radiation exposure to personnel are preplanned, evaluated, and approved per applicable station procedures and ALARA considerations (ALARA review). Where conditions dictate, a mockup is used for practice to reduce exposure time on the actual job. The use of special tools and temporary shielding to reduce personnel exposure is evaluated on a job-by-job basis. Post-job debriefing is conducted to enhance ALARA objectives for future tasks.

M. A bioassay program is included as part of the Health Physics Program. This program includes whole body counting and/or a urinalysis sampling program to measure the uptake of radioactive material (see Section 12.5).

N. An environmental monitoring program is in operation to measure any effect of the station on the surrounding environment (see Section 11.5).

O. All significant radioactive effluent pathways from the station are monitored and records maintained (see Section 11.2, 11.3, and 11.5).

P. There are sufficient experienced personnel to direct and train other personnel; training is accomplished via on-the-job experience, and by completing a required employee training course (see Section 13.2).

12.1.3.2 Operating Experience

The Radiation Work Permit or equivalent document process described in Section 12.1.3.1 provides a mechanism for collection and evaluation of data relating to personnel exposure. Information sorted by systems and/or components and job function assists in evaluating design or procedure changes intended to minimize future radiation exposures.

12.1.3.3 Exposure Reduction

Exposure reduction techniques employed at Quad Cities Station are described in Subsection 12.5.3. Procedures assure that applicable station 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.

12.2 RADIATION SOURCES

The initial licensing of Quad Cities Station predated issuance of Regulatory Guide 1.70, Revision 3. Therefore, the identification of radiation sources (beyond those in radwaste systems) was not developed as part of the PSAR or FSAR. The purpose of identifying radiation sources is to permit evaluation of radiation protection design features described in Section 12.3 in order to provide reasonable assurance that radiation exposure of plant personnel will be within allowable limits. Radiation surveys within the plant are made and evaluated as part of the ongoing ALARA program at Quad Cities.

Radiation sources generated in the reactor core and transported by the reactor coolant system are described in Section 11.1. Radiation sources from components of the radioactive waste management systems are described in Sections 11.2, 11.3, and 11.4.

Radioactivity is also present in the fuel pool cooling and cleanup systems described in Section 9.1.3, the reactor water cleanup system described in Section 5.4.8, and the condensate cleanup system described in Section 10.4.6.

12.3 RADIATION PROTECTION DESIGN FEATURES

This section describes plant design features used to ensure that occupational radiation exposures resulting from the radiation sources within the plant meet the As Low As Reasonably Achievable (ALARA) criteria described in Section 12.1. These features include shielding, ventilation systems, and radiation monitoring instruments. Supplemental procedures to control access to radiation areas and to control personnel exposure serve to limit radiation exposure to acceptable levels. As a result of recommendations from the NRC's Three Mile Island Unit 2 (TMI-2) Lessons Learned Task Force, Reference 1 documented a design review of plant shielding for areas requiring post-accident accessibility in response to Item 2.1.6.b of NUREG-0578 (TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations). [12.3-1]

12.3.1 Facility Design Features

Radiation sources within Quad Cities Station differ appreciably with respect to location, intensity, and characteristics. The magnitude of the dose rates that result from these sources is dependent on many factors including the facility and equipment design, layout, mode and length of operation, and radiation source strength and characteristics.

Additional information on the design features of Quad Cities Station that protect personnel from radiation exposure and minimize radiation damage to plant equipment can be found in the following:

A. Section 12.1.2 explains how the station layout is used to minimize radiation exposure;

B. Section 12.1 addresses control of access to radiation areas;

C. Section 11.5 addresses process and effluent radiation monitoring;

D. Section 11.1 through 11.4 describe radioactive waste processing;

E. Section 12.5 describes the radiochemical laboratory facilities; and

F. Section 12.1 addresses equipment selection to minimize exposure during operation and maintenance.

12.3.2 Shielding

Normal operating conditions determine the major portion of the shielding requirements. Two notable exceptions to this are the control room where shielding is determined by the radiation levels produced during a loss-of-coolant accident, and the shutdown cooling system where shielding is determined by shutdown conditions.

12.3.2.1 Design Objectives

The basis for the design of the radiation shielding is in compliance with the requirements of 10 CFR 20 which describes the limits of occupational radiation exposure. Compliance with these regulations is achieved in part through shield design which is based upon occupancy requirements in various areas. A list of generalized occupancy requirements and attendant radiation dose-rates is presented in Table 12.3-1. The duration of expected operating personnel occupancy in various areas of each unit was obtained from experience during operation of Dresden Unit 1 and other similar nuclear-powered units. [12.3-2]

Radiation areas with dose rates in excess of those listed in Table 12.3-1 are entered on a controlled time basis. Radiation areas in excess of 100 mrem/hr whole body dose are equipped with warning signs in compliance with 10 CFR 20.

The primary objective of the radiation shielding is to protect personnel against radiation emanating from the reactor, the turbine, and their auxiliary systems. [12.3-3]

The secondary objective of the radiation shielding is to limit radiation damage to operating equipment. Specific fabrication materials are given individual consideration. Of principal concern are organic materials used in the equipment; e.g., insulation, rubber tank linings, and gaskets.

In general, it is sufficient to limit the radiation exposure to 10^6 rads for materials of concern over the expected service life of the equipment or of individual parts. For certain materials the exposure must be less, or can be greater, without significantly affecting serviceability; e.g., a limit of 10^4 rads for teflon and about 10^8 rads for polyurethane.

