Regulatory Guidelines and Computational Methods for Safe Release of Radioactive Patients

II. Brachytherapy

Firas Mourtada, Ph.D., DABR

Chief of Clinical Physics
Helen F. Graham Cancer Center
Christiana Care Health System
Newark, Delaware

Associate Professor
Radiation Oncology Department
Kimmel Cancer Center
Thomas Jefferson University
Philadelphia, PA

Disclosures

- None

Talk Objectives

- Describe General Sealed Source Brachytherapy Applications
- Summarize NRC Rulings
- Describe Release Methods for LDR sources

Talk Objectives

- **Describe General Sealed Source Brachytherapy Applications**
- Summarize NRC Rulings
- Describe Release Methods for LDR sources

Introduction

- Brachy : short
- Brachytherapy: Therapy at a short distance
- Brachytherapy refers to radiation therapy that involves the application of radioactive material directly into or immediately adjacent to the tumor.

Brachytherapy Treatments

- Low Dose Rate vs. High Dose Rate
- Techniques
  - Intracavitary
  - Interstitial
  - Intraluminal
  - Surface (topical)
- Definitive vs. Boost
  - Example of definitive treatment - prostate implant
  - Example of boost treatment - cervical implant

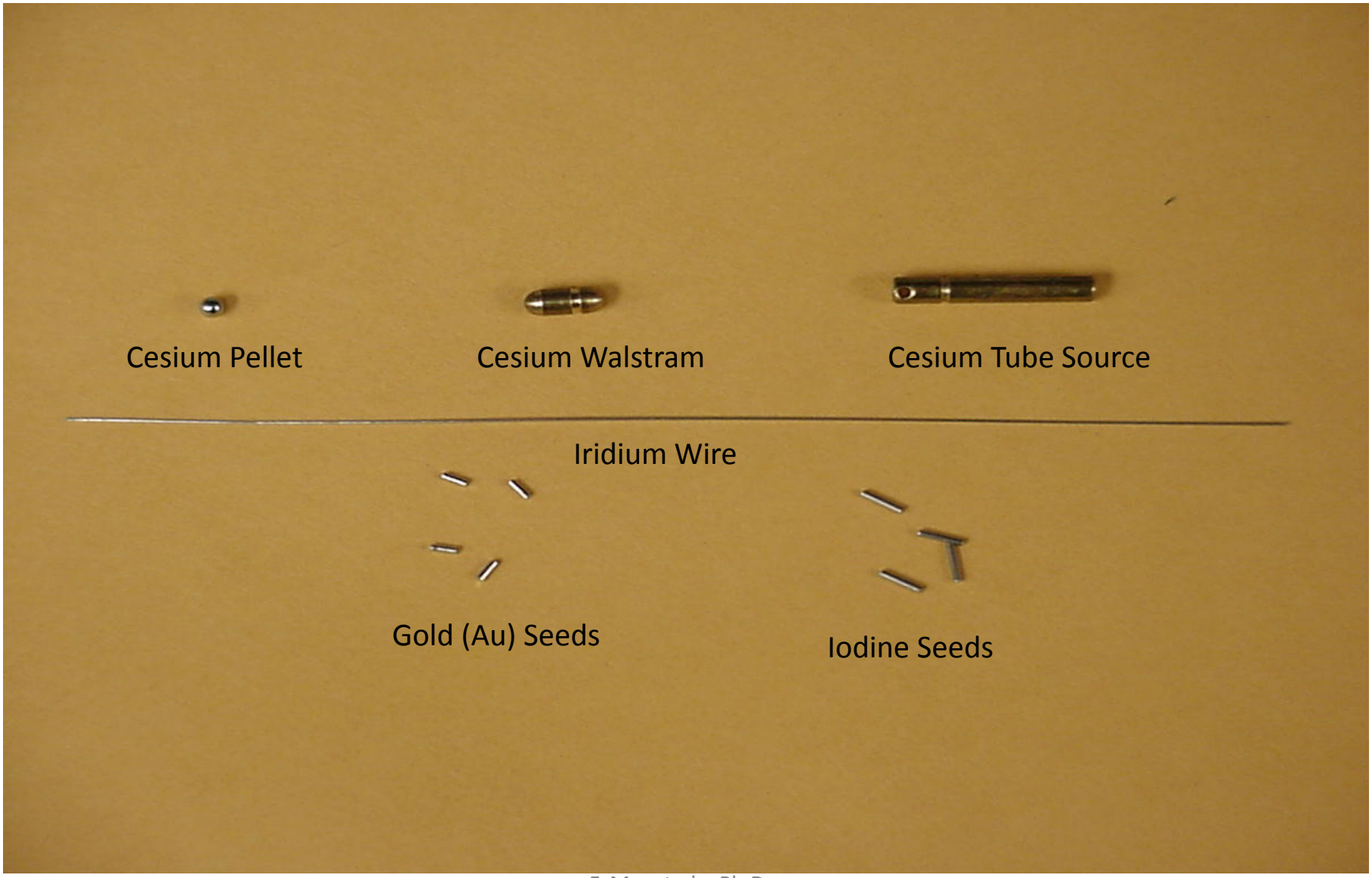
Dose Rate in Brachytherapy

- Low Dose Rate (LDR):
  - Range of 0.4 to 2.0 Gy/hr (per ICRU #38)
  - Time to deliver prescription is days
- High Dose Rate (HDR)
  - Dose rate > 12 Gy/hr (per ICRU #38)
  - Time to deliver prescription is minutes
- Note: Medium Dose Rate (MDR)
  - Dose rate between LDR and HDR
  - Not as common in the USA

From Multiple Sources/Manual Loading to a Single Source/Afterloading

Ra-226 Tubes →Cs-137 Tubes/Manual Loading →Cs-137 Pellet LDR → Ir-192 PDR/HDR

Manual LDR Sources (MDACC)

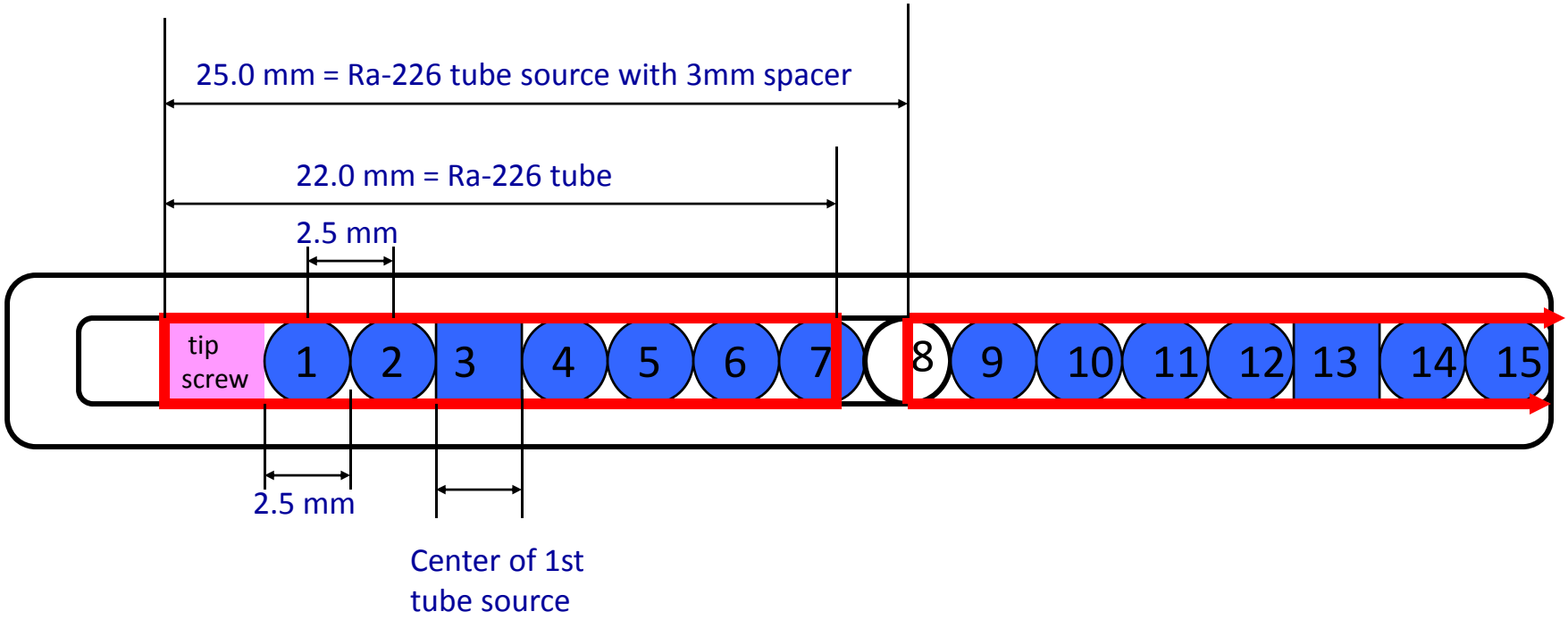


Selectron LDR Afterloaders

- ^{137}Cs Pellets sorted magnetically
- Active pellets stored in radiation protection safe
- Program active and inactive pellets in each channel
- Programmed pellets, in intermediate safe
- Compressed air transfer of pellets

