DSAR 11.2

Radioactive Waste and Radiation Protection and Monitoring

Radiation Protection and Monitoring

Rev 3

Safety Classification:

Safety

Usage Level:

Information

Change No.:	**EC 69743**
Reason for Change:	**Remove references to the installed containment area radiation monitors. These monitors are no longer required die to no fuel in the reactor.**
Preparer:	**Pearson, B.**

Fort Calhoun Station

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The following figures are controlled drawings and can be viewed and printed from the listed aperture card.

11.2 Radiation Protection and Monitoring

11.2.1 General

Radiation protection measures comprise the shielding of the predictable sources of significant ionizing radiation and operational and administrative controls and procedures. The latter, technically supervised by the radiation protection staff, include controlled access to hazardous and potentially hazardous spaces, permanently installed radiation monitoring systems, and control of contamination. The radiation protection staff and functions are discussed in Section 12.

11.2.2 Shielding

11.2.2.1 Purpose

Radiation shielding is designed to provide radiation protection for personnel inside and outside the plant, and for the general public.

Shielding provides adequate protection against direct radiation exposure during design basis accidents.

11.2.2.2 Plant Accessibility

Current information concerning plant accessibility is contained within Radiation Protection processes and procedures.

11.2.2.3 Design Dose Rates

Design dose rates, for normal operation at the maximum power level of 1500 MWt and during refueling were kept below the limitations set forth in 10 CFR Part 20. Due to the permanent cessation of operation at FCS, current dose rates are below the design dose rates for the operating plant.

11.2.2.4 Shielding Arrangements

Containment Building

The containment has one major shielding function:

a. It shields adjacent auxiliary plant and yard areas from radiation originating in the reactor vessel, in the reactor coolant loop, and in other radioactive equipment and piping located inside the containment. It reduces radiation exposure below 0.5 mrem/hr in those areas outside the containment which are occupied by personnel on a routine basis.

Primary Shield

The primary shield surrounds and supports the reactor vessel. It is designed to reduce radiation exposure from primary gamma, neutron, and secondary gamma sources sufficiently to prevent appreciable activation of nearby apparatus. The primary shield is adequate to permit routine work.

Secondary Shield

The secondary shield comprises all walls and floors inside the containment which are built around the reactor loop and around other equipment which contains radioactivity permanently. The secondary shield reduces exposure to levels permitting access.

The secondary shield provides adequate protection for inspection, repair and maintenance under the general supervision of the health physics staff.

Concrete shielding provides protection in the spaces close to the fuel transfer route and the reactor internals temporary storage area. The fuel transfer route is flooded with water which protects the air space above the fuel transfer canal.

Auxiliary Building Equipment Shielding

Adequate shielding is provided around equipment that carries radioactive liquid, slurry or gas.

Highly radioactive equipment is isolated in shielded compartments individually or in groups. The entrances of such containments are provided with labyrinths for full protection of adjacent areas. At concentrations of radioactive equipment and piping, the manually operated valves are grouped in adjacent valve rooms. Pumps and compressors serving highly contaminated tanks are in separate shielded compartments. Certain piping systems are shielded by lead blankets.

Control Room

The control room is shielded with concrete on all sides.

Radioactive Waste Processing Building and CARP Building Shielding

Adequate shielding is provided for each room in the Radioactive Waste Processing and CARP buildings to permit continuous occupancy in general access areas.

11.2.2.5 Shielding Materials

The bulk of shielding material is either ordinary concrete with a minimum density of 2.33 g/cc or concrete block with a bulk density of 1.92 g/cc. Where space requirements prohibit the use of ordinary concrete, high density concrete of 3.6 g/cc density with magnetite aggregate is used. Observation windows at the drumming area are of high density glass with the same attenuation properties as the surrounding shielding wall. Holes above the purification filters are plugged with slabs of high density concrete or steel. The mass of these slabs is 340 lb/ft2 horizontal surface. Lead blankets are also permanently installed on certain piping systems and were attached per engineering procedures to ensure that the shielding does not fall off the pipe during a seismic event. The lead shielding is identified on isometrics. Pipe stress analyses were conducted on those piping systems which required permanent lead shielding.

11.2.2.6 Reactor Radiation Sources

Shutdown Sources

The shutdown sources produce gamma fluxes outside the vessel. The sources are the reactor vessel, reactor internals, and any remaining reactor coolant.

11.2.2.7 Pressurizer Radiation Sources

Sources in the pressurizer are plated-out radioactive crud.

