Enclosure 1:

"ACRS Presentation Chapter 11 – Radioactive Waste Management," PM-0219-64543, Revision 0

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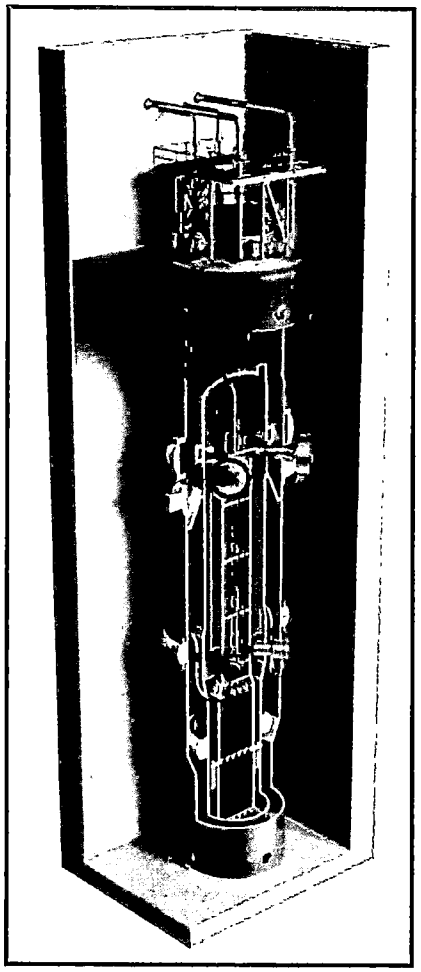
ACRS Presentation Chapter 11 – Radioactive Waste Management



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Chapter 11 Radioactive Waste Management

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Chapter 11 Acronyms

- ANSI – American National Standards Institute
- CES – Containment evacuation system
- COL – Combined license
- CRUD – Corrosion and wear activation products
- CVCS – Chemical and volume control system
- DSRS – Design specific review standard
- GAC – Granulated activated charcoal
- GALE – Gaseous and liquid effluents
- GRWS – Gaseous radioactive waste system
- GWD/MTU – Gigawatt days per metric ton of uranium
- HCW – High conductivity waste
- LCW – Low conductivity waste
- LLW – Low-level waste
- LRWS – Liquid radioactive waste system
- NPM – NuScale Power Module
- ODCM – Offsite Dose Calculation Manual
- PAM – Post-accident monitor
- PCP – Process Control Program

Chapter 11 Acronyms (continued)

- PZR - Pressurizer
- R/O – Reverse osmosis
- REMP – Radiological Effluent Monitoring Program
- SCALE – Standardized Computer Analysis for Licensing Evaluation
- SCFM – Standard cubic feet per minute
- SFP – Spent fuel pool
- SRWS – Solid radioactive waste system
- TUF – Tubular ultrafiltration
- UWS – Utility water system

Chapter 11 Radioactive Waste Management

- 11.1 Source Terms
- 11.2 Liquid Waste Management System
- 11.3 Gaseous Waste Management System
- 11.4 Solid Waste Management System
- 11.5 Process and Effluent Radiological Monitoring and Sampling Systems
- 11.6 I&C Design Features for Radiation Monitoring

11.1 Source Terms - Methodology

- Two source term models are developed for both primary and secondary coolants:
  - Design Basis and Normal Effluent ("Realistic") coolant source terms have three components:
    - Water activation products
      - » Calculated from first principles
      - » The same concentration for both Normal Effluent and Design Basis
    - Corrosion activation products (CRUD)
      - » Utilized ANSI 18.1-1999, adjusted to NuScale plant parameters
      - » The same concentration for both Normal Effluent and Design Basis
      - » CRUD strictly used the regulatory guidance provided and past precedence
    - Fission products
      - » Developed using first principles physics in SCALE 6.1 for core inventory

11.1 Source Terms - Methodology

- Being unique, and first of a kind, the NuScale design cannot rely solely on empirical source term data
- The NuScale methodology will use:
  - first principle physics based calculations, where appropriate
  - operational experience from recent industry, where applicable
  - lessons learned, where available

- Water activation products will be estimated from first principles using:

$$RR_x = \sum_{g=1}^{G} \Phi_g \sigma_{x,g} N = \sum_{g=1}^{G} \Phi_g \Sigma_{x,g}$$