MD Anderson, Houston, Tx

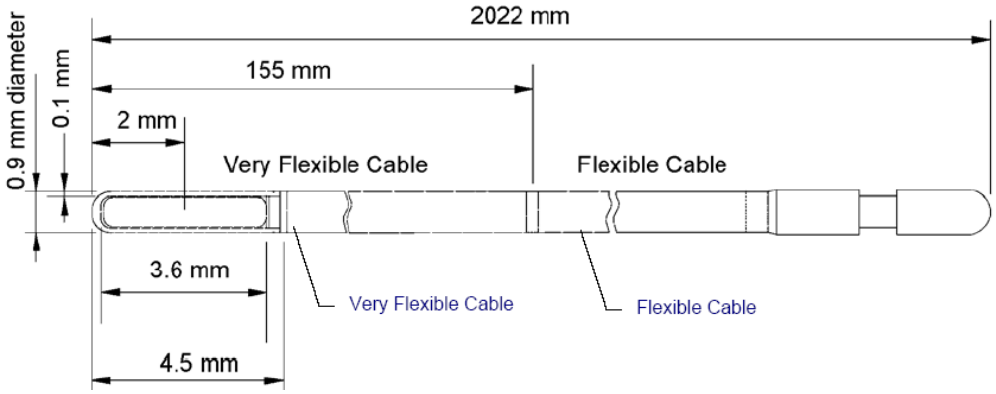
Radium Tubes Sources to Cesium Selectron Pellets in the Tandem

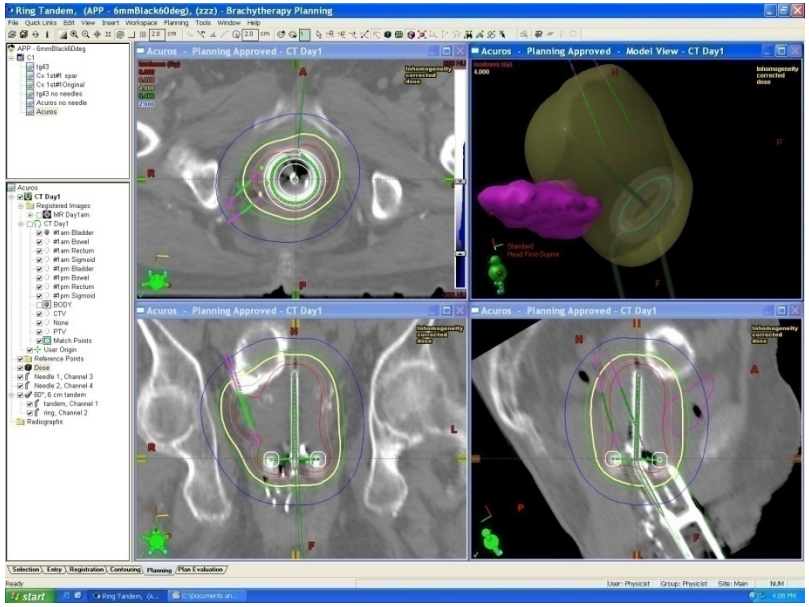


Note: each pellet has a nominal activity of 5 mgRaeq.

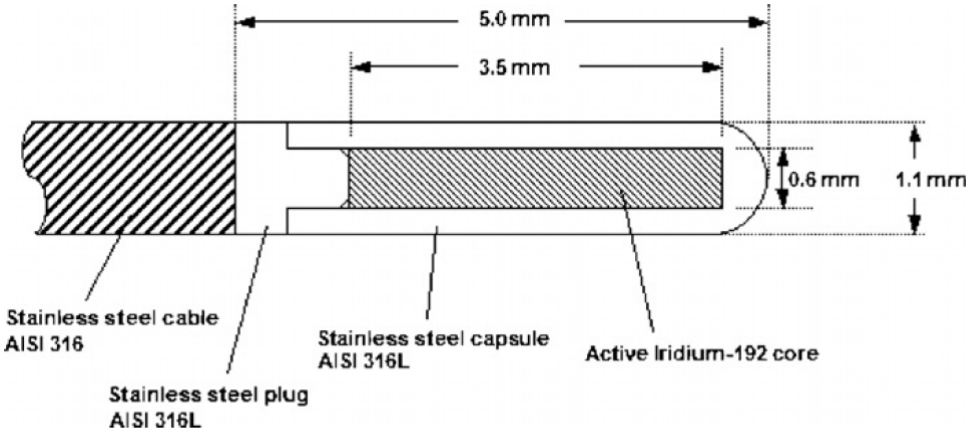
HDR/PDR Remote Afterloader

HDR: 10 Ci
PDR: 1-2 Ci





High-Energy Brachytherapy Sources-examples



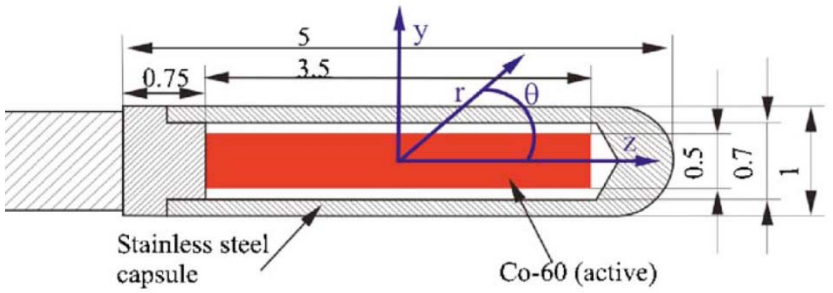


Figure 1. Schematic drawing of the Nucletron 'Classic' ^{192}Ir HDR brachytherapy source.

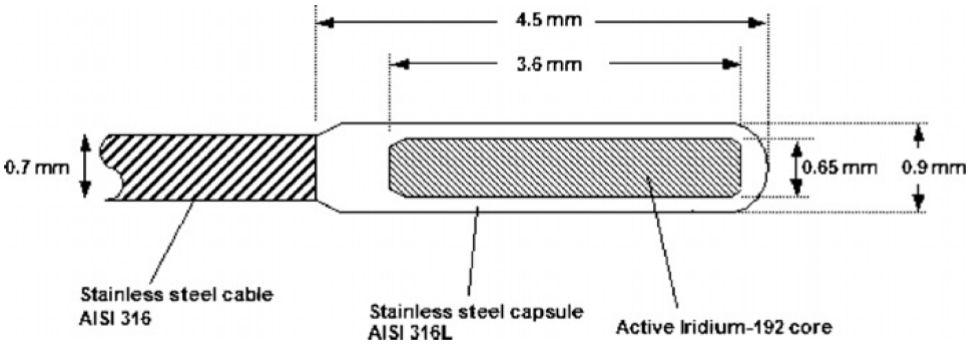
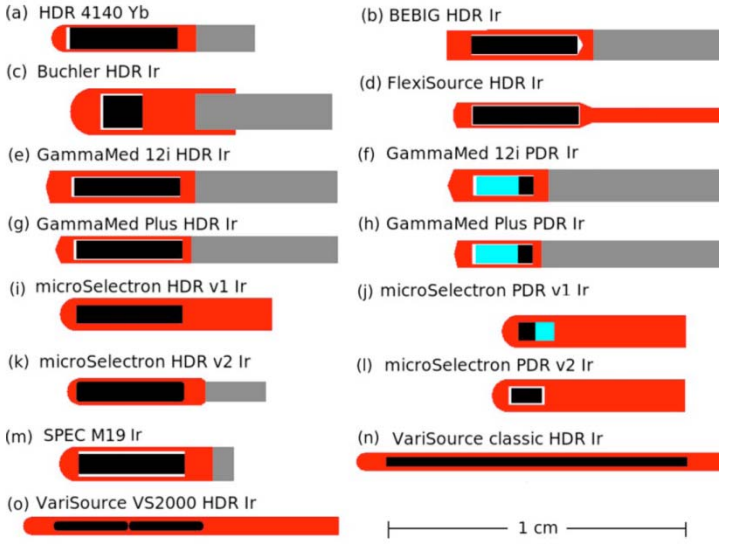
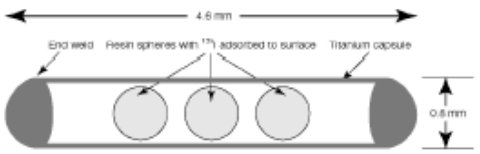


Figure 2. Schematic drawing of the Nucletron 'V2' ^{192}Ir HDR brachytherapy source.