11.2.2.8 Reactor Coolant System Radiation Sources

There is deposited crud activity in the reactor coolant system.

11.2.2.9 Waste Treatment Radiation Sources

The main remaining waste treatment source is waste gas.

11.2.2.10 Spent Fuel Pool Radiation Sources

CEAs and Spent Fuel Assemblies are major sources. Spent Fuel Assemblies and CEAs are concentrated in the Spent Fuel Pool. The Spent Fuel Pool as a whole is considered a Radiation Source.

11.2.3 Radiation Monitoring

11.2.3.1 General

Permanently installed radiation monitors are provided for surveillance of plant effluents and critical process streams (process monitors), and personnel exposure levels in hazardous and potentially hazardous plant areas (area monitors). Monitoring and recording is required for liquid and gaseous releases. The monitoring program meets the requirements of 10 CFR Part 50, Appendix I and the ODCM.

The following general design provisions and objectives apply to each monitor in containment, the Auxiliary Building and Radioactive Waste Processing Building regardless of category of functions:

a. Remotely operable check source at detector,

b. Two independently adjustable, high radiation setpoints; both setpoints are annunciated,

c. In addition to alarms, control room readouts include continuous indication, and recording on multi-point recorders (area monitors repeat indication and alarms at remote detector locations),

d. Independent channel power supplies,

e. Sufficient sensitivity, in relation to detector location, to ensure capability for compliance with 10 CFR Part 20.

Additional information concerning radiation monitoring in the vicinity of the plant, both on-and off-site is presented in Section 2.10.

The alarm setpoints are provided in the Operating Manual Technical Data Book (TDB) and will allow the operators to monitor activities between times grab samples are taken.

Two independently adjustable setpoints are provided for each monitor. The lower setpoint alarm, designated "ALERT/WARN", warns that the dose rate has reached an abnormal value. The upper setpoint alarm, designated "HIGH ALARM", warns that the dose rate has reached or passed the permissible limit. The local indicator, as well as the control room indicator and recorder, indicates the actual dose rate at the detector location.

Calibration of the radiation monitors is checked on a frequent, regular interval basis by exposing the detector to a known source and verifying that the reading is within the recommended tolerance of a previous calibration setting. If the reading is not within tolerance, the entire monitor components will be calibrated as necessary, e.g., the detector high voltage setting, alarm setpoints, discriminator setting or panel meter indication.

The principal functions of process radiation monitors are:

a. Continuous check of plant effluent activity concentrations and accumulation of data useful in accounting for released activity,

b. Early warning of equipment failures, malfunctions, and deteriorating performance,

c. Final check on proper execution of potentially hazardous periodic operations such as release of treated waste batches,

d. To determine release rates of radionuclides from the plant during Post-Accident operation.

Process radiation monitors were selected to provide adequate sensitivity to protect the public and the plant personnel based on 10 CFR Part 20 limits, and to provide reliable and stable long-term service. The design is modular to facilitate maintenance, updating, or changes to adapt to new requirements.

The process radiation monitor readings are compared with laboratory analysis of process samples. This procedure allows for a continuing evaluation of the process radiation monitor calibration and verifies the internal check source. If any process radiation monitor reading is questionable, corrective action such as testing and calibration will be taken as necessary to assure an accurate reading.

Administrative programs are maintained to ensure the capability to accurately determine the airborne radioactivity concentrations in vital areas in post-accident situations and to obtain and analyze radioactivity (for example particulates) in plant gaseous effluents.

11.2.3.2 Deleted

11.2.3.3 Auxiliary Building Exhaust Ventilation Stack Gaseous Effluent Monitors

The following radioactive and potentially-radioactive gaseous effluents are released to atmosphere via the Auxiliary Building Exhaust Ventilation Stack, which is a monitored release point:

a. Auxiliary Building ventilation exhaust;

Auxiliary Building Exhaust Ventilation Stack Monitors:

The following monitors are provided for full-time surveillance of waste gas releases at the release point:

a. RM-062 continuously monitors the ventilation stack gas. RM-062 is an off-line system with a particulate filter cartridge, sample pump, flow controls, control room indication alarm.

   Particulates are collected on a filter. Iodine can be collected on an impregnated charcoal filter canister mounted behind the particulates filter but iodine sampling is not required. Iodine is decaying away due to FCS ceasing operations.

   Following use, contents of the filter are laboratory counted for accurate assessment of particulate releases. Integrated sample flowrate is accumulated on the ratemeter.