  - RRx: number of reactions of type "x"
  - Φ_g: neutron flux in energy group "g"
  - G: maximum energy group
  - $\sigma_{x,g}$: Microscopic cross section for reaction "x" in energy group "g"
  - N: Number density of target atoms
  - $\Sigma_{x,g} \equiv \sigma_{x,g}$ N : Macroscopic cross section for reaction x in energy group "g"

11.1 Source Terms - Methodology

- Fission products are conservatively calculated using first principle physics in SCALE 6.1 Code to 60 GWD/MTU
- Release of fission products from fuel to primary coolant based on industry operational experience through use of fuel failure fraction
- NuScale evaluation of Corrosion and Wear Activation Products (CRUD) will use current large PWR operating data (ANSI/ANS 18.1-1999).
- ANSI/ANS 18.1-1999
  - There are no first principle physics models for CRUD generation, buildup, transport, plate-out, or solubility.
- To help ensure the source terms are conservative, NuScale has incorporated lessons learned by:
  - Using EPRIs primary water chemistry and steam generator guidelines to ensure source term is conservative.
  - Design of materials used cobalt reduction philosophy

11.1 Source Terms – Failed Fuel Fraction

- Fission products
  - Normal Effluent ("Realistic") source term
    - 0.0066% (~0.6 - 0.7 rods per reactor) failure rate is assumed
    - Supported by industry experience from large PWRs, which shows much improvement since the 1970s
      - » 90-95% of US LWRs are zero-defect since 2010
    - Industry data shows that most failures are due to grid-to-rod fretting and debris
      - » NuScale uses natural circulation, which mitigates these mechanisms
      - » Technical Report TR-1116-52065, "Effluent Release (GALE Replacement) Methodology and Results", Rev. 1
  - Design Basis source term;
    - 0.066% (~6-7 rods per reactor) failure rate is assumed
      - » 10x normal effluent source term
      - » Also, supported by Tech Spec 3.4.8 value based on this fuel failure rate

11.1 Source Terms – Secondary Coolant

- Secondary coolant source term
  - Primary-to-secondary tube leaks scaled from NUREG-0017
    - Design Basis = 75 lb/day/NPM = 900 lb/day for 12 units
    - Realistic = 3.5 lb/day/NPM = 42 lb/ day for 12 units
  - Direct neutron activation of secondary was determined to be negligible due to low neutron flux at the steam generators
  - Conservatively small secondary coolant mass assumed, which tends to increase the calculated concentration
- There are no COL Items associated with Section 11.1.

GALE Replacement Methodology

- Details provided in TR-1116-52065, "Effluent Release (GALE Replacement) Methodology and Results," Rev. 1
- GALE (NUREG-0017) was developed using empirical data from the existing (large) PWR fleet
- NuScale design is outside the range of applicability for several parameters (thermal power, coolant mass, other flows)
- Certain significant pathways in GALE were not modeled – e.g., Reactor Pool evaporation.
- Replacement method explicitly calculates radionuclide transport through NuScale plant systems using applicable guidance from NUREG-0017