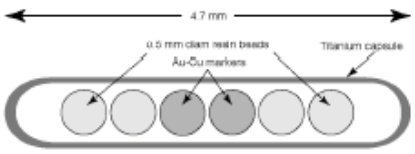


From MJ Rivard

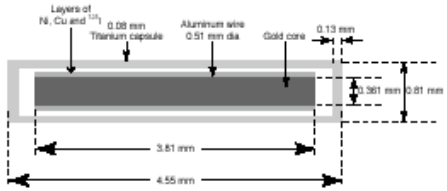
Low-Energy Brachytherapy Sources- examples



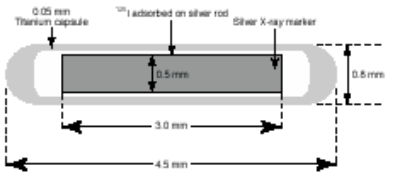
Amersham Health model 6702 source



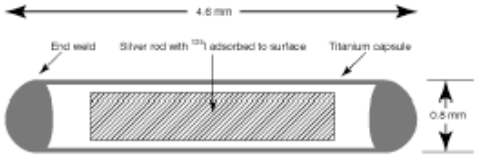
NASI model MED3631-A/M or MED3633 source



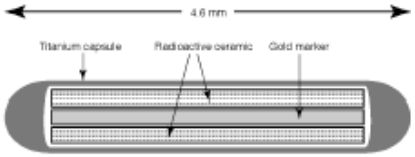
Source Tech Medical
STM1251 seed



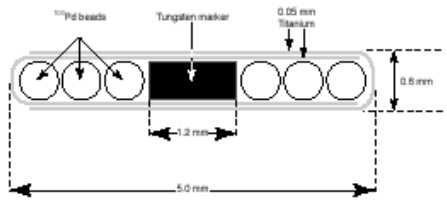
IsoAid Advantage



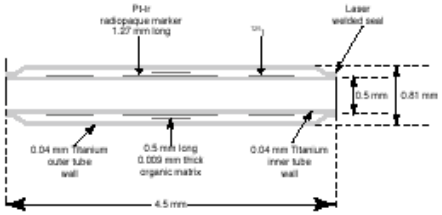
Amersham-Health model 6711 source



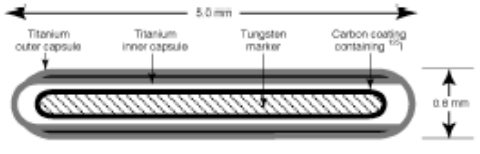
Bebig model I25.S06 source



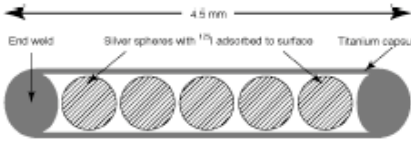
Best Pd



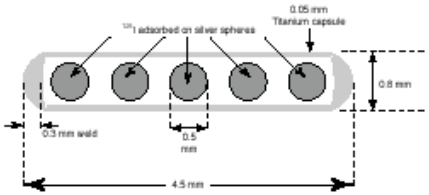
International Brachytherapy
InterSource



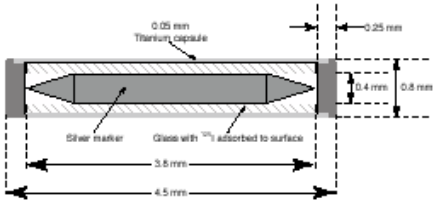
Best model 2301 source



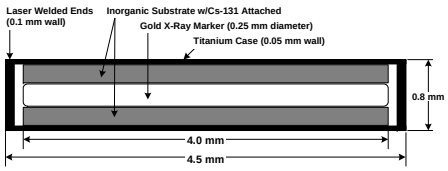
Imagyn model IS-I2501 source



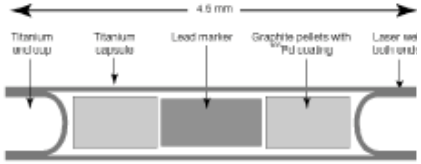
Mentor Prostaseed



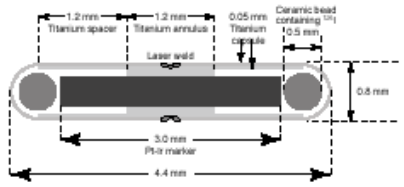
Implant Sciences 3500



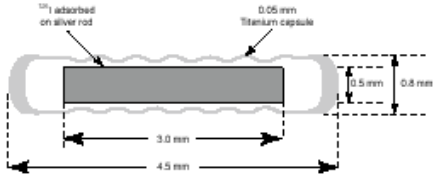
IsoRay model CS-1 Rev2



Theragenics model 200 source



DraxImage LS-1



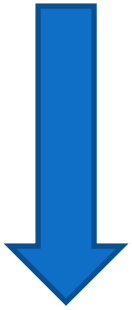
Amersham 6733

From MJ Rivard

Most Common Radionuclides in Brachytherapy (LDR/HDR)

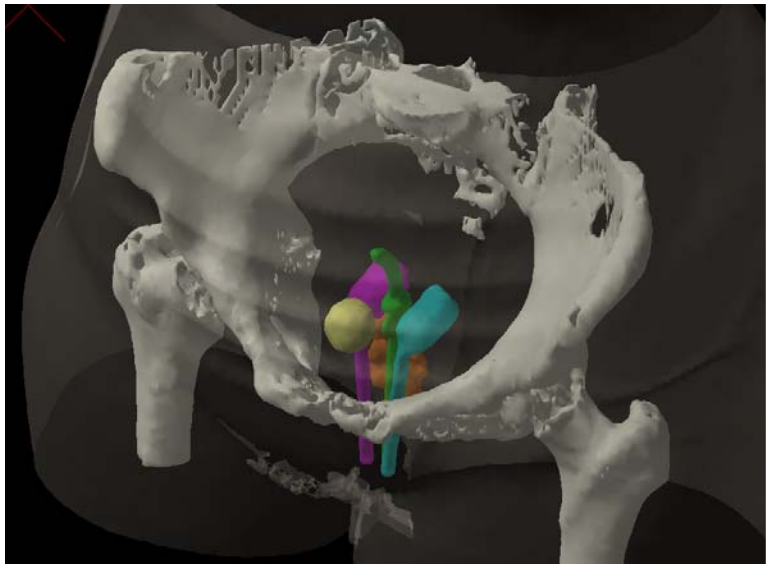
Isotope	$T_{1/2}$	E_{avg}(KeV)
^{226}Ra	1,622 y	830
^{60}Co	5.26 y	1,250
^{137}Cs	30 y	662
^{192}Ir	74.1 d	380
^{198}Au	2.7 d	410
^{131}Cs	~10 d	29
^{125}I	~60 d	28
^{103}Pd	~17 d	22

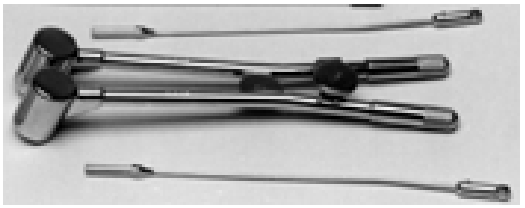
Low E (<50 keV)



ICBT- Gynecology

- Intracavitary: Places radioactive sources within a body cavity (cervical cancer)
- LDR (temporary, 48hrs) or HDR (temporary, minutes)





