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Shielding Design
SLE Cath Lab room (1C218)

The following shielding plan was developed in accordance with NCRP 147, *Structural Shielding Design for Medical X-Ray Imaging Facilities.*

The SLE-CV Cath Lab is installing a new Siemens Artis Zee fluoroscopic system. This device is to be located on the first floor in Saint Luke's East, 100 N.E. Saint Luke's Boulevard, Lee's Summit MO 64086 in Cath Lab-2 room (1C218).

The fluoroscopic system image-receptor assembly serves as a primary beam stop, hence only secondary radiation need to be considered for the procedure room.

For the secondary x-ray beam following equation was used:

$$B_{barrier} = \frac{P d^2}{K^1 U T N}$$

$$x_{barrier} + x_{pre} = \frac{1}{\alpha\gamma} \ln \left[\frac{\left(\frac{K^1 U T N}{P d^2} \right)^{\gamma} + \frac{\beta}{\alpha}}{1 + \frac{\beta}{\alpha}} \right]$$

Where:

$B_{barrier}$ = the transmission factor
$x_{barrier}$ = the thickness of the required additional shielding material (mm)
x_{pre} = the thickness of the existing barrier (mm)
P = shielding design goals (mGy/wk)
T = occupancy factor
d = distance from the radiation source (m)
K^1 = average unshielded air-kerma per patient at 1 meter due to (Primary or secondary radiation) (mGy/pat)
N = number of patients/week
U = Use factor for barrier
α, β, γ = fitting parameters for transmission of broad primary or secondary x-ray beams (materials specific)

Assumptions used in this calculation were:

1. Shielding design goals
    a. (2 mrem/week) for all uncontrolled areas
    b. (10 mrem/week) for controlled areas

2. Occupancy factors (T) used were:
    a. 1 for Control room; Adjoining Control room; Future PET/CT room; Floor above and below
    b. 0.5 (1/2) for patient care areas
    c. 0.2 ($1/5^{th}$) for hallway and rest room

3. Distance to the walls from the radiation source: (see attached spread sheet for details)
    a. 1 foot distal exterior walls
    b. 1 meter above current floor to .5 meters above floor above (table). (16'-3.28'+1.64' =14.36')
    c. 1 meter above current floor to 1.7 meters above floor below (table). (Ground Floor)

4. The K value
    a. Secondary (All Barriers) 3.8 mGy/patient (NCRP 147, Table 4.7:Cardiac Angiography)

5. The number of procedures per week were provided by Dave Strelow to be 13 per week basted on work load at SLH, was increased based on NCRP 147, Table 4.3 and estimates to account for future growth:
    a. 25 procedures per week

6. Lead equivalent thickness
    a. N/A

The calculated barrier thicknesses (x) were: [See Attached]

Construction Requirements:

Location	Required	Currently	Additional Required
AB (Wall)	1/16 inches of lead	None	1/16 inches of lead
C1D (Wall)	1/16 inches of lead	None	1/16 inches of lead
C1D (Window)	1/16 inches of lead equivalent	None	1/16 inches of lead equivalent
DEF (Wall)	1/16 inches of lead	None	1/16 inches of lead
FG (Wall)	1/16 inches of lead	None	1/16 inches of lead
GHI (Wall)	1/16 inches of lead	None	1/16 inches of lead
IJ (Wall)	1/16 inches of lead	None	1/16 inches of lead
JCA (Wall)	1/16 inches of lead	None	1/16 inches of lead
JCA (Doors)	1/16 inches of lead	None	1/16 inches of lead
Ceiling	3.6 inches of concrete	5 inches	None
Floor (Ground Floor)	None		None

Please be advised that any changes in the design of the room, designation of adjacent areas, types of radiation producing machines installed, or significant changes in the work load will necessitate reevaluation of the shielding requirements. Also any shielding required needs to be extended to 7 feet above floor and no holes or voids are acceptable in the shielded barrier. All outlet boxes, corners, joints, window frames, and door frames must be shielded to the same rating as the barrier.

Questions regarding these calculations should be directed to Roy Sions, Radiation Safety Officer, Saint Luke's Health System. Phone: 816-932-6262, email rsions@saint-lukes.org.

Signature: Roy L Sions Date: 11-22-2016
Missouri Qualified Expert: QE145

SLE Cath Lab (1C218)

E	Dose limit [uncontrolled area (2 mrem/ week) and controlled area (10 mrem/ week)]
U	Use
T	Occupancy factor
d	Distance to wall
K	Average unshielded air-kerma per patient at 1 meter (NCRP-147 Table 4.7)
N	25
E_0	Unshielded dose at point (d) $[E_0=K*U*T*N/d^2]$
B	Transmission factor (E/E_0)
α,β,Υ	Fitting paraeter for broad beam tranmission data (NCRP-147 Secondary - Table C.1 - Fluorocopy Tube)
X	$(1/\alpha\Upsilon) * \ln[[B^{-\Upsilon}+(\beta/\alpha)]/[1+(\beta/\alpha)]]$

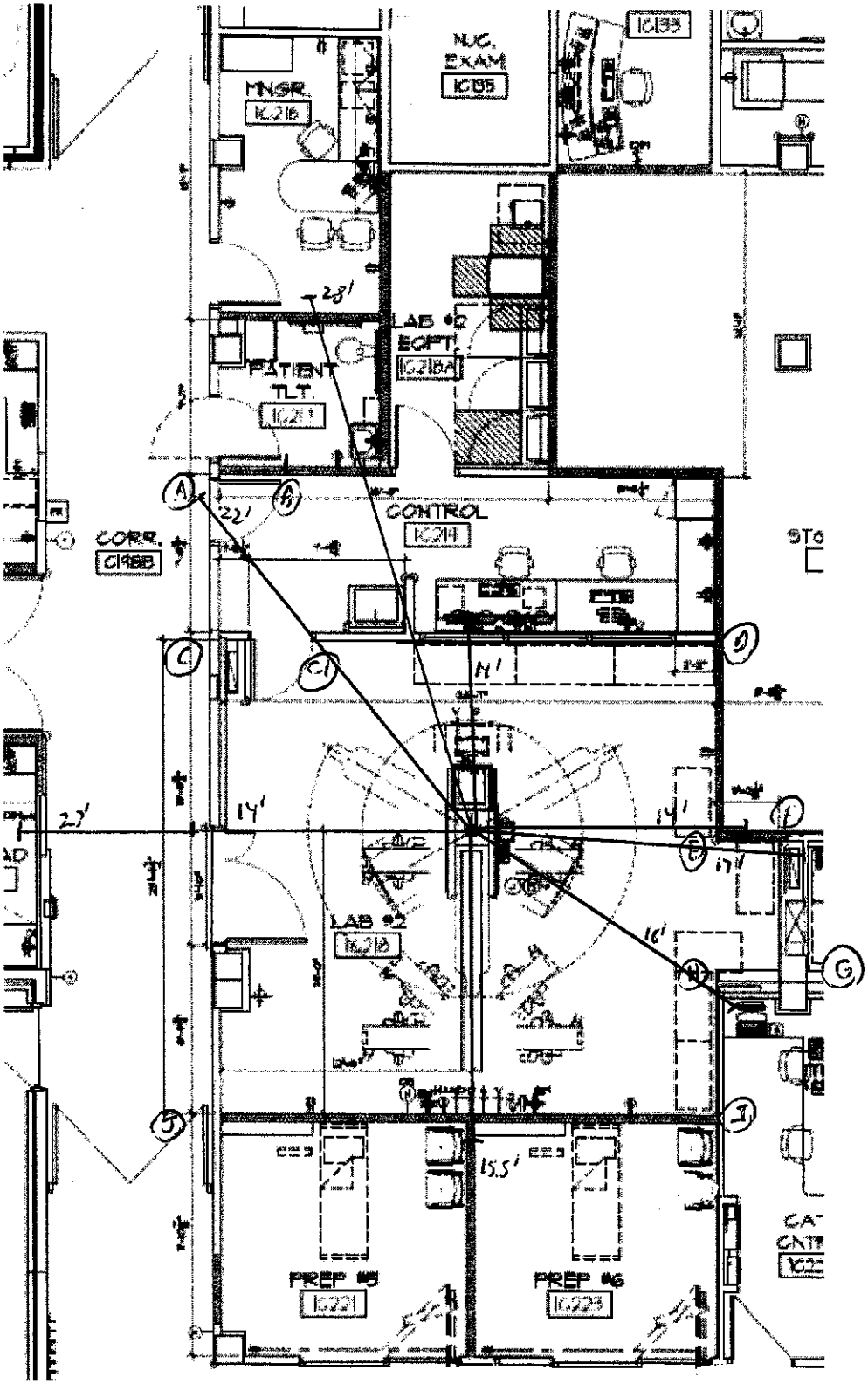
Location	E (mrem)	U	T	d(ft)	d(m)	K	Number of Patients	E_0 (Total dose) (mrem)	B	α	β	γ	x (inches)	
AB (Rest Room)	2	1	0.2	22	6.707	3.80	25	42.233	0.0473559	2.354	14.94	0.7481	0.0176	Lead
AB (Office Room)	2	1	1	28	8.537	3.80	25	130.363	0.0153417	2.354	14.94	0.7481	0.0308	Lead
CA (Hallway)	2	1	0.2	22	6.707	3.80	25	42.233	0.0473559	2.354	14.94	0.7481	0.0176	Lead
CD (Control Room)	5	1	1	11	3.354	3.80	25	844.668	0.0059195	2.354	14.94	0.7481	0.0441	Lead
DEF (Future PET/CT)	2	1	1	14	4.268	3.80	25	521.453	0.0038354	2.354	14.94	0.7481	0.0506	Lead
FG (Equipment room)	no occupancy													
FG (Other use)	2	1	1	17	5.183	3.80	25	353.650	0.0056553	2.354	14.94	0.7481	0.0447	Lead
GHI (Control Room)	2	1	1	16	4.878	3.80	25	399.238	0.0050095	2.354	14.94	0.7481	0.0465	Lead
IJ (Patient Room)	2	1	0.5	15.5	4.726	3.80	25	212.705	0.0094027	2.354	14.94	0.7481	0.0374	Lead
JC (hallway)	2	1	0.2	14	4.268	3.80	25	104.291	0.0191772	2.354	14.94	0.7481	0.0279	Lead
JC (across hallway)	2	1	1	23	7.012	3.80	25	193.204	0.0103518	2.354	14.94	0.7481	0.0361	Lead
Ceiling	2	1	1	14.36	4.378	3.80	25	495.636	0.0040352	0.0371	0.1067	0.5733	3.5553	Concrete
Floor	On Grade													

