Radiological Physics Associates
Medical Physics Consulting

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Radiation Shielding Plan

January 2, 2026

Kelly Judd
Medical Imaging Department
Pikeville Urgent Care
3062 Main Street
Pikeville, Tennessee 37367

	Equipment:	**Room:**
SUBJECT: Radiation Shielding Design for:	Amrad/Summit	X-Ray

Dear Kelly,

On the above indicated date, a radiation shielding plan was conducted for your facility according to the following standards:

- National Council on Radiation Protection and Measurements, NCRP Report No. 147 – Structural Shielding Design for Medical X-Ray Imaging Facilities

- American Association of Physicists in Medicine (AAPM) established protocol

Modifications to the specifications and calculations recommended by the organizations mentioned above are incorporated to comply with current Federal and State regulations.

The shielding design goals are such that the permissible exposure in controlled areas is no greater than 10 mR/week and no greater than 2 mR/week in uncontrolled areas, where controlled and uncontrolled areas are as defined in NCRP 147. Unless otherwise stated, the prescribed Pb for a wall is to span from the floor to 7 ft above the floor. Additionally, the Pb may be installed on either side of the wall.

No responsibility is assumed or implied for the adequacy of the enclosed specifications for workloads or conditions other than those stated.

Thank you for using Radiological Physics Associates for your physics consulting needs. If there are any questions concerning the design or if we can be of any further assistance, please feel free to contact me.

Respectfully,

Alexander Woods, MS, PhD
Physicist

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Radiation Shielding Plan

Pikeville Urgent Care
3062 Main Street
Pikeville, Tennessee 37367
FACILITY

January 2, 2026
DATE OF INSPECTION

Amrad/Summit
EQUIPMENT

Alexander Woods, MS, PhD
PHYSICIST

X-Ray
ROOM

Beam Orientation: Tube directed toward table / image receptor

Radiographic Workload: 160 **Patients/Week**

Barrier Description	Occupancy Type (C or UC)	Barrier Type (P or S)	Occupation Factor (T)	Use Factor (U)	Distance from Source (ft)	Maximum Allowable Exposure (mR/week)	Prescribed Shielding (inches Pb)
W1 - Control	C	S	1.00	1.00	6.0	<10	1/32 " Pb
W2 - Corridor	UC	S	0.20	1.00	6.0	<2	1/32 " Pb
D1 - Corridor	UC	S	0.20	1.00	6.0	<2	1/32 " Pb
W3 - CT	UC	S	1.00	1.00	5.0	<2	1/16 " Pb
W4 - Exterior	UC	S	0.03	1.00	6.0	<2	1/32 " Pb*
W5 - Toilet	UC	S	0.20	1.00	6.0	<2	1/32 " Pb
Floor	UC	S	0.03	0.89	14.0	<2	N/A
Ceiling	UC	S	0.03	1.00	14.0	<2	N/A

Ceilings and Floors: *Assumed no occupancy above and below*

Comments: *All viewing windows must have same or greater mm Pb equivalence as corresponding barrier.*
** For the exterior wall, the recommended shielding is for areas where CMU or brick is not pressent. If CMU or brick is used, no additional shielding is recommended.*

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Assumptions for Design and Construction

Windows within control booths for observing patients must provide the same degree of shielding as the barrier. The location of the booth opening should minimize exposure of the operator to scattered radiation.

When adding sheet Pb, the Pb exhibits 'cold flow' if improperly secured. The Pb should be laminated to sheet rock or contact cemented to the wall. Do not simply nail the Pb to the walls. Overlap of the adjoining sheets be a half inch or more.

If poured concrete barriers are constucted, voids must be prevented. If using solid concrete bricks, take care that a solid course of mortar joins the individual bricks. Do not 'spot' cement the bricks.

Vents, pipes, or other violation of the shielding integrity should enter the room above the 7 ft height limitation.