The shielding materials required to meet the preceding objectives are primarily concrete, water, and steel. High density concrete, lead, and neutron-absorbing material are used as alternates in special applications. The design dose rate in most areas outside of the drywell in the reactor building is one mrem/hr. Consequently, the drywell and its contents are shielded so that most areas outside the drywell and outside the pressure suppression chamber are accessible. Actual dose rate increases resulting from crud buildup are evaluated as part of the station ALARA program. [12.3-4]

12.3.2.1.1 Control Room

The dose rate in the control room is limited to 0.5 rem in any 8 hour period following a design basis accident in either Unit 1 or Unit 2. Including shielding by structures other than that associated with the reactor building, the total shielding provided for the control room is sufficient to limit the transmission of radiation from the reactor building during normal operation of either Unit 1 or Unit 2 to less than 0.1% of the above limit. A discussion of control room habitability is contained in Section 6.4. [12.3-5]

12.3.2.1.2 Reactor Building

Within the reactor building, but outside the primary containment, some of the regions where the radiation level may exceed one mrem/hr are:

A. Fuel storage pool;

B. Reactor water cleanup system;

C. Residual heat removal (RHR) system;

D. The operating floor directly over the drywell shielding plugs above the reactor vessel (estimate about 6 mrem/hr);

E. The region housing the suppression chamber portion of the pressure suppression system;

F. Miscellaneous equipment (e.g., fuel pool heat exchanger, cleanup heat exchangers, etc.);

G. High pressure coolant injection system;

H. Reactor building crane cab;

I. Reactor core isolation cooling system; and

J. Core Spray System. [12.3-6]

12.3.2.1.3 Turbine Building

Within the turbine building, where the major radiation source is N-16, shielding is provided for the following areas: [12.3-7]

A. Main condenser - hotwell;

B. Feedwater heaters;

C. Air ejector and the gland seal exhauster;

D. Condensate demineralizer tanks;

E. Steam piping - moisture separators; and

F. Steam turbine.

Most of the turbine operating floor is accessible and the turbine building crane can be operated remotely as required.

Table 12.3-2 provides a listing of design radiation levels outside shielded areas of the turbine building. When the hydrogen injection system is operated, the resulting increase in N-16 activity can cause these levels to increase. Any new high radiation areas created as a result of operating the hydrogen injection system are controlled in accordance with existing plant procedures implementing the ALARA Program. The hydrogen injection system is part of the hydrogen water chemistry (HWC) system and is described in Section 5.4.3. [12.3-8]

12.3.2.1.4 Off-Gas System

The shielding for the off-gas air ejector, recombiner room, and off gas condenser is based upon N-16 and the noble gases as principal radiation sources. Hydrogen injection has increased the original N-16 levels. The additional dose rates resulting from hydrogen injection are controlled as part of the ALARA program. The noble gas component of the combined radiation source is based upon an average annual release rate of 0.45Ci/s. Shielding for the off-gas filters is based upon the accumulation of particulate radionuclides that are produced by the decay of the noble gases during a 30-minute holdup time. [12.3-9]

12.3.2.1.5 Radwaste Building

The radwaste building shielding is designed to limit the dose rate in the building control room to approximately one mrem/hr. Regions where pumps and valves are located have higher radiation levels. The solid waste preparation area is shielded and provides for remote operation of equipment. Ample shielding has been provided in the radwaste system design to maintain personnel exposure well below established limits. Sumps, tanks, and other high activity vessels are housed in limited-access areas or concrete cells. Piping which would contribute significant radiation dose rates is shielded or kept out of normally frequented areas. [12.3-10]

12.3.2.2 Description

This subsection describes the design of the radiation shielding for the reactor vessel, the drywell, the RHR system components, the control room, the turbine and main steam system, and the condensate demineralizers.

12.3.2.2.1 Reactor Shield Wall

Within the drywell a shield wall of concrete is provided between the reactor vessel and the drywell walls to limit gamma heating in the drywell concrete, provide shielding for access in the drywell during shutdown, and limit activation of drywell materials by neutrons from the core. [12.3-11]

The reactor shield wall consists of a 24-foot diameter circular cylinder attached to the vessel support pedestal which extends upward approximately 45 feet. The reactor shield wall is 27 inches thick. The steel plates are increased in thickness for extra shielding opposite the elevation of the core. This shell is filled with concrete to provide shielding capability. See Section 3.6.2.3 for additional information on the construction of the shield wall.

The pipes leaving the vessel at elevations below the top of the reactor shield penetrate the shield. The penetrations in the vicinity of the core use removable shield plugs which fit around each pipe penetrating the shield wall. The plugs allow access to the pipe welds for inservice inspections. These removable plugs are covered by two 9-inch-thick steel plates attached to the shield wall by two 1 1/2-inch diameter vertical hinges, with both halves locked in place by a 1-inch diameter locking pin. Recirculation piping penetrates this annular shield wall around the reactor vessel. These penetrations also have removable shielding sections at the annular shield so that access is available for inspection of the connections between the recirculation piping and the reactor vessel. The region that houses the control rod drives is shielded against radiation from the recirculation piping. This piping constitutes a radiation source during shutdown as a result of deposited activation products. [12.3-12]

During reactor operation, the reactor shield wall serves as a thermal shield to protect the containment shield wall outside the drywell from thermal damage. During shutdown, this shield also serves to protect personnel in the drywell from gamma radiation from the core and the reactor vessel. The shield wall is cooled on both surfaces by circulating air from the drywell cooling system. [12.3-13]

12.3.2.2.2 Containment Shield Wall

The primary containment vessel for each reactor is completely enclosed in a reinforced concrete structure (an integral part of the reactor building) having a variable thickness of from 4 — 6 feet (see P&IDs M-3 and M-9). In addition to serving as the basic shielding for the reactor system, this concrete structure also provides a major mechanical barrier for the protection of the containment vessel and the reactor system against potential missiles generated external to the primary containment. It also serves as a backup for the drywell wall in resisting jet forces. Additional information on missile protection is contained in Section 3.5. Jet forces and other effects of pipe breaks are described in Section 3.6.

The main support for the containment shield wall (which is structurally designed to handle the loads of floors, equipment, and the higher elevations of the shield itself) is the reactor building foundation which is set on bedrock.

Penetrations through the containment shield wall are designed so that they are not aligned directly with the core or major items of equipment in the drywell. In addition, they are either terminated in shielded cubicles or are shielded with steel flanges to reduce radiation levels in accessible areas.