above (X'-3.28+1.64'=) Scatter from table	16	14.36
below (X'+3.28'-5.576'=) Scatter from table	0	-2.296

1/32 inch = .03125
1/16 inch = .0625
3/32 inch = .09375
1/8 inch = .125
3/16 inch = .1875

E_F = [((1+(β / α))exp(α *Y*X)-(β / α)] (-1/Y) * E0

Location	current (inches)	E_F Total Dose (mrem)	Limit (mem)
AB (Rest Room)	0.0625 lead	0.07524162	2
AB (Office Room)	0.0625 lead	0.23225093	2
CA (Hallway)	0.0625 lead	0.07524162	2
CD (Control Room)	0.0625 lead	1.50483249	5
DEF (Future PET/CT)	0.0625 lead	0.92900373	2
FG (Other use)	0.0625 lead	0.63005097	2
GHI (Control Room)	0.0625 lead	0.71126848	2
IJ (Patient Room)	0.0625 lead	0.37894845	2
JC (hallway)	0.0625 lead	0.18580075	2
JC (across hallway)	0.0625 lead	0.34420554	2
Ceiling	5 Concrete	0.45844403	2


MNGR.
IC.216
NUC.
EXAM
IC.195
IC.193
LAB #1
EQPT.
IC.218A
PATIENT
TLT.
IC.217
CONTROL
IC.214
CORR.
C1988
LAB #2
IC.218
PREP #5
IC.221
PREP #6
IC.223
28'
22'
14'
14'
17'
16'
15.5'
23'