U.S. EPA RADIATION REGULATIONS UPDATE

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ISCORS

November 9, 2010

Purpose of Presentation & Outline

- Purpose: Provide background on radiation regulatory actions underway or under consideration
- 40 CFR 190 (radiation protection standards for nuclear power operations)
- 40 CFR 192 (issued under authority of Uranium Mill Tailings Radiation Control Act (UMTRCA))
- 40 CFR 61, Subpart W (radon emissions from uranium mill tailings under Clean Air Act)
- Revising CAP88-PC and analyzing age-specific dose issues

History

- 40 CFR Part 190 establishes radiation protection standards for nuclear power operations (Jan 13, 1977)
- Applies to U milling, U conversion & enrichment, U fuel fabrication, nuclear power plants, & reprocessing facilities
- Specifies standards for U Fuel Cycle which include:
  - ✓ Public dose limit of 25/75/25 mrem/yr to whole body/thyroid/other organs
  - ✓ Annual limits on total quantities of radioactivity entering the environment for certain radionuclides per Gigawatt electricity produced
    - 50,000 curies Kr-85
    - 5 millicuries I-129
    - 0.5 millicuries combined of Pu 239 & other alpha emitters

SUBCHAPTER F—RADIATION PROTECTION PROGRAMS

PART 190—ENVIRONMENTAL RADIATION PROTECTION STANDARDS FOR NUCLEAR POWER OPERATIONS

Subpart A—General Provisions

Sec.

Subpart B—Environmental Standards for the Uranium Fuel Cycle

AUTHORITY: Atomic Energy Act of 1954, as amended; Reorganization Plan No. 3, of 1970.

SOURCE: 42 FR 2860, Jan. 13, 1977, unless otherwise noted.

Subpart A—General Provisions

§ 190.01 Applicability.

The provisions of this part apply to radiation doses received by members of the public in the general environment and to radioactive materials introduced into the general environment as the result of operations which are part of a nuclear fuel cycle.

§ 190.02 Definitions.

(a) *Nuclear fuel cycle* means the operations defined to be associated with the production of electrical power for public use by any fuel cycle through utilization of nuclear energy.

(b) *Uranium fuel cycle* means the operations of milling of uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel, to the extent that these directly support the production of electrical power for public use utilizing nuclear energy, but excludes mining operations, operations at waste disposal sites, transportation of any radioactive material in support of these operations, and the reuse of recovered non-uranium special nuclear and by-product materials from the cycle.

(c) *General environment* means the total terrestrial, atmospheric and aquatic environments outside sites upon which any operation which is part of a nuclear fuel cycle is conducted.

(d) *Site* means the area contained within the boundary of a location under the control of persons possessing or using radioactive material on which is conducted one or more operations covered by this part.

(e) *Radiation* means any or all of the following: Alpha, beta, gamma, or X-rays; neutrons; and high-energy electrons, protons, or other atomic particles; but not sound or radio waves, nor visible, infrared, or ultraviolet light.

(f) *Radioactive material* means any material which spontaneously emits radiation.

(g) *Curie* (Ci) means that quantity of radioactive material producing 37 billion nuclear transformations per second. (One millicurie (mCi)=0.001 Ci.)

(h) *Dose equivalent* means the product of absorbed dose and appropriate factors to account for differences in biological effectiveness due to the quality of radiation and its spatial distribution in the body. The unit of dose equivalent is the "rem." (One millirem (mrem)= 0.001 rem.)

(i) *Organ* means any human organ exclusive of the dermis, the epidermis, or the cornea.

(j) *Gigawatt-year* refers to the quantity of electrical energy produced at the busbar of a generating station. A gigawatt is equal to one billion watts. A gigawatt-year is equivalent to the amount of energy output represented by an average electric power level of one gigawatt sustained for one year.

(k) *Member of the public* means any individual that can receive a radiation dose in the general environment, whether he may or may not also be exposed to radiation in an occupation associated with a nuclear fuel cycle. However, an individual is not considered a member of the public during any

period in which he is engaged in carrying out any operation which is part of a nuclear fuel cycle.

