

MEDICAL RADIATION SAFETY  
OFFICER'S REVIEW  
2017 AAPM SPRING CLINICAL  
MEETING

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**I Have No Disclosures**

# RSO: Role –Medical Setting

- ▣ Radioactive Materials License:
  - NRC or Agreement State
  - Broad Scope & Medical Component
  - Limited License
  - Regulations - Basis
  - Nuclear Regulatory Commission (NRC) Code of Federal Regulations
    - 10 CFR 19: Notices Instructions
    - 10CFR 20: Standards For Radiation Protection
    - 10 CFR 35: Medical Use of Byproduct Material
    - 10 CFR 37: Physical Protection of category 1 & 2 Quantities of RAM
    - 10 CFR 71: Packaging and Transportation of Radioactive Material
    - 10 CFR 150.20: Reciprocity: Recognition of Agreement State Licenses
  - Radiation Safety Committee
    - Meeting Frequency F(x) Radioactive Materials License
    - Topics

# Supporting Documentation

- ▣ **Regulatory Guides**
- ▣ Volume 9, Rev. 2, Program-Specific Guidance About Medical Use Licenses
- ▣ Volume 9, Rev. 3, Program-Specific Guidance About Medical Use Licenses (Out For Comment)
- ▣ Volume 11, Program-Specific Guidance About Licenses of Broad Scope
- ▣ Radiation Dose Estimates for Radiopharmaceuticals (NUREG/CR-6345), April 1996
  - ▣ RG 8.9 - Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program
  - ▣ RG 8.13 - Instruction Concerning Prenatal Radiation Exposure
  - ▣ RG 8.20 - Applications for Bioassay for I-125 and -131
  - ▣ RG 8.29 - Instruction Concerning Risks from Occupational Radiation Exposure
- ▣ RG 8.35 - Planned Special Exposures
- ▣ RG 8.36 - Radiation Dose to the Embryo/Fetus

# Supporting Documentation

- ▣ **Regulatory Guides**

- ▣ [Volume 9, Rev. 2](#), Program-Specific Guidance About Medical Use Licenses
- ▣ [Volume 9, Rev. 3](#), Program-Specific Guidance About Medical Use Licenses (Out For Comment)
- ▣ [Volume 11](#), Program-Specific Guidance About Licenses of Broad Scope
- ▣ Radiation Dose Estimates for Radiopharmaceuticals ([NUREG/CR-6345](#)), April 1996
- ▣ Other Supporting Documents/Resources
- ▣ Complying with 10 CFR 35.400(a), 35.500(a), and 35.600(a) requirements for licensees to only use sources and devices "as approved in the [Sealed Sources and Devices Registry](#)" and "[Sealed Source and Device Registry: Supplement for 10 CFR Part 35 Uses](#)."

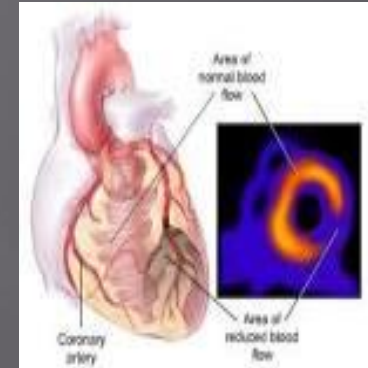
- ▣ [High Dose-Rate Remote Afterloader Brachytherapy Devices Approved for Patient Treatment Using Sources Exceeding 10 Curies](#) - provides a list of high dose-rate remote Afterloader brachytherapy devices that are FDA-approved for patient treatment using sources exceeding 10 Curies.

# Supporting Documentation

- ▣ NUREG-2155 – "Implementation Guidance for 10 CFR Part 37, Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material," dated February 2013
- ▣ NUREG-2166 – "Physical Security Best Practices for the Protection of Risk-Significant Radioactive Material," dated May 2014
- ▣ Part 37 rule/Security order comparison (Enclosure 2 to SECY-11-070)

## ▣ Radioactive Material - Unsealed Sources

- Nuclear Medicine
  - ▣ Diagnostic
    - Radionuclides
    - Clinical Procedures
  - ▣ Therapeutic
    - Radionuclides
    - Clinical Procedures

