PMTurkeyCOLPEm Resource

From: Franzone, Steve <Steve.Franzone@fpl.com>
Sent: Thursday, June 02, 2016 3:10 PM
To: Comar, Manny
Cc: TurkeyCOL Resource; Maher, William; Orthen, Richard
Subject: [External_Sender] Chap. 11
Attachments: FPL_ACRS Pesentation - Chapter_11_NRC.PDF

Attached is the slide summary for FSAR Sec. 11.2.
If you need any clarifications, please call myself or Rick Orthen (561.904.3787)

Thanks
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"Care about people's approval and you will be their prisoner." ~ Lao Tzu
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Turkey Point Nuclear Plant Units 6 & 7

Section 11.2 – Liquid Waste Management System

Site-Specific Information

- **Section 11.2: Liquid Waste Management System, PTN SUP 11.2-1**
  - Non-traditional disposal method for liquid radioactive waste
    - Discharge via deep well injection system (DIS) to the Lower Floridan aquifer (Boulder Zone), approximately 3000 feet below ground surface (bgs)
    - Not anticipated that radioactive waste effluent injected into the Boulder Zone would reach either an underground source of drinking water or the surface environment due to:
      - Confinement
      - Decay (slow movement and distance)
  - Traditional disposal method involves direct discharge to surface water where radioactive waste effluent is diluted and dispersed in the receiving waters and is immediately available for member-of-the-public exposure

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Turkey Point Nuclear Plant Units 6 & 7

Liquid Waste Management System Design

Liquid Waste Management System

- Liquid waste other than radioactive waste, including wastewater from the main condenser cooling system (blowdown), wastewater retention basin, and sanitary waste treatment system, will be collected in the common blowdown sump.
- Processed liquid radioactive waste will be discharged to the plant blowdown sump pump discharge line prior to release
  - The required minimum dilution factor to control the concentrations of liquid radioactive waste discharges to 10 CFR Part 20, Appendix B, effluent concentration limits are met by specifying flow rates at the blowdown sump discharge.
    - The required minimum dilution factor is calculated and applied prior to release of liquid radioactive waste (batch is the only release mode anticipated)
      - 6000 gpm typical dilution flow per unit (DCD Table 11.2-8)
  - Implementation of the liquid radioactive waste effluent control program will be in accordance with Units 6 & 7 Offsite Dose Calculation Manual

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Liquid Waste Management System Design

Deep Well Injection System (DIS)

- System consists of 12 Class I deep injection wells (10 primary and 2 backup wells), 6 dual-zone monitoring wells, piping, valving, pumps, and instrumentation for system operational monitoring located in the Plant Area
- The operation of the DIS is identical for both reclaimed and saltwater—only the number of deep injection wells used differs
  - *Reclaimed Water (4 cycles of concentration in cooling towers)*
    - Deep well injection flow rate is nominally 12,500 gpm (normal) and 13,000 gpm (maximum) for two units
    - Liquid radwaste component is 3 gpm (normal) and 150 gpm (maximum)
    - 3 deep injection wells are sufficient (2 active and 1 backup)
  - *Saltwater (1.5 cycles of concentration in cooling towers)*
    - Deep well injection flow rate is nominally 58,000 gpm (normal) and 59,000 gpm (maximum) for two units
    - Liquid radwaste component is 3 gpm (normal) and 150 gpm (maximum)
    - 11 deep injection wells are sufficient (9 active and 2 backup)

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Section 11.2 – Liquid Waste Management System

