EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Overview of Effective Dose Equivalent (External)

David Perkins
Program Manager

Phung Tran

Senior Technical Leader

NATC ISOE ALARA Symposium
January 13-15, 2014

What is EDEX?

- EDEX is an alternative, more accurate method for assessing external exposures:

  TEDE = DDE or EDE(external) + CEDE (internal)

- DDE (deep dose equivalent) often results in over reported dose because it uses the highest dose received for any part of the whole body and applies it to the entire body.

- EDEX is more accurate because it takes into account organ sensitivities (tissue weighting factors) when calculating dose

Example DDE vs EDEX for RVCH Volumetric Inspections

Maximum W.B. Exposure (mrem)	Calculated EDEX Exposure (mrem)	Delta column 1:2 (mrem)	% Difference	Highest EDEex compartment
288	183	105	36%	Head
199	115	84	42%	Head
417	264	153	37%	Head
244	147	97	40%	Head
468	266	202	43%	Head
460	243	217	47%	Head
233	122	111	48%	Head
392	211	181	46%	Head
2701	**1551**	**1150**	**43%**	**Total**

Method 1: Multiple Dosimetry with Compartment Factors

- Based on Section 3.0 of ANSI/HPS N13.41-1997, “Criteria for Performing Multiple Dosimetry”, Dec. 1996
- Measured DDE for each compartment (DDE_C) is weighted with associated compartment factor (W_C)
- Allows for combination of adjacent compartments into composite compartment
- Must measure at the highest exposed portion of compartment

$$EDEX = \sum W_C \, DDE_C.$$

Table 1. Compartment Factors

AREA OF THE BODY/COMPARTMENT	COMPARTMENT FACTOR (W_C)
Head and neck	0.10
Thorax, above the diaphragm	0.38
Abdomen, including the pelvis	0.50
Upper right arm	0.005
Upper left arm	0.005
Right thigh	0.005
Left thigh	0.005

More widely evaluated for use than Method 2

Reference: U.S. NRC Regulatory Guide 8.40

Method 2: Using Two Dosimeters

- Based on EPRI research
- Uses reading of a dosimeter worn in the front (DDE front) of the trunk and a dosimeter worn on the back (DDE back) of the trunk
- Limitations:
  - No partial shielding of the individual
  - No underwater
  - Dosimetry must meet directional dependence criteria
  - No sources within 12”
  - No hot particles on or near skin

$$EDEX = 3/4\ Hi + 1/4\ Lo$$

Limited use by industry due to implementation constraints

Reference: U.S. NRC Regulatory Guide 8.40

Industry Challenges

- Dosimeter placement in “highest exposed portion of compartment”
  - How would you assess and justify?
- Monitoring combined compartments
  - Recent industry experience:
    - Combined thorax and abdomen = “chest”
    - Assessed radiological conditions prior to work and placed dosimeter in upper chest compartment
    - However, dose records from adjacent compartments (e.g. thighs) indicated that dosimetry placement on chest may have underestimated dose to abdomen

EDEX Implementation Issues

- Utilities have approval to use the ANSI N13.41 compartment method and the EPRI 2-dosimeter method for EDEX; however they are not fully utilized in the industry and there have been some misapplications.
- Example of Issues:
  - EPRI method: restrictions on source location make it difficult to implement so use is limited.
  - ANSI method: some issues with proper placement of the badge within the compartment (i.e., not at highest dose point).
  - General issues with EDEX: Limited understanding of the EDEX concept, its benefits, and its limitations in the industry.
  - Cost associated with implementing EDEX due to additional time and personnel associated with providing and tracking multiple dosimetry

EPRI is Developing an EDEX Implementation Guide/Sourcebook

- Regulatory Information (regulatory experience, guides, and list of key issues)
- Program requirements/changes, such as training, badge placement, dose tracking
- Examples of good implementation, examples of poor implementation
- Decision process for determination of tasks or field conditions that will yield benefits if EDEX is used.
- Worker and Radiation Protection Acceptance
- Use of tungsten vests
- Lens of eye dose considerations
- Documentation

Together…Shaping the Future of Electricity