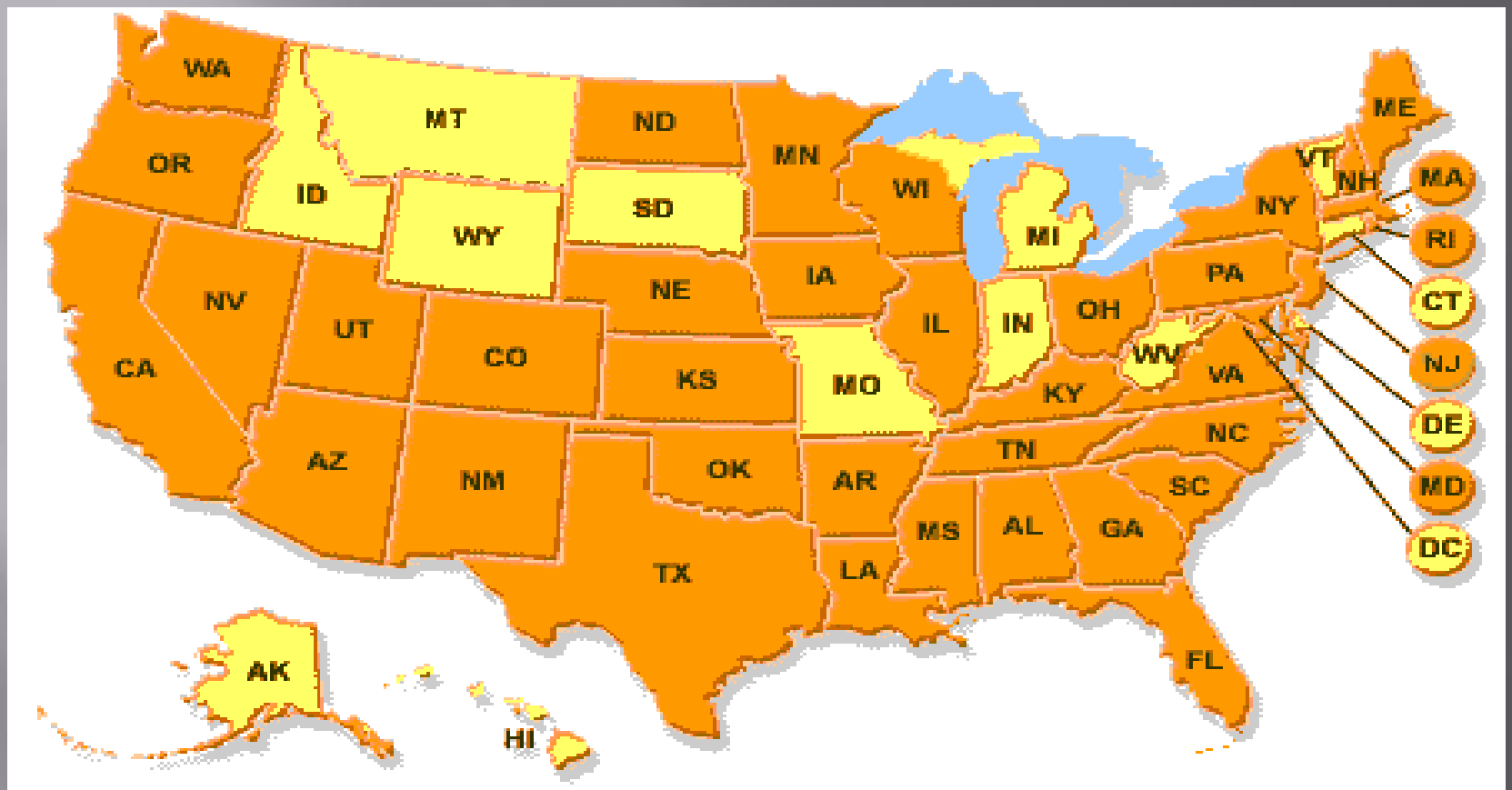


## ▣ Radioactive Material – Sealed Sources

- Nuclear Medicine
  - ▣ Reference Sources
    - Flood Source
    - Dose Calibrator Sources
    - Anatomical Marking Source
    - Check Sources
- Irradiators
  - ▣ Blood
  - ▣ Research



