NRC Licensing for Radium-223 Dichloride

An Overview of Radiation Safety Considerations

Ashley M. Cockerham
Health Physicist

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Overview

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Licensing decision
- Regulatory review
- Licensing challenges

Licensing Decision

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- 10 Code of Federal Regulations (CFR) Part 35 Subpart E – unsealed byproduct material – written directive required

- 10 CFR 35.390 or 35.396 training and experience appropriate

Activity Measurements

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Regulations
  - 10 CFR Part 35 Subpart C – general technical requirements
  - 10 CFR Part 20 Subpart F – surveys and monitoring

- Ion chamber dose calibrator
  - Reference standard
    - Half life less than 120 days, quantity less than 15 mCi
  - Single dial setting
  - No geometrical testing required

Contamination Surveys

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Regulations
  - 10 CFR Part 20 Subpart F – surveys and monitoring
  - 10 CFR 35.70 surveys

- Geiger-Mueller (GM) detectors with pancake probe
- Sodium Iodide (NaI) well counters

Long-lived Contaminants

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Regulations
  - 10 CFR Part 20 Subpart K – waste disposal
    - 10 CFR 35.92 decay-in-storage

- Thorium-227 ($t_{1/2}$=18.7 days)
- Actinium-227 ($t_{1/2}$=22 years)
- No results above limit of detection during purity testing

Annual Limits on Intake

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Regulations
  - 10 CFR Part 20 Subparts C, D, and F
  - 10 CFR Part 20 Appendix B
    - Radium-223 Inhalation ALI: 0.7 µCi
    - Radium-223 Ingestion ALI: 5 µCi

- Not volatile or easily respirable
- Ingestion unlikely

Patient Release

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Regulations
  - 10 CFR 35.75 release of individuals containing unsealed byproduct material or implants containing byproduct material

- Exposure to other individuals not likely to exceed 5 mSv
- Licensees may authorize immediate release
- Instructions not required

- Instructions available from Bayer
  - Patient treatment card
  - Security alarms from residual activity
  - Clean up of bodily wastes
  - Proper hygiene

Training

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Regulations
  - 10 CFR 35.390 training for use of unsealed byproduct material for which a written directive is required
  - 10 CFR 35.396 training for the parenteral administration of unsealed byproduct material requiring a written directive

- Parenteral administration
  - Affinity for target tissue
  - Measurability due to photons

Training (cont.)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Regulations
  - 10 CFR 35.390(b)(1)(ii)(G)(3) parenteral administration of any beta emitter, or a photon-emitting radionuclide with a photon energy less than 150 keV, for which a written directive is required
  - Ra-223 primarily used for its alpha-emitting properties
  - Ra-223 also emits betas and photons

Procedures

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Regulations
  - 10 CFR 35.41 procedures for administrations requiring a written directive
  - 10 CFR 20.1101 radiation protection programs

- Secure line
- Flush with saline
- Inject Ra-223 Dichloride
- Flush with saline

- Treat equipment used as radioactive waste

Dosimetry

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Regulations
  - 10 CFR 35.3045 report and notification of a medical event

- Excerpt of chart

Target Organ	Mean (Gy/MBq)	Mean (rad/mCi)
Small intestine wall	0.00726	26.87
Whole body	0.02311	85.50
Upper large intestine wall	0.03232	119.58
Lower large intestine wall	0.04645	171.88
Red marrow	0.13879	513.51
Osteogenic (bone) cells	1.15206	4262.60

Distribution

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Regulations
  - 10 CFR 35.300 use of unsealed byproduct material for which a written directive is required

- Unit dosages, no end user manipulation
- Non-commercial: direct from Norwegian manufacturer
- Commercial: from U.S. central radiopharmacy

Other Considerations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Regulations
  - 10 Code of Federal Regulations (CFR) Part 35 Subpart E – unsealed byproduct material – written directive required

vs

  - 10 CFR 35 Subpart K (35.1000) other medical uses of byproduct material or radiation from byproduct material

Advisory Committee Review

- Public meetings
  - April 17, 2012
  - July 9, 2012
  - September 20, 2012
- Advisory Committee on the Medical Uses of Isotopes (ACMUI) recommended licensing under 10 CFR Subpart E, including training under 10 CFR 35.390 or 10 CFR 35.396
- NRC accepted recommendation

Advisory Committee Review (cont.)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Clinical background
- Training for physicians
- Radiation Safety
- Logistical considerations

Licensing Challenges

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Questions received from NRC licensing staff and Agreement States
  - Limited and broad scope licenses
  - Storage
  - Distribution
  - Waste handling