Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Radiation Shielding Plan

January 2, 2026

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

SUBJECT: Radiation Shielding Design for: **Equipment:** Toshiba Aquilion Prime **Room:** CT

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

Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Radiation Shielding Plan

Pikeville Urgent Care
3062 Main Street
Pikeville, Tennessee 37367
FACILITY

January 2, 2026
DATE OF INSPECTION

Toshiba Aquilion Prime
EQUIPMENT

Alexander Woods, MS, PhD
PHYSICIST

CT
ROOM

Beam Orientation: Tube directed toward gantry

Radiographic Workload: 180 **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	10.0	<10	1/16" Pb
W2 - Exam	UC	S	0.50	1.00	7.0	<2	1/16" Pb
W3 - Corridor	UC	S	0.20	1.00	5.0	<2	1/16" Pb
D1 & D2 - Corridor	UC	S	0.20	1.00	5.0	<2	1/16" Pb
W4 - X-Ray	UC	S	1.00	1.00	6.0	<2	3/32" Pb
W5 - Exterior	UC	S	0.03	1.00	6.0	<2	*1/16" Pb*
Floor	UC	S	0.03	1.00	14.0	<2	N/A
Ceiling	UC	S	0.03	1.00	14.0	<2	N/A

Ceilings and Floors: No occupancy is assumed above or below the scan room.

Comments: *All viewing windows must have same or greater mm Pb equivalence as corresponding barrier.*
** Assuming brick or CMU is used for the exterior walls, only 1/16" lead is recommended at the windows. For any sections with less than 2.5" concrete or brick, 1/16" lead is recommended.*

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Assumptions for Design and Construction

Windows within control booths for observing patients must provide the same degree of shielding as the barrier. The

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.

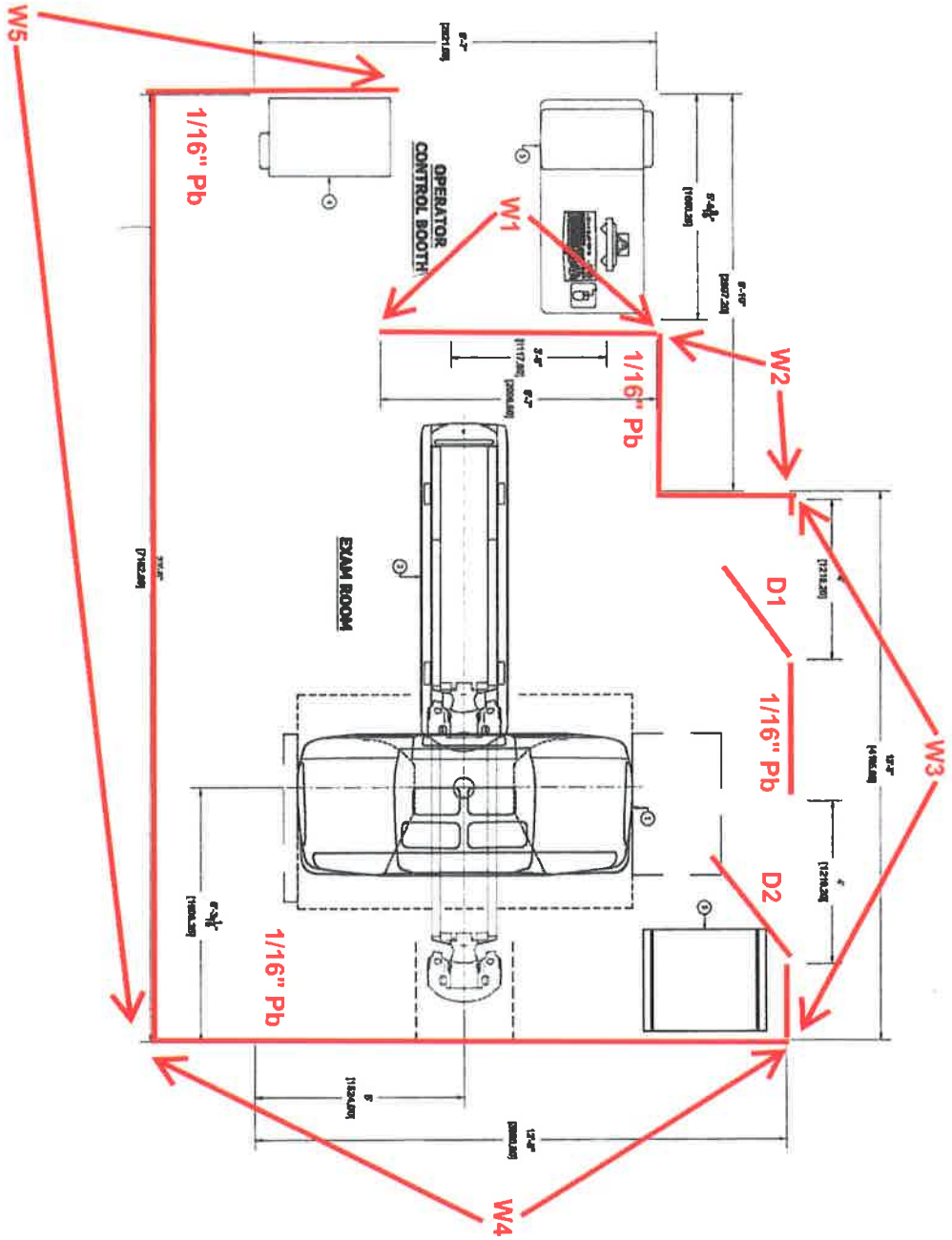
If poured concrete barriers are constucted, voids must be prevented. If using solid concrete bricks, take care that a solid course of mortar joins the individual bricks. Do not 'spot' cement the bricks.

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.

Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com



Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Summary of Calculations

For the purposes of shielding calculations for CT scanners, only secondary radiation is considered, as the primary beam is well attenuated by the gantry. NCRP 147 demonstrates that the scattered air kerma per patient at 1 meter can be approximated as

$$K_S^1 = \kappa \frac{L}{p} CTDI_{100}$$

L is the length scanned. p is known as the pitch and is defined as b/T_b. b is the patient movement through the bore per gantry rotation, and T_b is the beam width. For head and body phantoms, the scatter fraction per centimeter for the peripheral axis is assumed to be

$$\kappa_{head} = 9 \times 10^{-5} \text{ cm}^{-1}$$

$$\kappa_{body} = 3 \times 10^{-4} \text{ cm}^{-1}$$

For CT installations, it is convenient to use the dose length product, DLP, to compute shielding requirements, where

$$DLP = CTDI_{vol} L$$

and

$$CTDI_{vol} = \frac{1/3\ CTDI_{100,\text{ center}} + 2/3\ CTDI_{100,\text{ periphery}}}{p}$$

By assuming that the $CTDI_{100}$ for the peripheral axis in the body phantom is twice the $CTDI_{100}$ for the central axis and the $CTDI_{100}$ for the peripheral axis and central axis are equal in the head phantom,

$$K_{sec}^1 \text{ (head)} = \kappa_{head} DLP$$

$$K_{sec}^1 \text{ (body)} = 1.2\ \kappa_{body} DLP$$

Given a DLP, the air kerma can be scaled to appropriate distances and workloads to be included in a broad-beam transmission function. Thus, Figures A.2 and A.3 in Appendix A of NCRP 147 can be used to provide a barrier thickness to meet shielding design goals.

Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Summary of Calculations

Barrier Description: W1 - Control

Source Distance: 3.0 m
Source Modality: CT

Occupancy Type (P): 0.10 mGy per week
Occupation Factor (T): 1.00

$K^1_{sec}(body)$ = 0.28 mGy procedure^{-1}
$K^1_{sec}(head)$ = 0.15 mGy procedure^{-1}

Material: Lead

α (mm^{-1})	2.246
β (mm^{-1})	5.73
γ	0.547
K (mGy week^{-1})	5.01
B	0.01998
$x_{barrier}$ (mm)	0.924

x_{total}	0.924 mm	Thickness
x_{total}	2/55 inch	Required
x_{total}	1/16 inch	Recommended

Comments:

Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Summary of Calculations

Barrier Description: W2 - Exam

Source Distance: 2.1 m
Source Modality: CT

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.50

$K^1_{sec}(body)$ = 0.28 mGy procedure^{-1}
$K^1_{sec}(head)$ = 0.15 mGy procedure^{-1}

Material: Lead

α (mm^{-1})	2.246
β (mm^{-1})	5.73
γ	0.547
K (mGy week^{-1})	10.21
B	0.00392
$x_{barrier}$ (mm)	1.531

x_{total}	1.531 mm	Thickness Required
x_{total}	5/83 inch	
x_{total}	1/16 inch	Recommended

Comments:

Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Summary of Calculations

Barrier Description: W3 - Corridor

Source Distance: 1.5 m
Source Modality: CT

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.20

$K^1_{sec}(body)$ = 0.28 mGy procedure^{-1}
$K^1_{sec}(head)$ = 0.15 mGy procedure^{-1}

Material: Lead

α (mm^{-1})	2.246
β (mm^{-1})	5.73
γ	0.547
K (mGy week^{-1})	20.02
B	0.00499
$x_{barrier}$ (mm)	1.435

x_{total}	1.435 mm	Thickness
x_{total}	3/53 inch	Required
x_{total}	1/16 inch	Recommended

Comments:

Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Summary of Calculations

Barrier Description: D1 & D2 - Corridor

Source Distance: 1.5 m
Source Modality: CT

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.20

$K^1_{sec}(body)$ = 0.28 mGy procedure^{-1}
$K^1_{sec}(head)$ = 0.15 mGy procedure^{-1}

Material: Lead

α (mm^{-1})	2.246
β (mm^{-1})	5.73
γ	0.547
K (mGy $week^{-1}$)	20.02
B	0.00499
$x_{barrier}$ (mm)	1.435

x_{total}	1.435 mm	Thickness
x_{total}	3/53 inch	Required
x_{total}	1/16 inch	Recommended

Comments:

Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Summary of Calculations

Barrier Description: W4 - X-Ray

Source Distance: 1.8 m
Source Modality: CT

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 1.00

$K^1_{sec}(body)$ = 0.28 mGy procedure^{-1}
$K^1_{sec}(head)$ = 0.15 mGy procedure^{-1}

Material: Lead

α (mm^{-1})	2.246
β (mm^{-1})	5.73
γ	0.547
K (mGy $week^{-1}$)	13.90
B	0.00144
$x_{barrier}$ (mm)	1.938

x_{total}	1.938 mm	Thickness Required
x_{total}	1/13 inch	
x_{total}	3/32 inch	Recommended

Comments: *1/16" lead-lined wallboard at each side of the wall (CT & X-Ray) is recommended.*

Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Summary of Calculations

Barrier Description: W5 - Exterior

Source Distance: 1.8 m
Source Modality: CT

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.03

$K^1_{sec}(body)$ = 0.28 mGy procedure^{-1}
$K^1_{sec}(head)$ = 0.15 mGy procedure^{-1}

Material: Concrete

α (mm^{-1})	0.0383
β (mm^{-1})	0.0142
γ	0.658
K (mGy week^{-1})	13.90
B	0.05754
$x_{barrier}$ (mm)	64.223

x_{total}	64.223 mm	Thickness Required
x_{total}	2 28/53 inch	
x_{total}	2.5 inch	Recommended

Comments:

Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Summary of Calculations

Barrier Description: Floor

Source Distance: 4.3 m
Source Modality: CT

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.03

$K^1_{sec}(body)$ = 0.28 mGy procedure^{-1}
$K^1_{sec}(head)$ = 0.15 mGy procedure^{-1}

Material: Concrete

α (mm^{-1})	0.0383
β (mm^{-1})	0.0142
γ	0.658
K (mGy week^{-1})	2.55
B	0.31327
$x_{barrier}$ (mm)	24.114

x_{total}	24.114 mm	Thickness
x_{total}	75/79 inch	Required
x_{total}	0.9 inch	Recommended

Current Thickness of Concrete in Floor:

Additional Required Thickness of Floor:

Comments: *There is no occupancy below. No additional shielding is recommended.*

Radiological Physics Associates
Medical Physics Consulting

2603 Elm Hill Pike, Suite P
Nashville, TN 37214
800-262-6723
inspections@rpanashville.com
www.rpanashville.com

Summary of Calculations

Barrier Description: Ceiling

Source Distance: 4.3 m
Source Modality: CT

Occupancy Type (P): 0.02 mGy per week
Occupation Factor (T): 0.03

K^1_{sec} *(body)* = 0.28 mGy procedure^{-1}
K^1_{sec} *(head)* = 0.15 mGy procedure^{-1}

Material: Concrete

α (mm^{-1})	0.0383
β (mm^{-1})	0.0142
γ	0.658
K (mGy week^{-1})	2.55
B	0.31327
$x_{barrier}$ (mm)	24.114

x_{total}	24.114 mm	Thickness
x_{total}	75/79 inch	Required
x_{total}	0.9 inch	Recommended

Current Thickness of Concrete in Ceiling:

Additional Required Thickness of Ceiling:

Comments: *There is no occupancy above. No additional shielding is recommended.*