12.3.2.2.3 Residual Heat Removal System

The heat exchangers and pumps of the RHR system are located in separate, shielded cubicles. Gamma radiation from the equipment in these cubicles is reduced to a designed dose-rate of about 2 mrem/hr or less at the time the system was initially placed in operation.

12.3.2.2.4 Control Room

The shielding for the control room consists of poured-in-place reinforced concrete. The floor and ceiling slabs are 6 inch thick ordinary concrete whereas the walls range in thickness from 18 inches of ordinary concrete to 27 inches of magnetite concrete.

Shadow shielding offered by other structures is used to reduce shielding thicknesses and to locate penetrations. The control room shielding is described more fully in Section 6.4.2.5.

12.3.2.2.5 Turbine Steam Handling Equipment

The steam handling equipment associated with the turbine-generator unit is shielded with concrete to reduce the radiation levels in accessible areas, as shown in Table 12.3-2.

12.3.2.2.6 Condensate Demineralizer System

For each reactor, the demineralizer vessels are located in a shielded enclosure. The radiation penetrating the concrete shielding of this enclosure was initially less than 1 mr/hr exclusive of radiation shine (streaming). Recycle pumps, valves, some piping,and instrumentation associated with the demineralizer vessels are located in the operating aisle. Piping carrying condensate or demineralized condensate does not require shielding.

12.3.2.3 Performance Analysis

Visual inspections of the shielding were conducted during the construction phase to locate major defects. Upon initiation of reactor operation, radiation surveys were performed at various power levels. The purpose of these surveys was to assure that: [12.3-14]

A. There were no defects or inadequacies in the shielding, equipment or operating procedures that could result in unacceptable levels of radiation exposure to the public, the operators, or the equipment.

B. Radiation areas are posted. In addition to posting, high radiation areas are controlled by 10 CFR 20 requirements.

These surveys consisted of both gamma and neutron monitoring with appropriate portable instrumentation. Gamma surveys were performed on all shielding, while neutron surveys were conducted around the containment shield wall and associated penetrations.

The radiation protection department routinely conducts surveys of dose rates throughout the plant during the course of plant operation, and additional shielding is added when and where the need arises. [12.3-15]

12.3.3 Ventilation

Quad Cities Station has separate ventilation systems for the control room, reactor building, turbine building, and radwaste building. Each of these systems provides personnel protection from airborne radioactive contaminants by filtering inlet air and routing filtered air to areas of progressively greater contamination potential. Pressure differentials are maintained to prevent backflow of potentially contaminated air. Additionally, the control room ventilation system is capable of isolation from the outside air during a radioactivity release. The plant ventilation systems are addressed in Section 9.4. Control room habitability is addressed in Section 6.4.

12.3.4 Area Radiation and Airborne Radioactivity Monitoring Instrumentation

The area radiation monitoring system continuously monitors and records the radiation level in accessible work areas of the plant. Monitors are provided in four different sensitivity ranges chosen to match the expected radiation level of the area in which the monitor is installed. If the radiation level in any area exceeds that determined by site health-physics requirements, an alarm is annunciated to alert personnel to the hazard potential. A description of the use of the area radiation monitors to detect radioactive water leakage is presented in Section 5.2.6.2. The high radiation sample system is described in Section 9.3.2. [12.3-16]

The area radiation monitors (ARM) constitute a fixed in-place network encompassing 70 stations, reporting alarm conditions to the control room for Unit 1 and 2 ARMs and, in areas where high radiation is most likely to occur, also actuating a local alarm. The Unit 1/2 ARMs provide local indication and alarm conditions only.

Areas (stations) monitored by the area radiation monitoring system are listed in Tables 12.3-3, 12.3-4 and 12.3-5 which also identify expected background radiation and those stations with local auxiliary units (local alarms). Typical monitoring channels with and without local auxiliary units are shown in Figure 12.3-1. Each channel consists of a sensor, a converter (detector) unit with a corresponding indicator and trip unit. Each Unit has a common multipoint recorder in the main control room that is shared by the channels. The channels also share common power supplies, each of which can supply up to 10 channels. The power supplies are mounted on the same control room panel [901(2)-11] as the indicator and trip units. The only controls used during operation of the area radiation monitoring system are reset switches on the indicator and trip units. Actuation of an alarm requires manual resetting of the alarm circuit in the corresponding indicator and trip unit. [12.3-18]

The sensor in each channel is a Geiger-Mueller (G-M) tube, polarized by high voltage from the power supply. Pulses produced in the tube by radiation are converted to dc output signals by the converter, and applied to the indicator and trip unit to drive a back panel meter and the multipoint recorder. Trip circuits in the indicator and trip unit actuate control room alarms which denote high or low radiation. Downscale trips share a common malfunction annunciator. Station 31 in Unit 1 and Station 25 in Unit 2 have individual downscale alarms in panel 901(2)-54. Upscale trips are applied to one of six high radiation annunciators.

During exposure to higher-than-rated exposure levels, a G-M tube will operate with increasing output (to at least $10^{\wedge 4 \wedge}$ R/hr). The G-M tube circuitry is designed utilizing both the pulse and dc G-M modes with the outputs summed into the indicator and trip units. Additionally, a special circuit has been included to prevent meter fall-off at exposure levels considerably in excess of full scale. The circuit output continues to increase until the amplifier saturates, and then remains at that level for further increases in flux. Under extended periods of operation at high levels, the detector could be subject to failure by deterioration of the ionization gas or by heat induced mechanical failure. [12.3-19]

In channels provided with local auxiliary units, these units are located near the sensor and converter (detector). High radiation trips in these channels result in the sounding of a local audio alarm (Klaxon horn) as well as the control room annunciation. [12.3-20]

Area radiation monitor detectors are distributed (see Tables 12.3-3, 12.3-4 and 12.3-5) in such a way that radiation detection coverage is provided in any areas where personnel may be required to work for extended periods. The ranges and sensitivities of the equipment are sufficient to detect increases in radiation level and annunciate an alarm above a preselected level. All monitors annunciate an alarm on failure.