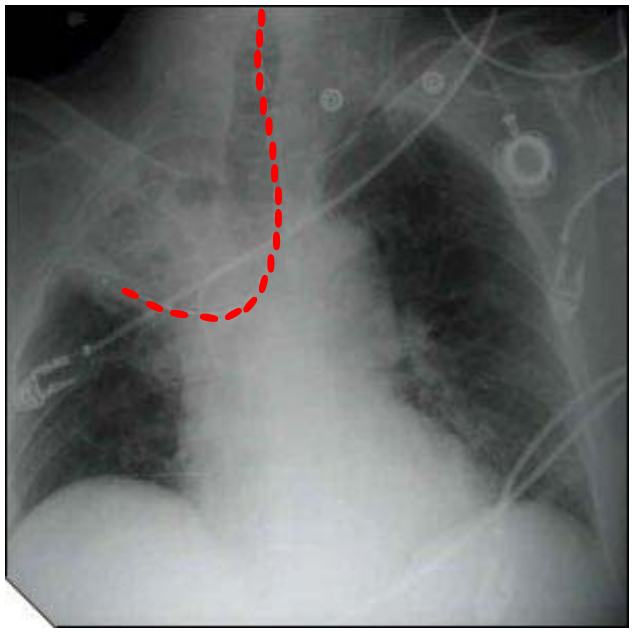
Characteristics of Cervical Cancer Treatment

Total doses to reference points (LDR+EBRT)) - MDACC

Reference point	Dose ± S.D.
Point A	87 ± 8 Gy
Bladder	70 ± 9 Gy
Rectum	70 ± 8 Gy
Vaginal surface	125 ± 15 Gy

Intraluminal

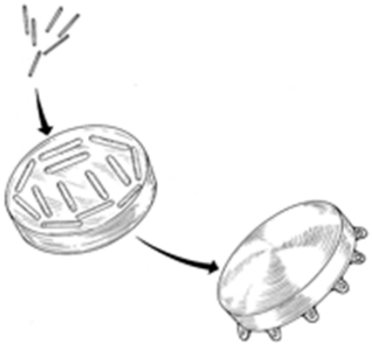
- Intraluminal: Places the source of radiation within body “tubes” such as esophagus, trachea, bronchus and rectum.
- Temporary (HDR, minutes)

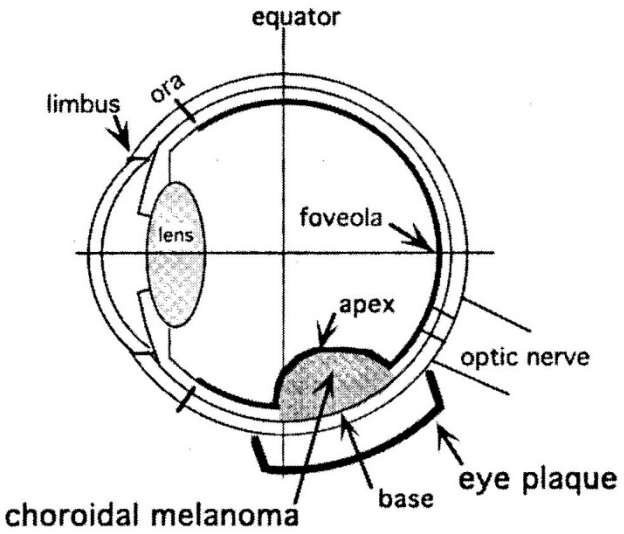


Surface (Topical)

- Places the radioactive sources on top of the area to be treated (choroidal melanoma)
- Temporary: ~72hrs (LDR)

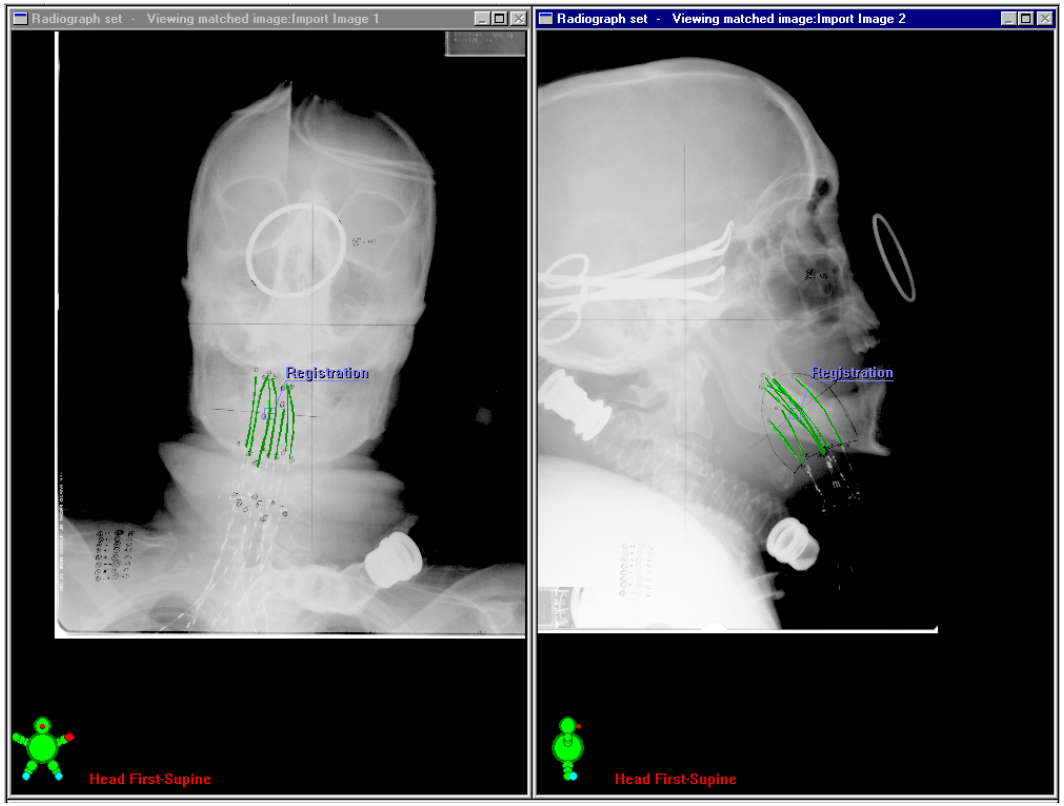
A custom-made radiation plaque. On the left is the inside of a plaque with the radiation seeds. On the right is the gold coating on the outside of the plaque.





Interstitial Examples

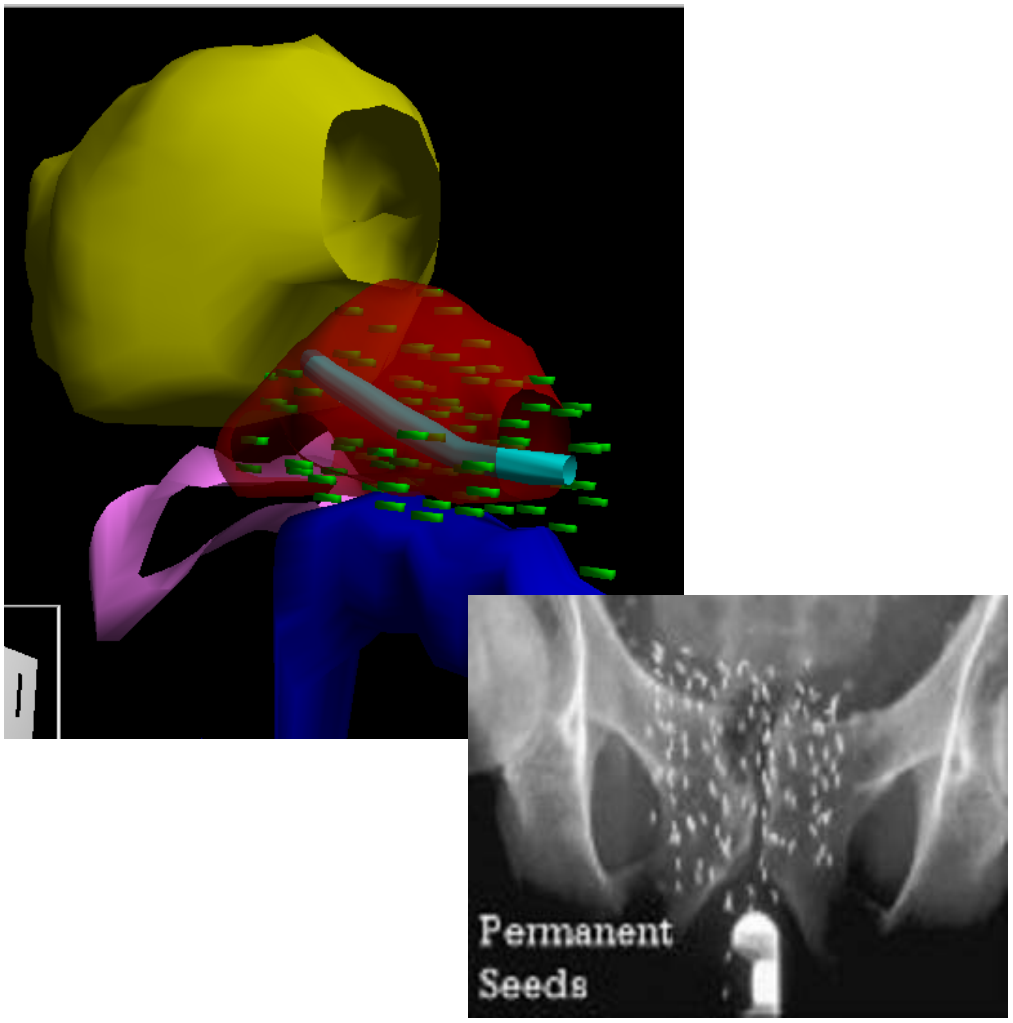
- Interstitial
  - Temporary
    - Sarcoma - muscle
      - Iridium seeds or wire, LDR
    - GI - rectum
      - Iridium seeds or wire, LDR
    - H&N - BOT, FOM nasal septum
      - Iridium seed or wire, LDR
    - Prostate
      - Iridium, HDR