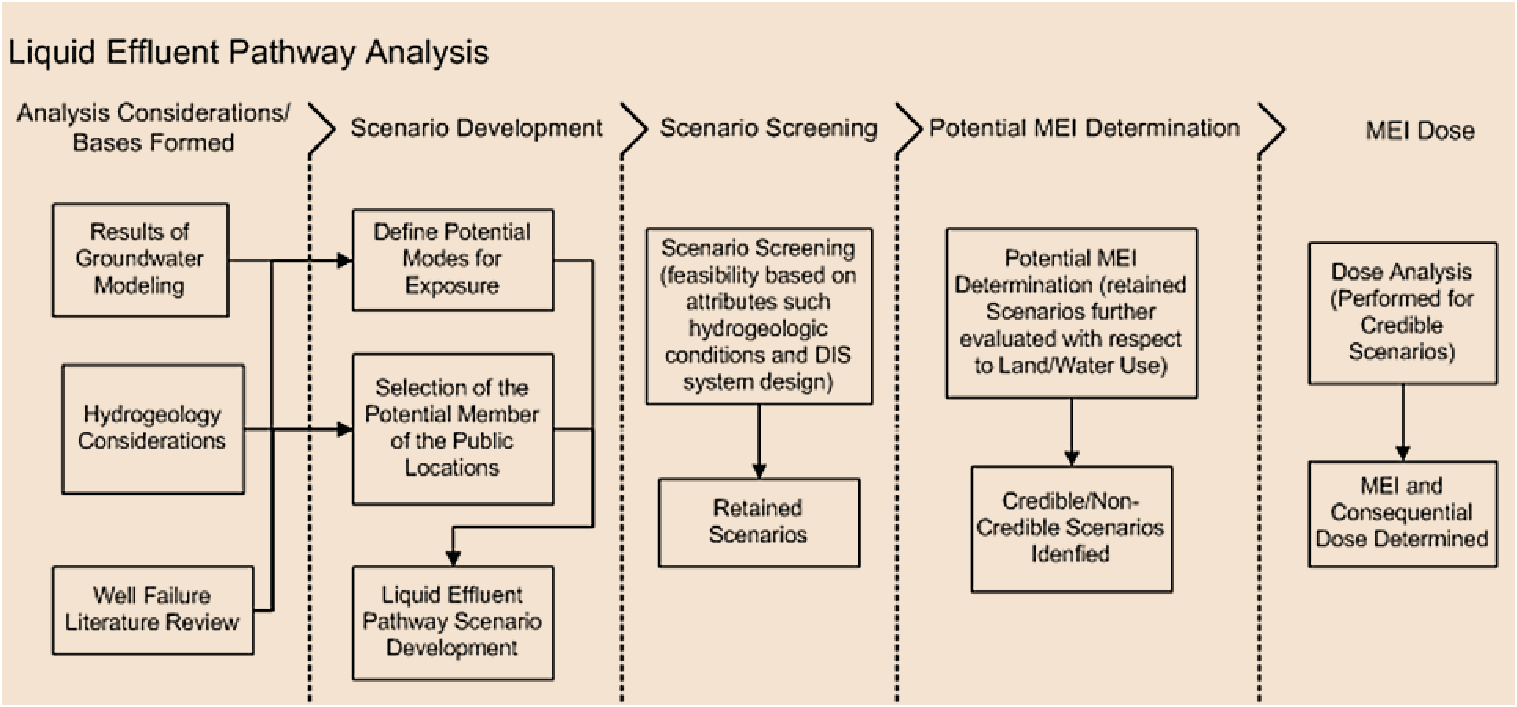
Liquid Effluent Pathway Analysis

- Liquid effluent pathway analysis performed to assess DIS disposal method for liquid radioactive waste to determine effects as they relate to credible and non-credible Maximally Exposed Individual (MEI) exposures
- Liquid effluent pathway analysis:
  - Identifies any appropriate member-of-the-public receptors and ultimately determines the MEI
  - Culminates in an assessment of the doses potentially delivered to the MEI as a result of the injection of radioactive waste effluent to the Boulder Zone

Turkey Point Nuclear Plant Units 6 & 7

Liquid Waste Management System

Process:



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Section 11.2 – Liquid Waste Management System

Liquid effluent pathway analysis considerations/bases

- Because liquid effluent is released via deep well injection, there is no surface release; groundwater transport is the only exposure pathway
  - Groundwater Modeling
    - Radial Transport
    - Vertical Transport
  - Hydrogeology
  - Well Failure

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Groundwater Modeling Deep Well Injection

Radial Transport Model in the Boulder Zone (BZ)

- Objective
  - Determine radionuclide concentrations and spatial distributions in BZ
  - Provide input to MEI dose calculation
- Variable density groundwater flow and transport model (SEAWAT)
  - Injectate density differs from BZ water (36.2 kg/m^3 TDS)
    - Cycled reclaimed water (2.7 kg/m^3 TDS) => “floats”
    - Cycled saltwater from radial collector well (57.0 kg/m^3 TDS) => “sinks”
- Conceptual model
  - Two-dimensional, radially symmetric flow
  - BZ confined
  - Continuous injection
- Radionuclides of interest
  - H-3, Sr-90, Cs-134 and Cs-137 => 99% of dose
  - No adsorption