The ARMs in the vicinity of the spent fuel pool are part of the reactor building ventilation radiation monitoring subsystem described in Section 11.5.2.4 and have the capability of shutting down the reactor building HVAC system and starting the standby gas treatment system (SBGTS) in the event of a refueling accident. The refueling accident is analyzed in Section 15.7.2.4.

Eight ARMs also serve for satisfying the requirements of the Station's Exemption to 10 CFR 70.24, "Criticality accident requirements." Four of these ARMs are part of the ARM System, and are Unit 1 ARM Stations 1, 3, & 4, and Unit 2 Station 1, which are described in more detail in UFSAR Table 12.3-3 or 12.3-4. The other four ARMs are the four Refuel Floor Radiation Monitors shown on UFSAR Figure 11.5-3, which are part of the Reactor Building Ventilation Radiation Monitoring Subsystem, and are described in more detail in UFSAR Section 11.5.2.4. These eight ARMs are provided in fuel storage and handling areas to detect excessive radiation levels and to either initiate, or allow initiation of, appropriate safety actions. The Exemption from 10 CFR 70.24 is described in more detail in UFSAR Section 9.1.1.4.

12.3.5 Reactor Building Crane Monitoring Subsystem

The purpose of this subsystem is to prevent the crane operator from causing accidental exposure to radioactive material by raising irradiated material above the level of the water and exposing the operator and other personnel to radiation. The reactor building crane is described in Section 9.1. [12.3-21]

As shown in Figure 12.3-2, a sensor and converter (detector) unit is mounted on the crane in a position to monitor the crane work area. A four-decade indicator and trip unit mounted in the crane cab displays the radiation level signaled by the sensor and converter unit. The indicator and trip unit provides trip functions for upscale and downscale radiation level changes. The trip points may be preset to trip at any desired level. The trips operate inhibit/permissive relays in the crane control circuits to prevent the crane hook from being raised in the event of a high radiation (upscale) or malfunction (downscale) signal from the indicator and trip unit. Signal power is provided by a cab-mounted power supply and line cord, which draws 120-Vac from the crane power ac circuit breaker.

A keylock switch is installed in the crane cab to bypass the ARM trip unit. This bypass is used when moving highly radioactive material with the crane. Bypassing the trip unit will allow the crane hoist to operate in a high radiation field while still allowing the operator to read the ambient radiation level from the ARM indicator. [12.3-22]

12.3.6 References

1. Post-Accident Radiation Levels Report (A Review of the Quad Cities Station in Response to Item 2.1.6.b of NUREG-0578).

Table 12.3-1

RADIATION AREAS OCCUPANCY REQUIREMENTS AND DESIGN RADIATION DOSE RATES (Note 1)

Degree of Access Required	Design Radiation Dose Rate, at Shield Wall -- mrem/hr
1. Continuous Occupancy	
a. Outside controlled areas	0.5
b. Inside controlled areas	1
2. Limited Occupancy	
a. Occupancy up to 10 hours/week	6
b. Occupancy up to 5 hours/week	12

1. Plant radiation levels are routinely surveyed to determine boundaries of controlled areas. Due to plant operations, dose rates inside and outside controlled areas may vary from those listed above. These areas are controlled by 10 CFR 20 requirements.

Table 12.3-2

SHIELDED TURBINE STEAM HANDLING EQUIPMENT AND DESIGN RADIATION DOSE RATES

Equipment	Design Radiation Level Outside Shield	Radiation Level Outside Shield with Hydrogen Injection System Operating (Note 1 and 2)	Radiation Level Outside Shield with Noble Metal Chemical Addition and Hydrogen Injection System Operating (Note 4)
Turbine-Generator, Stop-Intercept Valves, Piping	5 mrem/hr in regions beyond the turbine shield wall at the operating floor level at elevation 639 ft.	80 mrem/hr (Note 3)	0.2-1 mrem/hr in regions beyond the turbine shield wall at the operating floor level at elevation 639 ft.
Moisture Separators and Piping	1 mrem/hr through walls	0.6 mrem/hr	0.1 mrem/hr
Stop Valves and Piping	1 mrem/hr through building operating floor	1.8 mrem/hr	No data available
Air Ejectors, Steam Packing Exhausters, and Piping	5 mrem/hr through walls	0.2 mrem/hr	0.2 mrem/hr
Low Pressure Feedwater Heaters	1 mrem/hr through walls	1.0 mrem/hr	0.1 mrem/hr

1. Surveys have measured levels similar to those listed, primarily due to hydrogen injection system increase of N-16 levels above the original design dose rates. Access to radiation areas created in this manner is controlled by ALARA considerations.
2. Dose rates obtained from “Hydrogen Injection Test, Quad Cities Nuclear Power Station, Radiation Protection Report, September 1990.”
3. Survey Points taken at gates in the turbine shield wall that provide access to the turbine-generator. These do not impact safety due to the rapid decline in dose rate with respect to distance from the gates.
4. Dose rates taken from surveys on Unit 1 after noble metal chemical addition and hydrogen injection system operating at 11 scfm.