Interstitial Examples

- Interstitial
  - Permanent
    - GU - prostate

      (I-125, Pd-103, Cs-131)
    - GYN - pelvic side wall (Au-198)
    - GI - rectum (Au-198)

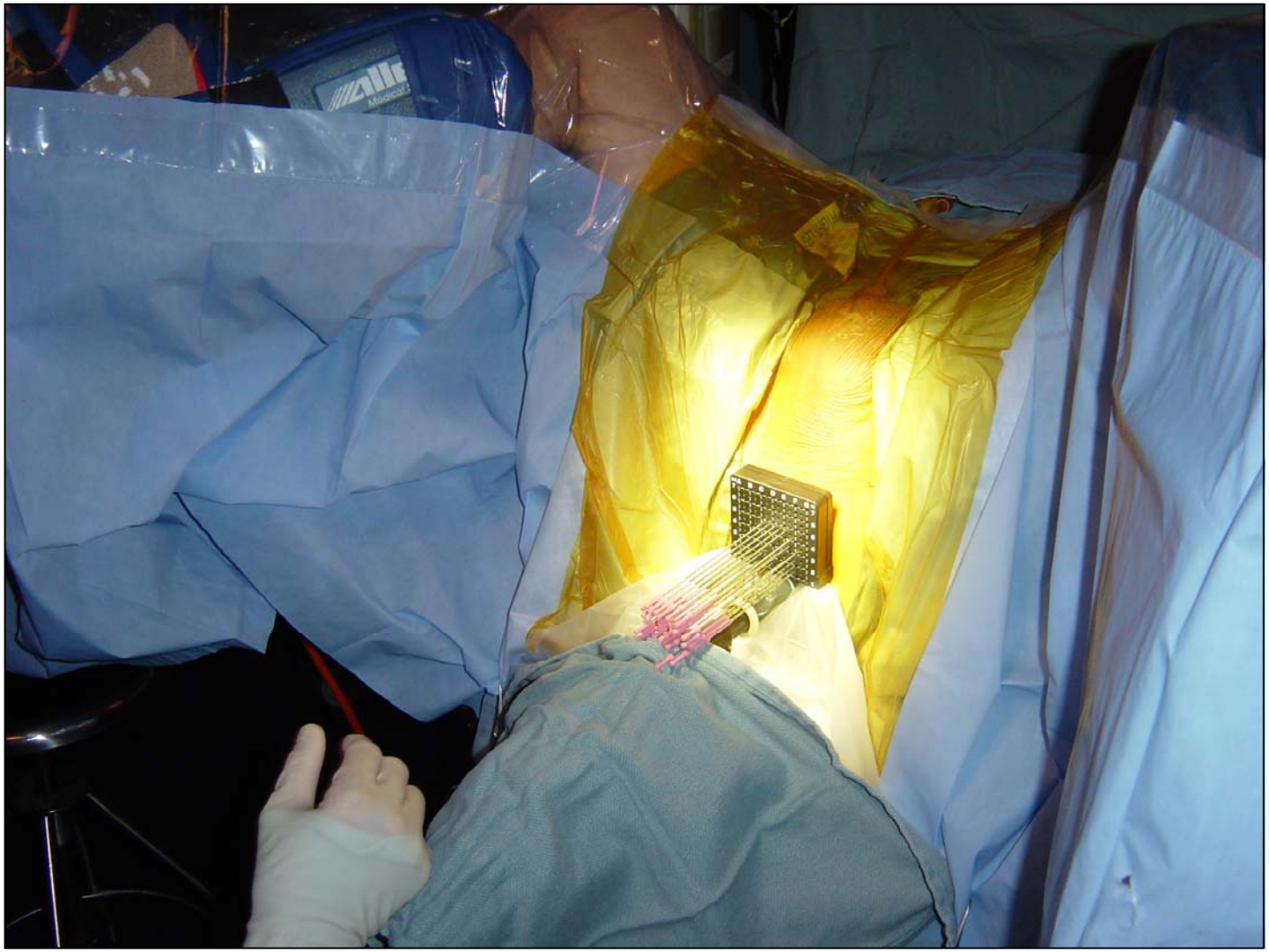


Trans Rectal Ultrasound (TRUS) for Prostate Implants

- 1990's - Advancements of the Ultrasound Guided Transperineal Brachytherapy Procedure

- Advancements made with the TRUS
    - pre-operatively plans the placement and number of seeds
    - Calculate 3-D radiation dose distribution for prostate, rectum, urethra, and bladder
    - adjust variables for dose escalation and normal tissue sparing

Prostate Implant OR Procedure



CHRISTIANA CARE HEALTH SYSTEM

Prostate Implant Typical LDR Prescriptions

Source	$T_{1/2}$ (days)	Energy (median, KeV)	90% Dose delivered (days)	Monotherapy (Gy)	Boost (Gy)
I-125	~60	~28	204	145	100-110
Pd-103	~17	~22	58	120 or 125	90-100
Cs-131	~10	~30	33	115	85

Rivard et al. *Brachytherapy*, 6:34-37, 2007

AAPM Task Group 43

- **Dosimetry of interstitial brachytherapy sources: Recommendations of the AAPM Radiation Therapy Committee Task Group 43, Med Phys 22, 209 - 234, 1995.**

TG-43 Updates

Update of AAPM Task Group No. 43 Report: A revised AAPM protocol for brachytherapy dose calculations

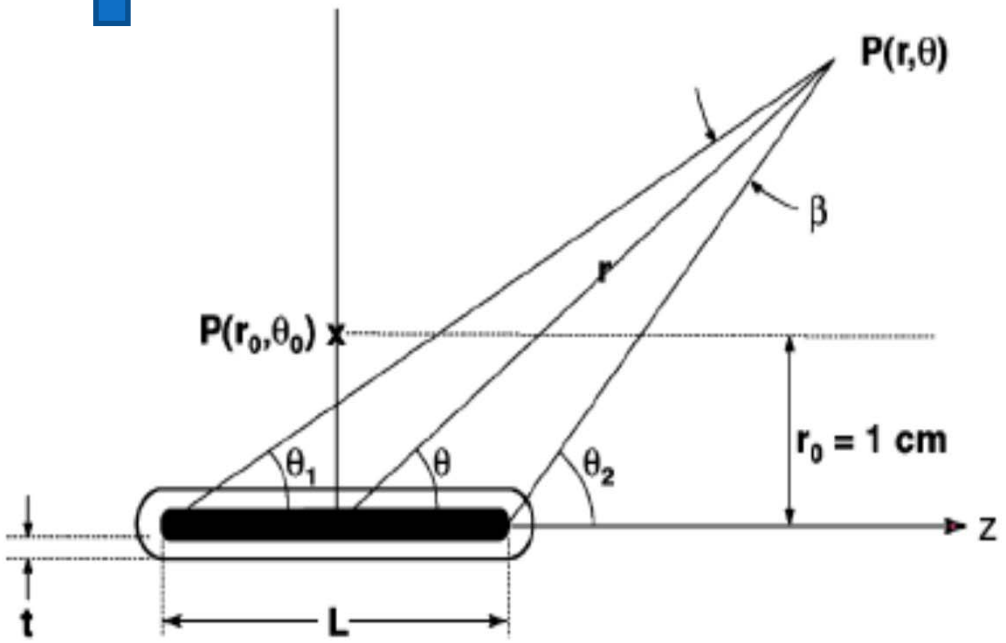
Medical Physics, Vol. 31, No. 3, March 2004