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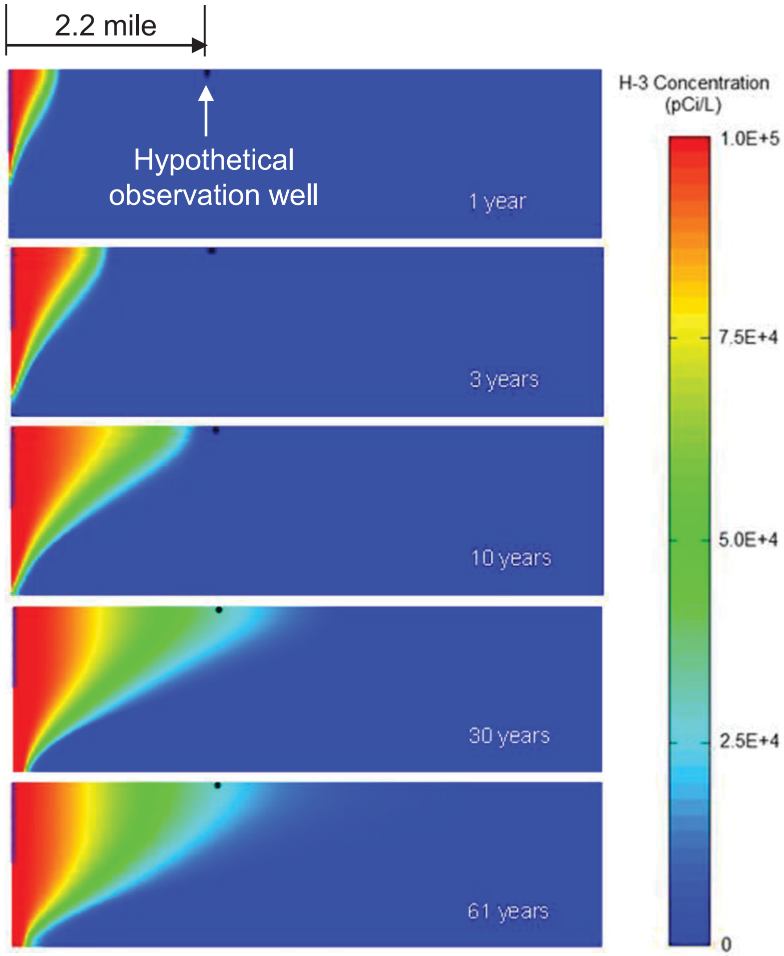
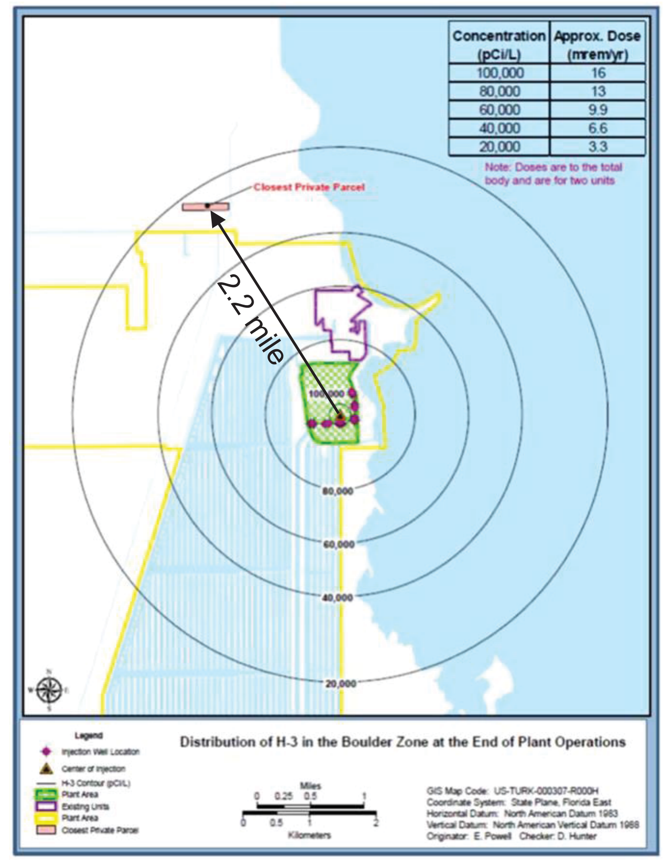
Groundwater Modeling Deep Well Injection



Base Case Boulder Zone Tritium Concentrations
Source: FSAR Figure 11.2-201



Model Layer 1 Distribution of Tritium in the Boulder Zone for the Base Case Simulation at the End of Plant Operations
Source: FSAR Figure 11.2-202