(l) *Regulatory agency* means the government agency responsible for issuing regulations governing the use of sources of radiation or radioactive materials or emissions therefrom and carrying out inspection and enforcement activities to assure compliance with such regulations.

Subpart B—Environmental Standards for the Uranium Fuel Cycle

§ 190.10 Standards for normal operations.

Operations covered by this subpart shall be conducted in such a manner as to provide reasonable assurance that:

(a) The annual dose equivalent does not exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public as the result of exposures to planned discharges of radioactive materials, radon and its daughters excepted, to the general environment from uranium fuel cycle operations and to radiation from these operations.

(b) The total quantity of radioactive materials entering the general environment from the entire uranium fuel cycle, per gigawatt-year of electrical energy produced by the fuel cycle, contains less than 50,000 curies of krypton-85, 5 millicuries of iodine-129, and 0.5 millicuries combined of plutonium-239 and other alpha-emitting transuranic radionuclides with half-lives greater than one year.

§ 190.11 Variances for unusual operations.

The standards specified in § 190.10 may be exceeded if:

(a) The regulatory agency has granted a variance based upon its determination that a temporary and unusual operating condition exists and continued operation is in the public interest, and

(b) Information is promptly made a matter of public record delineating the nature of unusual operating conditions, the degree to which this operation is expected to result in levels in excess of the standards, the basis of the variance, and the schedule for achieving conformance with the standards.

§ 190.12 Effective date.

(a) The standards in § 190.10(a) shall be effective December 1, 1979, except that for doses arising from operations associated with the milling of uranium ore the effective date shall be December 1, 1980.

(b) The standards in § 190.10(b) shall be effective December 1, 1979, except that the standards for krypton-85 and iodine-129 shall be effective January 1, 1983, for any such radioactive materials generated by the fission process after these dates.

PART 191—ENVIRONMENTAL RADIATION PROTECTION STANDARDS FOR MANAGEMENT AND DISPOSAL OF SPENT NUCLEAR FUEL, HIGH-LEVEL AND TRANSURANIC RADIOACTIVE WASTES

Subpart A—Environmental Standards for Management and Storage

Sec.

Subpart B—Environmental Standards for Disposal

Subpart C—Environmental Standards for Ground-Water Protection

Technical Considerations

- GW protection – Current standard does not have groundwater protection requirements
  - ✓ Recent experience has shown that the potential for groundwater contamination exists (Tritium leaks)
  - ✓ Rule did not anticipate GW problems and did not analyze them

The New York Times

As Clock Ticks, Nuclear Plant Searches for Leak

By MATTHEW L. WALD
Published: February 26, 2010

VERNON, Vt. – At Vermont Yankee, a nuclear reactor on the ropes, the search for a tritium leak that may doom the plant is proceeding as quickly as possible – which is to say, at a painstaking pace.

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Toby Talbot/Associated Press
Onlookers cheered when lawmakers voted to shut the Vermont Yankee reactor in 2012.

Related

Vermont Senate Votes to Close Nuclear Plant (February 25, 2010)

Over the last few weeks, in the buildup to a vote Wednesday in which the State Senate approved shutting down the plant, engineers have been digging well after well here in an exploratory strategy that evokes the child's game of Battleship. At each spot, workers measure the level of radioactive tritium found in the water in the hope of triangulating their way to the source of the contamination.

To avoid losing track of the wells under the blanket of snow that renews itself here every few days, the locations are marked with yellow cones like the ones janitors use to warn of wet floors.

Finding and fixing the leak would be a first step toward rebuilding the plant's credibility – crucial if the owner, the Louisiana-based nuclear company Entergy, is to persuade lawmakers to reverse their decision to force the plant to close when its license expires in 2012.

In voting 26 to 4 on Wednesday to shut the plant, senators cited the leak, a collapsed cooling tower and initial denials by company employees that underground pipes carry tritium – even though they do.