Recommendations of the American Association of Physicists in Medicine regarding the Impact of Implementing the 2004 Task Group 43 Report on Dose Specification for ^{103}Pd and ^{125}I Interstitial Brachytherapy

Medical Physics, Vol. 32, No. 5, May 2005

Task Group 43-updated

$$\dot{D}(r,\theta) = S_K \cdot \Lambda \cdot \frac{G_L(r,\theta)}{G_L(r_0,\theta_0)} \cdot g_L(r) \cdot F(r,\theta)$$



Source Strength (Activity)

- 1 Ci (curie): 3.7×10^{10} disintegration/sec
- 1 Bq (becquerel): 1 disintegration/sec
- 1 Ci = 37 GBq
- mg-Ra-eq is the mass of radium required to produce the same exposure rate at 1cm from the substitute source

Source Strength (Air Kerma)

- Product of air kerma rate times distance squared, usually 1 m, to point of specification.
- $S_k = (dK(r)/dt)*r^2$, units are in U
  - 1U = 1 μGy - m^2/hr or 1 cGy- cm^2/hr
- AAPM TG-43 protocol specifies air kerma strength on perpendicular bisector of source at 1cm

$$S_K = \dot{K}_\delta(d)d^2$$

*Updated – 5 keV cutoff

TG 43-updated Dose Rate Constants

$$\dot{D}(r,\theta) = S_K \cdot \Lambda \cdot \frac{G_L(r,\theta)}{G_L(r_0,\theta_0)} \cdot g_L(r) \cdot F(r,\theta)$$

TABLE I. NIST standard WAFAC calibration dates for air kerma strength for each manufacturer, and dose rate constant values. Note that for a given source type, the % change in Λ from the 1999 value is not necessarily equal to the average % change in air-kerma strength due the 1999 NIST WAFAC anomaly because some of the Λ values were calculated based on air-kerma strength measurements of a single seed.

Manufacturer and source type		NIST date used by ADCL and NIST as standard	${}_{\text{CON}}\Lambda$ [$\text{cGy}\cdot\text{h}^{-1}\cdot\text{U}^{-1}$]	% difference in Λ from 1999 value
Amersham 6702	^{125}I	April 15, 1998	1.036	N/A
Amersham 6711	^{125}I	April 15, 1998	0.965	N/A
Best Industries 2301	^{125}I	August 18, 2000	1.018	+3.3%
NASI MED3631-A/M	^{125}I	June 30, 2001	1.036	+1.0%
Bebig/Theragenics I25.S06	^{125}I	January 27, 2001	1.012	+2.2%
Imagyn IS-12501	^{125}I	October 21, 2000	0.940	+3.5%
Theragenics 200	^{103}Pd	July 8, 2000	0.686	+4.0%
NASI MED3633	^{103}Pd	April 23, 2001	0.688	+4.3%

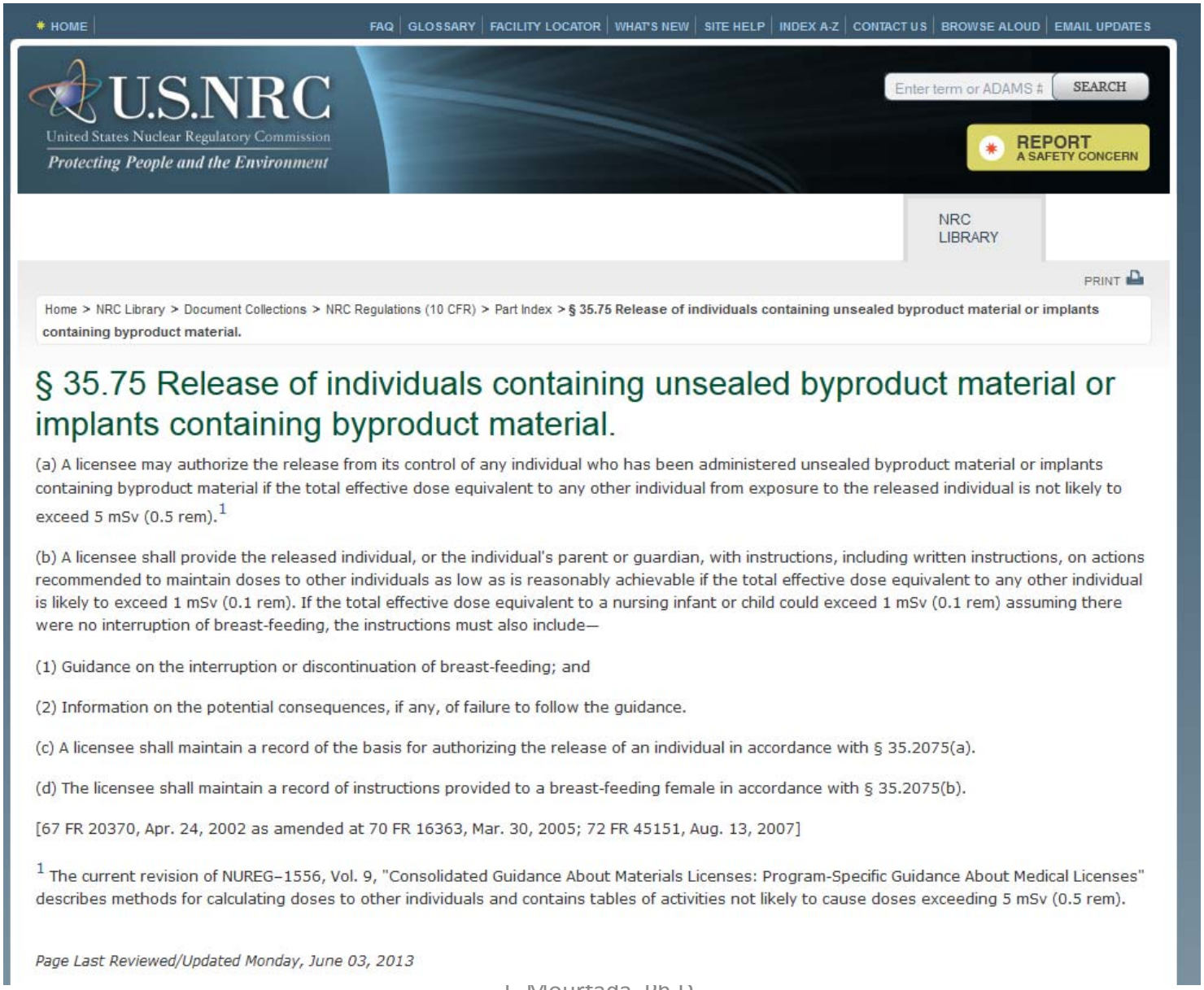
Talk Objectives

- Describe General Sealed Source Brachytherapy Applications
- **Summarize NRC Rulings**
- Describe Release Methods for LDR sources

PART 35—MEDICAL USE OF BYPRODUCT MATERIAL

Full Text Version (240.95 KB)

http://www.nrc.gov/reading-rm/doc-collections/cfr/part035/part035-0075.html



HOME | FAQ | GLOSSARY | FACILITY LOCATOR | WHAT'S NEW | SITE HELP | INDEX A-Z | CONTACT US | BROWSE ALOUD | EMAIL UPDATES

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

Enter term or ADAMS # SEARCH

REPORT A SAFETY CONCERN

NRC LIBRARY

PRINT

Home > NRC Library > Document Collections > NRC Regulations (10 CFR) > Part Index > **§ 35.75 Release of individuals containing unsealed byproduct material or implants containing byproduct material.**

§ 35.75 Release of individuals containing unsealed byproduct material or implants containing byproduct material.

(a) A licensee may authorize the release from its control of any individual who has been administered unsealed byproduct material or implants containing byproduct material if the total effective dose equivalent to any other individual from exposure to the released individual is not likely to exceed 5 mSv (0.5 rem).[1]

(b) A licensee shall provide the released individual, or the individual's parent or guardian, with instructions, including written instructions, on actions recommended to maintain doses to other individuals as low as is reasonably achievable if the total effective dose equivalent to any other individual is likely to exceed 1 mSv (0.1 rem). If the total effective dose equivalent to a nursing infant or child could exceed 1 mSv (0.1 rem) assuming there were no interruption of breast-feeding, the instructions must also include—

(1) Guidance on the interruption or discontinuation of breast-feeding; and

(2) Information on the potential consequences, if any, of failure to follow the guidance.

(c) A licensee shall maintain a record of the basis for authorizing the release of an individual in accordance with § 35.2075(a).