Table 12.3-3

QUAD CITIES UNIT 1
AREA RADIATION MONITORING SYSTEM
SENSOR LOCATION AND RANGE

Station	Floor Elevation	Column Row	Area	Range (mR/hr)	Expected Background (mR/hr)	Local Auxiliary Unit and Alarm
1	690 ft 6 in.	H-15	Reactor Building Refueling Floor - Low Range	0.01—100	1	X
2	690 ft 6 in.	H-15	Reactor Building Refueling Floor - High Range	10—10^6^	1	
3	690 ft 6 in.	N-14	Reactor Building Refueling Floor - Equipment Hatch	0.01—100	1	
4	666 ft 6 in.	M-14	New Fuel Storage Vault Access	0.1—1,000	1 (10 in vault)	
5	666 ft 6 in.	L-18	Contaminated Equipment Storage	0.01—100	6	
6	647 ft 6 in.	M-15	Fuel Pool Pump and Heat Exchanger Area	0.01—10,000	1	
7	647 ft 6 in.	M-18	CRD Storage and Repair Room	0.1—1,000	6	
8	647 ft 6 in.	J-17	Cleanup Instrument Rack Area	0.01—10,000	1	
9	623 ft 0 in.	J-18	Cleanup Pump Area	0.01—10,000	1	
10	623 ft 0 in.	M-13	Mezzanine Floor Access	0.01—100	1	

Table 12.3-3

QUAD CITIES UNIT 1
AREA RADIATION MONITORING SYSTEM
SENSOR LOCATION AND RANGE

Station	Floor Elevation	Column Row	Area	Range (mR/hr)	Expected Background (mR/hr)	Local Auxiliary Unit and Alarm
11	595 ft 0 in.	K-19	CRD Hydraulic Control Units - South	0.01—10,000	1	
12	595 ft 0 in.	K-13	CRD Hydraulic Control Units - North	0.01—10,000	1	
13	595 ft 0 in.	H-13	TIP Drive Machinery	0.01—10,000	1	X
14	595 ft 0 in.	H-15	TIP Cubicle	1—10,000	1000 (wire withdrawn)	X
15	554 ft 0 in.	N-17	Suppression Chamber Access	1—10,000	15 (200 at contact)	
16	554 ft 0 in.	G-15	HPCI Cubicle	1—10,000	30 (operating) 1 (normal)	
17	554 ft 0 in.	G-14	RCIC Cubicle	1—10,000	6 (operating) 1 (normal)	

Table 12.3-3

QUAD CITIES UNIT 1
AREA RADIATION MONITORING SYSTEM
SENSOR LOCATION AND RANGE

Station	Floor Elevation	Column Row	Area	Range (mR/hr)	Expected Background (mR/hr)	Local Auxiliary Unit and Alarm
18	639 ft 0 in.	E-25	Turbine Building Operating Floor Access - South	0.01—100	1	
19	639 ft 0 in.	D-14	Turbine Building Operating Floor Elevator Area	0.01—100	1	
20	626 ft 0 in.	C-21	Air Ejector Access - 1B	0.01—100	1	X
21	626 ft 0 in.	C-18	Air Ejector Access - 1A	0.01—100	1	X
22	623 ft 0 in.	G-25	Control Room	0.01—100	0.5	
23	595 ft 0 in.	C-19	Feedwater Heater Access	0.1—1,000	1	
24	595 ft 0 in.	G-21	Feedwater Pump	0.01v100	1	
25	572 ft 6 in.	D-18	CRD Feed Pump Access	0.1—1,000	1	
26	547 ft 0 in.	E-19	Condensate/Booster Pump	0.01—100	10	
27	595 ft 0 in.	C-14	Radwaste Control Room	0.01—100	0.5	X

Table 12.3-3

QUAD CITIES UNIT 1
AREA RADIATION MONITORING SYSTEM
SENSOR LOCATION AND RANGE

Station	Floor Elevation	Column Row	Area	Range (mR/hr)	Expected Background (mR/hr)	Local Auxiliary Unit and Alarm
28	595 ft 0 in.	B-13	Radwaste Operating Area - South Wall	0.01—100	1	X
29	571 ft 0 in.	B-12	Radwaste Pump Room Access	0.01—100	6	X
30	622 ft 0 in.	B-12	Radwaste Centrifuge Access	0.01—100	1	X
31	561 ft 0 in.	-	Filter Building Charcoal Bed Vault	$1—10^{6}$	1000	X
32	648 ft 6 in.	-	Recombiner Area Level 1	0.01—100	5	
33	668 ft 0 in.	-	Recombiner Area Level 2	0.01—100	5	
34						
35	591 ft 0 in.	E. Wall	Max. Recycle Building	1—10,000	10	X
36	596 ft 11 in.	SW Corner	Radwaste Tank Room	0.1—1,000	2	X

NOTE: Unit 1 SBGTS is monitored by Unit 2 ARM Station 16.

Table 12.3-4

QUAD CITIES UNIT 2
AREA RADIATION MONITORING SYSTEM
SENSOR LOCATION AND RANGE

Station	Floor Elevation	Column Row	Area	Range (mR/hr)	Expected Background (mR/hr)	Local Auxiliary Unit and Alarm
1	690 ft 6 in.	H-11	Reactor Building Refueling Floor - Low Range	0.01—100	1	X
2	690 ft 6 in.	H-11	Reactor Building Refueling Floor - High Range	10—10^6^	1	
3	647 ft 6 in.	M-11	Fuel Pool Pump and Heat Exchanger Area	0.01—10,000	1	
4	647 ft 6 in.	J-9	Cleanup Instrument Rack Area	0.01—10,000	1	
5	623 ft 0 in.	J-8	Cleanup Pump Area	0.01—10,000	1	
6	595 ft 0 in.	K-13	CRD Hydraulic Control Units - South	0.01—10,000	1	
7	595 ft 0 in.	K-7	CRD Hydraulic Control Units - North	0.01—10,000	1	
8	595 ft 0 in.	H-13	TIP Drive Machinery	0.01—10,000	1	X
9	595 ft 0 in.	H-11	TIP Cubicle	1—10,000	1000 (wire withdrawn)	X
10	554 ft 0 in.	N-9	Suppression Chamber Access	1—10,000	15 (200 at contact)	

