Back to Basics - Dose Algorithms

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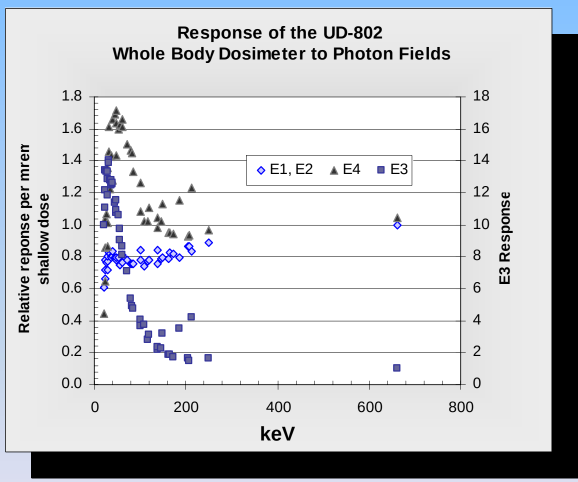
Overview

- Performance goals
- Response data
- Designs
- Testing
- DOELAP revision
- Issues

Goals

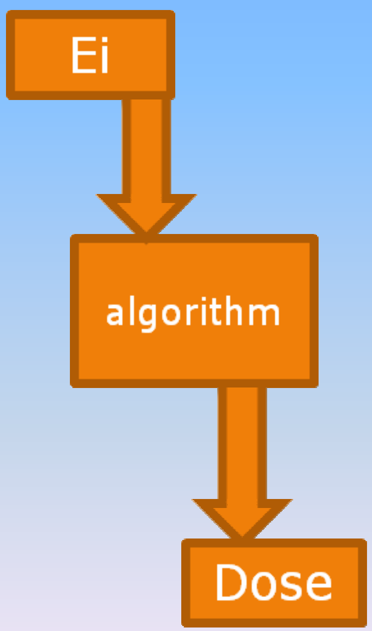
- Performance
  - Good dosimetry in the field
    - Accurately record dose
  - Meet the standard
    - Which one?
- Design
  - Simple design?
  - Hand calculation friendly?
  - Linear?

Response Data



- Critical investment
- Establishes algorithm "calibration"
- Only pure fields are necessary
- Panasonic (Ash & Doc) data excellent starting point
- Most algorithm designs allow good performance using a representative subset of possible fields.

Design - Simple

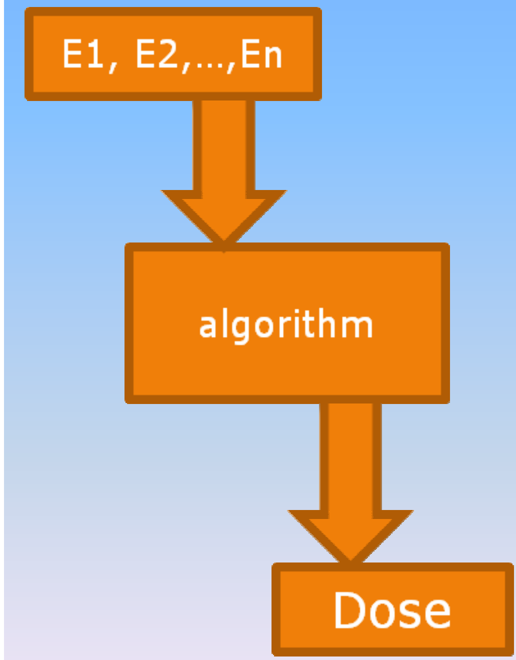


- Single element
- Dose = response * correction factor
- Knowledge of field or perfect dosimeter required for best accuracy
- Example: single element extremity dosimeter

Design – Simple (ctd.)

- Benefits
  - Simplicity
  - Minimal uncertainty
  - Very useful for troubleshooting more complex algorithms
  - Hand calculations possible
- Drawbacks
  - Need field information or perfect dosimeter
  - Minimal redundancy

Design - Complex



- Multiple elements.
- Use relative element responses (ratios) to determine correction factors
- Knowledge of field or perfect dosimeter not required
- Examples: SDose, DOC, branching style Panasonic, Thermo,...

Design – Complex (ctd.)

- Benefits
  - Versatility, range of accommodated fields
  - No need for *a priori* field knowledge
  - Readings provide information about the field
  - Can provide redundancy with multiple elements
- Drawbacks
  - Complexity means greater uncertainty
  - Hand calculation can be difficult to impossible

Testing

- Pure fields (from test data)
  - Optimize design
- Mixed fields (synthetic testing)
  - Optimize design
- Worker data
  - Check for unreasonable doses
- Low dose data
  - Check for unreasonable doses

Testing – Synthetic testing

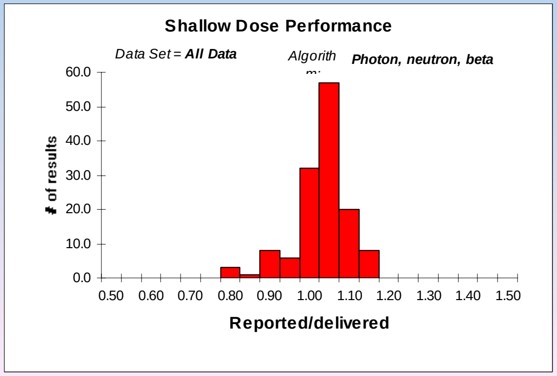
Results of 130 test fields

Shallow dose:

85% within 10%
98% within 20%

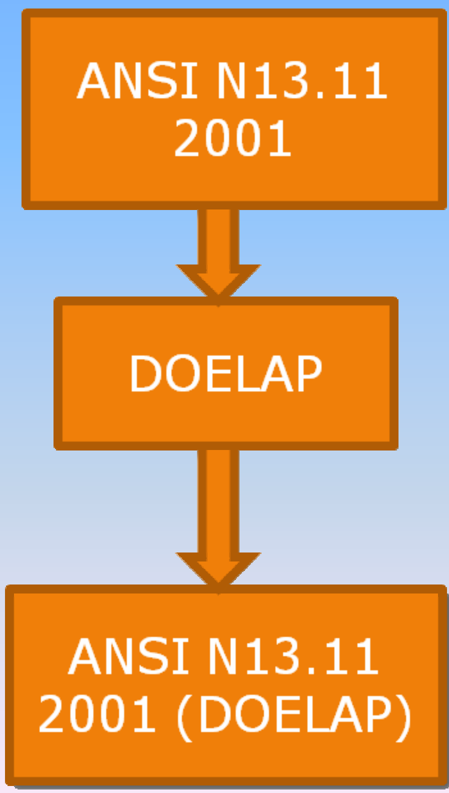
Deep dose:

83% within 10%
94% within 20%



- Use arithmetic to combine pure field responses and generate mixed field responses (TLD responses are additive)
- Run and rerun test file to fine tune algorithm

DOELAP Revision



- Proficiency test standard for DOE facilities being revised
- New revision will adopt much of ANSI N13.11-2001
- Algorithms <u>must</u> be revised to maintain performance levels

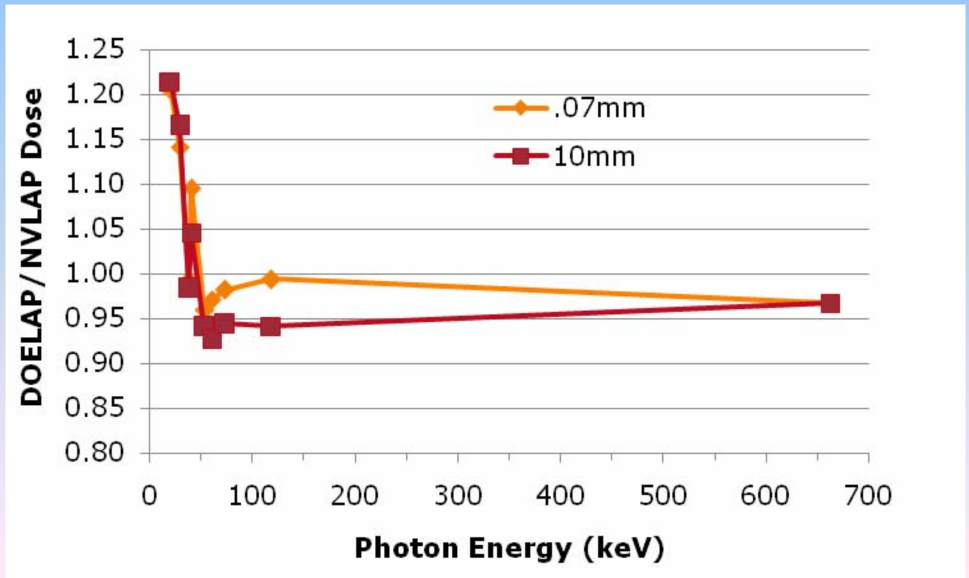
DOELAP revision (ctd.)

	DOE/EH-0027 (1986)	ANSI N13.11-2001
Photon fields	6 fields 20-662 keV	•70 fields, 20-1332 keV, •New ck factors, •Angles for keV > 70
Beta fields	3 fields (^{204}Tl, ^{90}Sr/Y, DU)	3 fields (^{85}Kr, ^{204}Tl, ^{90}Sr/Y)
Neutron fields	2 fields (^{252}Cf bare, D_2O mod)	-- same --
Mixtures	•^{137}Cs + any x-ray, • Any photon plus neutron, • High E beta + any photon • Any beta + ^{137}Cs	Same, with ^{60}Co as well as ^{137}Cs available for gamma source
Other		10% rule?

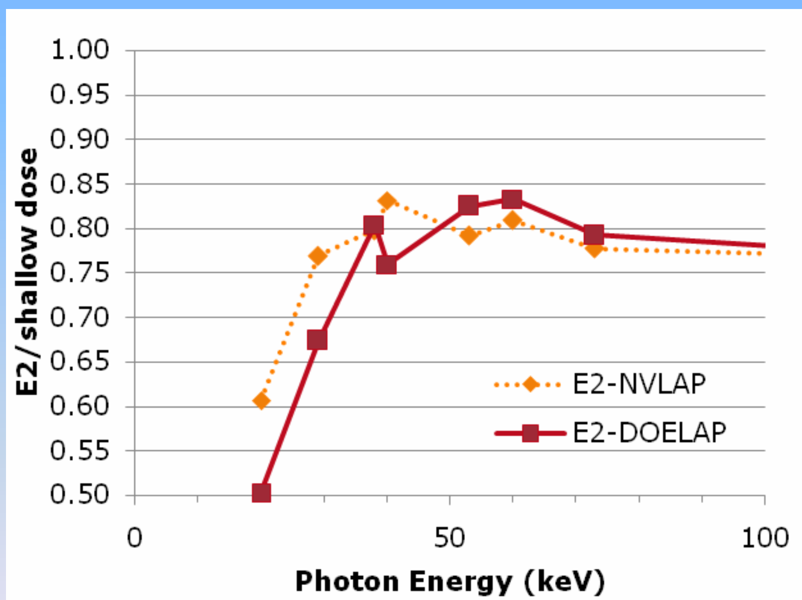
DOELAP Revision (ctd.)

Photon dose conversion factors will change

- DOELAP (1986) was based on Yoder et al
- NVLAP (2001) based on Grosswendt data



DOELAP Revision (ctd.)



- Dose ≠ Dose
  - Dose (DOELAP) is not equal to Dose (NVLAP)
  - Most pronounced for energies < 50 keV
- Response/dose will change, algorithm will need modification.

Issues

- Background subtraction
  - Element specific
  - Dose
- Investigating suspect performance
  - Algorithm problem
  - Dosimeter/reader problem

Issues – Background

- How do you subtract background?
  1. Subtract background doses
     - Net dose = alg(gross response) – alg(bkgd response)
  2. Subtract background responses
     - Net dose = alg(gross responses-bkgd responses)
- Subtracting doses:
  - Reduces available information on worker field
  - Added uncertainty with dose calculation on background dosimeter

Issues – Background (ctd.)

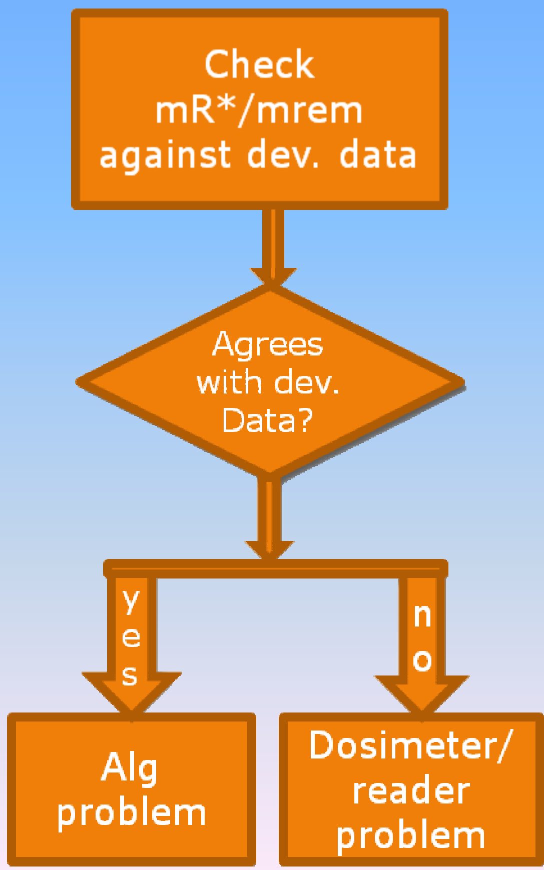
Example:

30 mrem 20 KeV x-ray
+ 30 mrem Cs bkgd

	E1	E2	E3	E4	R34	Energy
Net	37	30	499	22	*22.7*	*20 keV*
bkgd	29	30	30	31	*1.0*	*662 keV*
Gross	**66**	**60**	**529**	**53**	***10.0***	***42 keV***

Using (gross dose) – (background dose) confounds information available on worker dosimeter response.

Issues – Suspect performance



Is it the algorithm or the dosimeter/reader?

1. Calculate response/dose for pure fields
   - Observed = mR*/mrem
2. Compare to algorithm development data
3. If current response=R&D resp. then problem is with algorithm design.
4. Otherwise, check dosimeter and reader for instability or non-standard conditions

Issues – Suspect performance

- Example:
  - 500 mrem M30 (20 keV x-ray)
  - Calculated doses low by 20%

	E1	E2	E3	E4
Observed mR*	300	240	5000	218
mR*/mrem	0.6	0.48	10	0.436
Dev. Data mR/mrem*	*0.7332*	*0.6068*	*9.9758*	*0.4404*
%diff	-18.2%	-20.9%	0.2%	-1.0%

- Something changed since algorithm dev data.
- This is a good time to apply “simple algorithm” approach.

Final Thoughts

- Start with good data
- Keep algorithm design as simple as practical
- Test it as much as possible
- Document it thoroughly
- Check it constantly
- Revise it when necessary

More information

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