Standard wood doors may be used, if the Pb is laminated or contact cemented to the door. The Pb should be equivalent to the calculated barrier.

Corridors, toilets, dressing rooms, and other areas not directly related to the use of radiation are considered uncontrolled areas.

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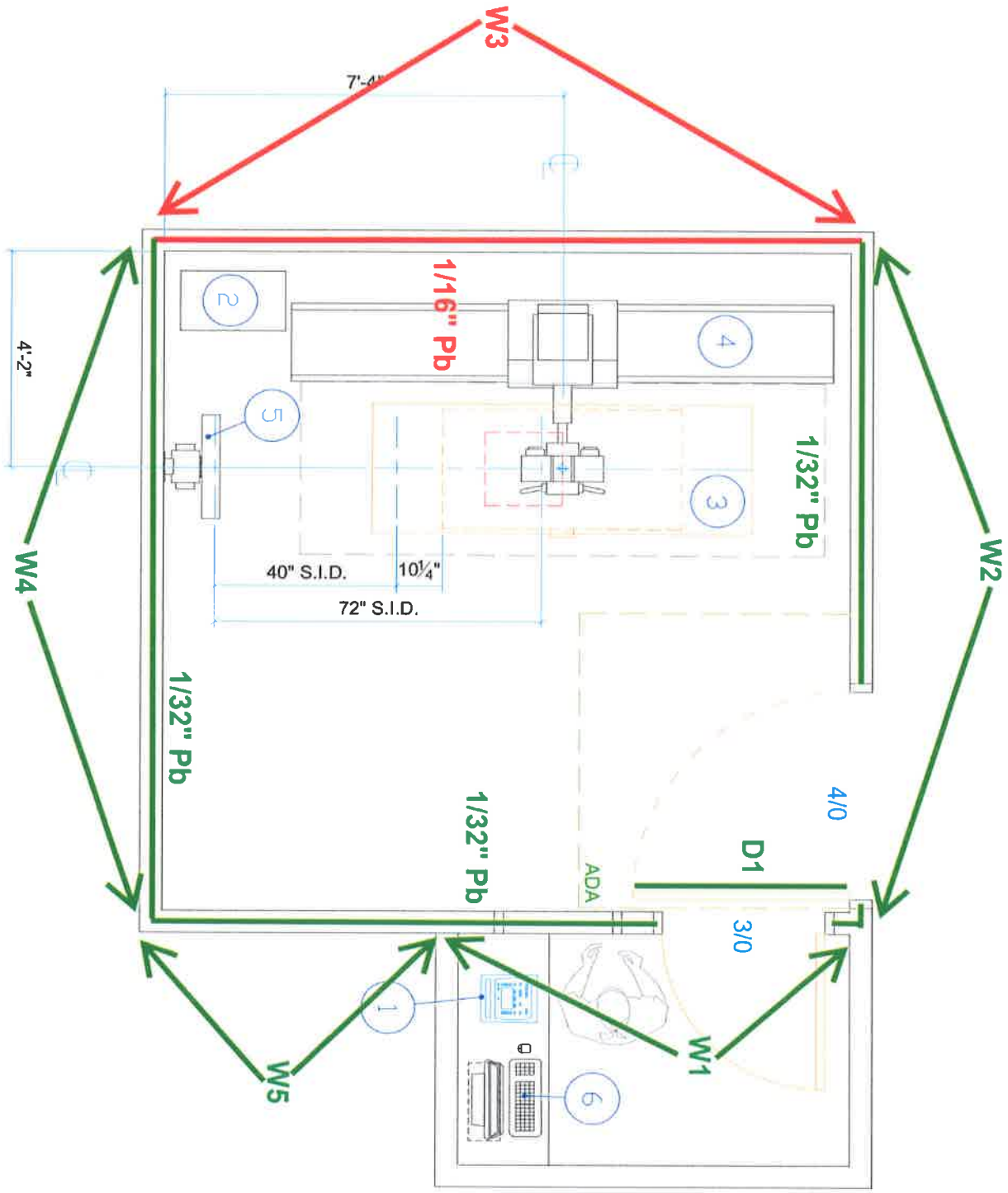

