Radiology Compliance Branch
RADIATION PROTECTION SECTION

Division of Health Service Regulation ● N.C. Department of Health and Human Services

Diagnostic Reference Levels in Medicine

DENTAL ESAK (ESE)

Procedure	Diagnostic Reference Level	Achievable Doses
Bitewing, periapical	1.6 mGy (185 mR)	1.2 mGy (140 mR)
Note: DRL applies to all film speeds, photostimulable phosphor technology (CR) and solid-state technology (DR). ***Measurements taken without phantom. The chamber is at the end of the cone for the NEXT dental measurements, i.e.,no separation.***		

MEDICAL ESAK(ESE)

Procedure	Diagnostic Reference Level	Achievable Doses
AP Abdomen (23 cm)	3.4 mGy (390 mR)	2.4 mGy (275 mR)
AP Lumbar (23 cm)	4.2 mGy (480 mR)	2.8 mGy (320 mR)
Adult PA Chest w/grid(23 cm)	0.15 mGy (17 mR)	0.11 mGy (13 mR)
Pediatric PA chest (12.5 cm), without grid	0.06 mGy (7 mR)	0.04 mGy (5 mR)
Pediatric PA chest (12.5 cm), with grid	0.12 mGy (14 mR)	0.07 mGy (8 mR)
Note: DRL applies to all film-screen speeds, photostimulable phosphor technology (CR) and solid-state technology (DR).		

UNDER TABLE ADULT FLUOROSCOPIC IMAGING (EAKR)
(22 cm PA abdomen with grid)

Procedure	Diagnostic Reference Level	Achievable Doses
Upper GI fluoroscopy, without oral contrast media	54 mGy/min (6.2 R/min)	40 mGy/min (4.6 R/min)
Upper GI fluoroscopy, with oral contrast media	80 mGy/min (9.1 R/min)	72 mGy/min (8.2 R/min)

CT DOSE INDEX ($CTDI_{vol}$)

Procedure	Diagnostic Reference Level	Achievable Doses
Adult Head	75 mGy $CTDI_{vol}$	57 mGy $CTDI_{vol}$
Adult Abdomen-Pelvis	25 mGy $CTDI_{vol}$	17 mGy $CTDI_{vol}$
Adult Chest	21 mGy $CTDI_{vol}$	14 mGy $CTDI_{vol}$
Pediatric Abdomen 5yr	20 mGy $CTDI_{vol}$	14 mGy $CTDI_{vol}$
Pediatric Head 5 yr	40 mGy $CTDI_{vol}$	31 mGy $CTDI_{vol}$
Brain Perfusion	*500 mGy $CTDI_{vol}$	

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Diagnostic Reference Level (DRL) is a dose metric for an average size patient or a phantom. Entrance Skin Air Kerma (ESAK) in radiography, Entrance Air Kerma Rate in fluoroscopy, and CT Dose Index ($CTDI_{vol}$) in CT can be used as metric in a quality control program to identify possible situations where certain protocols, equipment, or procedures may be producing unnecessarily high radiation doses to patients. The objective of a diagnostic reference level (DRL) is to help avoid radiation dose to the patient that does not contribute to the clinical purpose of a medical imaging task. Diagnostic reference levels are determined based upon data collected from nationwide studies such as the Nationwide Evaluation of X-ray Trends (NEXT) Program and are typically set at the seventy-fifth percentile of the study data set. Facilities should perform dose metric comparisons to DRL's to help to identify outliers. This practice is a useful tool in identifying imaging protocols and practices that may be delivering unusually high radiation doses to patients. If a DRL is consistently exceeded, a review of procedures, protocols, and equipment should be performed. If possible, dose reduction measures should then be taken. ***Satisfying a DRL for a particular exam or protocol does not imply that the protocol or procedure is fully optimized. If an exam or protocol is identified that consistently exceeds the DRL, justification must be provided.*** Facility staff should consult with a qualified medical physicist regarding the measurement of patient doses for the purpose of comparison of these doses to the DRL. The qualified medical physicist should make measurements so that the facility can determine the patient entrance dose from the technique factors which they routinely use for each patient examination. Patient entrance doses should be determined for all X-ray units used for specific projections, as doses can vary significantly among different imaging units. Additionally, DRL's should be reviewed with a medical physicist when selecting CT protocol parameters. It should be stressed, however, that one cannot apply the As Low As Reasonably Achievable Principle to patient doses as this may result in unsatisfactory clinical image quality. The key is "Dose Optimization" where the goal is to maintain, or improve, clinical image quality while lowering the radiation dose to the patient.

Additional Definitions:

Achievable Dose Level - The achievable dose level is set at the median dose of the Nationwide Evaluation of X-ray Trends (NEXT) survey data or other survey data on which DRL's are based. The achievable dose level indicates a radiation dose which is readily attainable by fifty percent of the facilities.

American College of Radiology Reference Levels -The ACR publishes reference levels determined from its radiation dose data derived from its imaging modality accreditation programs. Data submitted to the ACR accreditation program by individual imaging facilities was used by the National Council of Radiation Protection in its report, Diagnostic Reference Levels in Medical and Dental Imaging: Recommendations for Application in the United States (NCRP Report 172).

CT Dose Index (CTDIvol)-This is a CT dose metric that considers the dose to a volume of tissue encompassed by a single rotation of the CT gantry as a function of the pitch of the helix: CTDIvol = CTDIW/ pitch. The CTDIvol dose indicator can be used by the facility in determining if the radiation dose for a particular CT protocol is within the appropriate range when compared to the DRL.

Entrance Skin Air Kerma (ESAK)-(Formerly Entrance Skin Exposure ESE) - This value is used to determine if the radiation dose delivered to patients with projection or "plain film" radiography is within the established DRL's. The ESAK dose metric values are usually recorded in mGy and require measurements in air to minimize backscatter, for a given specific radiographic projection.

Entrance Air Kerma Rate (EAKR)-This is the entrance air kerma measurement detected in air per unit of time, usually recorded in mGy/min, used to indicate the approximate radiation dose rate to the patient in fluoroscopy procedures. Established entrance air kerma rate DRL's from the 2003 NEXT study on fluoroscopic procedures are available for reference (see link below).

Nationwide Evaluation of X-ray Trends (NEXT) Program - The Nationwide Evaluation of X-ray Trends (NEXT) program is a partnership between the Conference of Radiation Control Program Directors, Inc. (CRCPD), and the Food and Drug Administration (FDA) Center for Devices and Radiological Health (CDRH), and state agencies with financial

support from the American College of Radiology (ACR), to evaluate and monitor radiation doses which patients receive during diagnostic X-ray examinations.

Diagnostic Reference Levels and Achievable Doses resources:

NCRP REPORT *Diagnostic Reference Levels in Medical and Dental Imaging: Recommendations for Application in the United States* (NCRP Report 172).

1999 NEXT Dental Survey (reported in 2003 and reported 2007)
2001 NEXT Adult Chest
2002 NEXT Adult Abdomen/Lumbosacral Spine Survey
2003 NEXT FluoroTrifold
2005-2006 NEXT CT Survey
2010 Monitoring And Tracking Fluoro Dose-PubE-10-7
*CRCPD-CT Dose Management
2013 ACR–AAPM Practice Guideline for Diagnostic Reference Levels and Achievable Doses in Medical X-Ray Imaging