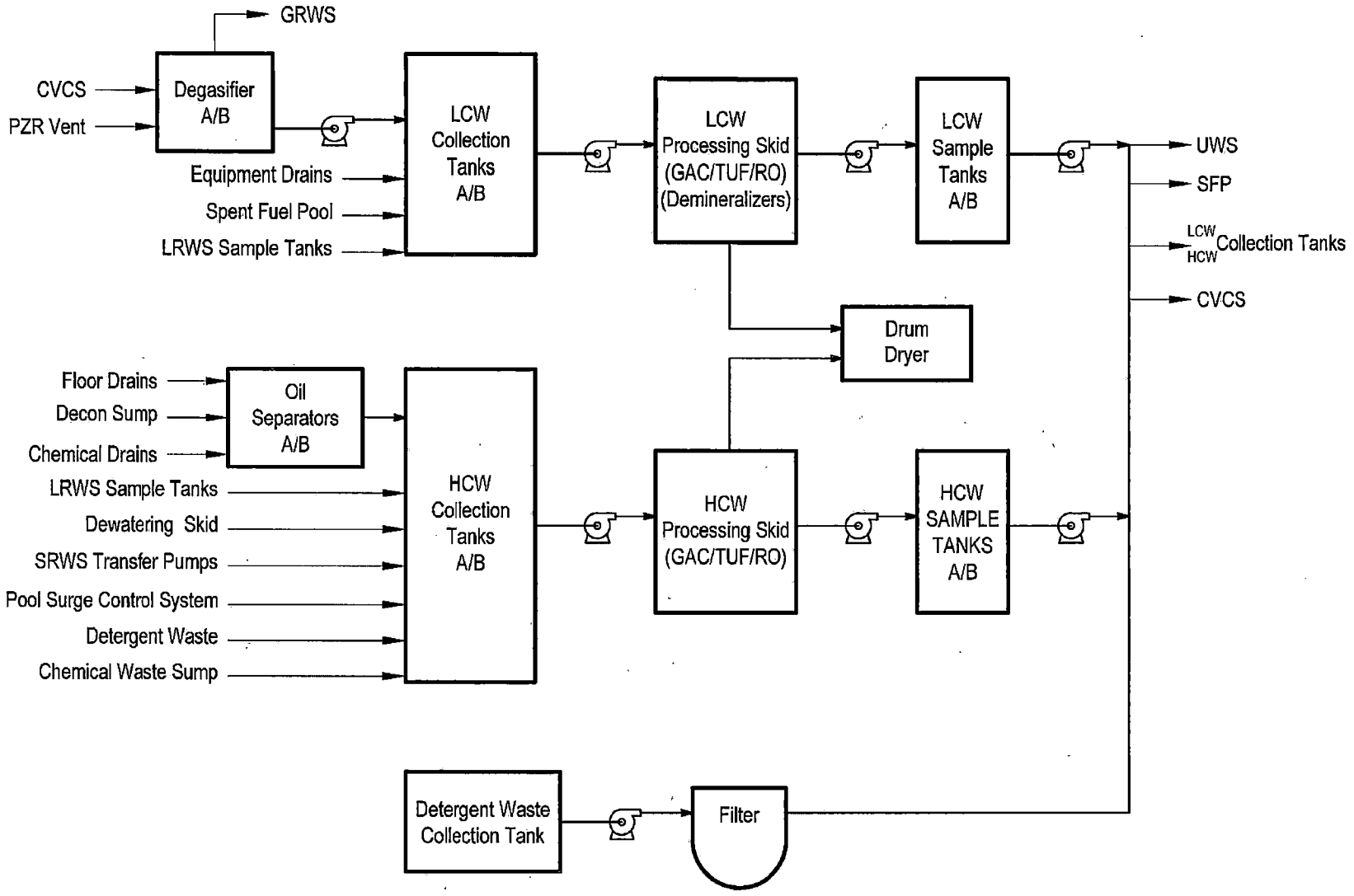
11.2 Liquid Waste Management

- Objective: Collect, store, and process radioactive liquid waste
- Subsystems:
  - Low Conductivity Waste
  - High Conductivity Waste
  - Chemical Waste
  - Detergent Waste
  - Clean-in-Place
  - Drum Dryer
- System Classification:
  - Non-safety related
  - LRWS Degasifier is RW-IIa, LCW collection tank is RW-IIb, other components are RW-IIc (RG 1.143)
- Location:
  - Reactor Building (Degasifer only) and Radioactive Waste Building

11.2 Liquid Waste Management

- Design Features:
  - Uses R/O and TUF technologies for performance improvement
  - Waste streams segregated to minimize waste generation
  - Four waste collection tanks with approximately 60,000 gallons capacity
  - Four sample tanks with approximately 60,000 gallons capacity
  - Tanks in separate, steel-lined cubicles
  - Integrated clean-in-place system
  - Liquid discharge can be recycled to the reactor pool, primary coolant, returned to waste collection tank for reprocessing, or discharged offsite
- Processing rate 25 gpm
  - Can process a full (80%) collection tank in about 8.5 hours
- Effluent
  - Meets 10 CFR 20, Appendix B, Table 2
  - Meets 10 CFR 50, Appendix I
  - Continuous radiation monitoring

11.2 Liquid Waste Management



11.2 Liquid Waste Management

- Section 11.2 COL Items

COL Item #	Description
11.2-1	A COL applicant that references the NuScale Power Plant design certification will ensure mobile equipment used and connected to plant systems is in accordance with ANSI/ANS-40.37, Regulatory Guide (RG) 1.143, 10 CFR 20.1406, NRC IE Bulletin 80-10 and 10 CFR 50.34a.
11.2-2	A COL applicant that references the NuScale Power Plant design certification will calculate doses to members of the public using the site-specific parameters, compare those liquid effluent doses to the numerical design objectives of 10 CFR 50, Appendix I, and comply with the requirements of 10 CFR 20.1302 and 40 CFR 190.
11.2-3	Not used
11.2-4	A COL applicant that references the NuScale Power Plant design certification will perform a site specific evaluation using the site-specific dilution flow.
11.2-5	A COL applicant that references the NuScale Power Plant design certification will perform a cost benefit analysis as required by 10 CFR 50.34a and 10 CFR 50, Appendix I, to demonstrate conformance with regulatory requirements. This cost-benefit analysis is to be performed using the guidance of Regulatory Guide 1.110.