(d) The licensee shall maintain a record of instructions provided to a breast-feeding female in accordance with § 35.2075(b).

[67 FR 20370, Apr. 24, 2002 as amended at 70 FR 16363, Mar. 30, 2005; 72 FR 45151, Aug. 13, 2007]

[1] The current revision of NUREG–1556, Vol. 9, "Consolidated Guidance About Materials Licenses: Program-Specific Guidance About Medical Licenses" describes methods for calculating doses to other individuals and contains tables of activities not likely to cause doses exceeding 5 mSv (0.5 rem).

Page Last Reviewed/Updated Monday, June 03, 2013

10 CFR 35.75

“Release of individuals containing unsealed byproduct material or implants containing byproduct material”

10 CFR 35.75
Release Dose Limit

- A licensee may authorize the release from its control of any individual who has been administered unsealed byproduct material or implants containing byproduct material if the total effective dose equivalent (TEDE) to any other individual from exposure to the released individual is not likely to exceed **5 mSv (500 mrem).***

*NUREG–1556, Vol. 9, "Consolidated Guidance About Materials Licenses: Program-Specific Guidance About Medical Licenses"

10 CFR 35.75
Written Instructions for Release

- A licensee shall provide the released individual, or the individual's parent or guardian, with instructions:

  including written instructions, on actions recommended to maintain doses to other individuals as low as is reasonably achievable if the TEDE to any other individual is likely to exceed **1 mSv (100 mrem)**.

10 CFR 35.75
Nursing Infant or Child Ruling

- If TEDE to a nursing infant or child could exceed 1 mSv (100 mrem) assuming there were no interruption of breast-feeding, the instructions must also include:

  (1) Guidance on the interruption or discontinuation of breast-feeding; and

  (2) Information on the potential consequences, if any, of failure to follow the guidance.

10 CFR 35.75
Maintenance of Records Ruling

- A licensee shall maintain a record of the basis for authorizing the release of an individual in accordance with § 35.2075(a).

- The licensee shall maintain a record of instructions provided to a breast-feeding female in accordance with § 35.2075(b).

Talk Objectives

- Describe General Sealed Source Brachytherapy Applications
- Summarize NRC Rulings
- **Describe Release Methods for LDR sources for permanent implants (prostate)**

Consolidated Guidance About Materials Licenses: Program - Specific Guidance About Medical Use Licenses (NUREG-1556, Volume 9, Revision 2)

On this page:

- Publication Information
- Table of Contents
- Abstract

Download complete document

This page includes links to files in non-HTML format. See Plugins, Viewers, and Other Tools for more information.

- NUREG-1556, Volume 9, Revision 2
  - Abstract–License Fees (PDF - 2.25 MB)
  - Contents of an Application (PDF - 5.87 MB)
  - Appendices A–H (PDF - 5.54 MB)
  - Appendices I–W (PDF - 5.62 MB)
  - Appendices X–Z (PDF - 2.66 MB)

Calculation of release limits following implant brachytherapy

Publication Information

Manuscript Completed: January 2008
Date Published: January 2008

Prepared by:
D.B. Howe, M. Beardsley, S.R. Bakhsh

Office of Federal and State Materials and Environmental Management Programs
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1556/v9/r2/

NUREG - 1556
Vol. 9, Rev. 2

Consolidated Guidance About Materials Licenses

Program-Specific Guidance About Medical Use Licenses

Final Report

Date Completed: January 2008
Date Published: January 2008

Prepared by
D. B. Howe, M. Beardsley, S. R. Bakhsh

Office of Federal and State Materials and Environmental Management Programs
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

APPENDIX U

Model Procedure for Release of Patients or Human Research Subjects Administered Radioactive Materials

Release Equation

The activity at which patients could be released was calculated by using, as a starting point, the method discussed in the National Council on Radiation Protection and Measurements (NCRP) Report No. 37, "Precautions in the Management of Patients Who Have Received Therapeutic Amounts of Radionuclides." This report uses the following equation to calculate the exposure until time *t* at a distance *r* from the patient:

Equation U.1:

$$D(t) = \frac{34.6\,\Gamma\,Q_0\,T_P\,(1 - e^{-0.693t/T_P})}{r^2}$$

where:
- D(t)= Accumulated exposure at time t, in roentgens
- 34.6= Conversion factor of 24 hrs/day times the total integration of decay (1.44)
- Γ = Specific gamma ray constant for a point source, R/mCi-hr at 1 cm
- Q_0 = Initial activity of the point source in millicuries, at the time of the release
- T_p = Physical half-life in days
- r = Distance from the point source to the point of interest, in centimeters
- t = Exposure time in days.

S_k ⟺

*The dose to an individual likely to receive the highest dose from exposure to the patient is taken to be the dose to total decay ➔ (1-e -0.693t/Tp) is set equal to 1.
*It is assumed that 1 R is equal to 10 mSv (1 rem).

Implants with radionuclides with a physical half-life greater than 1 day: Use Equation U.2

$$D(\infty) = \frac{34.6\ \Gamma\ Q_0\ T_p\ (0.25)}{(100\ cm)^2} \qquad \text{Eq. (U2)}$$

It is assumed that the individual likely to receive the highest dose from exposure to the patient would receive a dose of 25% of the dose to total decay (0.25 in Equation U.2), at a distance of 1 meter.*

*Selection of 25% of the dose to total decay at 1 meter for estimating the dose is based on measurements discussed in the supporting regulatory analysis that indicate the dose calculated using an occupancy factor, *E*, of 25% at 1 meter is conservative in most normal situations.

Supplement A

Table U.5 Half-Lives and Exposure Rate Constants of Radionuclides Used in Medicine		
Radionuclide	**Physical Half-Life (days)[1]**	**Exposure Rate Constant[2] (R/mCi-h at 1 cm)**
Ag-111	7.45	0.15
Au-198	2.696	2.3
Cr-51	27.704	0.16
Cu-64	0.529	1.2
Cu-67	2.578	0.58
Ga-67	3.261	0.753
I-123	0.55	1.61
I-125	60.14	1.42
I-125 implant[3]	60.14	1.114
I-131	8.04	2.2
In-111	2.83	3.21
Ir-192 implant[3]	74.02	4.594
P-32	14.29	N/A[5]
Pd-103 implant[4]	16.96	0.865
Re-186	3.777	0.2
Re-188	0.708	0.26
Sc-47	3.351	0.56
Se-75	119.8	2
Sn-117m	13.61	1.48
Sr-89	50.5	N/A[5]
Tc-99m	0.251	0.756
Tl-201	3.044	0.447
Yb-169	32.01	1.83
Y-90	2.67	N/A[5]
Yb-169	32.01	1.83

$$X = \Gamma_{isotope} A \frac{1}{d^2}$$

$$S_k = X.d^2 . W_e$$

Footnotes for Table U.5

[1] K. F. Eckerman, A. B. Wolbarst, and A. C. B. Richardson, "Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," Report No. EPA-520/1-88-020, Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, DC, 1988.

[2] Values for the exposure rate constant for Au-198, Cr-51, Cu-64, I-131, Sc-47, and Se-75 were taken from the *Radiological Health Handbook*, U.S. Department of Health, Education, and Welfare, p. 135, 1970. For Cu-67, I-123, In-111, Re-186, and Re-188, the values for the exposure rate constant were taken from D. E. Barber, J. W. Baum, and C. B. Meinhold, "Radiation Safety Issues Related to Radiolabeled Antibodies," NUREG/CR-4444, U.S. NRC, Washington, DC, 1991. For Ag-111, Ga-67, I-125, Sm-153, Sn-117m, Tc-99m, Tl-201, and Yb-169, the exposure rate constants were calculated because the published values for these radionuclides were an approximation, presented as a range, or varied from one reference to another. Details of the calculation of the exposure rate constants are shown in Table A.2 of Appendix A to NUREG-1492, "Regulatory Analysis on Criteria for the Release of Patients Administered Radioactive Material," U.S. NRC, February 1997.

[3] R. Nath, A. S. Meigooni, and J. A. Meli, "Dosimetry on Transverse Axes of ^{125}I and ^{192}Ir Interstitial Brachytherapy Sources," Medical Physics, Volume 17, Number 6, November/December 1990. The exposure rate constant given is a measured value averaged for several source models and takes into account the attenuation of gamma rays within the implant capsule itself.

[4] A. S. Meigooni, S. Sabnis, R. Nath, "Dosimetry of Palladium-103 Brachytherapy Sources for Permanent Implants," *Endocurietherapy Hyperthermia Oncology*, Volume 6, April 1990. The exposure rate constant given is an "apparent" value (i.e., with respect to an apparent source activity) and takes into account the attenuation of gamma rays within the implant capsule itself.