# Sources of Exposure – Medical Setting



RAM NRC/Agreement States



**Common**

- **<sup>99m</sup>Tc**: MDP, HDP, Sulfur Colloid, Ceretec, Myoview, Cardiolite, Neurolite, MAA, Choletec, DTPA, DMSA, MAG3, Fanolesomab, & WBC
- **<sup>201</sup>Tl**: Chloride
- **<sup>123</sup> & <sup>131</sup>I**:  
Iodomethylnorcholesterol, Tositumomab, MIBG, OIH, & NA I
- **<sup>111</sup>In**: Pentriotide & WBC
- **<sup>67</sup>Ga**: Citrate
- **<sup>14</sup>C**:
- **<sup>18</sup>F**: FDG
- **<sup>82</sup>Rb**: Chloride

Name & Radiation	Half Life ( $T_{1/2}$ )	Energy (keV)	Medical Use
$^{99m}\text{Tc} - \gamma$	6.04 hr.	140	Many
$^{210}\text{Tl} - \gamma$	73.0 hr.	69-83 Hg X-rays	Myocardial Perfusion
$^{123}\text{I} - \gamma$	13.1 hr.	159	Thyroid Uptake & Scan
$^{131}\text{I} - \gamma$	8.1 d	364	Thyroid
$^{111}\text{In} - \gamma$	2.8 d	173, 247	Tag Wbc's & others
$^{67}\text{Ga} - \gamma$	78.3 h	93, 184, & 300	Infection, Tumor etc.
$^{14}\text{C} - \beta^-$	5730 y	156.5	H Pylori
$^{18}\text{F} - \beta^+$	110 m	511	Tumor, brain, & cardiac
$^{82}\text{Rb} - \beta^+$	1.3 m	511	Cardiac

# Nuclear Medicine – Diagnostic

## ▣ Common R<sub>x</sub> Radiopharmaceuticals

- <sup>131</sup>I: Sodium Iodine
- <sup>223</sup>Ra: Xofigo
- <sup>32</sup>P: Sodium Phosphate or Polycythemia Vera
- <sup>89</sup>Sr: Chloride
- <sup>90</sup>Sr: Zevalin
- <sup>153</sup>Sm: EDTMP
- <sup>90</sup>Y: Sirspheres Theraspheres

Name & Radiation	Half Life (T <sub>1/2</sub> )	Energy (kEv)	Medical Use
<sup>131</sup> I - γ & (β-)	8.1 d	364 (606)	Thyroid
<sup>223</sup> Ra - α	11.4 d	5606	Prostate
<sup>32</sup> P - β-	14.3 d	1710	RBC Poly Phosphate - METS
<sup>89</sup> Sr - β-	50.5 d	1463	Bone Pain & Mets
<sup>90</sup> Sr - β-	28.6 y	546	MoAb RIT
<sup>153</sup> Sm - β-, (γ)	46.7 h	632, 702, 805 (103)	Bone Pain & Mets
<sup>90</sup> Y - β-	64 h	2284	MoAb RIT

## Nuclear Medicine – Therapy

- ▣ **Common  $R_x$  Radionuclides**
  - **$^{60}\text{Co}$** : Gamma Knife
  - **$^{137}\text{Cs}$** : GYN Implants; C&T
  - **$^{192}\text{Ir}$** : HDR & Mammosite
  - **$^{125}\text{I}$** : Eye Plaque
  - **$^{103}\text{Pd}$** : Prostate
  - **$^{90}\text{Y}$** : Sirspheres & Theraspheres

Name & Use	Half Life ( $T_{1/2}$ ) & Energy (mEv)	Exposure Rate Constant ( $\Gamma$ ) Rcm <sup>2</sup> / mCi-hr	Half Value Layer (Pb mm)
$^{60}\text{Co}$	5.26 y 1.17 & 1.33	13.07	11
$^{137}\text{Cs}$	30.0 y 0.662	3.26	5.5
$^{192}\text{Ir}$	73.8 d 0.380 Ave.	4.69	2.5
$^{125}\text{I}$	60 d 0.028 Ave.	1.46	0.025
$^{103}\text{Pd}$	17 d 0.021 Ave.	1.48	0.008
$^{90}\text{Y}$ - $\beta$ -	64 h	2284	MoAb RIT