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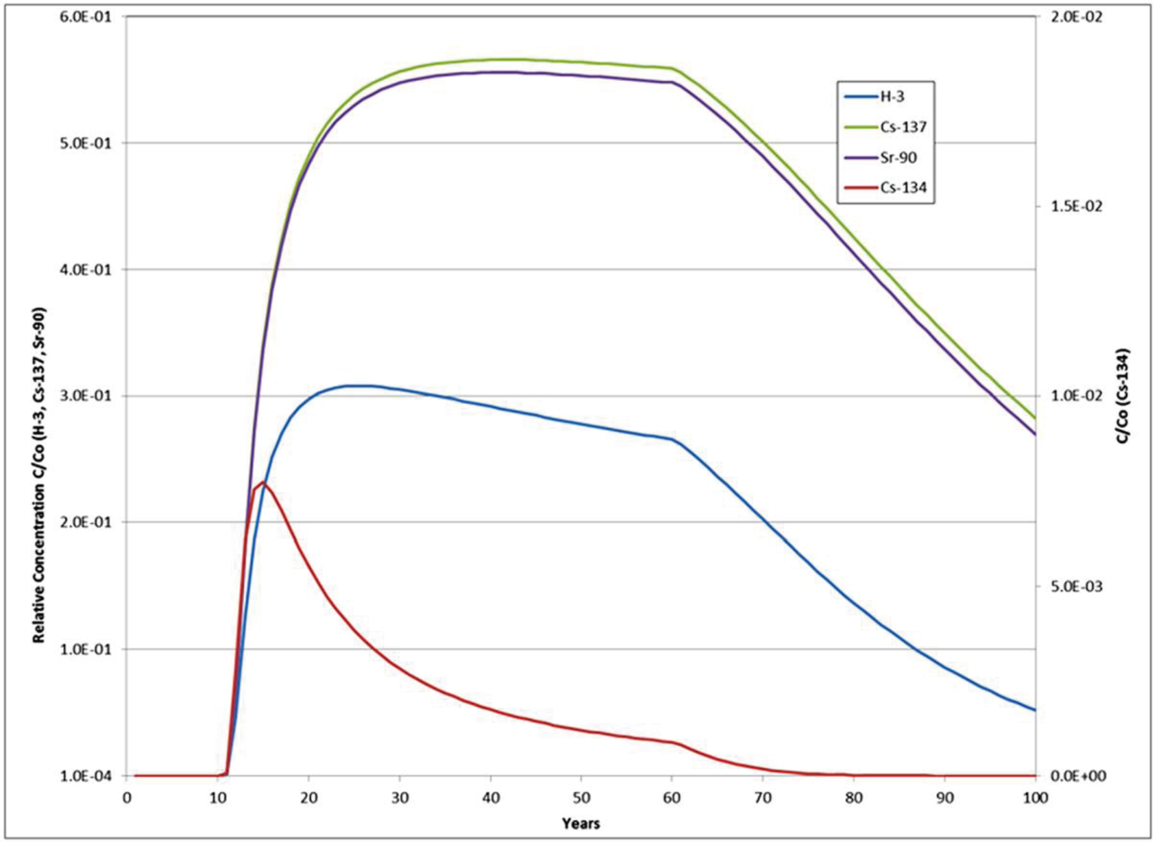
Groundwater Modeling Deep Well Injection



Model Layer 1 Base Case Relative Breakthrough Curves at 2.2-mile Receptor Location (Concentrations at Hypothetical Observation Well)

Source: FSAR Figure 11.2-209

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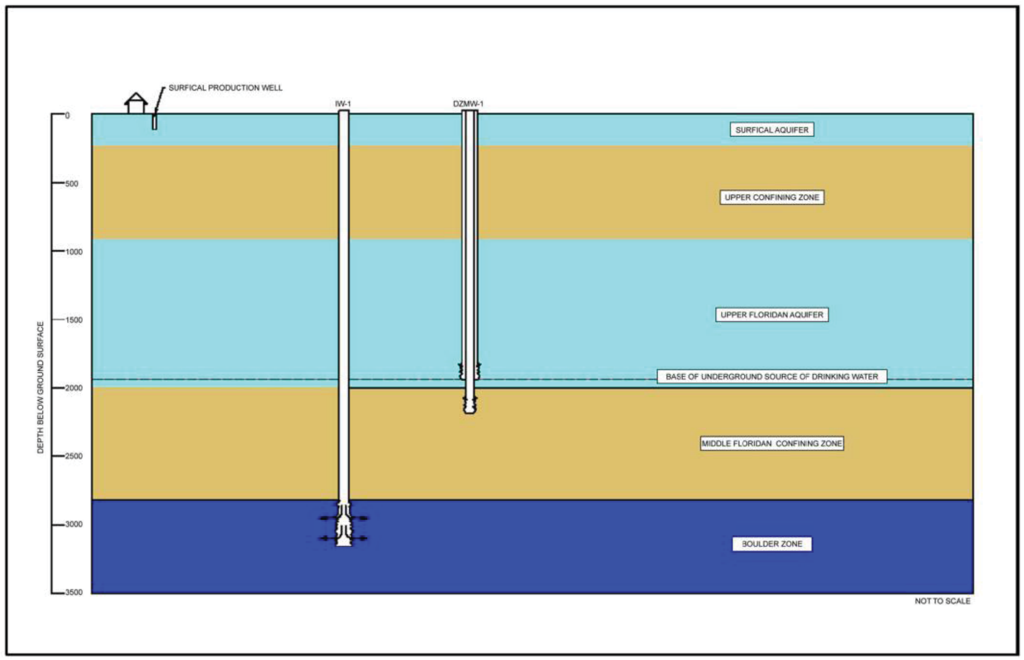
Groundwater Modeling Deep Well Injection

Vertical Transport Model

- Objective
  - Evaluate upward migration of injectate from BZ through the Middle Confining Unit to the Upper Floridan aquifer
- Model attributes
  - Variable density groundwater flow and transport model (SEAWAT)
  - 3D model simulating injection of cycled reclaimed water into BZ
- Model results
  - 300 ft vertical migration into Middle Confining Unit after 100 years
  - Migration of radionuclides out of the BZ not significant



Typical Injection Well System
Source: FSAR Figure 2.4.12-244

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Section 11.2 – Liquid Waste Management System

- **Scenario Development/Screening**
  - Potential exposure modes identified
  - Selection of the potential member-of-the-public locations
  - Liquid effluent pathway scenario development
- **MEI Determination**
  - Two scenarios are evaluated at MEI location 2.2 miles away: off-normal operation and inadvertent intrusion

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Section 11.2 – Liquid Waste Management System

MEI Dose Analysis

- Off-Normal Operation – Upper Floridan aquifer is used as a source of drinking water for community
  - Applies to MEI and population doses
- Inadvertent Intrusion – Intruder drills well into the Boulder Zone, resulting in following exposure pathways
  - Ingestion of water and irrigated vegetables and meat
  - Inhalation of airborne contamination from evaporation during drilling of well
  - Immersion in airborne cloud from evaporation during drilling of well
  - Exposure to contamination in puddle on the ground during drilling of well
  - Applies to MEI only, as the well is assumed to be on private property

Section 11.2 – Liquid Waste Management System

MEI Dose Analysis-Liquid Effluent

- Ingestion doses are calculated using the LADTAP II computer program
  - Effective decay time during transit determined for each radionulide, based on concentrations at injection point (calculated using DCD Table 11.2-7 release rate and site-specific dilution flow rate of 6230 gpm per unit) and the MEI location (calculated using SEAWAT)
  - A separate LADTAP II run is made for each radionuclide, with the release rate being the DCD Table 11.2-7 value multiplied by 365/292 (scaling the assumed days of operation in DCD to full calendar year) and transit time being the calculated decay time
  - LADTAP II runs are for two units, consistent with the SEAWAT model for peak concentrations
  - Doses during drilling via inhalation, immersion, and deposition pathways are calculated using Environmental Protection Agency guidance and Regulatory Guide 1.109
- Calculated doses are within 10 CFR 50 Appendix I guidelines

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Section 11.2 – Liquid Waste Management System

MEI Dose Analysis-Liquid Effluent

Member-of-the-Public Ingestion Dose Summary

Radionuclide	Total Body Dose for 2 Units (mrem/year)	Liver[a] Dose for 2 Units (mrem/year)
Tritium	1.8E00	1.8E00
Cesium-134	3.1E-04	1.5E-03
Cesium-137	1.8E-02	1.2E-01
Strontium-90	1.5E-04	0
Total	1.8	1.9

(a) Liver is the organ receiving the maximum dose.

Source: FSAR Table 11.2-208

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Turkey Point Nuclear Plant Units 6 & 7

Section 11.2 – Liquid Waste Management System

MEI Dose Analysis-Liquid Effluent

- Calculated doses are within 10 CFR 50 Appendix I guidelines

Inadvertent Intrusion Subsistence Driller Dose Summary

Pathway	Dose (mrem) per Unit[b]	
	Total Body	Liver[a]
Annual Ingestion of Water and Irrigated Foods	2.7	3.8
Inhalation During Drilling	8.2E-02	8.3E-02
Air Immersion During Drilling	2.6E-06	2.6E-06
Deposition During Drilling	1.8E-05	0
Total	2.8	3.9
10 CFR Part 50, Appendix I Design Objectives	3	10

(a) Liver is the organ receiving the maximum dose.

(b) Doses are calculated based on the operation of two units, as this maximizes the doses at offsite receptors. The calculated two-unit dose is then divided by two to obtain the dose per unit.

Source: FSAR Table 11.2-209

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