Table U.1 Activities and Dose Rates for Authorizing Patient Release†				
Radionuclide	COLUMN 1 Activity At or Below Which Patients May Be Released		COLUMN 2 Dose Rate at 1 Meter, At or Below Which Patients May Be Released*	
	(GBq)	(mCi)	(mSv/hr)	(mrem/hr)
Ag-111	19	520	0.08	8
Au-198	3.5	93	0.21	21
Cr-51	4.8	130	0.02	2
Cu-64	8.4	230	0.27	27
Cu-67	14	390	0.22	22
Ga-67	8.7	240	0.18	18
I-123	6	160	0.26	26
I-125	0.25	7	0.01	1
I-125 implant	0.33	9	0.01	1
I-131	1.2	33	0.07	7
In-111	2.4	64	0.2	20
Ir-192 implant	0.074	2	0.008	0.8
P-32	**	**	**	**
Pd-103 implant	1.5	40	0.03	3
Re-186	28	770	0.15	15
Re-188	29	790	0.2	20
Sc-47	11	310	0.17	17
Se-75	0.089	2	0.005	0.5
Sm-153	26	700	0.3	30
Sn-117m	1.1	29	0.04	4
Sr-89	**	**	**	**
Tc-99m	28	760	0.58	58
Tl-201	16	430	0.19	19
Y-90	**	**	**	**
Yb-169	0.37	10	0.02	2

Footnotes for Table U-1

† The activity values were computed based on 5 millisieverts (0.5 rem) total effective dose equivalent.

* If the release is based on the dose rate at 1 meter in Column 2, the licensee must maintain a record as required by 10 CFR 35.75(c), because the measurement includes shielding by tissue. See Item U.3.1, "Records of Release," for information on records.

- For brachy implants use max dose rate method to release
- Assumed physical half life only
- Occupancy factor of 0.25 at 1 meter for physical half-lives greater than 1 day
- No shielding by tissue assumed

Cs-131 is not in Table U1

Cs–131: $T_{1/2} = 9.7$ days, $E = 0.25$

$$D(\infty) = 0.5\text{rem}(5\text{mSv}): X_{1\text{m}} = \frac{D(\infty)}{34.6 \text{ x } 9.7 \text{ days x } 0.25}$$

$$= 6 \text{ mrem/hr } (0.06\ mSv/hr)$$

Where,

$X_{1\text{m}} = \Gamma \text{ Q } (1\text{cm}/100\text{cm})^2$

Release Criteria for Brachytherapy

- Release of patients based on measured dose rate
- 10 CFR 35.75(c) requires a record because the release is based on considering shielding by tissue
- Use dose rate limits in Table U2 to determine when instructions must be given.

APPENDIX U

Table U.2 Activities and Dose Rates Above Which Instructions Should Be Given When Authorizing Patient Release* *(continued)*

Radionuclide	COLUMN 1 Activity Above Which Instructions Are Required		COLUMN 2 Dose Rate at 1 Meter Above Which Instructions Are Required	
	(GBq)	(mCi)	(mSv/hr)	(mrem/hr)
I-125	0.05	1	0.002	0.2
I-125 implant	0.074	2	0.002	0.2
I-131	0.24	7	0.02	2
In-111	0.47	13	0.04	4
Ir-192 implant	0.011	0.3	0.002	0.2
P-32	**	**	**	**
Pd-103 implant	0.3	8	0.007	0.7
Re-186	5.7	150	0.03	3
Re-188	5.8	160	0.04	4
Sc-47	2.3	62	0.03	3
Se-75	0.018	0.5	0.001	0.1
Sm-153	5.2	140	0.06	6
Sn-117m	0.21	6	0.009	0.9
Sr-89	**	**	**	**
Tc-99m	5.6	150	0.12	12
Tl-201	3.1	85	0.04	4
Y-90	**	**	**	**
Yb-169	0.073	2	0.004	0.4

Footnotes for Table U.2

* The activity values were computed based on 1 millisievert (0.1 rem) total effective dose equivalent.

** Activity and dose rate limits are not applicable in this case because of the minimal exposures to members of the public resulting from activities normally administered for diagnostic or therapeutic purposes.

Notes: The values for activity were calculated using Equations U.2 or U.3 and the physical half-life. The values given in SI units (gigabecquerel values) were using conversion factors.

In general, values are rounded to two significant figures; however, values less than 0.37 gigabecquerel (10 millicuries) or 0.1 millisievert (10 millirems) per hour are rounded to one significant figure. Details of the calculations are provided in NUREG-1492.

Agreement State regulations may vary. Agreement State licensees should check their State regulations before using these values.

Note:
NRC does not intend to enforce patient compliance with the instructions nor is it the licensee's responsibility to do so.

Content of Instructions

- Be specific to the type of treatment given
  - such as permanent implants
- Include the name of a knowledgeable contact person.

A small radioactive source has been placed (implanted) inside your body. The source is actually many small metallic pellets or seeds, which are each about 1/3 to 1/4 of an inch long, similar in size and shape to a grain of rice. To minimize exposure to radiation to others from the source inside your body, you should do the following for_____days.

- Stay at a distance of _____ feet from _____.
- Maintain separate sleeping arrangements.
- Minimize time with children and pregnant women.
- Do not hold or cuddle children.
- Avoid public transportation.
- Examine any bandages or linens that come into contact with the implant site for any pellets or seeds that may have come out of the implant site.
- If you find a seed or pellet that falls out:
  - — Do not handle it with your fingers. Use something like a spoon or tweezers to place it in a jar or other container that you can close with a lid.
  - — Place the container with the seed or pellet in a location away from people.
  - — Notify _____ at telephone number _____ .

Records of Release

- **For Immediate Release of a Patient Based on Measured Dose Rate:**
  - The results of the measurement, the specific survey instrument used, and the name of the individual performing the survey.

Table U.4 Summary of Release Criteria, Required Instructions to Patients, and Records to Be Maintained

Patient Group	Basis for Release	Criteria for Release	Instructions Needed?	Release Records Required?
All patients, including patients who are breast-feeding an infant or child	Administered activity	Administered activity ≤Column 1 of Table U.1	Yes – if administered activity > Column 1 of Table U.2	No
	Retained activity	Retained activity ≤ Column 1 of Table U.1	Yes – if retained activity > Column 1 of Table U.2	Yes
	Measured dose rate	Measured dose rate ≤ Column 2 of Table U.1	Yes – if dose rate > Column 2 of Table U.2	Yes
	Patient-specific calculations	Calculated dose ≤ 5 mSv (0.5 rem)	Yes – if calculated dose > 1 mSv (0.1 rem)	Yes
Patients who are breast-feeding an infant or child	All the above bases for release		Additional instructions required if: Administered activity > Column 1 of Table U.3 or Licensee calculated dose from breast-feeding > 1 mSv (0.1 rem) to the infant or child	Records that instructions were provided are required if: Administered activity > Column 2 of Table U.3 or Licensee calculated dose from continued breast-feeding > 5 mSv (0.5 rem) to the infant or child

PATIENT RELEASE CRITERIA FOR LOW DOSE RATE BRACHYTHERAPY IMPLANTS

Dale E. Boyce* and Michael A. Sheetz†

- NUREG1556 is overly conservative in its assumption in the case of the common LDR sources (^{131}Cs, ^{125}I, and ^{103}Pd).
- The low mean energies cause the measured exposure rate (R/hr) to greatly exceed the "actual" effective dose equivalent rate (Sv/hr) due to tissue shielding of exposed individual.
- The effective dose equivalent rate may also be reduced by self-shielding by the patients themselves.

Health Physics April 2013, Volume 104, Number 4

PATIENT RELEASE CRITERIA FOR LOW DOSE RATE BRACHYTHERAPY IMPLANTS

Dale E. Boyce* and Michael A. Sheetz†

- I-125 mesh implant along chest wall special case could exceed limits in NUREG 1556 Table U1
- Section U1.3 of NUREG 1556 permits patient-specific dose calculations
- See details in paper

Health Physics April 2013, Volume 104, Number 4

Remember

- Determination of release rests with the authorized user physician.
- Communicating the radiation safety dose reduction instructions to the patient rests with the authorized user physician.
- Records of the basis for authorizing patient release shall be maintained for a minimum of 3 years.
- Records that dose reduction and/or breast-feeding discontinuation instructions were provided where applicable shall also be maintained.