## Radiation Therapy – Brachytherapy

Name	Half Life ( $T_{1/2}$ ) & Energy (mEv)	Calibration Use	Geometry
$^{60}\text{Co}$	5.26 y 1.17 & 1.33	NM Dose Calibrator & Therapy Chambers	Vial or Chamber
$^{137}\text{Cs}$	30.0 y 0.662	NM Dose Calibrator, Well Counters, Survey Meters, & Therapy Chambers	Vial, Rod, Survey Meter, & Button Check Source
$^{57}\text{Co}$	270.1 d 0.122	Dose Calibrator, Well Counters, & Gamma Camera	Vial, Rod, Flood, or button Check Source
$^{133}\text{Ba}$	10.54 y 0.358	Dose Calibrator, Thyroid Uptake Probes, & Well Counters	Vial, or Rod Check Source
$^{129}\text{I}$	59.4 d 0.028	Well Counter, Uptake Probe, Ionization Chambers	Rod, Chamber Source

## Nuclear Medicine & Radiation Therapy Calibration Sources



## Nuclear Medicine Calibration Sources

# Clinical Procedures

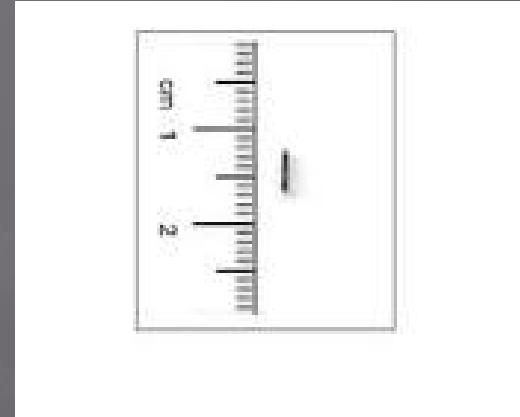
- Stereotactic
- Radiosurgery (SRS)

## Radionuclides

- Clinical Procedures
- Radiation Oncology –  
Unsealed Sources

## Radionuclides

- Clinical Procedures



**Brachytherapy: Prostate Seed & Clinical  
HDR Applicators**

▣ **Sources of Exposure – Medical Setting**

- Radiation Oncology – Sealed Sources
  - ▣ Brachytherapy Sources
    - Low Dose Brachytherapy (LDR)
      - Manual Brachytherapy
      - Radionuclides
      - Clinical Procedures
    - High Dose Brachytherapy (HDR)
      - High Dose Remote After loaders
      - Radionuclides
      - Clinical Procedures
      - Gamma Knife
      - Radionuclide



▣ **Clinical Procedures**

- Stereotactic Radiosurgery (SRS)
- Radionuclides
- Clinical Procedures
- Radiation Oncology – Unsealed Sources
- Radionuclides
- Clinical Procedures



## Brachytherapy – Clinical Applicators



# 10 CFR Part 37—Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material

The objective of 10 CFR Part 37 is to provide reasonable assurance of preventing the theft or diversion of Category 1 and Category 2 quantities of radioactive materials.

The new 10 CFR Part 37 was effective on May 20, 2013, and NRC licensees were to comply with the requirements by March 19, 2014. The NRC confirmed the Agreement States' adoption of adequate and compatible 10 CFR Part 37 requirements by the March 19, 2016, deadline.

[Academic and Research Licensees](#)

[Medical Licensees](#)



# Table 1—Category 1 and Category 2 Threshold

Radioactive material	Category 1 (TBq)	Category 1 (Ci)	Category 2 (TBq)	Category 2 (Ci)
Cobalt-60	30	810	0.3	8.10
Cesium-137	100	2,700	1	27.0
Iridium-192	80	2,160	0.8	21.6

- Low Dose Rate Brachytherapy
- High Dose Rate Brachytherapy
- Gamma Knife
- Radionuclide Therapy
  - $^{131}\text{I}$  Thyroid
  - $^{131}\text{I}$  Bexar
  - $^{90}\text{Y}$  SirSphere & Theraspheres
  - $^{153}\text{Sm}$ ,  $^{89}\text{Sr}$ ,
  - $^{223}\text{Ra}$



