

# Evaluation of Diagnostic Reference Levels and Achievable Doses for Digital Radiographic Images

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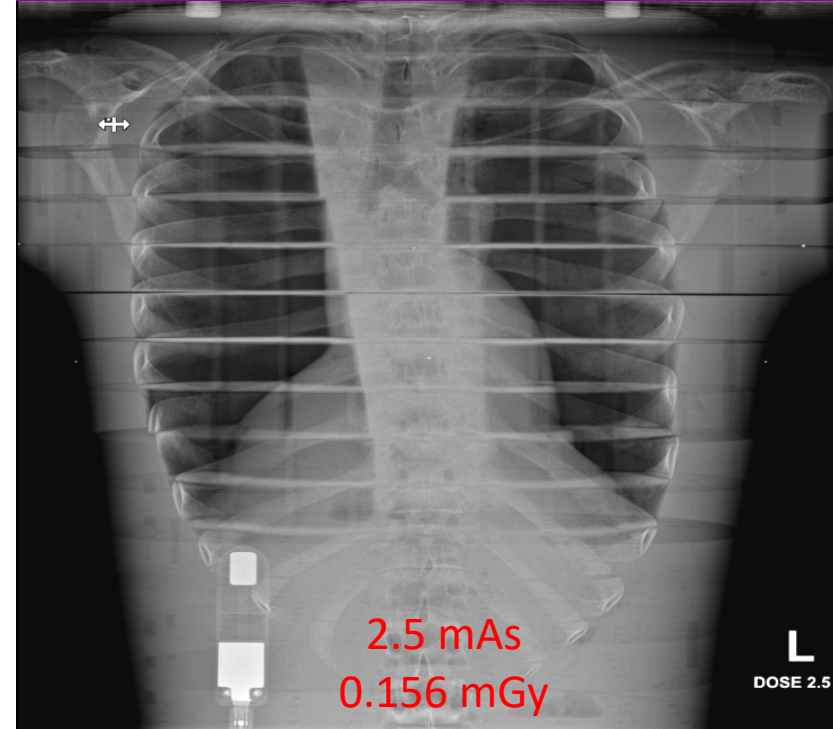
# Study Purpose

- Develop a consistent and practical method in evaluating the entrance air kerma (EAK) on digital radiographic (DR) units
- ACR-AAPM and NCRP recommend Diagnostic Reference Levels (DRL) and Achievable Doses (AD) be used as action levels to review facility EAK values to assist in optimizing image quality and dose [1,2]
- Initially focused on PA chest image EAK measurements
  - Posterior anterior PA chest thickness (23 cm), DRL = 0.15 mGy, AD = 0.11 mGy [1,2]
- Goal: Identify opportunities for EAK dose reduction towards AD while maintaining required image quality

1. ACR–AAPM–SPR. (2018). Practice parameter for diagnostic reference levels and achievable doses in medical x-ray imaging. *Reference levels and achievable dose (diagnostic)*.

2. *Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States*. Bethesda, MD: National Council on Radiation Protection and Measurements; 2012. NCRP report 172.