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Summary of Calculations

For primary barriers, the required thickness of construction material, in order to achieve the radiation safety goal, P, is determined by

$$x_{\text{barrier}} = \frac{1}{\alpha\gamma}\ln\left[\frac{\left(\frac{NTUK_{\text{P}}^{1}}{Pd_{\text{P}}^{2}}\right)^{\gamma}+\frac{\beta}{\alpha}}{1+\frac{\beta}{\alpha}}\right]-x_{\text{pre}}$$

where N is the expected number of patients examined in a 40 hour work week, T is the occupancy factor, $K^{1}{}_{p}$ is the workload distribution (mGy patient^{-1}), d_p is the distance from the source to the barrier, and α, β, and γ are fitting parameters. Values for α, β, γ are provided by Table B.1 of NCRP 147. x_{pre} refers to the equivalent thickness of the primary beam preshielding, perhaps provided by an image receptor or cassette holder. If not provided by the facility, assumed values for N, T, and $K^{1}{}_{p}$ are those provided in Table 4.3, Table 4.1, and Table 4.5 of NCRP 147, respectively. Assumed values for x_{pre} are those listed in Table 4.6 of NCRP 147.

For secondary barriers, the required thickness of construction material, in order to achieve the radiation safety goal, P, is determined by

$$x_{\text{barrier}} = \frac{1}{\alpha\gamma}\ln\left[\frac{\left(\frac{NTK_{\text{sec}}^{1}}{Pd_{\text{sec}}^{2}}\right)^{\gamma}+\frac{\beta}{\alpha}}{1+\frac{\beta}{\alpha}}\right]$$

where $K^{1}{}_{sec}$ is provided by Table 4.7 of NCRP 147.

For barriers subject to primary and secondary radiation, the required thickness of building material is calculated considering the contribution from each independently. Likewise, for exam rooms with multiple radiation sources, such as an R&F room, the greatest contributor of radiation through each barrier is identified. The recommended thickness is chosen to achieve the radiation safety goal, assuming the greatest contributing source.

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Summary of Calculations

Barrier Description: W1 - Control

Source Distance: 6.0 ft
Source Modality: Rad
Occupancy Type (P): 0.10 mGy per week
Occupation Factor (T): 1

Rad Tube (all barriers): Leakage & Sidescatter

Material: Lead

α (mm^{-1})	2.346
β (mm^{-1})	15.9
γ	0.4982
N (patient $week^{-1}$)	160
T	1
U	1
K (mGy $patient^{-1}$)	0.034
P (mGy $week^{-1}$)	0.100
d (m)	1.83
$x_{pre\ (mm)}$	0
Dose (mGy $week^{-1}$)	**1.627**
$x_{barrier}$ (mm)	**0.280**

Unshielded Dose Beyond Barrier	**1.63**	(mGy $week^{-1}$)
	84.58	(mGy $year^{-1}$)
	8458.04	(mrad $year^{-1}$)

x_{total}	0.28 mm	**Minimum Thickness Required**
x_{total}	1/91 "	
x_{total}	1/32 "	**Recommended**

Comments:

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Summary of Calculations

Barrier Description: W2 - Corridor

Source Distance: 6.0 ft
Source Modality: Rad
Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.2

Rad Tube (all barriers): Leakage & Sidescatter

Material: Lead

α (mm^{-1})	2.346
β (mm^{-1})	15.9
γ	0.4982
N (patient $week^{-1}$)	160
T	0.2
U	1
K (mGy $patient^{-1}$)	0.034
P (mGy $week^{-1}$)	0.020
d (m)	1.83
$x_{pre\ (mm)}$	0
Dose (mGy $week^{-1}$)	**0.325**
$x_{barrier}$ (mm)	**0.280**