   RM-062 gas monitor is a beta scintillator detector. The lower setpoint alarms only. The higher setpoint also alarms.

   RM-062 samples and monitors the stack to satisfy post accident monitoring requirements.

b. Deleted

c. RM-052 is a dual function gas monitor. RM-052 is a beta scintillator detector. This off-line gas monitor can sample from either the Auxiliary Building vent stack or from the containment. There is no longer any requirement to align RM-052 to containment. When RM-052 is aligned to sample the stack, it utilizes independent sample lines (see P&ID 11405-M-1).

   Optionally, particulates and iodine can be collected for analysis. Particulates are collected on a filter. Iodine may be collected on an impregnated charcoal filter canister mounted behind the particulate filter.

   Following use, contents of the filter and of the cartridge are laboratory counted for accurate assessment of particulate and iodine releases. Iodine analysis is not required. Integrated sample flowrate is accumulated on the ratemeter.

11.2.3.3.1 Laboratory and Radioactive Waste Processing Building Exhaust Stack Monitor:

The potentially radioactive noble gas, particulate, and iodine effluents from the CARP and Radioactive Waste Processing Building are released to the atmosphere via the Laboratory and Radioactive Waste Processing Buildings Exhaust Stack which is a monitored release point. These effluents are collected, combined, filtered, monitored and released through this exhaust stack as shown on drawing 7753-03-M-1.

RM-043 continuously monitors the Laboratory and Radioactive Waste Processing Building (LRWPB) ventilation stack gas (see P&ID 7753-03-M-1). RM-043 is an off-line system with a particulate filter and iodine cartridge, sample pump, flow controls, and control room indication alarms.

Particulates are collected on a filter. Iodine can be collected on an impregnated filter canister mounted behind the particulate filter. Following use, contents of the filter and of the cartridge are laboratory counted for accurate assessment of particulate and iodine releases. Iodine sampling is not required.

RM-043 gas monitor is a beta scintillator detector. RM-043 alarm setpoints alarm only.

11.2.3.4 Deleted

11.2.3.5 Deleted

11.2.3.6 Plant Liquid Effluent Monitor

Radioactive or potentially-radioactive liquid effluents reach the plant circulating water system, hence the river, via the RWDS overboard header and two raw-water overboard headers.

WDS Overboard Header

RM-055 is an in-line liquid monitor located in the Radioactive Waste Discharge System (RWDS) effluent header. RM-055 monitors the waste tank discharge line to the circulating water discharge tunnel (see P&ID 11405-M-9).

RM-055 liquid monitor is a gamma scintillator detector. RM-055 has control room indication and alarms. The lower setpoint alarms only. The higher setpoint alarms and initiates closure of the discharge valves to the circulating water overboard header, stops the waste monitor tank pumps, and hotel waste tank pumps.

11.2.3.7 Other Process Monitors

Component Cooling Water Monitor

RM-053 is an in-line monitor that continuously monitors the component-cooling water system downstream of the component-cooling/raw-water heat exchangers (see P&ID 11405-M-10). RM-053 monitor is a gamma scintillator detector with control room indication alarms. RM-053 alarm setpoints alarm only.

The component-cooling water system is a closed system cooled and buffered from the river by the raw-water system.

11.2.3.8 Area Radiation Monitors

A seventeen channel area monitoring system is provided to protect plant personnel in the Auxiliary Building, and Radioactive Waste Processing Building. Detectors, located where potential hazard exists and routine access is required, are air filled ionization chambers.

Readout modules, independent channel power supplies, and a multipoint recorder are installed on radiation monitor panel AI-33 (see Section 7.6.2). Alarms and indication are, however, repeated at the detector locations.

The area monitors respond monotonically over an eight decade range extending from 0.1 mr/hr to 10^7 mr/hr. The indicator displays all eight decades. The full eight decades are recorded in the control room for each channel.

Two independently adjustable setpoints are provided for each monitor. The lower setpoint alarm, designated "warn", warns that the dose rate has reached an abnormal, but still safe value. The upper setpoint alarm, "high radiation", warns that the dose rate has reached or passed the permissible limit for continued occupancy. The local indicator, as well as the control room indicator and recorder, indicates the actual dose rate at the detector location.

Area monitor detector locations are shown in Table 11.2-14.