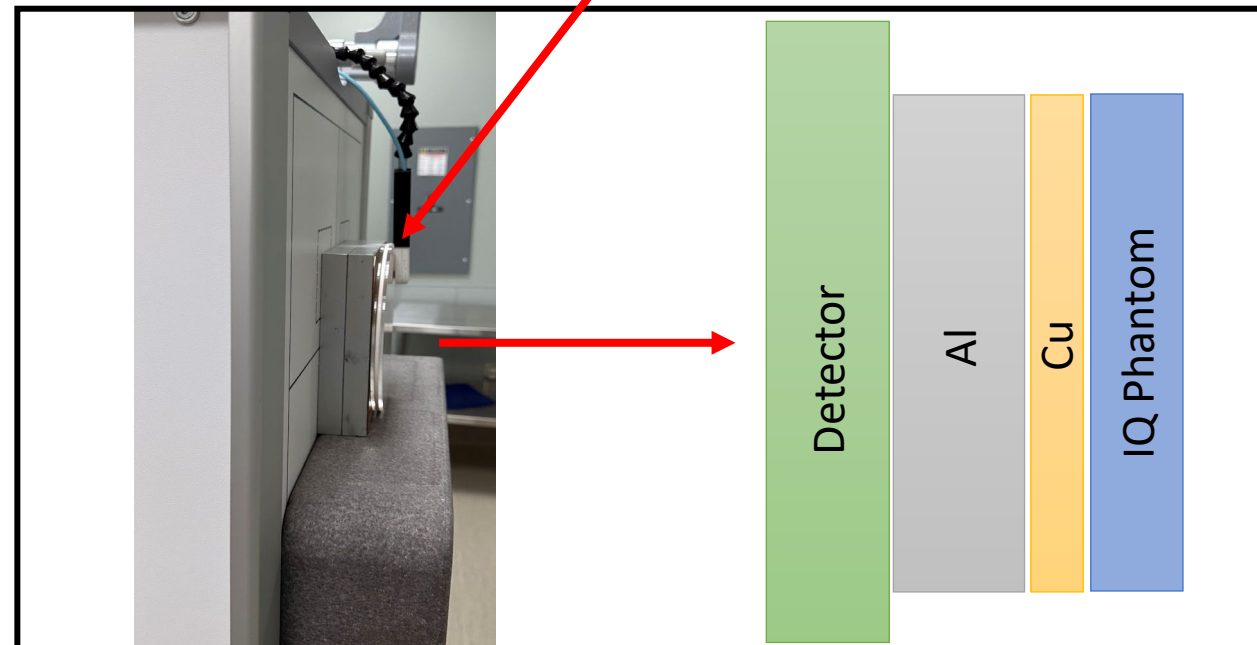
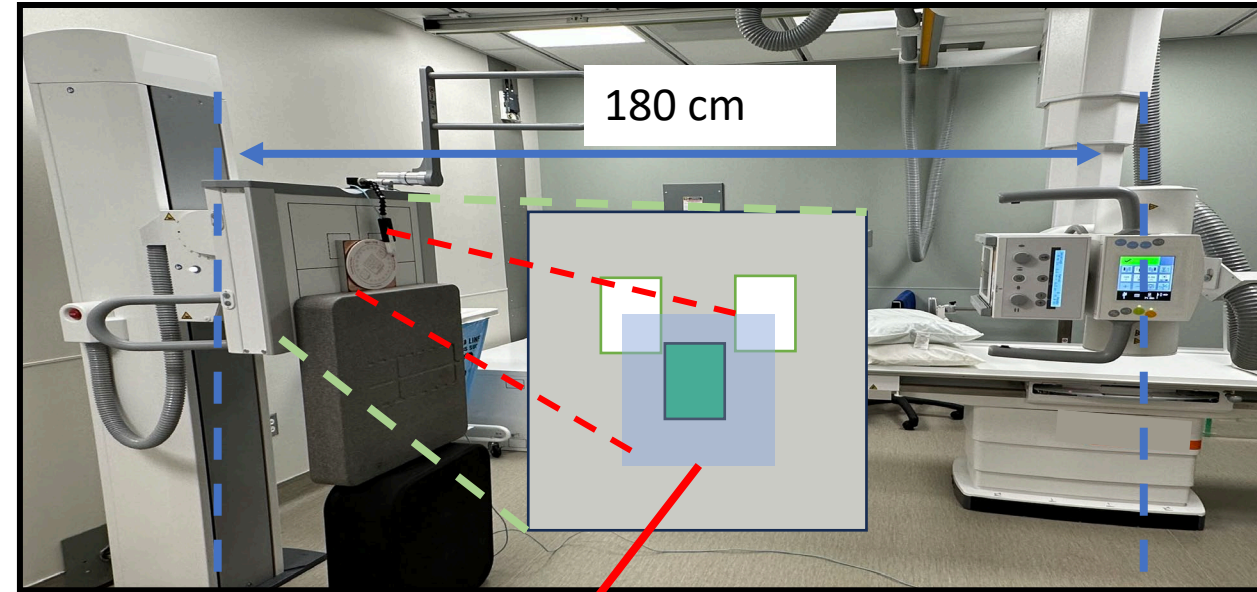
# EAK for PA Chest with Anthropomorphic Phantom