Unshielded Dose Beyond Barrier	**0.33**	(mGy $week^{-1}$)
	16.92	(mGy $year^{-1}$)
	1691.61	(mrad $year^{-1}$)

x_{total}	0.28 mm	**Minimum Thickness Required**
x_{total}	1/91 "	
x_{total}	1/32 "	**Recommended**

Comments:

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Summary of Calculations

Barrier Description: D1 - Corridor

Source Distance: 6.0 ft
Source Modality: Rad
Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.2

Rad Tube (all barriers): Leakage & Sidescatter

Material: Lead

α (mm^{-1})	2.346
β (mm^{-1})	15.9
γ	0.4982
N (patient $week^{-1}$)	160
T	0.2
U	1
K (mGy $patient^{-1}$)	0.034
P (mGy $week^{-1}$)	0.020
d (m)	1.83
$x_{pre\ (mm)}$	0
Dose (mGy $week^{-1}$)	**0.325**
$x_{barrier}$ (mm)	**0.280**

Unshielded Dose Beyond Barrier	**0.33**	(mGy $week^{-1}$)
	16.92	(mGy $year^{-1}$)
	1691.61	(mrad $year^{-1}$)

x_{total}	0.28 mm	Minimum Thickness Required
x_{total}	1/91 "	
x_{total}	1/32 "	Recommended

Comments:

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Summary of Calculations

Barrier Description: W3 - CT

Source Distance: 5.0 ft
Source Modality: Rad

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 1

Rad Tube (all barriers): Leakage & Sidescatter
Material: Lead

α (mm^{-1})	2.346
β (mm^{-1})	15.9
γ	0.4982
N (patient $week^{-1}$)	160
T	1
U	1
K (mGy $patient^{-1}$)	0.034
P (mGy $week^{-1}$)	0.005
d (m)	1.52
x_{pre} (mm)	0
Dose (mGy $week^{-1}$)	**2.342**
$x_{barrier}$ (mm)	**1.102**

Rad Tube (Floor or other): Primary
Material: Lead

α (mm^{-1})	2.651
β (mm^{-1})	16.56
γ	0.4585
N (patient $week^{-1}$)	160
T	1
U	0.09
K (mGy $patient^{-1}$)	5.200
P (mGy $week^{-1}$)	0.015
d (m)	1.52
x_{pre} (mm)	0.3
Dose (mGy $week^{-1}$)	**358.223**
$x_{barrier}$ (mm)	**1.105**

Unshielded Dose Beyond Barrier	**360.57**	(mGy $week^{-1}$)
	18749.39	(mGy $year^{-1}$)
	1874938.86	(mrad $year^{-1}$)

x_{total}	1.10 mm	**Minimum Thickness Required**
x_{total}	1/23 "	
x_{total}	1/16 "	**Recommended**

Comments: *Refer to radiation shielding plan for CT for additional notes regarding this wall.*

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Summary of Calculations

Barrier Description: W4 - Exterior

Source Distance: 6.0 ft
Source Modality: Rad

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.025

Rad Tube (Chest Bucky): Primary
Material: Lead

α (mm^{-1})	2.264
β (mm^{-1})	13.08
γ	0.56
N (patient $week^{-1}$)	160
T	0.025
U	1
K (mGy $patient^{-1}$)	2.300
P (mGy $week^{-1}$)	0.015
d (m)	1.83
$x_{pre\ (mm)}$	0.85
Dose (mGy $week^{-1}$)	**2.751**
$x_{barrier}$ (mm)	**0.157**