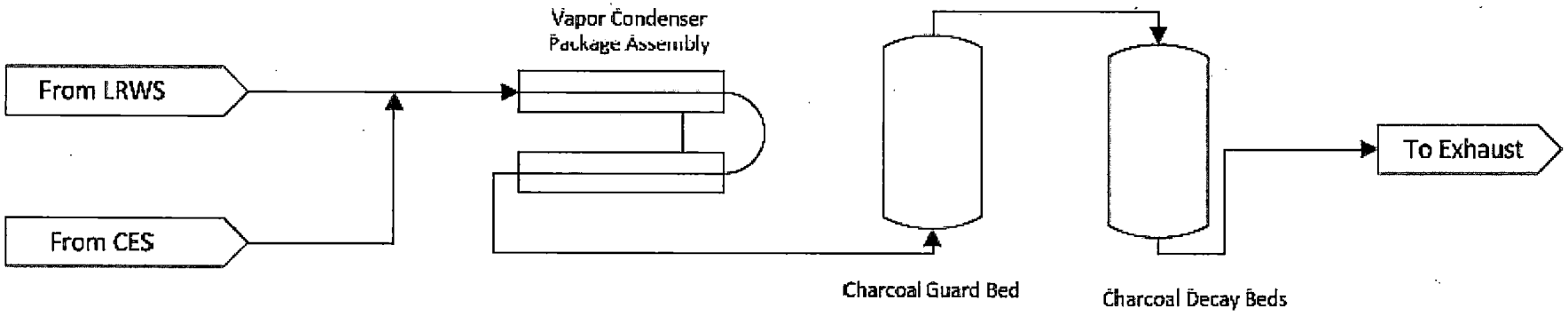
11.3 Gaseous Waste Management

- Objective: Collect, store, and process radioactive gaseous waste
- Subsystems:
  - None – single system design
- System Classification:
  - Non-safety related
  - GRWS guard bed and decay beds are RW-IIa, other components are RW-IIc (RG 1.143)
- Location:
  - Radioactive Waste Building

11.3 Gaseous Waste Management

- Design Features:
  - Uses charcoal decay beds to allow for noble gas decay
  - Prevent degradation of decay beds by using moisture separators and guard bed
  - Dual monitors for oxygen and hydrogen concentration to prevent flammable mixtures
  - Includes nitrogen deluge for fire suppression capabilities
  - High radiation condition will initiate effluent isolation
  - Low operating pressure (~2 psig), low flow design
- Processing rate ~1.5 scfm
  - Mostly nitrogen, to keep Hydrogen <1%
- Effluent
  - Meets 10 CFR 20, Appendix B, Table 2
  - Meets 10 CFR 50, Appendix I
  - Continuous radiation monitoring

11.3 Gaseous Waste Management



11.3 Gaseous Waste Management

- Section 11.3 COL Items

COL Item #	Description
11.3-1	A COL applicant that references the NuScale Power Plant design certification will perform a site specific cost-benefit analysis.
11.3-2	A COL applicant that references the NuScale Power Plant design certification will calculate doses to members of the public using the site-specific parameters, compare those gaseous effluent doses to the numerical design objectives of 10 CFR 50, Appendix I, and comply with the requirements of 10 CFR 20.1302 and 40 CFR 190.
11.3-3	A COL applicant that references the NuScale Power Plant design certification will perform an analysis in accordance with Branch Technical Position 11-5 using the site-specific parameters.

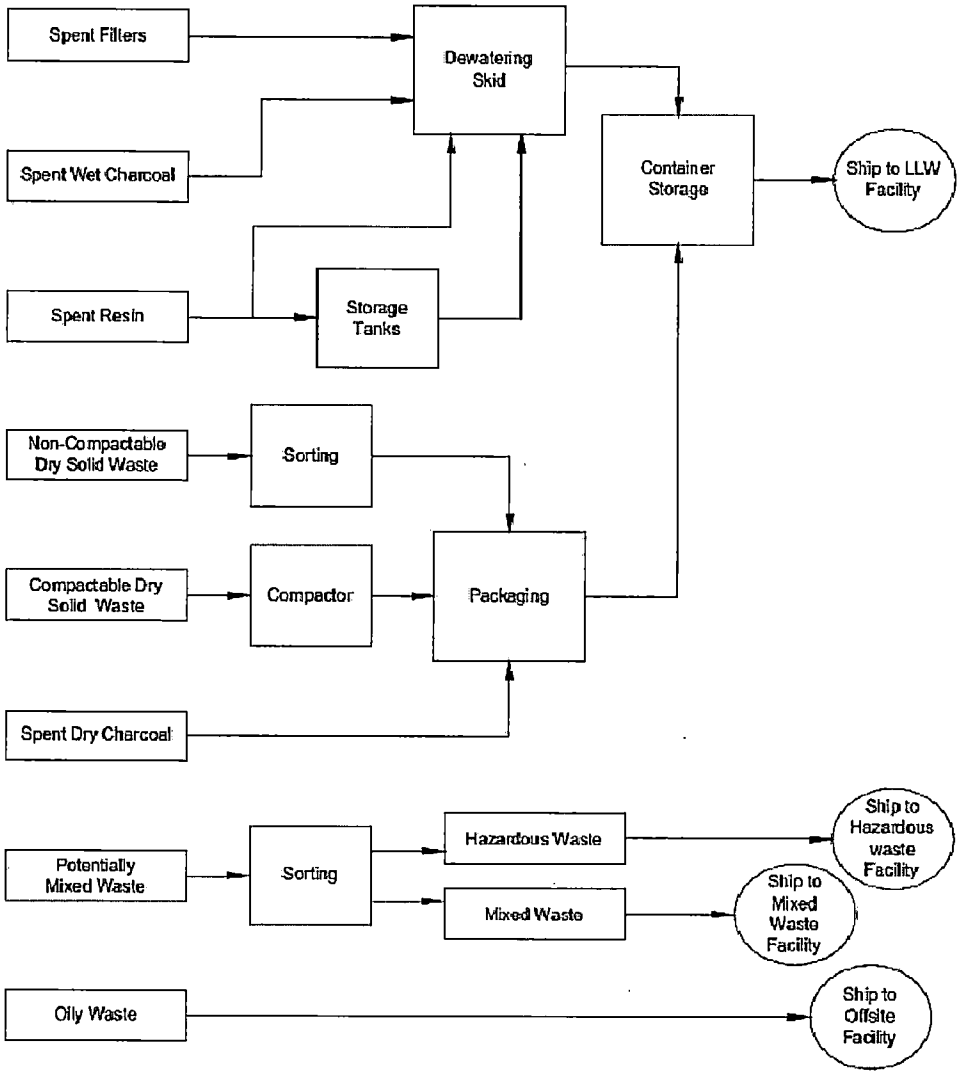
11.4 Solid Waste Management

- Objective: Collect, store, process, and package radioactive solid waste
- Subsystems:
  - Dry solids
    - DAW
    - HVAC filters
  - Wet solids
    - Spent resins
    - Cartridge filters
    - Spent charcoal
- System Classification:
  - Non-safety related
  - SRST is RW-IIa, PST is RW-IIb, other components are RW-IIc (RG 1.143)
- Location:
  - Radioactive Waste Building

11.4 Solid Waste Management

- Design Features:
  - Two spent resin storage tanks (16,000 gallons each)
  - Two phase separator tanks (5,000 gallons each)
  - Tanks in separate, steel-lined cubicles
- Storage Capacity:
  - Class B/C: 4 years
  - Class A: 4 years

11.4 Solid Waste Management



11.4 Solid Waste Management

- Section 11.4 COL Items

COL Item #	Description
11.4-1	A COL applicant that references the NuScale Power Plant design certification will describe mobile equipment used and connected to plant systems in accordance with ANSI/ANS 40.37, Regulatory Guide 1.143, 10 CFR 20.1406, NRC IE Bulletin 80-10, and 10 CFR 50.34a.
11.4-2	A COL applicant that references the NuScale Power Plant design certification will develop a site-specific process control program following the guidance of Nuclear Energy Institute (NEI) 07-10A (Reference 11.4-3).

11.5 Process & Effluent Radiological Monitoring Instrumentation & Sampling

- Objective: Measure and record radioactivity levels of selected liquid and gaseous process streams and effluents
- Function:
  - Monitor liquid and gaseous process streams and effluent paths for radioactivity
  - Indicate potential malfunctions of radioactive systems and generate alarms and controls
- Classification: Non-Safety
- Design Features:
  - High radiation condition initiates isolation of the liquid and gaseous radioactive waste effluents
  - Main steam line monitors will monitor for Ar-41, since N-16 is decayed away
  - There is a single liquid waste discharge line
  - The plant vent stack releases most of the gaseous waste
  - Turbine Building releases include turbine gland sealing steam and condenser air removal

11.5 Process & Effluent Radiological Monitoring Instrumentation & Sampling

- Gaseous Monitors
  - Auxiliary boiler system
  - Annex Building ventilation system
  - Condenser air removal system - *effluent* (PAM variable)
  - Containment evacuation system
  - Containment flood and drain separator tank
  - Normal control room ventilation system
  - Main control room supply air duct
  - Gaseous radioactive waste system decay bed and system discharges
  - Main steam lines
  - Pool surge control system storage tank vent - *effluent*
  - Reactor Building ventilation stack exhaust - *effluent* (PAM variable)
  - Radioactive Waste Building ventilation system
  - Turbine gland sealing steam exhaust - *effluent*
- All monitors are non-safety related, but are augmented quality

11.5 Process & Effluent Radiological Monitoring Instrumentation & Sampling

- Liquid Monitors
  - Aux boiler system return flow to module heating system
  - Balance of plant drain system
  - Chemical and volume control system RCS sample line
  - Containment evacuation system sample vessel discharge line
  - Condensate polisher resin regeneration skid
  - Demineralized water system headers
  - Liquid radioactive waste discharge line – *effluent*
  - Reactor component cooling water system
  - Radioactive waste drain system
  - Site cooling water
  - Utility water system outfall – *effluent*
- All monitors are non-safety related, but are augmented quality

11.5 Process & Effluent Radiological Monitoring Instrumentation & Sampling

- Section 11.5 COL Items

COL Item #	Description
11.5-1	A COL applicant that references the NuScale Power Plant design certification will describe site specific process and effluent monitoring and sampling system components and address the guidance provided in ANSI N13.1-2011, ANSI N42.18-2004 and Regulatory Guides 1.21, 1.33 and 4.15.
11.5-2	A COL applicant that references the NuScale Power design certification will develop an offsite dose calculation manual (ODCM) that contains a description of the methodology and parameters used for calculation of offsite doses for gaseous and liquid effluents, using the guidance of Nuclear Energy Institute (NEI) 07-09A (Reference 11.5-8).
11.5-3	A COL applicant that references the NuScale Power design certification will develop a radiological environmental monitoring program (REMP), consistent with the guidance in NUREG-1301 and NUREG-0133, that considers local land use census data for the identification of potential radiation pathways radioactive materials present in liquid and gaseous effluents, and direct external radiation from systems, structures, and components.

11.6 I&C Design Features for Radiation Monitoring

- New Section added to the NuScale DSRS
- Information is already contained in other Sections
- Monitors for gaseous and liquid process and effluent streams are described in Section 11.5
- Sampling system information is described in Section 9.3.2
- Fixed area and airborne radiation monitors are described in Chapter 12
- Post-accident monitoring (PAM) variables from radiation monitors are described in Chapter 7
- There are no COL Items associated with Section 11.6

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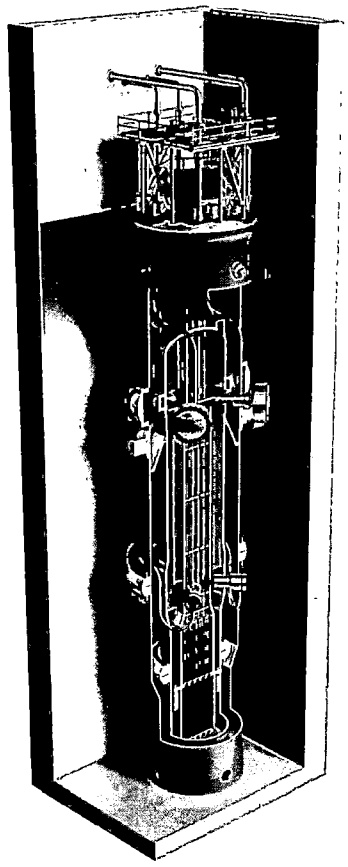

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Backup Slides

11.5 Process & Effluent Radiological Monitoring Instrumentation & Sampling