## Rx Sealed & Unsealed Sources

## RESEARCH IRRADIATOR



## BLOOD IRRADIATOR



Sources Of Medical Exposure

## GAMMA KNIFE



## HDR SYSTEM



## Radiation Oncology

## LOW DOSE BRACHYTHERAPY

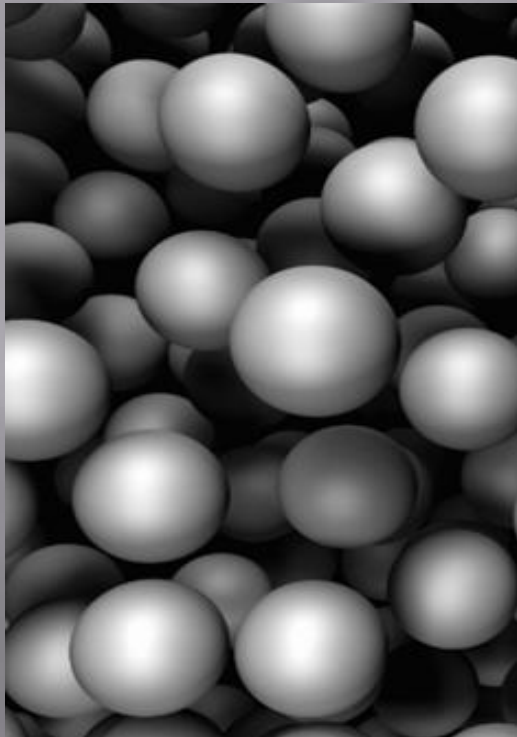


## HIGH DOSE BRACHYTHERAPY



Sources Of Medical Exposure Radiation  
Oncology

SIRSPHERES



THERASPHERES



Radiation Oncology Sealed Source Therapy

RADIOGRAPHIC  
FLUOROSCOPIC  
DIGITAL ROOM



BONE DENSITY



Radiology Devices



CT



MRI



Radiology Devices



# PET/CT SCANNER



## CATH & INTERVENTIONAL



## SURGERY



Radiology Devices

# STEREOTACTIC MAMMOGRAPHY

## DIGITAL MAMMO



Radiology Devices

- Stereotactic
- Tomosynthesis
- Film/Screen
- Faxitron



## Mammography

LINEAR ACCELERATOR



CT SIM



Radiation Oncology

## ▣ Radiographic

- Fixed Devices
- Bone Mineral
- Mobile Devices

## ▣ Fluoroscopic

- Diagnostic
- Cardiology
- Interventional
- Surgery
- Endoscopy
- Pulmonary
- Pain Management



**X-Ray Devices**

## ▣ Mobile Fluoroscopic Devices

- C-arms
- O-arms



## ▣ CT Scanning

- Axial
- Helical
- Dual Source
- PET/CT
- SPECT/CT



**X-Ray Devices**

## ▣ Dental

- Intraoral
- Extraoral
- Panoramic
- Cephalometric
- Digital Radiography & Cone Beam (CB)
- Charge Couple Devices (CCD)
- Photostimulable Storage Phosphors Receptor



**X-Ray Devices**



# Ultrasound



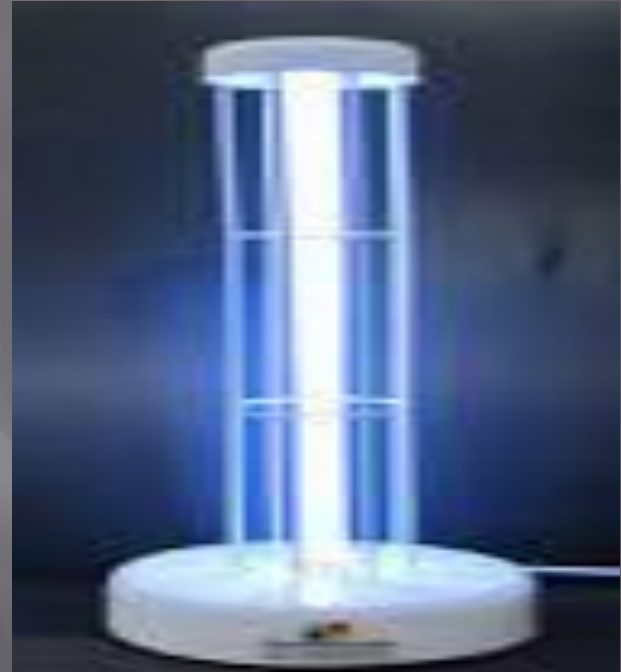
# Diagnostic Review Work Stations



LASERS



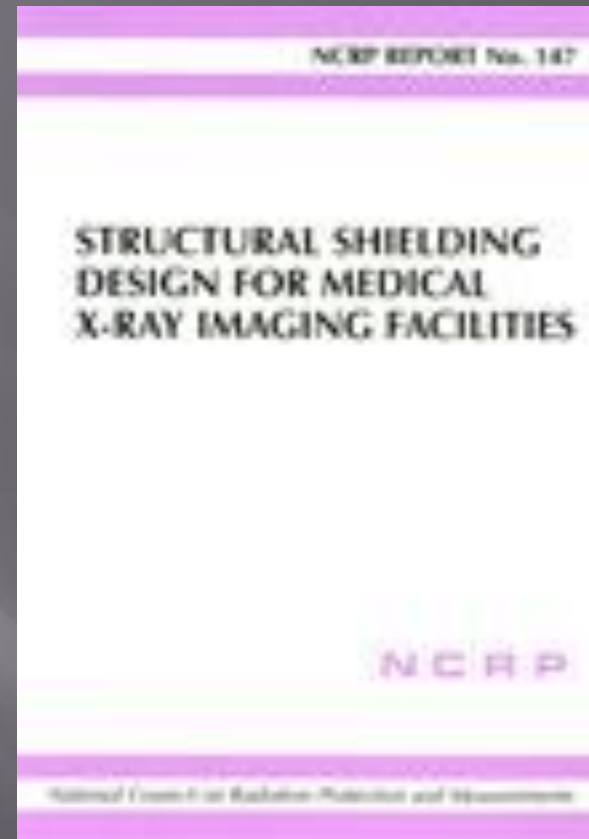
UV LIGHTS



Sources Of Medical Exposure Non Ionizing

## ▣ Site Planning

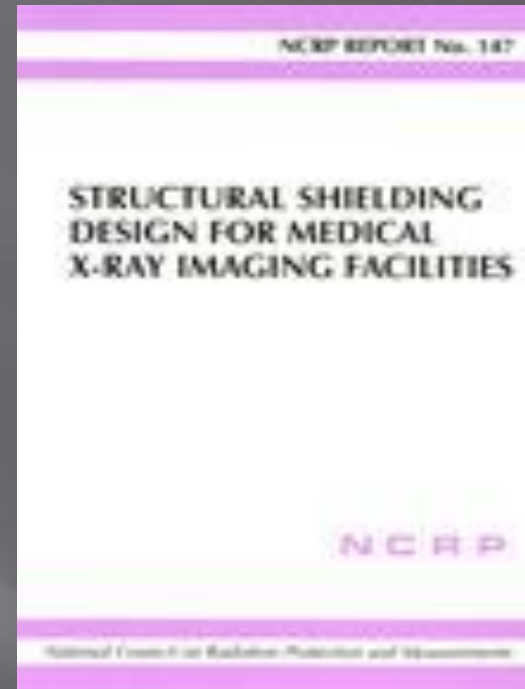
- Diagnostic Radiology
- Radiographic
- Fluoroscopic
- Cath/EP & Interventional
- CT
- SPECT/CT & PET/CT
- Mammography



# Diagnostic Shielding

## ▣ Site Planning NCRP Report 147

- Bone Density
- Dental
- Pain Management
- Surgery Centers



# Diagnostic Shielding Design

## ▣ Diagnostic Radiology

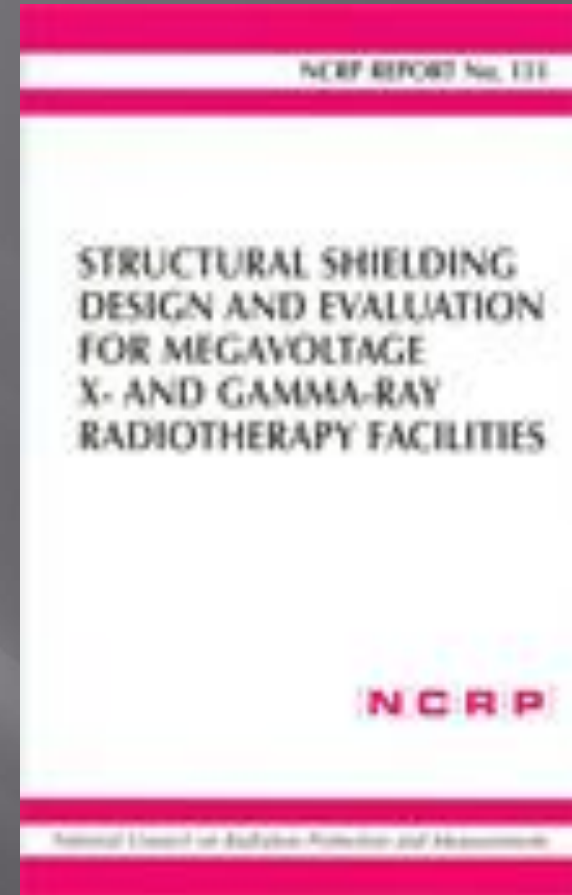
- Radiographic/Fluoroscopic
- Cath/EP & Interventional
- CT
- SPECT/CT & PET/CT
- Mammography
- Bone Density
- Dental
- Pain Clinics
- Surgery