- EAK slightly above reference DRL of 0.15 mGy
- Subjectively, images had comparable bone detail and subject contrast across multiple EAK and mAs values

# EAK Testing Setup

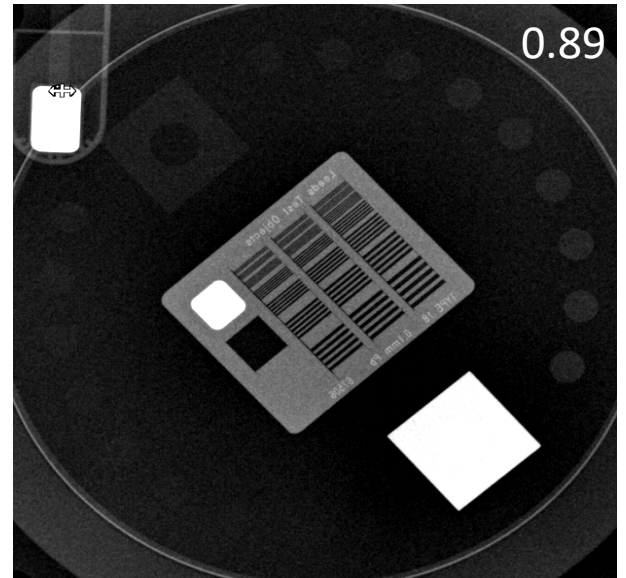
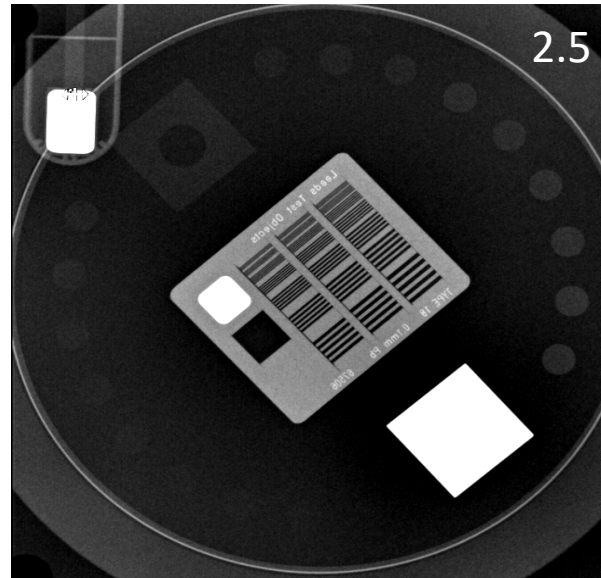
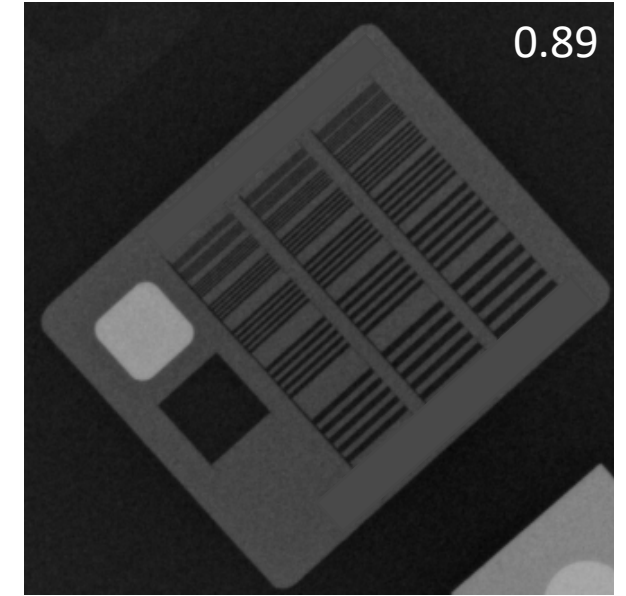
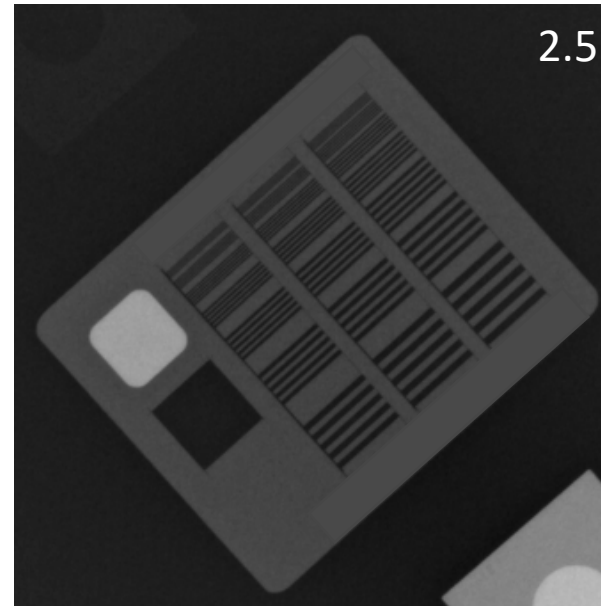
- Scatter phantom
  - EAK Phantom 1 aluminum (180 x 180 x 19 mm) + 1 copper (180 x 180 x 0.6 mm)
- Exam technique
  - 125 kVp, automatic exposure control, center cell, 43 x 43 cm DR detector, 140  $\mu$ m pixel, focused grid 10:1
  - mAs varied by changing the manufacturer dose setting from 0.89 to 2.5 (dose setting 2.5 equivalent to a 400-speed film)
  - Solid-state dosimeter detector positioned on the surface of the phantom set-up; corrected to 23 cm