Table 11.2-14 - Area Radiation Monitors

Building	Channel Number
Auxiliary Building	
Basement	RM-076/7/8/9
Ground Floor	RM-080/1/2/4
Operating Floor	RM-085/6/7/8
Control Room	
Mechanical Room	RM-089
Radioactive Waste Processing Bldg.	
Room 506	RM-095
Room 504	RM-096
Room 502	RM-097
Office Hallway	RM-098

11.2.3.9 Personnel Contamination Monitors

Several personnel contamination monitors are provided at points beyond which persons should not proceed with contaminated clothing, supplies, equipment, or tools. High sensitivity beta monitors are provided at key locations to detect personnel and equipment contamination as well as Station Exit Monitors of the walk-thru portal type in the Security Building.

11.2.3.10 Power Supply

Each process and area monitor channel has an individual power supply for development of the required internal operating voltages. Channel power supplies are distributed among the plant a-c instrument buses (see Section 8.3).

11.2.3.11 Deleted

11.2.3.12 Deleted

11.2.4 Radioactive Material Storage

11.2.4.1 Radioactive Waste Storage

Radioactive waste awaiting disposal is stored in the Radioactive Waste Processing Building (RWPB), the Independent Spent Fuel Storage Installation (ISFSI) located inside the protected area, and the Original Steam Generator Storage Facility (OSGSF) located on the West side of the plant site, North of the main access road.

- The OSGSF contains two decommissioned steam generators and four concrete reactor vessel head missile shield blocks.
- The OSGSF contained 404 curies in 2006 when components were first stored in it.
- The OSGSF housed approximately 8,542 ft^3 of material when components were first stored in it.
- The radiological dose impact at site boundary is < 4E-9 mRem/hr/Ci
  - It is assumed that all dose rates emanating from the OSGs are due to Co-60 only. This is conservative because Co-60 has higher energy gammas than the other isotopes present within these components, thereby yielding higher dose rates outside the OSGSF (Reference 11.4.20). This is subject to change if waste is added or removed from the OSGSF.

The Radioactive Waste Processing Building (RWPB) is designed for packaging, solidification, and storage of low-level radioactive wastes.

- Radioactive wastes stored in the RWPB are process resins, dry active radioactive waste (DAW), filters, and other reactor water treatment residues.
- The RWPB is designed to store 104 curies without any additional shielding.
- The radiological impact to the site boundary is <2.3E-5 mRem/hr/Ci
- The RWPB can hold up to 16.84 ft^3 of unshielded waste

11.2.4.2 Radioactive Waste Storage

Radioactive material is stored in the Auxiliary Building and the Radioactive Waste Building located inside the protected area.

11.2.5 Miscellaneous Radioactive Material Sources

To assure that leakage from byproduct, source, and special nuclear material radioactive sources does not exceed allowable limits, radioactive sources shall be leak tested for contamination. The leakage test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. If the test reveals the presence of 0.005 microcurie or more of removable contamination, it shall immediately be withdrawn from use, decontaminated, and repaired, or be disposed of in accordance with Commission regulations.

Ingestion or inhalation of source material may give rise to total body or organ irradiation. This DSAR Section assures that leakage from radioactive material sources does not exceed allowable limits. In the unlikely event that those quantities of radioactive byproduct materials of interest to this Section, which are exempt from leakage testing are ingested or inhaled, they represent less than one maximum permissible body burden for total body irradiation. The limits for all other sources (including alpha emitters) are based upon 10 CFR Part 70, Section 70.39(c) limits for plutonium.

Those quantities of byproduct material that exceed the quantities listed in 10 CFR 30.71, Schedule B are to be leak tested in accordance with the schedule shown in Table 11.2-15 - Leak Check Surveillance Requirements.

All other sources, including alpha emitters, containing greater than 0.1 microcurie are also to be leak tested in accordance with Table11.2-15.

Table 11.2-15 - Leak Check Surveillance Requirements

Tests for leakage and/or contamination shall be performed by the licensee or by other persons specifically authorized by the Commission or an agreement State, as follows:

1. Each sealed source, except startup sources subject to core flux, containing radioactive material, other than Hydrogen 3, with a half-life greater than thirty days and in any form other than gas shall be tested for leakage and/or contamination at intervals of six months.

2. The periodic leak test required does not apply to sealed sources that are stored and not being used. The sources excepted from this test shall be tested for leakage prior to any use or transfer to another user unless they have been leak tested within six months prior to the date of use or transfer. In the absence of a certificate from a transferor indicating that a test has been made within six months prior to the transfer, sealed sources shall not be put into use until tested.

3. Startup sources shall be leak tested prior to and following any repair or maintenance.