## Radiation Protection Surveys

## ▣ Therapeutic Shielding Design; NCRP Report 151

- External Beam
  - Low Energy Accelerators
  - High Energy Accelerators
- ▣ Total Body Irradiation (TBI)
- ▣ Stereotactic Radiosurgery (SRS)
- ▣ Intensity Modulated Radiation Therapy (IMRT)
- ▣ Stereotactic Radiotherapy (SRT)
- ▣ Neutron Shielding, Skyshine, Intraoperative
  - Surgery Procedures



# Therapeutic Shielding Design

- Nuclear Medicine
- Diagnostic Radiology
- Radiation Oncology
- Non Ionizing Radiation

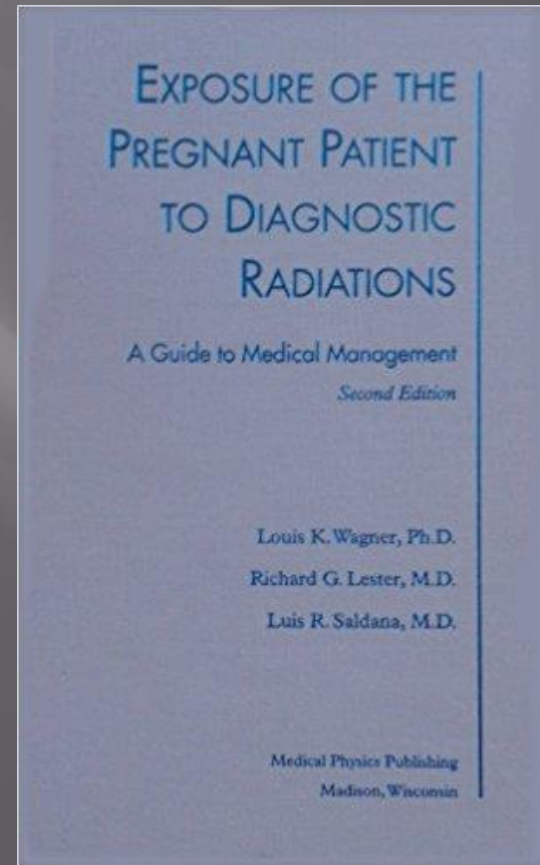


## Radiation Protection In Medicine



# Patient Safety

- ▣ Review IR, Cath Lab, EP & Diagnostic Procedures – Patient Exposure – Air Kerma
- ▣ Patient Dose Estimates
  - Fetal Dose Calculations
  - (Great Resource)



- ▣ Nuclear Medicine
- ▣ Diagnostic Radiology
- ▣ Operating Suites
- ▣ Lab
- ▣ Research Labs
- ▣ Radiation Oncology
- ▣ Pulmonary, Pain
- ▣ Endoscopy



## Occupational Monitoring

## ▣ Nuclear Medicine

- Adult Patient
- Pediatric Patient
- Pregnant & or Breast Feeding Patient



Limiting Patient Exposure

## ▣ **Diagnostic Radiology**

- Adult Patient
- Pediatric Patient
- Pregnant & or Breast Feeding Patient

## ▣ **Radiation Oncology**

- Adult Patient
- Pediatric Patient
- Pregnant

**Limiting Patient Exposure**

# Joint Commission (JC)

## ▣ Key Areas:

- Aprons & Protective Devices – Inventory & Tracking
- Dose Monitoring & Dose Metrics
  - ▣ Dose Alerts – CT
- XR-29 Compliance & CT
- Other Tidbits
  - ▣ CR – DR Conversion & CMS Payments

# Thank You

▣ Think Spring