Dose Issues

- Before "effective dose," there was "critical organ dose" (ICRP 2, 1959) and focus on radiation doses to whole body, thyroid, and any other organ
- Over time there have been changes in both the biokinetics and dosimetric models
- Updated radiation protection limits –ICRP Report #103 allows for standards to consider vulnerable sub-populations
  - ✓ Standards protective of children
  - ✓ Environmental justice concerns – Native Americans
- Radionuclide "caps" (release limits) were developed based on collective dose—Is it still appropriate?
  - ✓ Proving compliance is difficult if not impossible on facility basis (based on per Gigawatt of electricity)

Other Technology Considerations

Some new applications for nuclear energy were not considered and are not covered by existing standards

- Thorium based fuel cycles
- Non-electrical energy production
  - ✓ Hydrogen cell generation
- Long term "interim" storage of spent fuel
  - ✓ 50 – 100+ years of storage possible, instead of months as envisioned in regulation
  - ✓ At current & decommissioned reactor sites, potential centralized facility(ies)
  - ✓ Fuel cladding degrades over time, releasing gases

So, Why Consider This Now? Confluence of Technical and Policy Issues

- Growing concern over groundwater contamination at/around nuclear power plants
- Re-invigorated interest in advanced nuclear technologies
  - ✓ Nuclear power seen as a possibility in reducing greenhouse gases
  - ✓ Reprocessing of spent nuclear fuel gaining interest
- Opportunity to update dosimetry
- Realization that the current construct of the regulation creates problems with enforcement (not focused on individual facilities)

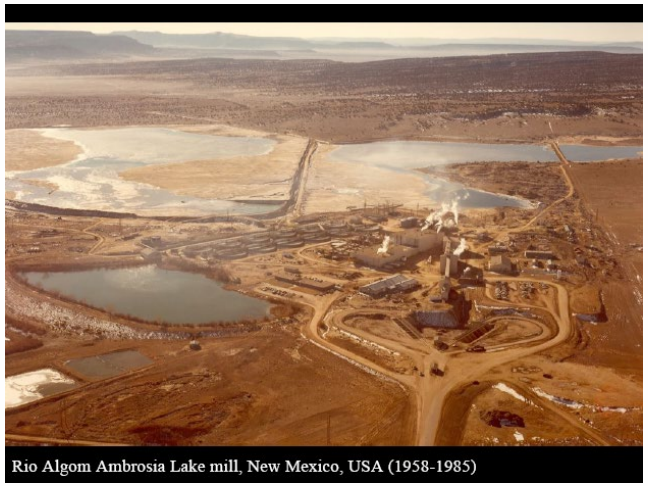
40 CFR 190 Summary

- We are currently considering whether a formal regulatory review of 40 CFR 190 is necessary
- If EPA proceeds with reviewing and revising this standard, the public review process would be an important factor in the Agency's decisions
- Would have multiple opportunities for input
  - ✓ Anticipate would do an ANPR
  - ✓ Anticipate we would have public meetings in several cities
  - ✓ Web

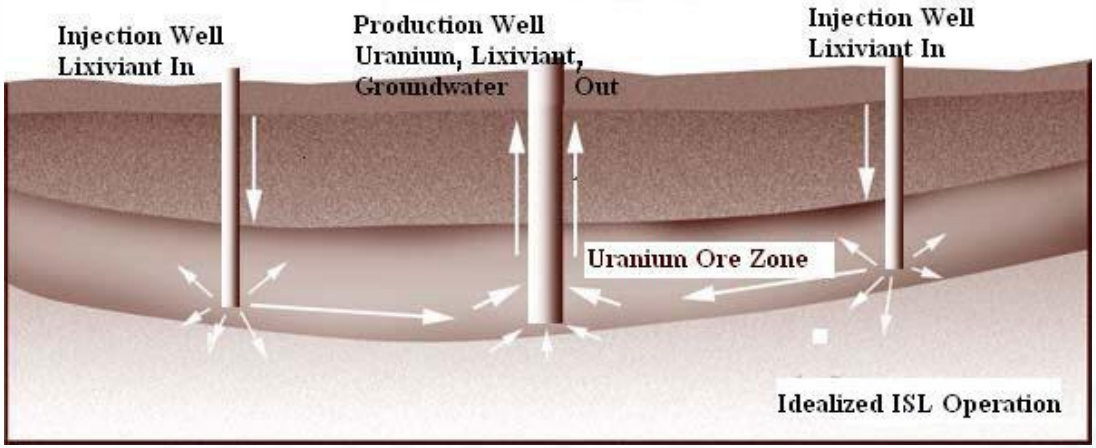
40 CFR 192: Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings

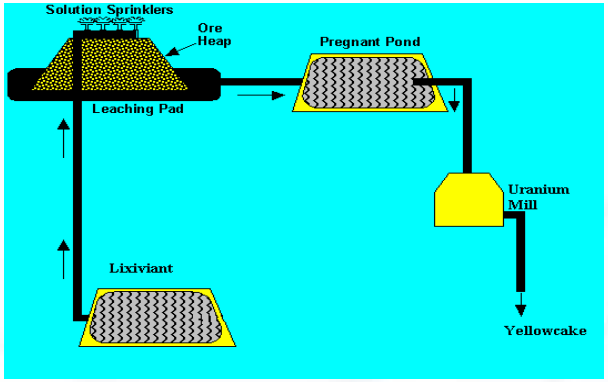
- Establishes standards for active and closed mill sites, including soil, bldg clean-up requirements
- Implemented for their oversight of uranium and thorium extraction facility licensing, operations, sites, and wastes by
  - ✓ U.S. Nuclear Regulatory Commission (NRC) and its Agreement States, and
  - ✓ U.S. Department of Energy (DOE)
- Applies to byproduct material from conventional mills, In Situ Leach/Recovery (ISL/ISR) facilities, and heap leach facilities, <u>but not conventional mines (open pit or underground)</u>
  - ✓ ISL/ISR considered to be "underground milling"

Background

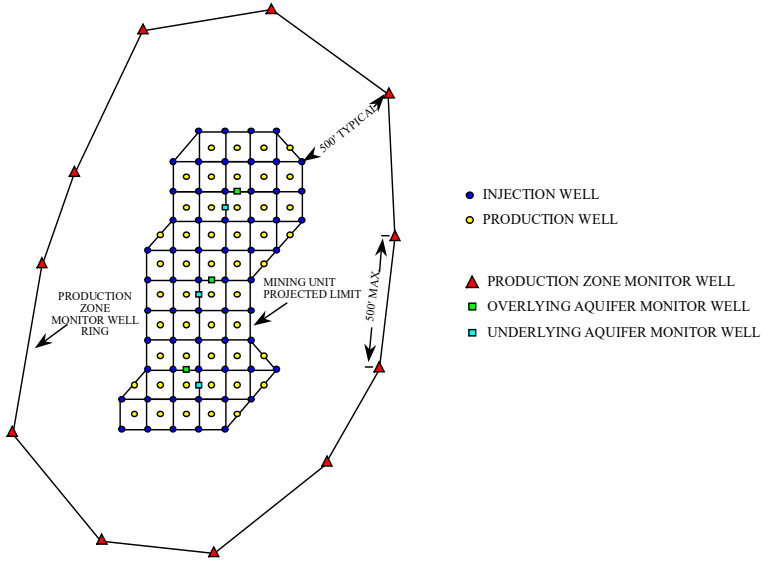

Rio Algom Ambrosia Lake mill, New Mexico, USA (1958-1985)

Conventional Surface mill





Heap leaching



Reason for Review and Update

- Over 25 years since originally finalized, ~15 years since last update for groundwater protection
- Lacks explicit provisions for In Situ Leach/Recovery (ISL/ISR), now principal means of uranium recovery in U.S., and for heap leach facilities
- Changes in EPA protective standards for hazardous substances in groundwater and drinking water
- Changes in economics of extraction & site remediation
- Changes in dose factors for radiation/radon, principal scenarios for exposure, free release of sites (ISL/ISR's) after decommissioning
- Potential for uranium extraction in new areas (e.g., VA, MI)