EAK phantom setup on wall bucky

# Imaging Quality Evaluation

- Image quality phantom
  - 21 spatial resolution patterns (0.5 - 5 lp/mm)
  - 18 low contrast masses (6.7% - 0.9%)
- All images were windowed and leveled to optimize spatial and low contrast resolution before scoring.
- Note hi-res lines rotated 45° to reduce aliasing artifact



Imaging phantom at highest and lowest detector dose setting. Top optimized for high contrast, bottom row optimized for low contrast.

# Results/Discussion

- Anthropomorphic phantom exam techniques and EAK (Table 1-green)
- 19 mm of Al + 0.6 mm of Cu phantom resulted in EAK within 20% of the anthropomorphic phantom (Table 1-blue)
- Spatial resolution and low contrast detectability did not change with dose when window/level optimized

Phantom	Dose Setting	mAs	EAK (mGy)	Spatial Resolution (lp/mm)	Low Contrast (%)
Anthropomorphic Phantom	2.50	2.50	0.156	NA	NA
	1.75	2.20	0.136		
	1.25	1.60	0.096		
	0.89	1.25	0.072		
19 mm Al + 0.6 mm Cu	2.50	2.45	0.129	3.15	1.30
	1.75	1.83	0.092	3.15	1.30
	1.25	1.35	0.065	3.15	1.30
	0.89	1.07	0.047	3.15	1.30

Table 1. Anthropomorphic and equivalent phantom results; 125 kVp used for all images

Phantom results show no image quality degradation at lower EAK

# Conclusions

- DRL and AD benchmarks for patient dose optimization
- For 19 mm of Al and 0.6 mm of Cu phantom, spatial resolution and low contrast appear unaffected at reduced EAK
- Phantom testing demonstrates EAK can meet AD recommendations with no image degradation
- Next steps require clinical validation i.e., panel of radiologists to confirm our findings for clinical diagnostic PA chest images
- Simple but reproducible method for on site EAK quantification