Table 12.3-4

QUAD CITIES UNIT 2
AREA RADIATION MONITORING SYSTEM
SENSOR LOCATION AND RANGE

11	554 ft 0 in.	G-11	HPCI Cubicle	1—10,000	20 (operating) 2 (normal)	
12	554 ft 0 in.	G-11	RCIC Cubicle	1—10,000	8 (operating) 1 (normal)	
13	639 ft 0 in.	F-1	Turbine Building Operating Floor	0.01—100	1	
14	626 ft 6 in.	C-5	Air Ejector Access	0.01—100	1	X
15	626 ft 6 in.	C-8	Air Ejector Access	0.01—100	1	X
16	666 ft 6 in.	N-17	Standby Gas Treatment - Unit 1	0.01—10,000	6 (operating) 1 (normal)	X
17	595 ft 0 in.	C-7	Feedwater Heater Area	0.1—1000	1	
18	595 ft 0 in.	G-5	Feedwater Pump Area	0.01—100	1	
19	595 ft 0 in.	D-13	Condensate Demineralizer Control Panel	0.01—100	1	X

Table 12.3-4

QUAD CITIES UNIT 2
AREA RADIATION MONITORING SYSTEM
SENSOR LOCATION AND RANGE

20	595 ft 0 in.	G-11	Safe Shutdown Pump Area	0.1—1000	1	
21	572 ft 6 in.	D-8	CRD Feedwater Pump Access Area	0.1—1000	1	
22	547 ft 0 in.	E-7	Condensate/Booster Pump Area	0.01—100	10	
23	666 ft 6 in.	N-9	Standby Gas Treatment - Unit 2	0.01—10,000	6 (operating) 1 (normal)	X (No local alarm.)
24		-				
25	561 ft 0 in.	-	Filter Building Charcoal Bed Vault	1—10^6	2000	X
26	648 ft 6 in.	-	Recombiner Area Level 1	0.01—100	5	
27	668 ft 0 in.	-	Recombiner Area Level 2	0.01—100	5	
28	561ft 0 in.	-	Off-Gas Filter Building Level 1	0.01—100	5	X
29	574 ft 6 in.	-	Off-Gas Filter Building Level 2	0.01—100	1	X
30	594ft 6 in.	-	Off-Gas Filter Building Level 3	0.01—100	1	X

Table 12.3-5

QUAD CITIES UNIT 1/2
AREA RADIATION MONITORING SYSTEM
SENSOR LOCATION AND RANGE

Station	Floor Elevation	Column-Row	Detector Location	Range (MR/HR)	Expected Background (mR/hr)	Local Unit Auxilliary and Alarm
1	690 ft 6 in		Reactor Building Crane	0.1—1,000	2	X
2	605 ft 0 in		Radwaste Bldg. Catwalk Shield - East Wall	1—10,000	2	X
3	595 ft 0 in		Radwaste Bldg. North Truckbay - North Wall	0.1—1,000	2	X
4						
5			Radwaste Bldg. Mixing Tank	10—100,000	Varies	
6			Radwaste Bldg. Mixing Tank Room	10—100,000	Varies	
7			Radwaste Bldg. Valve Room on Decant Line	1—10,000	Varies	

12.4 DOSE ASSESSMENT

Dose assessment is a continuing program for the Quad Cities Station as a part of the ALARA program. The station collects and evaluates radiation dose data in accordance with the ALARA program. Dose assessment information was not developed as a part of the FSAR and its amendments during initial licensing. Design radiation dose rates for Quad Cities Station are presented in Table 12.3-1. [12.4-1]

12.5 HEALTH PHYSICS PROGRAM

12.5.1 Organization

The station organization provides the Radiation Protection Technical Supervisor direct access to the Radiation Protection Manager and Plant Manager to assure uniform support of the Health Physics Program and ALARA policy. This organization allows the Radiation Protection Manager and Station Manager direct involvement in the review and approval of specific ALARA goals and objectives as well as review of data and dissemination of information related to ALARA policy implementation. [12.5-1]

12.5.2 Equipment, Instrumentation, and Facilities

Refer to Section 12.3 for a discussion of facility design features to ensure radiation exposures are maintained as low as reasonably achievable (ALARA).

12.5.2.1 Monitoring

Contamination monitors are provided at the exits from potentially contaminated areas. A portal monitor is located in the security building, where each person leaving the plant is required to pass and check through this monitor when operational.

12.5.2.2 Laboratories

The following instrument list is intended to be typical of in-service instrumentation:
For ALPHA, monitor type - gross activity with either an ionization or scintillation detector
For BETA, monitor type - gross activity with either an ionization or scintillation detector
For GAMMA, monitor type - specific activity with an Hp Ge ionization detector
For TRITIUM, monitor type - specific activity with a scintillation detector [12.5-2]

12.5.2.3 Health Physics and Laboratory Radiation Measuring Instruments

Battery powered portable radiation survey instrumentation is provided for use by qualified personnel. Select station personnel are acquainted with and qualified to operate this instrumentation. [12.5-3]

12.5.2.3.1 Design Basis

Radiation survey instruments are available for the measurement of alpha, beta, gamma, and neutron radiation expected in normal operation and emergencies, as needed. Appropriate instruments and auxiliary equipment are available to detect and measure radioactive contamination on surfaces, in air, and in liquids. [12.5-4]

12.5.2.3.2 Description

Contamination monitors are provided at exits from potentially contaminated areas. Personnel dosimeters are provided to and worn by persons in these areas as required by 10 CFR 20 regulations. Laboratory radiation-measuring instruments are provided for alpha, beta, and gamma radiation, and for gaseous, liquid, and solid samples. Secondary calibration sources and check-test sources for the various instruments are provided.

12.5.3 Radiation Protection Program

12.5.3.1 General

Radiation Protection Procedures are designed to ensure protection of personnel against exposure to radiation and radioactive materials in a manner consistent with applicable regulations. Procedures for personnel radiation protection are consistent with the requirements of 10 CFR 20 and are approved, maintained, and adhered to for all operations involving personnel radiation exposures. It is the policy of Exelon Generation Company to maintain personnel radiation exposure within the regulations, and further reduce such exposure ALARA. Therefore, personnel are instructed to minimize exposure consistent with discharging their duties. Each individual is responsible for observing rules adopted for his or her safety and that of others. [12.5-5]

The R.P.M. evaluates the radiological condition of plant operations and establishes the procedures to be followed by all personnel. This ensures compliance with all applicable regulations and maintenance of the required radiation protection records.

Training of operators, maintenance personnel, and technical personnel in radiation protection principles and procedures takes place as determined using processes derived from the Systematic Approach to Training. New employees, contractors and other supporting personnel are given orientation training at the beginning of their work assignments.

12.5.3.2 Personnel Monitoring

The official and permanent records of accumulated external radiation exposure received by individuals required to be monitored by 10 CFR 20 are obtained from the interpretation of the dosimeter of legal record (DLR) and/or direct reading dosimeters.

12.5.3.3 Dosimeters

Radiation monitoring devices are issued to all personnel as required by 10 CFR 20. Dosimeter records furnish the exposure data for the administrative control of radiation exposure. [12.5-6]

Each individual is instructed in the necessity of checking the direct reading dosimeter at frequent intervals while in radiation areas.

12.5.3.4 Monitoring of Visitors

All visitors to the Quad Cities Station who enter a radiation area are monitored by a direct reading dosimeter and/or a DLR, or are provided with an escort having such monitoring devices. Any visitor who enters a high radiation area is issued a DLR and/or a direct reading dosimeter.

12.5.3.5 Bioassay and Medical Examination Program

Exelon Generation Company provides whole-body radiation counting service for all regularly assigned personnel, contractors, and visitors at Quad Cities Station. [12.5-7]

Medical examinations are performed on a schedule consistent with ANSI Z88.6 section 6.1. The Medical Department reviews these examinations to ensure compliance with federal requirements and guidelines.

12.5.3.6 Personnel Protective Equipment

All personnel shall adhere to RWP or equivalent document requirements when entering the RPA. The nature of the work to be done is the governing factor in the selection of protective clothing to be worn. The protective apparel available includes shoe covers, head covers, gloves, and coveralls or lab coats. Additional items of specialized apparel such as plastic or rubber suits, face shields, and respirators are available for operations involving high level contamination. Available respiratory protective equipment has been approved for use by the NRC, in accordance with Regulatory Guide 8.15 and 30 CFR 11. (30 CFR 11 has been relocated to 42 CFR 84) In all cases, radiation protection personnel shall evaluate the radiological conditions and specify the required items of protective clothing. [12.5-8]

12.5.3.7 Radiological Posted Areas

Radiological areas are posted as radiation areas, high radiation areas, radioactive materials areas, airborne radioactivity areas, or combinations thereof. Access to posted areas for all work is authorized in accordance with the Radiation Protection Procedures. [12.5-9]

12.5.3.8 Access to Radiation Areas

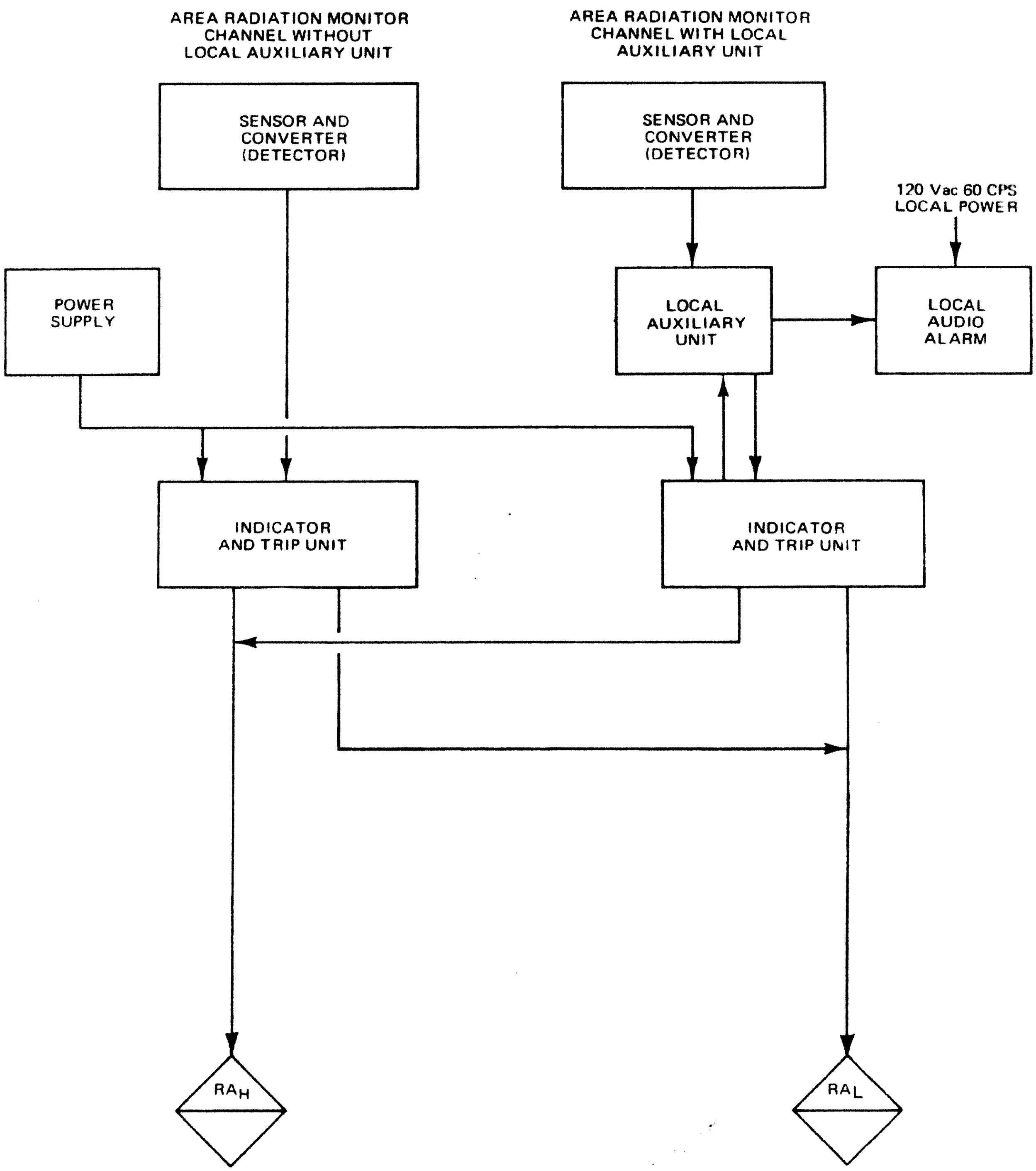
A restricted area is defined by 10 CFR 20 as any area controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. A radiation area is defined by 10 CFR 20 as any area, accessible to personnel, in which there exists radiation, at such levels that an individual could receive in any one hour a dose equivalent in excess of 5 millirem, at 30 cm from the radiation source or from the surface that the radiation penetrates. Radiation protection procedures control access to restricted areas and radiation areas to meet the requirements of 10 CFR 20. Personnel who work in or frequent any portion of a restricted area are trained in accordance with the requirements of 10 CFR 19. [12.5-10]

12.5.3.9 Access to High Radiation Areas

Areas in which radiation levels meet or exceed the definition of High Radiation Areas per Station Technical Specifications are posted and access controlled per Station Technical Specifications. [12.5-11]

12.5.3.10 In-Plant Radiation Monitoring

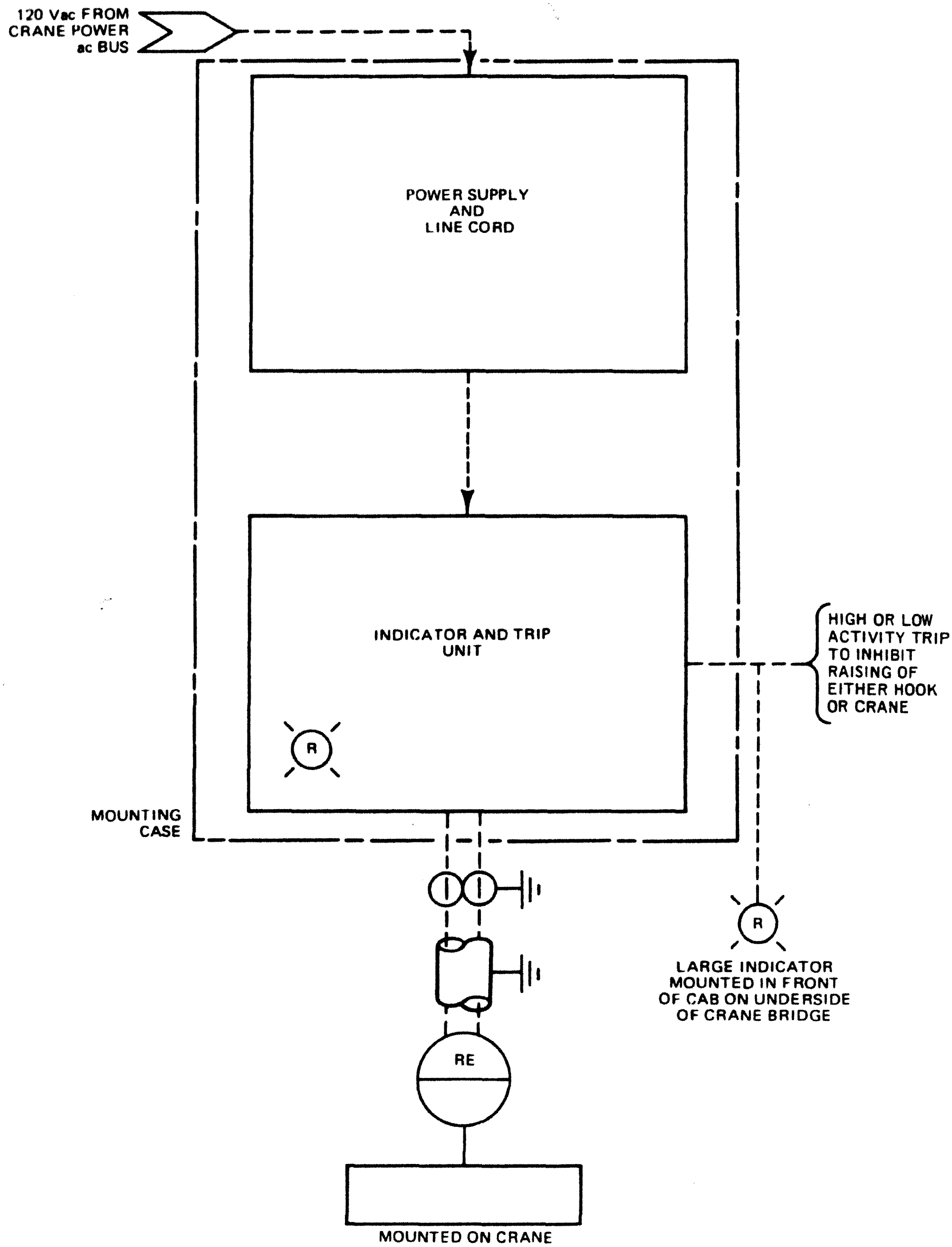
This program provides the controls which ensures the capability to accurately determine the airborne iodine concentration in vital areas under accident conditions. This program includes the training of personnel, procedures for monitoring, and provisions for the maintenance of sampling and analysis equipment. [12.5-12]



QUAD CITIES STATION
UNITS 1 & 2

TYPICAL AREA RADIATION MONITORING CHANNELS

FIGURE 12.3-1



QUAD CITIES STATION UNITS 1 & 2
REACTOR BUILDING CRANE RADIATION MONITORING SUBSYSTEM
FIGURE 12.3-2