Status of 40 CFR 192 Efforts

- Regulation is under formal review
- Schedule for major milestones
  - ✓ Decision for option selection (go/no go) in 2011
  - ✓ If we revise the regulation, anticipate a 2012 proposal
- Focus has been:
  - ✓ External -- Public information meetings
  - ✓ Internal -- Organization and technical review

40 CFR 61 Subpart W Summary

- Applies to radon emissions from operating uranium mill tailings
  - Radon emissions flux standard: 20 pCi/m^{2}-sec
- After 12/15/1989, new impoundments were required to meet one of two new work practices
  - ✓ Phased disposal – Impoundment size $\leq$ 40 acres
  - ✓ Continuous disposal – dewatered tailings with no more than 10 acres uncovered
  - ✓ Both must meet design, construction, ground-water monitoring standards at 40 CFR 192.32(a)
- Work practices were designed to achieve at least equivalent emissions reductions as obtained by the numerical standard

Review of Subpart W

- Review began after receiving Notice of Intent to Sue (NOI) by two Colorado environmental groups
  - ✓ Based on EPA's alleged failure to review & revise regulation within ten years after enactment of Clean Air Act Amendments of 1990 (11/15/2000)
  - ✓ Plaintiffs filed suit against EPA in October 2008
  - ✓ Settlement agreement reached November 2009

- EPA is currently reviewing with intent to revise Subpart W, projected proposal, late summer 2011

Subpart W, continued

- In Situ Leach (ISL) extraction is becoming more commonplace and does not generate significant tailings, but wastes containing uranium byproduct material are placed in evaporation ponds/impoundments
- Currently 2 conventional mills and 3 ISL facilities operating
- Approximately 30 ISL operations expected
- Regulatory Reviews
  - ✓ of the current standard
  - ✓ of the original EPA radon risk assessment

Subpart W, Scientific Data/Research

- Review and compile a list of existing & proposed U mill tailing facilities & the containment technologies being used, as well as proposed
- Compare & contrast those technologies with the engineering requirements of RCRA Subtitle C land disposal facilities, which are used as the design basis for existing uranium byproduct material impoundments
  - ✓ Review regulatory history of Rad-NESHAPS and Subpart W, Tailings impoundment technologies, and radon measurement method
  - ✓ Comparison of 1989 risk assessment with current risk assessment approaches (adequacy and appropriateness)

Status of the 40 CFR Part 61, Subpart W

- Regulation is under formal review
- Schedule for major milestones
  - ✓ Decision for option selection (go/no go) in 2011
  - ✓ If we revise the regulation, expect a 2011 proposal
- Focus has been:
  - ✓ External -- Public information meetings to address settlement agreement requirements
  - ✓ Internal -- Technical review

CAP88-PC Age-Dependency Issue

- CAP88-PC is used by DOE facilities to determine compliance with 40 CFR Part 61, Subpart H
- Emissions shall not cause *any member of the public* to receive an annual effective dose equivalent > 10 mrem at any offsite point where there is a residence, school, business or office
- Current population risk estimates predict approximately 4 in 10,000 excess fatal cancers in a population exposed at 10 mrem for 70 years
- Capability now exists to calculate age-specific doses

CAP88-PC Age-Dependency Issue

- CAP88-PC v.3 users manual states: "Although FGR 13 contains age-dependent dose factors, CAP88-PC only uses the adult factors in order to maintain consistency with previous versions."
  - ✓ Maximum risk dependent on the age of an individual; would vary according to the radionuclide
- The most exposed individual may not be an adult male (Reference Man, as noted in FGR 11 and ICRP 26)
- EPA is currently researching this issue, and will make a determination on a suitable and appropriate approach

Summary

- The Agency is considering for review or reviewing
  - ✓ 40 CFR 190 (fuel cycle operations)
  - ✓ 40 CFR 192 (uranium mills)
  - ✓ 40 CFR 61, Subpart W (radon emissions from operating uranium facilities)

- The Agency is revising its CAP88-PC air modeling computer code used for DOE facilities