Rad Tube (Chest Bucky): Leakage & Forward/Backscatter
Material: Lead

α (mm^{-1})	2.264
β (mm^{-1})	13.08
γ	0.56
N (patient $week^{-1}$)	160
T	0.025
U	1
K (mGy $patient^{-1}$)	0.007
P (mGy $week^{-1}$)	0.005
d (m)	0.91
$x_{pre\ (mm)}$	0
Dose (mGy $week^{-1}$)	**0.035**
$x_{barrier}$ (mm)	**0.201**

Unshielded Dose Beyond Barrier	**2.79**	(mGy $week^{-1}$)
	144.86	(mGy $year^{-1}$)
	14485.64	(mrad $year^{-1}$)

x_{total}	0.20 mm	**Minimum Thickness Required**
x_{total}	0 "	
x_{total}	1/32 "	**Recommended**

Comments: *Brick or CMU for the exterior wall will provide sufficient radiation protection. For any sections of this wall not containing CMU or brick, 1/32" lead is recommended.*

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Summary of Calculations

Barrier Description: W5 - Toilet

Source Distance: 6.0 ft
Source Modality: Rad

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.2

Rad Tube (all barriers): Leakage & Sidescatter

Material: Lead

α (mm^{-1})	2.346
β (mm^{-1})	15.9
γ	0.4982
N (patient $week^{-1}$)	160
T	0.2
U	1
K (mGy $patient^{-1}$)	0.034
P (mGy $week^{-1}$)	0.020
d (m)	1.83
$x_{pre\ (mm)}$	0
Dose (mGy $week^{-1}$)	**0.325**
$x_{barrier}$ (mm)	**0.280**

Unshielded Dose Beyond Barrier	**0.33**	(mGy $week^{-1}$)
	16.92	(mGy $year^{-1}$)
	1691.61	(mrad $year^{-1}$)

x_{total}	0.28 mm	**Minimum Thickness Required**
x_{total}	1/91 "	
x_{total}	1/32 "	**Recommended**

Comments:

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Summary of Calculations

Barrier Description: Floor

Source Distance: 14.0 ft
Source Modality: Rad

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.025

Rad Tube (Floor or other): Primary
Material: Concrete

α (mm^{-1})	0.03994
β (mm^{-1})	0.1448
γ	0.4231
N (patient $week^{-1}$)	160
T	0.025
U	0.89
K (mGy $patient^{-1}$)	5.200
P (mGy $week^{-1}$)	0.020
d (m)	4.27
$x_{pre\ (mm)}$	72
Dose (mGy $week^{-1}$)	**1.142**
$x_{barrier}$ (mm)	**-33.296**

Unshielded Dose Beyond Barrier	**1.14**	(mGy $week^{-1}$)
	59.40	(mGy $year^{-1}$)
	5939.92	(mrad $year^{-1}$)

Current Thickness of Concrete in Floor:

Additional Required Thickness of Floor:

x_{total}	0.00 mm	**Minimum Thickness Required**
x_{total}	0 "	
x_{total}	N/A	Recommended

Comments:

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Summary of Calculations

Barrier Description: Ceiling

Source Distance: 14.0 ft
Source Modality: Rad

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.025

Rad Tube (all barriers): Leakage & Forward/Backscatter

Material: Lead

α (mm^{-1})	2.346
β (mm^{-1})	15.9
γ	0.4982
N (patient $week^{-1}$)	160
T	0.025
U	1
K (mGy $patient^{-1}$)	0.049
P (mGy $week^{-1}$)	0.020
d (m)	4.27
$x_{pre\ (mm)}$	0
Dose (mGy $week^{-1}$)	**0.011**
$x_{barrier}$ (mm)	**-0.030**

Unshielded Dose Beyond Barrier	**0.01** (mGy $week^{-1}$)
	0.56 (mGy $year^{-1}$)
	55.97 (mrad $year^{-1}$)

Current Thickness of Concrete in Ceiling:

Additional Required Thickness of Ceiling:

x_{total}	0.00 mm	**Minimum Thickness Required**
x_{total}	0 "	
x_{total}	N/A	**Recommended**

Comments: